

# SF-3050

## GNSS Product User Guide



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## Notices

SF-3050 GNSS Product User Guide

P/N 96-310034-3001

Rev J

August, 2016

Serial Number: \_\_\_\_\_

Date Delivered: \_\_\_\_\_

Purchased From: \_\_\_\_\_

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This device complies with Part 15 Subpart B Class B of the FCC Rules. Operation is subject to the following two conditions:

This device may not cause harmful interference, and

This device must accept any interference received, including interference that may cause undesired operation.

The GNSS sensor has been tested in accordance with FCC regulations for electromagnetic interference. This does not guarantee non-interference with other equipment. Additionally, the GNSS sensor may be adversely affected by nearby sources of electromagnetic radiation.

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### Software License Agreement

By powering on and using this GNSS StarFire™ Receiver, you agree to the terms and conditions of the NavCom Technology, Inc. GNSS Receiver Software License and Open Source Software Licenses. The complete terms and conditions of these software licenses may be found in the SF-3050 GNSS Products User Guide, Appendix E.

## USG FAR

### Technical Data Declaration (Jan 1997)

The Contractor, NavCom Technology, Inc., hereby declares that, to the best of its knowledge and belief, the technical data delivered herewith under Government contract (and subcontracts, if appropriate) are complete, accurate, and comply with the requirements of the contract concerning such technical data.

### Global Navigation Satellite System

Global Navigation Satellite Systems (i.e., GPS, GLONASS) are under the control of the respective Governmental agencies, and the operation of these satellites may be changed at any time without warning.

GPS Selective availability (S/A code) was disabled on 02 May 2000 at 04:05 UTC. The United States government has stated that present GPS users use the available signals at their own risk.

The U.S. State Department International Traffic in Arms Regulations (ITAR) regulations limit the performance of commercial GNSS products. As a result, access to satellite measurements and navigation results will be limited from display and recordable output when predetermined values of velocity and altitude are exceeded. These threshold values are far in excess of the normal and expected operational parameters of the SF-3050 GNSS Sensor.

## Revision History

Rev K (Aug 2017)	Appendix C: Added StarFire ITRF 2014 transition information and StarFire broadcasting satellites and locations subject to change without notice.
Rev J (Aug 2016)	Chapter 6: Rewrote Rapid Recovery description and updated Rapid Recovery with Quick Start description Removed Table 23 StarFire Satellites v.1.0.1.5 and Earlier Appendix A: Updated Rapid Recover specification
Rev I (Aug. 2014)	Chapter 1: Updated Figures 33 and 37 to reflect StarFire GNSS Chapter 2: Changed StarFire Over IP to one server/caster. Chapter 6: Added description of Rapid Recovery with Quickstart. Appendix A: Measurement Performance: Changed RTK Extend operating time to 15 minutes for nonNavCom bases. Added note regarding RTK Extend maximum performance. Added specs and note for RTK-WL mode Added specs for SF-LP Added pull-in time for SF-LP Appendix C: Added StarFire ITRF-2008 transition information Deleted reference to StarFire Single and Bundle A throughout.
Rev H (Apr 2013)	Added Chapter 3: WebServer Chapter 2: Added Upload Webpages Added Appendix G – RoHS certification (both English and Chinese) Added Table 33: .Toxic or Hazardous Substances or Elements Disclosure by Part Number (both English and Chinese) Chapter 5: Added RapidRecovery feature
Rev G (Nov 2012)	Deleted all references to Galileo, E1 and E5A.
Rev F (Sep 2012)	Related Standards, added IEC contact information Chapter 2, added definition for DTM in Standard and Proprietary sections under NMEA-0183. Chapter 4, added a note regarding hardware installation above 40K feet.

	<p>Chapter 5, added note under NMEA messages that in software version 3.0.16 and greater, the NMEADTM will change at the same rate as the fastest NMEA message scheduled by user.</p> <p>Appendix A: Added DTM, GFA, GNS to the list of standard NMEA-0183 data strings. Added note regarding message scheduling. Added note on hardware altitude restriction.</p> <p>Chapter 2, Unique Features section -added StarFire Over IP.</p>
Rev E (Dec 2011)	<p>Chapter 2, section Antennae and section Base – added new link for antennae calibration values (12/15/11)</p>
Rev E (Oct 2011)	<p>Appendix C, changed StarFire visibility from “76°N to 76°S latitude” “10 degree look angle”</p> <p>Chapter 3, revised the Note below Figure 91; added a Note regarding missing cable pins</p> <p>Added StarFire GNSS service specifications throughout manual</p> <p>Corrected 1PPS pulse characteristics in Chapter 3</p> <p>Specifications: added pulse width to 1PPS</p>
Rev D (Nov. 2010)	<p>Updated graphics throughout , as necessary, to reflect new StarUtil 3000 GUI designs</p> <p>Added NTRIP standards to “Related Standards” section in front matter</p> <p>Chapter 1: in the “Product Configuration Files” section: updated the first Note to reference Bundle A; in the “Connect Equipment” section: updated the Note re availability of Bluetooth connectivity; in the “Establish Communications” section: changed the USB driver warning to a Note and added a Note re installing file “navcomx1c45x3050.inf” before starting Star Util 3000; deleted ambiguous Step 14; in new Step 14, added Mass Storage as a USB Port option; updated Step 16 (now Step 15) to include AutoBaud button; updated “Determine Current Firmware Versions” section: added to the Note that firmware ensembles are always referenced to the Navigation Firmware number; updated Figure 9 to include unified file; added “Determine Firmware Version via the Input Terminal” section; in the “Upload Firmware” section: changed the first two warnings to Notes; added “Upload a Unified Firmware File” section; added “Upload a Single Firmware File” section; updated the “Upload Software Options” section and added Bundle A; added “Upload Software Options via the Input Terminal” section; updated “Upload StarFire License” section to align it with new StarUtil 3000 GUIs and their functionality; added “How to Cancel a StarFire</p>

License” section; added the “Enable or Disable Receiver Tracking and/or Use of Select Signals and Frequencies” section; added “Enable or Disable Receiver Use of Signals for Navigation” section

*Chapter 2:* Updated “GNSS Sensor System” section: added software Bundle A; updated the RTK description; deleted footnotes and revised notes; in the “Accuracy” section: added info re L1-RTK; in the “SBAS” section: added a Note re the TRACKINGMODE command and ; added a footnote that Galileo is not supported in the current firmware (v.2.0.22.0); in the “Features” section: updated “NMEA-0183 Data”; added description of software bundle SF-3050A; deleted footnotes from SF-3050M; updated “Ethernet Connection”; updated “Airborne”; added photo of L1 antenna under the L1/G1 description; updated Figure 40 to show L1 antenna; updated “Unique Features” section: under “Multi-Format RTK,” added Moving Base RTK and Heading; and added “User-Defined Datum”, “Internal Memory”, “Control of Power Consumption”, “CORS Support”, and “NTRIP Support” bulleted items

*Chapter 3:* Added drawing of new power cable to Figure 80 (previously Figure 37); updated PIN assignments of updated Ethernet cable in Table 17; updated “Bluetooth Communications Setup” section and updated the graphics for Bluetooth configuration; updated Positronic socket type connector part number:

was: P/N FR11FP9ZZLM0/AA

is: P/N FR11FP922LM0/AA

Updated description of the LOGFILE command parameters; added Note referring user to Appendix C of the *Sapphire Technical Reference Manual*; updated the “Direct Ethernet Connection via Static IP Address” section: added that SF-3050 supports TCP connection in addition to UDP; referred user to Chapter 2 of the *StarUtil 3000 User Guide* for detailed instructions on configuring Ethernet connection

*Chapter 5:* Added “Setting Up a StarFire Priority Network” section; updated “User Profiles” section; in section “Reassignment of StarFire Network List”, added table numbers to the tables and links to those tables

*Appendix A:* in “Features” section: added MBRTK and Heading; added Heading Slew to “Measurement Performance” and updated Velocity for all DGPS modes; added PDOP disclaimer; added Note about RTK Extend being required only on Rover receiver; added Note referring user to Chapter 5 of the *StarUtil 3000 User Guide* ;updated User-Programmable Output Rates table to include Bundle A; added Bundle A to note re default PVT and Raw Data Rate; added “Networked Transport of RTCM Internet Protocol (NTRIP)

	<p>Setup” section; added Heading and Slew degrees to “Measurement Performance” table</p> <p><i>Appendix B:</i> added antenna info for L1</p> <p><i>Appendix C:</i> in “Infrastructure” section: changed statement “GPS satellites transmit navigation data on two L-Band frequencies” to “GPS satellites transmit navigation data on several L-Band frequencies”; changed “dual-frequency” to “multi-frequency” throughout this section; added a Note about SF-3050A single-frequency operation availability; in “StarFire Satellites” section: added Table 28 and Table 29 and a note regarding the reassignment of satellites ID # 609 and # 643</p> <p><i>Appendix E:</i> added this appendix (Networked Transport of RTCM Internet Protocol Setup)</p> <p><i>Appendix F:</i> (formerly Appendix E)</p> <p>Glossary: Updated table references</p>
<p>Rev C (Nov. 2009)</p>	<p>Removed all references to Tall L-band antenna and combiner kit</p>
<p>Rev B (Nov. 2009)</p>	<p>Added the Software License Agreement section to Notices, and added Appendix E Software License Agreement</p> <p>Added information about MED Compass Safe Distance</p> <p>Added information on equipment that is required to pass the conducted MED type emission criteria</p> <p>Extensively updated Firmware, Software Options, and StarFire License sections in Chapter 1</p> <p>Updated various screen captures of StarUtil 3000 in Chapter 1</p> <p>Changed extensions to *.opt for Software Options File and *.lic for StarFire License File</p> <p>Added the part number for the Positronic plug on both data cables, with the pin type</p> <p>Changed reference to “supplied GNSS antenna” to “supplied Rover, Base, or Airborne antenna”</p> <p>Added the caveat that the SF-3050 is IP67 compliant only when cables are connected</p> <p>Updated information on the supplied unterminated DC power cable: for Early Production Units the cable is without a filter (P/N 94-310262-3010LF); for Later Production Units the cable has a filter (P/N 94-310274-3010LF)</p> <p>Revised the proper shutdown of the SF-3050 via ignition pin</p>



	Removed 0x5D as a supported NCT RTK correction type
Rev A (July 2009)	Initial release

## Use of This Document

This User Guide is intended to be used by someone familiar with the concepts of GNSS and satellite surveying equipment.



Note indicates additional information to make better use of the product.



This symbol means *Reader Be Careful*. Indicates a caution, care, and/or safety situation. The user might do something that could result in equipment damage or loss of data.



This symbol means *Danger*. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical and RF circuitry and be familiar with standard practices for preventing accidents.

Revisions to this User Guide can be obtained in digital format from

<http://www.navcomtech.com/Support/>

## Related Documents

All of the documents below, except for the NavCom Release Notes, are included on the supplied SF-3050 Product Configuration USB Flash Drive (P/N 82-043000-0001).

### SF-3050 Quick Start Guide

P/N 96-310033-3001

Provides instructions to quickly set up the standard configuration of the SF-3050

### StarUtil 3000 User Guide

P/N 96-310029-3001

Describes the operation and use of NavCom's Windows-based control program

### Sapphire Technical Reference Manual

P/N 96-3120001-3001

Describes the control and output data message formats utilized by this instrument (for customer programming purposes)

### RINEXUtil User Guide

P/N 96-310021-2101

Describes the conversion program used on NavCom proprietary output data message formats to RINEX

ver. 2.10 observation and navigation files (for customer programming purposes)

## NavCom Release Notes

Describes software updates for NavCom products. Current and archived Release Notes are available on the NavCom web site:

<http://www.navcomtech.com/Support/DownloadCenter.cfm?category=releasenotes>.

NavCom Customer Support provides software updates described in the Release Notes. Submit a request for software updates via the Request Support web page.

## Related Standards

### ICD-GPS-200

NAVSTAR GPS Space Segment /Navigation User Interfaces Standard. ARINC Research Corporation; 2250 E. Imperial Highway; El Segundo, California 90245

IEC 60945, IEC 61108-1, IEC 61162-1,  
IEC 61162-2

International Electrotechnical Commission. 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

### GLONASS ICD, Version 5.0, 2002

Russian Space Agency, Information Analytical Center  
Internet: <http://www.glonass-ianc.rsa.ru/>

### RTCM-SC-104

Recommended Standards for Differential GNSS Service. Radio Technical Commission for Maritime Services; 1800 N. Kent St, Suite 1060; Arlington, Virginia 22209

### NTRIP

Radio Technical Commission for Maritime Services (RTCM) Standard 10410.0 (RTCM Paper 200-2004/SC104-STD, Version 1.0 for Networked Transport of RTCM via Internet Protocol (Ntrip)

Radio Technical Commission for Maritime Services (RTCM) Standard 10410.1 (RTCM Paper 111-2009-SC104-STD, Version 2.0 for Networked Transport of RTCM via Internet Protocol (Ntrip)

### CMR, CMR+

Compact Measurement Record; Trimble Navigation Limited; 935 Stewart Drive; Sunnyvale, CA 94085

### RINEX

Receiver Independent Exchange Format; Astronomical Institute of the University of Berne

## QZSS

Quasi Zenith Satellite System. Japan Aerospace Exploration Agency (JAXA). 7-44-1 Jindaiji Higashi-machi, Chofu-shi, Tokyo 182-8522.

## NMEA-0183

National Marine Electronics Association Standard for Interfacing Marine Electronic Devices. NMEA National Office; 7 Riggs Avenue; Severna Park, Maryland 21146

## Publicly Operated SBAS Signals

## RTCA/DO-229D

The Radio Technical Commission for Aeronautics (RTCA) develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management (CNS/ATM) system issues.

RTCA. 1828 L Street, NW, Suite 805, Washington, DC 20036.

These organizations implement the RTCA/DO-229D standard set by RTCA:

## WAAS (Wide Area Augmentation System)

U.S. Department of Transportation. Federal Aviation Administration. 800 Independence Ave, SW, Washington, DC 20591

## EGNOS (European Geostationary Navigation Overlay Service)

European Space Agency. 8, 10 rue Mario-Nikis, F-75738 Paris Cedex 15, France.

## MSAS (MTSAT Satellite-based Augmentation System)

Japan Civil Aviation Bureau. Ministry of Transport. Kasumigaseki 2-1-3, Chiyoda-ku, Tokyo 100, Japan.


## GAGAN (GPS Aided Geo Augmented Navigation)

Indian Space Research Organization. Antariksh Bhavan, New Bel Road, Bangalore - 560 094, India.

## Chapter 1 ..... Getting Started

This chapter provides instructions to enable the robust functionality of the SF-3050.




- ✓ Confirm that all ordered equipment is delivered. Refer to these tables for detailed lists:
  - *Supplied Equipment*: Table 5
  - *Optional Data Cables*: Table 13

 If any items are missing or damaged, immediately contact NavCom Customer Support:

Telephone: +1 (310) 381-2000


Web:

<http://www.navcomtech.com/Contact/ContactSupport.cfm>


-  Consult your dealer to determine if the SF-3050 is already fully configured. If it is configured, the SF-3050 is ready to use. To get started, refer only to the sections below to connect equipment and operate the receiver.
-  If the SF-3050 is not dealer-configured, the receiver is not operational until the steps in this chapter are performed.
-  *MED Compass Safe Distance*: The SF-3050 receiver may not be installed closer than 250mm to the ship's compass.

### Product Configuration Files

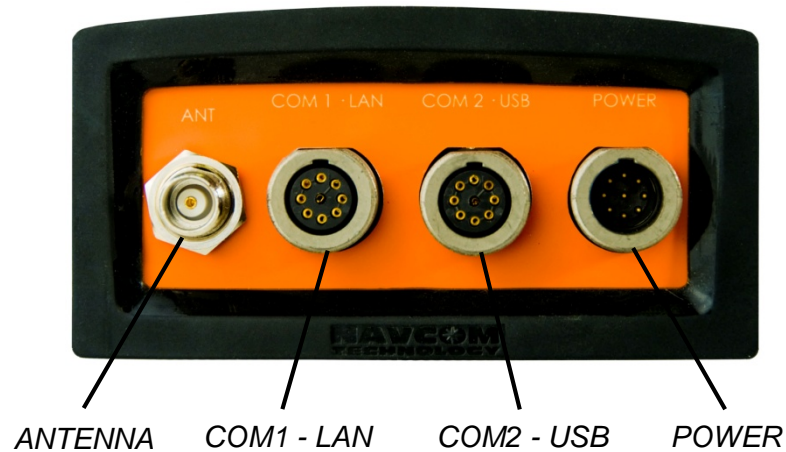
All the files needed to set up the ordered configuration of the SF-3050 are included on the SF-3050 Product Configuration USB Flash Drive (P/N 82-043000-0001). The main product configuration files are:

- ✓ Firmware (\*.s19): The most current firmware.
- ✓ Software Options (\*.opt): The options enable the functionality of the SF-3050. Software Options may be purchased in a bundle and/or individually.
- ✓ StarFire License (\*.lic): The SF-3050 is hardware ready for StarFire. The StarFire License *and* the StarFire Software Option are required to enable the StarFire Subscription Service.
  -  The StarFire Software Option is standard for the SF-3050 A, G, S, and M Software Bundles, and may also be purchased individually. The StarFire License is a purchased item in addition to the StarFire Software Option.
- ✓ StarUtil 3000 (Starutil 3000\_v0,0,x.exe): NavCom's Windows-based control program is used to upload the product configuration files.
- ✓ USB Driver (navcomx1c45x3050.inf)
- ✓ User Profiles (\*.npt): The SF-3050 is already configured with a factory default User

Profile. If desired, replace the factory default user profile with a predefined profile, or create a profile. Predefined User Profiles are available on the USB Flash Drive or by email.

 Refer to *Chapter 5/User Profiles* for details.

## Connect Equipment



*Figure 1: SF-3050 Rear View*


Refer to *Figure 1* for the steps below:

1. Use one of the two supplied data cables for communications:

- DB9S cable (P/N 94-310260-3006LF): Connect the Positronic connector end to COM2 - USB at the rear of the SF-3050. Connect the DB9S end to the PC.

Or

- USB 2.0 Device cable (P/N 94-310266-3006LF): Connect the Positronic connector end to COM2 - USB at the rear of SF-3050. Plug the USB plug end into the PC.

 , *Communication Ports*, for details on the ports and Bluetooth™ connection.

2. Mount the supplied Rover, Base, or Airborne antenna. Locate the antenna in an area with a 360° clear view of the sky.

 Refer to *Chapter 4/Antennae* for additional considerations and restrictions.

3. Connect the supplied GNSS antenna cable (P/N 94-310261-3012LF) to the GNSS antenna. Connect the other end of the cable to the TNC connector, labeled ANT, at the rear of the SF-3050.

 Refer to

☐ Table 21 for longer cable lengths.

4. Perform these steps to set up power:
5. Plug the supplied AC power cord (P/N 73-200002-0001LF) into the supplied Universal AC/DC Power Adapter (P/N 82-020007-3001LF). The adapter operates on either 120 or 240 VAC power.

☐ The purchase of a separate appliance cable may be necessary if the VAC plug configuration needed is not the standard 2-prong American connector.

6. Connect the female Positronic connector end of the Power Adapter cable into the male connector, labeled POWER, at the rear of the SF-3050.
7. Plug the AC power cord into an AC receptacle.
8. Press the front panel On/Off switch to turn on the SF-3050 (see Figure 82). All front panel LEDs illuminate for a period of 3 to 5 seconds during power-up. The Power/GNSS Status LED changes from Red to Green.

### Save Folder/Files to PC

☐ The SF-3050 Product Configuration USB Flash Drive includes:

- Root Directory: Software Options File and StarFire License (if purchased)
- NavCom Folder: Includes these sub-folders: Firmware, Marketing Materials, Utilities, User Guides, User Profiles  
(The contents of the NavCom folder are subject to change.)

9. Plug the SF-3050 Product Configuration USB Flash Drive into the PC.
10. Browse to the USB Flash Drive.
11. Save the Software Options File, StarFire License (if purchased), and NavCom folder to the PC.
12. On the PC, create two folders in the NavCom folder for the Software Options File and the StarFire License (see Figure 2).

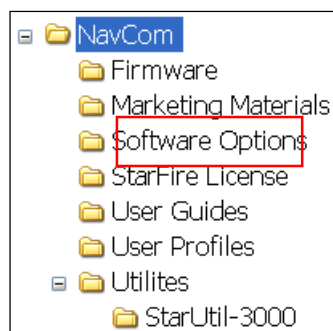


Figure 2: NavCom Sub-Folders on PC

- Only Software Options and StarFire License files are sent via email. All other files are available either on NavCom’s website or via Customer Support.

**Establish Communications**

- Browse to Navcom\Utilities\StarUtil 3000 on the PC (see Figure 2).
- Ensure that these files are in the StarUtil 3000 folder: “StarUtil3000\_v0,0,x.exe” (program executable file), “navcomx1c45x3050.inf” (USB driver), 96-312007-3001RevX\_Sapphire TRM.pdf, and 96-310029-3001RevX\_StarUtil3000.pdf.
  - The USB driver must be in the same folder as StarUtil 3000 for the USB port to auto-recognize the SF-3050.
  - When the SF-3050 is first connected to the PC port, a Windows wizard opens. Locate and install the “NAVCOMx1c45x3050.inf” file before starting StarUtil 3000. Also, note the com port number once the install completes.
- Double-click “Starutil3000\_v0,0,x.exe” to open the program.

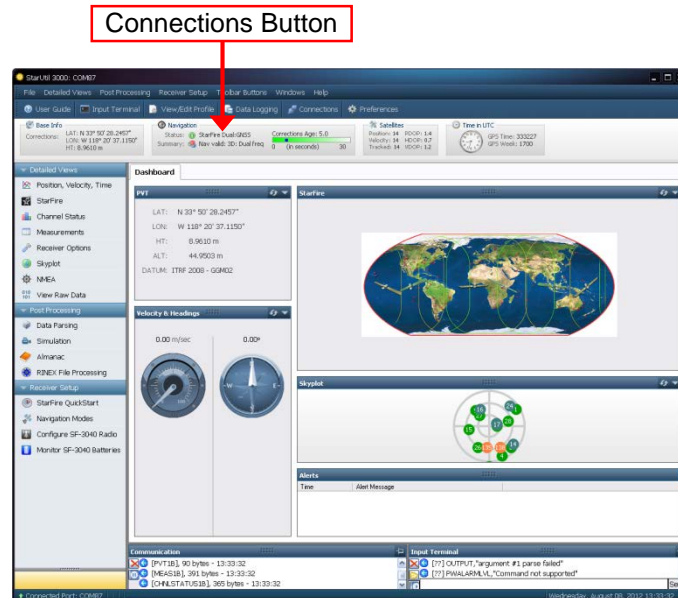
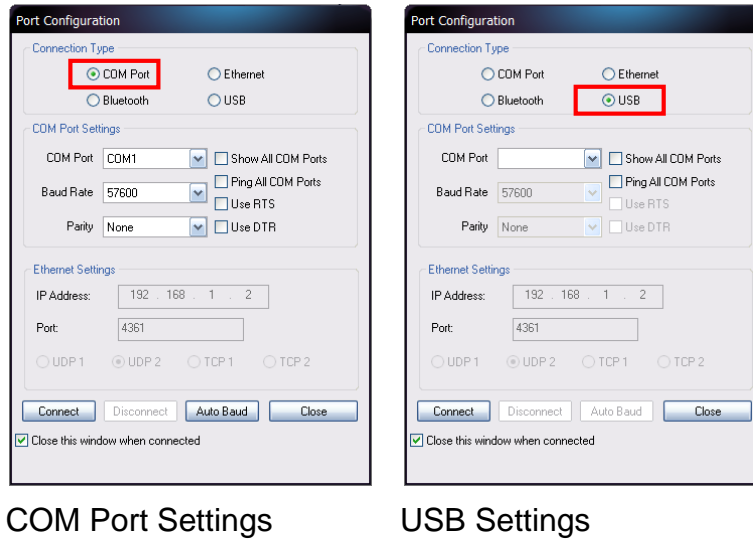



Figure 3: StarUtil 3000 – Main Window

- Click the *Connections* button to establish communications between the PC and the SF-3050 (see Figure 3). The *Port Configuration* dialog box opens (see Figure 4). Refer to Figure 4 for the steps below:




*Figure 4: Port Configuration*

17. Set the appropriate options according to the *Connection Type*:

- COM Port (on the PC):
  - COM2 (on the SF-3040)
  - Baud Rate: 57600 (keep the default)
  - Parity: None (keep the default)
- Click  to connect.

Or

- USB (on the PC)
  - USB-COM1 (on the SF-3040)
  - Baud Rate: 57600 (keep the default)
  - Parity: None (keep the default)
- Click  to connect.

18. Verify that the SF-3050 is connected to the PC: Scrolling messages in the *Communication* window indicate that a valid connection is established at the required baud rate (see Figure 5).



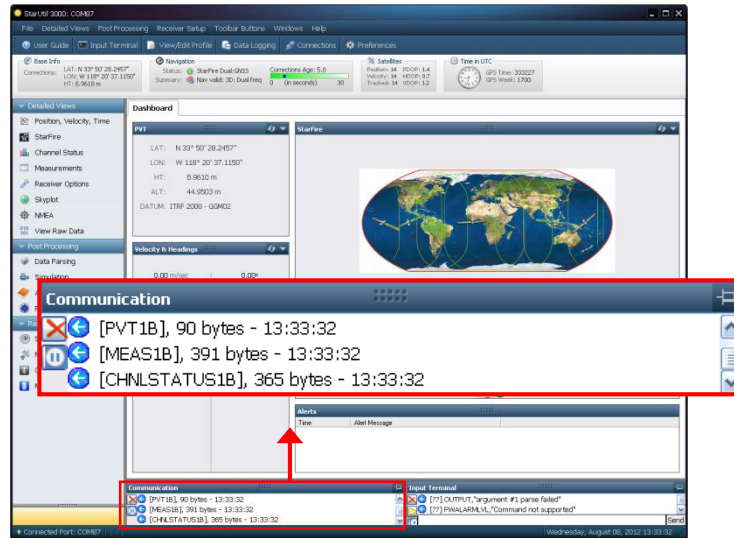




Figure 5: StarUtil 3000 Communication Window

- 

A blue arrow indicates messages received by the GUI. A green arrow indicates messages sent by the GUI.
- 

**COM Port Connection:** Scrolling lines designated as “DATA” indicate a connection is established but the baud rate is not correct (see Figure 6). Reopen the *Port Configuration* dialog box.

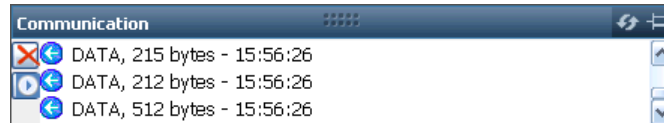


Figure 6: Connection at Incorrect Baud Rate

- For remote operation, connection to either Com 1 or Com 2 is highly recommended as a backup to the Ethernet interface. The Com1 or Com 2 backup connection can be made via a cell modem, MOXA to Ethernet, etc.

### Determine Current Firmware Versions

The user determines if the most current firmware is installed in the SF-3050. The version of the installed firmware is important to ensure the proper operation of the receiver.

In StarUtil 3000, checking the contents of the *Firmware Info* window (see Figure 7) on the *Receiver Options* tab is the easiest way to determine if the installed firmware is the most current. An alternative method is to use the *Input Terminal* window (see Determine Firmware Version via the Input Terminal, below).

- Click *Receiver Options* on the *Detailed Views* menu to open the *Receiver Options* tab (see Figure 7).

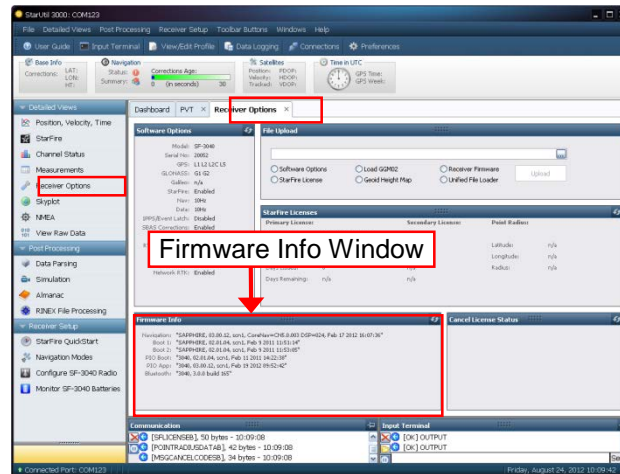



Figure 7: Access to Receiver Options Tab

- Click  (refresh) on the *Firmware Info* window to view the current output data (see Figure 8).

- The firmware is identified by version number. For example, the NAV firmware in the example below is version 01.00.00.003. Firmware ensembles are always referenced to the Navigation Firmware Number.

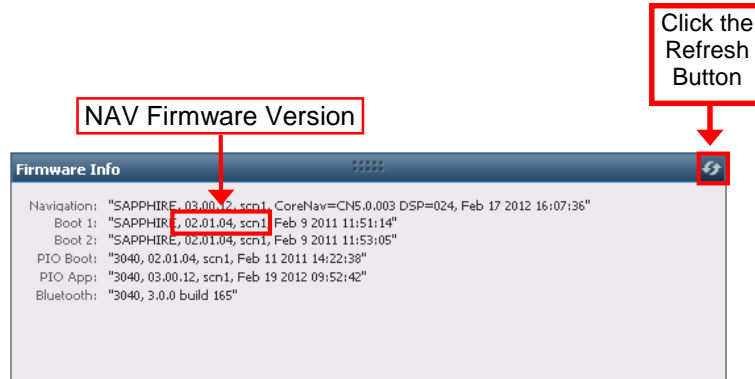


Figure 8: Example of Installed Firmware

21. Browse to the NavCom\Firmware folder on the PC (see Figure 2). The Firmware folder is copied from the SF-3050 Product Configuration USB Flash Drive. It contains the *most current firmware* (see example files in Figure 9). The firmware file extension is \*.s19.

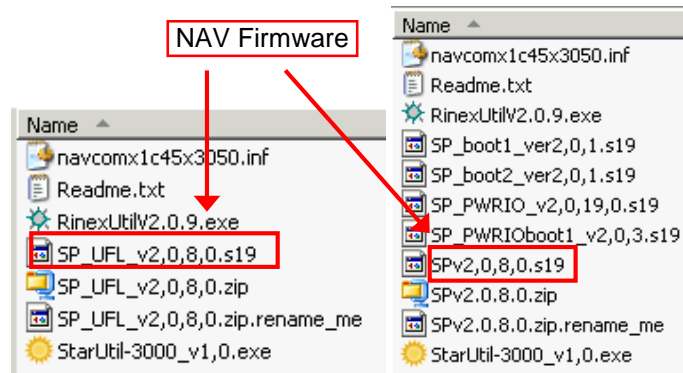


Figure 9: Firmware Folder

- ☐ Open the Readme.txt file for additional information.
22. Compare the current NAV Firmware version in the Firmware folder with the installed version displayed in the *Firmware Info* window (see Figure 10).
- ☐ In the example below, the NAV firmware in the *Firmware* folder is more current than the installed firmware. As a result, the user must update the NAV firmware in the receiver.

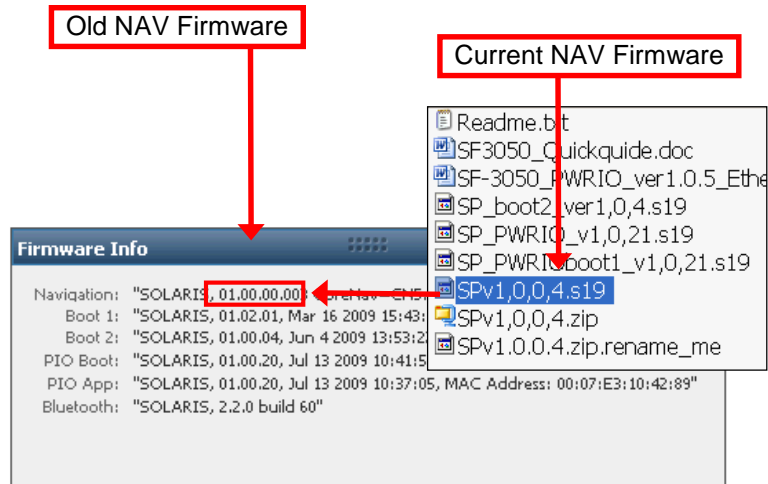


Figure 10: Comparing Current and Installed Firmware

23. If the NAV firmware installed in the receiver is *not* the most current version:

- Check the versions of the other firmware.
- Write down all of the firmware that must be updated.
- Go to the section below, [Upload Firmware](#).

Determine Firmware Version via the Input Terminal

24. Locate the *Input Terminal* on the bottom right (see Figure 12).

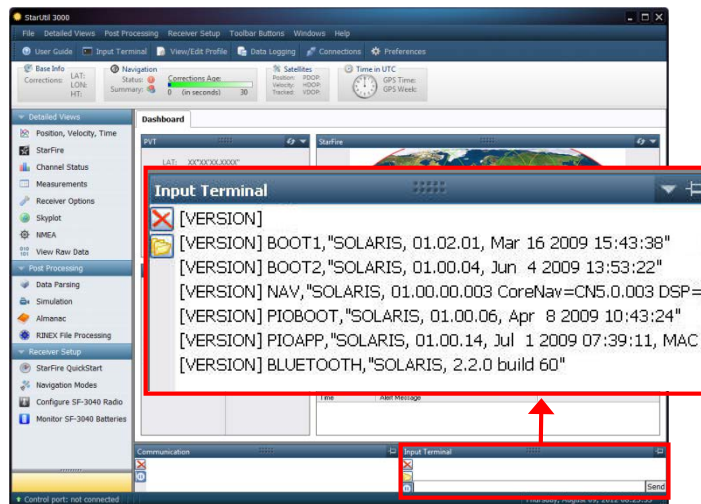


Figure 11: Input Terminal – Firmware Versions

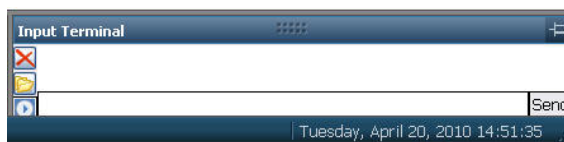


Figure 12: Input Terminal

25. Click and drag the top edge of the *Input Terminal* window to enlarge it.

26. Type [VERSION] in the field at the bottom of the *Input Terminal* window (see Figure 13).

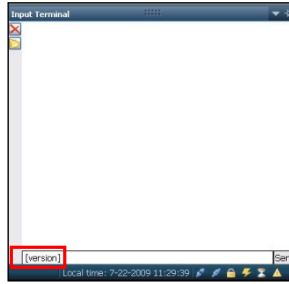


Figure 13: Version Command

27. Click the *Send* button on the *Input Terminal*. The receiver returns a list of the currently installed firmware.
28. Browse to NavCom\Firmware on the PC (refer to Figure 2). The Firmware folder contains the *most current firmware*. The firmware file extension is \*.s19.
29. Compare the current NAV Firmware version in the Firmware folder with the installed version displayed in the *Input Terminal* window (see Figure 12).



If the NAV firmware installed in the receiver is *not* the most current version:

- Check the versions of the other firmware.
- Write down all firmware that must be updated.

### Upload Software Options

Software options may be purchased in a bundle and/or individually. The SF-3050 software bundles are SF-3050A, SF-3050G, SF-3050S, and SF-3050M. Refer to *Chapter 2/ Software Bundles* for descriptions of the software options in each bundle.



Software Options must be uploaded before uploading the StarFire License, if purchased.



The receiver must be navigating at the time of the software options upload.

30. Select *Software Options* on the *File Upload* window (see Figure 14).



Figure 14: Software Options

31. Click

32. Browse to NavCom\Software Options on the PC. The Software Options file extension is \*.opt.
33. Select the Software Options file. The path to the file appears in the upload field (see Figure 15).

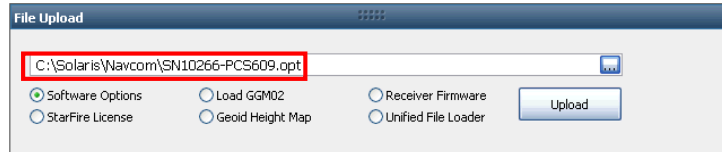




Figure 15: Software Options Upload

34. Click . At the end of upload, a confirmation box opens. Click OK.

 The *Input Terminal* window also displays the outcome of the upload (see Figure 16). In the example below, the upload is successful. Refer to the *Sapphire Technical Reference Manual* for detailed information on the INPUTSWOPTION command (see *Related Documents* in the fore-matter).

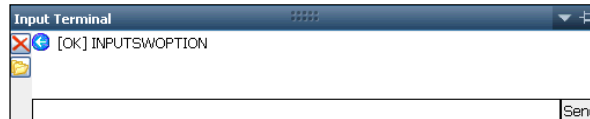



Figure 16: Successful Software Options Upload

35. Click  (refresh) on the *Software Options* window and check to ensure that all uploaded software options are displayed (see Figure 17).

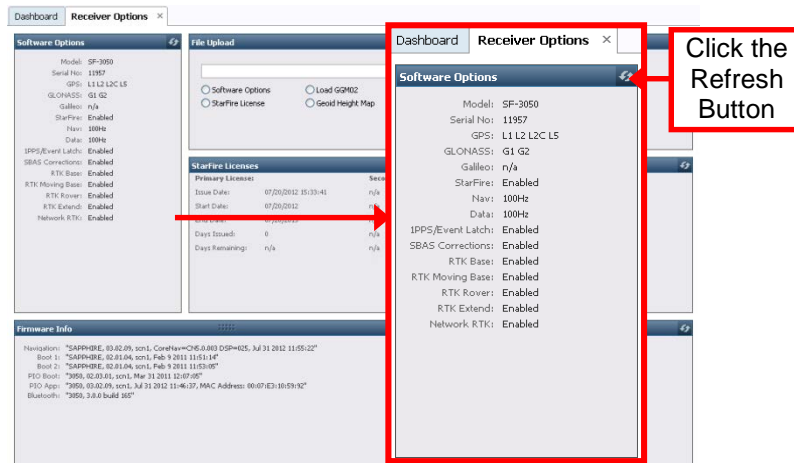





Figure 17: Software Options Window

 “StarFire: Enabled” indicates that the StarFire Software Option is loaded. It does not indicate that a StarFire License is installed.

36. Do not close StarUtil 3000. Perform one of these steps:
  - If a StarFire License is purchased, go to the Upload StarFire License section.
  - If a StarFire License is not purchased, go to the *Factory Default User Profile* section.


-  The SF-3050 returns the entire list of loaded software options. However, StarUtil 3000 does not display the entire list in the *Software Options* window. Perform steps 55 through 58 to confirm the software uploaded to the receiver.

37. Type the command [INPUTSWOPTION] on the *Input Terminal* window.
38. Click *Send*.
39. Highlight and copy the entire output.
40. Open any text editor (e.g., Microsoft Notepad) and paste the output there to verify that all software options have been uploaded to the receiver.




-  If the above method fails to upload any of the purchased software options, refer to the next section.

### Upload Software Options via the Input Terminal

Perform steps 12 through 17 to upload software options via the *Input Terminal*.

41. Open the software option file in any text editing program (e.g., Notepad).
42. Locate the option code at the bottom of the file (e.g., 74C91E91 789FA173 8E70296A 3259B2E6).
43. Highlight and copy the option code.
44. Enter the command [INPUTSWOPTION] on the *Input Terminal* window and then paste the option code: 74C91E91 789FA173 8E70296A 3259B2E6.
45. Click *Send* on the *Input Terminal* window. If the software options loaded successfully, the *Input Terminal* window displays a confirmation message (see Figure 16).
46. To view all currently loaded software options, click  (refresh) on the *Software Options* window (see Figure 17).

### Upload Firmware

-  The required PC Baud rate to upload firmware via the supplied DB9S cable (RS-232) on COM2 is 57600 (default). This requirement does not apply to the supplied USB 2.0 Device cable.
-  The receiver must be navigating at the time of the firmware upload.
-  Typically, if any firmware needs to be updated, it is NAV and PIOAPP.

### Upload a Unified Firmware File

47. Click *Receiver Options* on the *Detailed Views* menu to open the *Receiver Options* tab (see Figure 18).

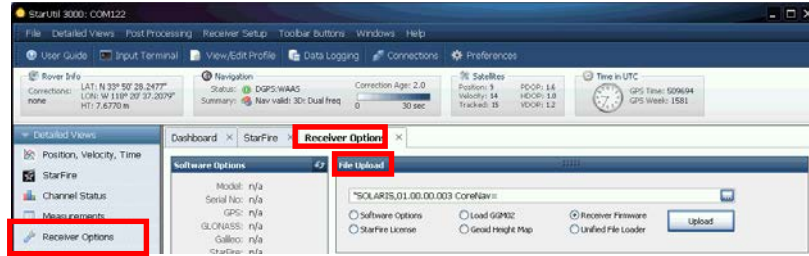


Figure 18: Receiver Options Tab

48. Select *Unified File Loader* on the *File Upload* window (see Figure 19).

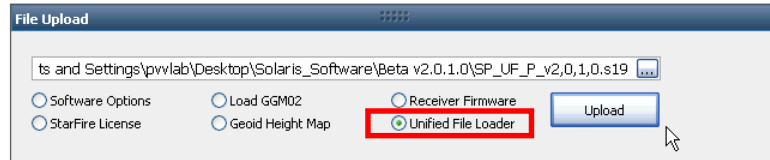


Figure 19: File Upload – Unified File Loader Option

49. Click .

50. Browse to the NavCom\Firmware folder on the PC (refer to Figure 20).

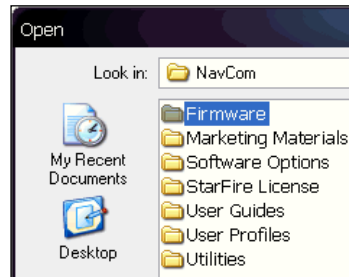


Figure 20: Firmware Folder

51. Select the appropriate *unified* file to upload and click  (see Figure 20).

52. The files to be uploaded are displayed on the *Ready to Downline Load File* dialog box with their corresponding check boxes selected (see Figure 21). Select and deselect files as necessary.



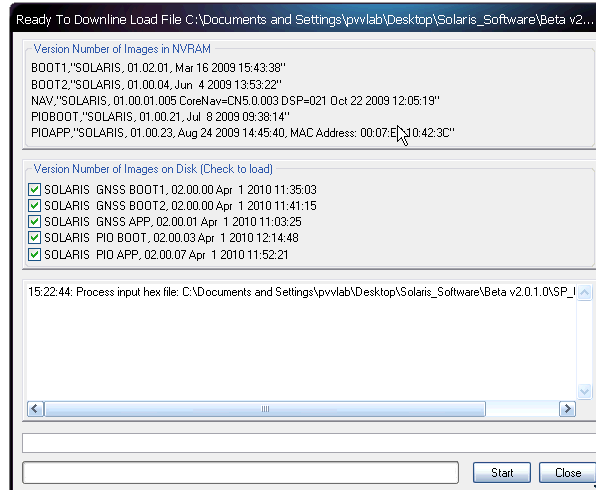


Figure 21: Ready to Downline Load File

53. Click .

54. Once the firmware files are uploaded, the *Finished with All Downline Loads* dialog box is displayed (see Figure 22).

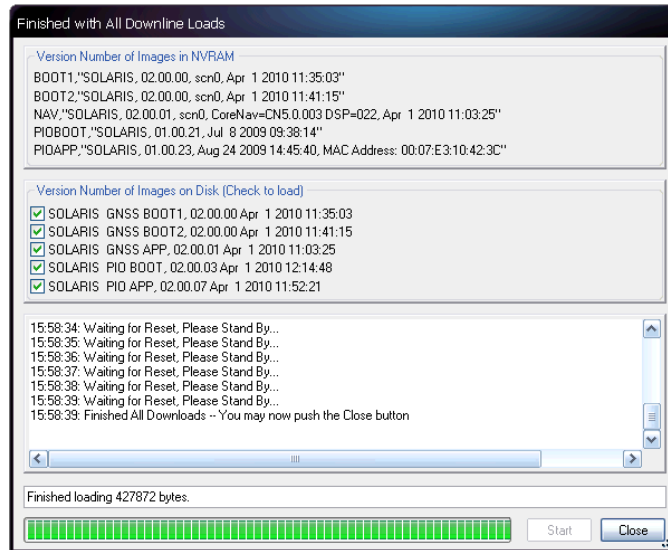


Figure 22: Finished with All Downline Loads

55. Click .

56. Check the *Firmware Info* window (see Figure 8) to view the current versions of all uploaded firmware.



If any file failed to load, go to Upload a Single Firmware File

### Upload a Single Firmware File

57. Locate the *File Upload* window on the *Receiver Options* tab (see Figure 23).

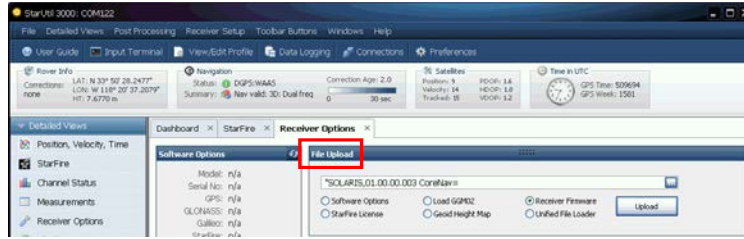


Figure 23: File Upload Window

58. Select *Receiver Firmware* on the *File Upload* window (see Figure 24).

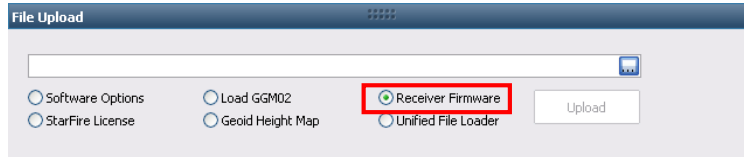


Figure 24: Receiver Firmware Option

59. Click  and the *Load Receiver Firmware* dialog box opens (see Figure 25).

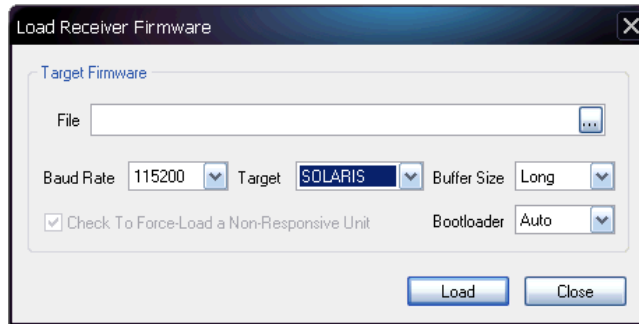


Figure 25: Load Receiver Firmware

60. Click .

61. Browse to NavCom\Firmware on the PC (see Figure 26).

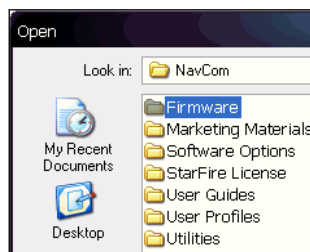



Figure 26: Firmware Folder

62. Select the appropriate firmware file.

-  Upload Boot files before application files if both types require updating.

Example Boot File: SP\_boot1\_ver2,0,1.s19

-  The format of the NAV firmware file is:  
SPv + version number.s19

Example NAV File: SPv1,0,0,4.s19

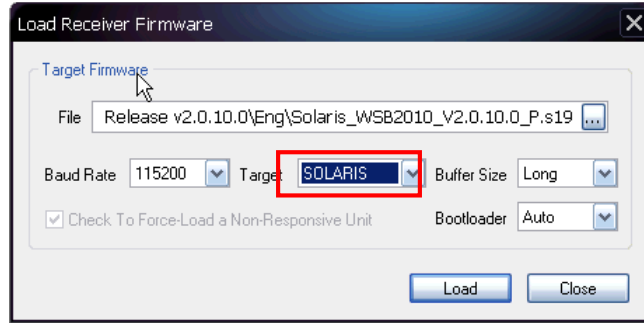


Figure 27: Settings for GNSS Firmware

63. Set these options:

- *Baud Rate:*
  - DB9S cable: Use the highest baud rate (i.e., 115200) unless the load fails. If the load fails, use 57600.
  - USB 2.0 Device Cable: No selection is necessary (automatic connection speed)
- *Target:*
  - Select SOLARIS to upload GNSS firmware (see Figure 27):  
 SP\_boot1\_[version number].s19  
 SP\_boot2\_[version number].s19  
 SPv[version number].s19

Or

- Select SOLARIS PIO to upload PWRIO firmware (see Figure 28):  
 SP\_PWRIOboot1\_[version number].s19  
 SP\_PWRIO\_[version number].s19
- *Buffer Size:* Do not set this option. The program automatically sets it.
- *Bootloader:* Do not set this option. The program automatically sets it.
- *Force Load Firmware Without PING:* Keep the default (unchecked).

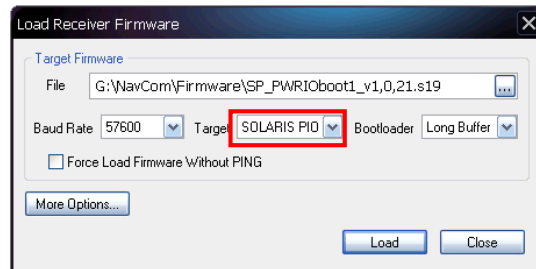


Figure 28: Settings for PWRIO Firmware

64. Click . An upload progress window opens (see Figure 29).

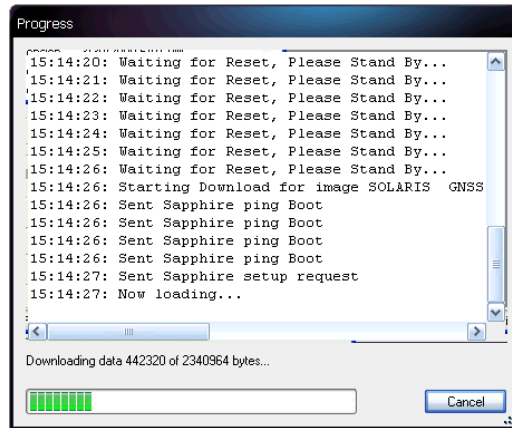




Figure 29: Progress Dialog Box

- 65. At the end of the upload, a confirmation box opens. Click *OK*.
- 66. Repeat steps 39 through 48 to upload another firmware file, if necessary.
- 67. Do not close StarUtil 3000. Continue to the next section.

### Upload StarFire License

 For the initial configuration, the StarFire license must be installed via data cable. Subsequent renewals of the license are typically transmitted to the receiver via radio broadcast. Refer to *Over the Air StarFire Licensing* for details.

 The receiver must be tracking GPS satellites and providing a valid position solution at the time of the StarFire license upload to accept the license.

68. To confirm a valid position solution on the *PVT* tab/*Navigation Status* window, first click *Position, Velocity, Time* (see Figure 30) on the *Detailed Views* menu to open the *PVT* tab (see Figure 31).

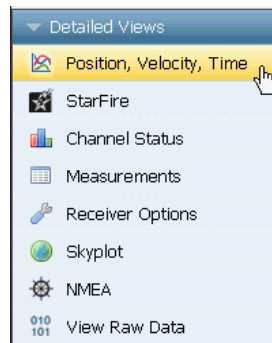


Figure 30: Position, Velocity, Time Menu Item

- Click  (refresh) on the *Navigation Status* window to ensure that the current position solution is displayed (see Figure 31).

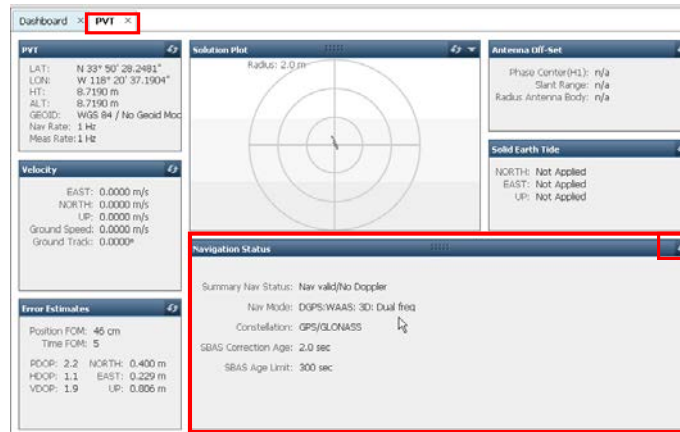


Figure 31: PVT Tab/Navigation Status Window

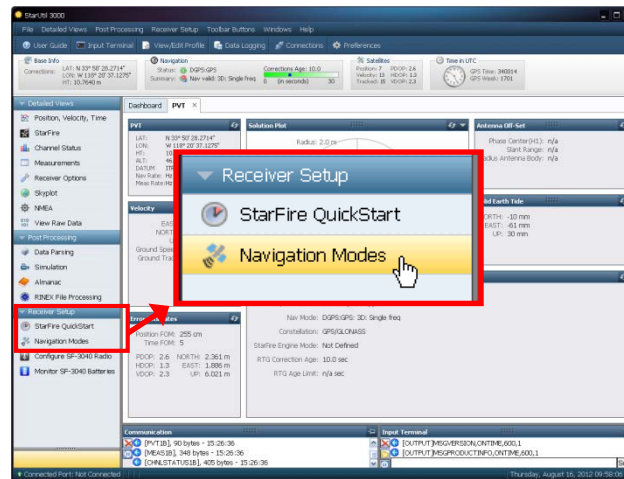


Figure 32: Navigation Modes Menu Item

- Click *Navigation Modes* on the *Receiver Setup* menu to open the *Set Navigation Modes* dialog box (see Figure 33).

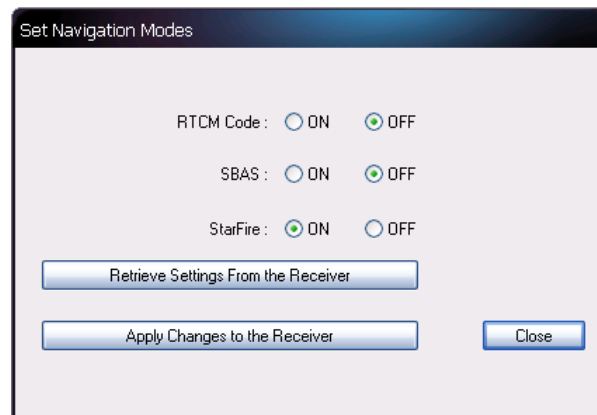


Figure 33: Set Navigation Modes/StarFire ON

Refer to Figure 33 for the steps below:

70. Click the *Retrieve Settings From the Receiver* button to retrieve the currently set navigation modes from the receiver.
71. Select the ON radio button next to StarFire if StarFire is not enabled.
72. Click the *Apply Changes to the Receiver* button to enable StarFire navigation. Then click *Close*.
73. Select *StarFire License* in the *File Upload* window on the *Receiver Options* tab (see Figure 34).

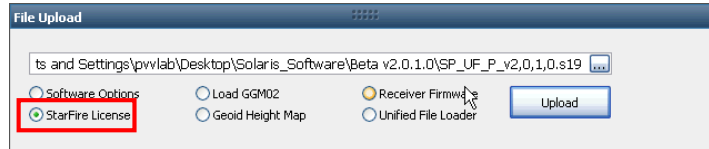


Figure 34: StarFire License

74. Click .

75. Browse to NavCom\StarFire License on the PC. The StarFire License file extension is \*.lic.

76. Select the StarFire License file. The path to the file appears in the upload field (see Figure 34).

77. Click the *Upload* button. At the end of the upload, a confirmation box opens. Click *OK*.


 The *Input Terminal* window displays the outcome of the upload (see Figure 35). In the example below, the upload is successful. Refer to the *Sapphire Technical Reference Manual* for detailed information on the INPUTSFLICENSE command (see *Related Documents* in the fore-matter).



Figure 35: Successful StarFire License Upload

78. Ensure that the purchased StarFire License is loaded. These tabs provide license information:

- *Receiver Options* tab: *StarFire Licenses* and *License Status* windows
- *StarFire* tab: *License Info* window

 To open the *StarFire* tab, click *StarFire* in the *Detailed Views* menu (see Figure 36).

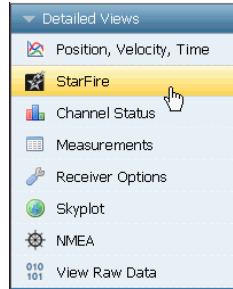


Figure 36: StarFire Menu Item

### Confirm StarFire Navigation

79. Click *Position, Velocity & Time* on the *Detailed Views* menu (see Figure 30) to determine if the receiver is navigating in *StarFire* mode. The *PVT* tab opens (see Figure 37).

- ☐ The receiver enters StarFire mode approximately 3 minutes after it is first turned on; then the convergence period starts.

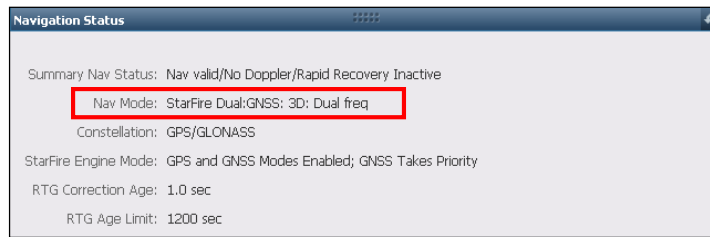


Figure 37: Nav Mode: StarFire Dual GNSS

- ☐ The Nav Mode: *StarFire Dual:GNSS: 3D: Dual freq* in Figure 37 indicates that the receiver is navigating in StarFire dual frequency with a 3D position fix, which is very accurate.

### How to Cancel a StarFire License

At the time [CANCELSFLICENSE] is input, the receiver must be tracking GPS satellites and providing a valid position solution for the receiver to accept the license cancellation.

80. Input the [CANCELSFLICENSE] command on the *Input Terminal* window to cancel the current StarFire license (see Figure 38).

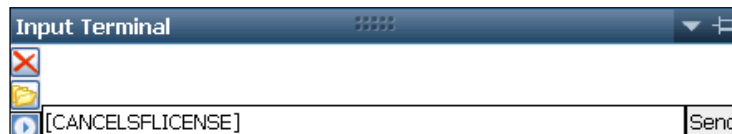



Figure 38: Input Terminal – Cancel StarFire License

- ☐ This action cancels the subscription to StarFire signal service. Users need to contact their dealer or NavCom to replace the license.

View the *Cancel License Status* window on the *Receiver* tab to confirm the StarFire license cancellation. The window also displays a cancel code to affirm the cancellation of the StarFire license before the expiration date

### Factory Default User Profile

Further configuration is not necessary for this initial use of the SF-3050. The receiver is pre-configured with a factory default user profile that includes settings for the various port assignments/parameters, navigation parameters, and output message lists.


 If the SF-3050 does not function properly, refer to these online tools:


- [Troubleshooting Guides](#)
- [User Manuals](#)

Contact the authorized dealer or NavCom Customer Support (refer to the beginning of this chapter for contact information).

### Upload User Profile (optional)

If desired, replace the factory default user profile with a predefined profile, or create a profile. Refer to the *StarUtil 3000 User Guide* for detailed instructions.


 Predefined user profiles are available in the Navcom\User Profiles folder saved on the PC from the SF-3050 Product Configuration USB Flash Drive.

 Refer to *Chapter 5/User Profiles* in this guide for information on profiles.

### Enable or Disable Receiver Tracking and/or Use of Select Signals and Frequencies

Receiver tracking of various signals and frequencies can be enabled or disabled.

Refer to the [TRACKINGMODE] and [NAVMEASUSE] commands in the *Sapphire Technical Reference Manual* for detailed instructions on enabling and disabling the tracking of and receiver use of various signals and frequencies. Also refer to the *StarUtil 3000 User Guide*.


 These commands are used primarily for engineering experiments or receiver testing. They are not recommended for use in other applications.

### Enable or Disable Receiver Use of Signals and Frequencies for Navigation

Receiver use of various signals and frequencies for navigation can be enabled or disabled.



Refer to the [NAVMEASUSE] command in the *Sapphire Technical Reference Manual* for detailed instructions on enabling and disabling navigation signals and frequencies. Also refer to the *StarUtil 3000 User Guide*.

 This command is used primarily for engineering experiments or receiver testing. It is not recommended for use in other applications.

### Upload WebPages

1. Update firmware on SF-3050 receiver. The latest version of the software (v3.3.x.0 or later) is required for this feature.
2. Determine the receiver’s IP address OR give it a static IP address by entering the [ETHCONFIG] command in the Input Terminal screen.
  - Specify [ETHCONFIG]MANUAL to manually change the IP address.
  - Using [ETHCONFIG]AUTO will automatically set the IP address.

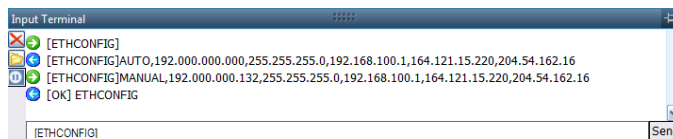




Figure 39: Input Terminal – [ETHCONFIG]

 The IP address consists of the first four sets of three numbers separated by periods. For further information on this command, see the Technical Reference Manual.

3. Save the profile by entering [PROFILE]SAVEAS “XXX” in the Input Terminal screen where the Xs indicate the name chosen for the profile.



Figure 40: Input Terminal – Save Profile

 If the profile is not saved, the IP address will be lost the next time the receiver is shut off and rebooted.

- Format the internal memory by entering `[FSFORMAT]A;DEFAULT` in the Input Terminal screen.

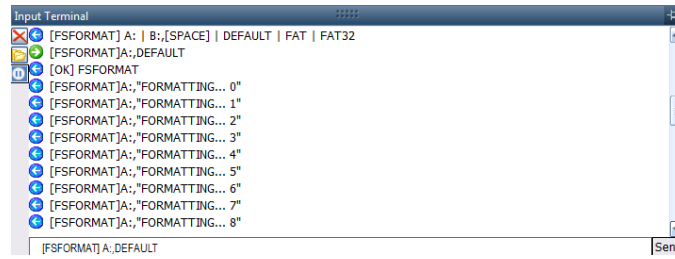



Figure 41: Input Terminal – Format Memory Card

 The SF-3050 has a permanent 2GB SD card permanently installed. Once this card is formatted, there is no need to reformat it. Reformatting the memory after the 3.3.x.0 software update is necessary to repartition the memory chip.

- To load the Webpage files, select the File Upload screen under the Receiver Options tab.
- Click the Webpage Loader button and browse to the SolarisWebpagesv3.3.x/NCT file on the USB stick.

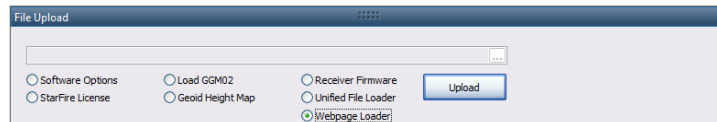


Figure 42: File Upload – Webpage Loader

- Select the NCT folder and click **OK**.

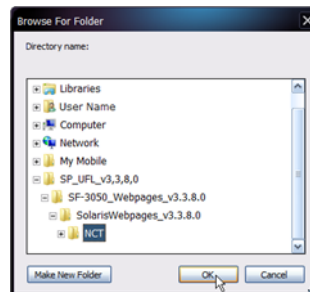

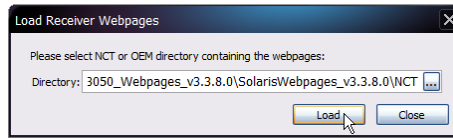


Figure 43: Webpage NCT Directory

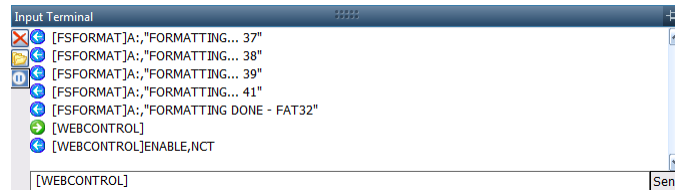
 The Webpage files are contained in the NCT directory. Loading the NCT directory will load all the webpage files.

8. Click the Load button to load the NCT directory.



*Figure 44: Load Webpages NCT file*

9. Enable the WebServer and choose webpage directory by entering the [WEBCONTROL]ENABLE,NCT command in the Input Terminal screen. This will ensure that the webpages in the NCT directory are enabled.



*Figure 45: Input Terminal – Webcontrol*

## Chapter 2 ..... Introduction

### System Overview

#### GNSS Sensor System

The SF-3050 Global Navigation Satellite Systems (GNSS) sensor delivers superior accuracy to the precise positioning community. This unique receiver is designed with a robust and long-term performance upgrade path to meet changing needs via software upgrades. Increased functionality does not typically require the costly purchase of additional hardware.




The SF-3050 software-enabled features, bundled or purchased individually, cover a wide variety of applications.

The SF-3050 is uniquely suited for real-time applications in areas such as surveying, machine control, precise positioning, and construction. The sensor delivers the required millimeter measurement precision and fast update rates at low data latency. Depending on the software bundle, the SF-3050 provides flexibility to be configured as a base station or as a rover.

Superior interference suppression (both in-band & out-band), multipath mitigation, and measurement accuracy are only a few of the sensor’s technological advances. The SF-3050 GNSS engine incorporates several patented innovations advancing the existing GNSS technology to the next generation. The receiver provides near optimal GPS P-code recovery, providing a significant signal-to-noise ratio advantage over competing technologies, among other benefits.

There are four software bundles: the SF-3050A, SF-3050G, SF-3050S, and SF-3050M. Depending upon the bundle, this receiver provides, but is not limited to:

- ✓ NavCom’s StarFire<sup>1</sup> Network: A worldwide Satellite Based Augmentation System (SBAS) for decimeter level position accuracy (post-convergence period). Refer to [Appendix C](#) for detailed information.

 <sup>1</sup>Dependent on the bundle: Subscription and Software Option Required

- ✓ RTK: This unique receiver is designed to integrate easily into Real-Time Kinematic (RTK), field data verification, topographical surveys, and a wide variety of surveying applications. The system resolves ambiguities at startup or on satellite reacquisition typically within 2 seconds. The SF-3050 delivers centimeter level position accuracy via external RTK<sup>2</sup> correction formats. The receiver is capable of NCT RTK/UltraRTK™, RTCM 2.3 and 3.1 (code and phase), Network RTK, and CMR/CMR+ DGPS operating methods. The operating software is also capable of supporting an external radio modem.

 <sup>2</sup> Dependent on the bundle: Separate Software Option Required

- ✓ Signal Reception: The SF-3050 GNSS engine includes a digital ASIC to handle high speed signal processing. The sensor provides proven unparalleled performance in

spite of adverse signal tracking conditions by incorporating the use of GPS (L1, L2, L2C, L5), GLONASS (G1, G2), and SBAS (WAAS, EGNOS, MSAS, GAGAN) signals (standard for most software bundles).

- ✓ 66 Signal Channels: Provides the ability to track multiple frequencies of satellites in several constellations simultaneously. This allows for extended navigation in otherwise adverse conditions for a single constellation. An additional channel is dedicated to tracking StarFire signals.

The system includes a Rover, Base, or Airborne antenna, and interconnection accessories outlined in Table 13.

### Performance Upgrade Path

The SF-3050 is designed with a robust and long-term performance upgrade path to meet changing needs via software upgrades. The following tables outline the standard and optional features of each SF-3050 software bundle.

*Table 1: Performance Upgrade Path – Position & Data Rates*

Rate	SF-3050 Bundles			
	A <sup>1</sup>	G	S	M
Position, Velocity, and Time				
1,5*Hz	Std	Std	Std	Std
10Hz	Opt	Opt	Opt	Std
25*Hz	Opt	Opt	Opt	Std
50, 100Hz	Opt	Opt	Opt	Opt
Raw Data				
1, 5*Hz	Std	Std	Std	Std
10Hz	Opt	Opt	Opt	Std
25*Hz	Opt	Opt	Opt	Std
50, 100Hz	Opt	Opt	Opt	Opt




<sup>1</sup> Bundle A is not available in software prior to v. 2.0.22.0.



\*5Hz is the default PVT and Raw Data Rate for software bundles G and S. 25Hz is the default PVT and Raw Data Rate for bundle M.


*Table 2: Performance Upgrade Path – Signals*

<i>Signals</i>	SF-3050 Bundles		
	<b>G</b>	<b>S</b>	<b>M</b>
GPS			
L1	Std	Std	Std
L2	Std	Std	Std
L2C	Std	Std	Std
L5	Std	Std	Std
GPS			
G1	Std	Std	Std
G2	Std	Std	Std
Correction Source			
SBAS	Std	Std	Std
StarFire <sup>1</sup>	Std	Std	Std

 <sup>1</sup> The StarFire software option is standard for software bundles G, S, and M. It does not include a StarFire license, which must be purchased to use the StarFire subscription service. See Glossary or Web site.

*Table 3: Performance Upgrade Path – RTK*

RTK	SF-3050 Bundles		
	G	S	M
RTK Base	Opt	Std	Opt
RTK Moving Base	Opt	Opt	Opt
RTK Rover	Opt	Std	Opt
RTK Extend™	Opt	Opt	Opt
Network RTK <sup>1</sup>	Opt	Std	Opt

 <sup>1</sup> Dependent on bundle options



*Table 4: Performance Upgrade Path – 1PPS/Event*

	SF-3050 Bundles		
	G	S	M
1PPS/Event	Opt	Opt	Std

### Accuracy

#### SBAS

When WAAS, EGNOS, MSAS, or GAGAN (RTCA/DO-229D compliant) SBAS correction signals are used, the system provides <30cm 2D position accuracy.

-  System accuracy with WAAS, EGNOS, MSAS, or GAGAN signals is subject to the quality and update rate of these publicly operated signals. Refer to *Related Standards/Publicly Operated SBAS Signals* in the fore-matter for contact information regarding the organizations that implement the RTCA/DO-229D standard.
-  See the *Sapphire Technical Reference Manual* (TRACKINGMODE command) and the *StarUtil 3000 User Guide* for details on disabling WAAS, EGNOS, and MSAS.



#### StarFire

The system provides <5cm position accuracy (post-convergence period)<sup>1</sup> when StarFire correction signals are used.

#### RTK

The system provides immediate < 1 cm position accuracy when UltraRTK<sup>1</sup> correction signals are used:

- L1, L2, L2G, L5, G1,G2 baseline:  
< 40 km, ±1 cm + 0.5 ppm)  
– Also applies to Moving Base RTK


-  <sup>1</sup> Dependent on software bundle options
-  After RTK correction signals are received, the baseline determines how long it takes to enter RTK mode. A rover close to the base enters RTK mode almost immediately. For longer baselines, it may take a minute or two. For L1/G1 RTK, antenna model selection is also a factor in ambiguity resolution and time required to enter RTK.


### Features (for All Software Bundles)

#### Output Data Rate

The SF-3050 GNSS receiver can output proprietary raw data at programmable rates from ≤1Hz to predetermined rates up to 100Hz<sup>1</sup> and Position Velocity Time (PVT) data at programmable rates from ≤1Hz to predetermined rates up to 100Hz<sup>1</sup> through the data ports<sup>2</sup> with less than 10ms latency. Accuracies are maintained as each output is

independently calculated based on an actual GNSS position measurement, as opposed to an extrapolation/ interpolation between 1Hz measurements.

 The throughput capacity of the ports is limited by the Baud rate and the byte size and number of messages output.

 <sup>1</sup> Dependent on software bundle options

 <sup>2</sup> Port dependent, refer to Communications Ports for details.

### NCT Binary Proprietary Data

The sensor can output proprietary raw data containing information including (but not limited to):

- ✓ Satellite Ephemeris (EPHEM1B)
- ✓ Satellite Almanac (ALM1B)
- ✓ Raw Pseudorange Measurements (MEAS1B)
- ✓ Position, Height, & Time (PVT1B)
- ✓ Velocity & Heading (PVT1B)
- ✓ Signal to Noise (CHNLSTATUS1B)
- ✓ Channel Status (CHNLSTATUS1B)
- ✓ Correction Data (mirror data; RTKSTATUS1B)
- ✓ Event/Marker (EVENTLATCHA)
- ✓ Measurement Quality (PVT1B and PSEUDORANGESTATSB)

These data can be integrated in real-time positioning applications or post-processed against any number of software applications designed to handle NCT or RINEX raw data. The *Sapphire Technical Reference Manual*, available on NavCom's Web site, describes the attributes of each of the input/output records (see *Related Documents* in the fore-matter).

### NMEA-0183 Data

The SF-3050 is capable of outputting several standard NMEA-0183 data strings (see *Related Standards* in the fore-matter) and several proprietary data strings. All data are headed with \$GN, except for MLA, which is headed with \$GL. All header formats are accepted (e.g., \$GP, \$GL). Proprietary data strings are denoted with a \$PNCT header. The *Sapphire Technical Reference Manual* provides additional controls for heading types and message lengths for some NMEA messages. NMEA data complies with v.4.1 of the standard in SF-3050 v.3.0.16 or later.

#### ■ Standard

- ✓ ALM – GPS Almanac Data
- ✓ DTM – Datum Reference
- ✓ GBS – GNSS Satellite Fault Detection
- ✓ GFA– GNSS Fix Accuracy and Integrity



(v.3.0.16 or later)

- ✓ GGA – GPS Fix Data
- ✓ GLL – Geographic Position – Lat /Lon
- ✓ GNS– GNSS Fix Data (v.3.0.16 or later)
- ✓ GRS – GPS Range Residuals
- ✓ GSA – GNSS DOP & Active Satellites
- ✓ GST – GNSS Pseudorange Error Statistics
- ✓ GSV – GNSS Satellites In View
- ✓ HDT – Heading Degrees True
- ✓ MLA – GLONASS Almanac Data
- ✓ RMC – Recommended Min. Specific GNSS Data
- ✓ ROT – Rate of Turn
- ✓ RRE – Range Residual Errors  
(This command is not defined in NMEA 0183 Standard version 3.0.)
- ✓ TTM – Moving Base / Rover RTK data
- ✓ VTG – Course Over Ground & Ground Speed
- ✓ ZDA – Time & Date

■ **Proprietary (header \$PNCT)**

Described in the Sapphire Technical Reference Manual (see Related Documents in the fore-matter)

- ✓ DTM– Datum Reference for user-selected reference frame
- ✓ GGA – GPS Fix with Field 14
- ✓ GST – GNSS Pseudorange Error Statistics
- ✓ MDE – Marginally Detectable Error
- ✓ SET – Solid Earth Tide

■ **Software Bundles**

Software Options may be purchased in a bundle and/or individually.

The Software Options File contains all of the purchased Software Options, whether purchased in a bundle or individually. The initial Software Options File must be uploaded to the receiver to enable the functionality of the SF-3050. Later purchased software upgrades are also provided in a Software Options File for upload.

**SF-3050G**

The SF-3050G is a multi-constellation, StarFire-enabled<sup>2</sup> GNSS receiver system for users that require high-availability, worldwide, decimeter accuracy.

Upgrade paths for higher data rates and other options make the SF-3050G ideal for many Offshore Survey and Positioning applications:

- ✓ Nautical Stationkeeping
- ✓ Dynamic Positioning
- ✓ Dredging and Offshore Construction
- ✓ Deep Water Survey

☐ <sup>2</sup>StarFire Software Option is standard. StarFire subscription is required.

### SF-3050S

Adding Base, Rover, and Network RTK<sup>2</sup> to the feature- rich SF-3050G receiver, the SF-3050S is a powerful engine for use in Land Survey applications where precision is vital. The small form-factor, light weight (only 1.1 lb), and Bluetooth connectivity allow the receiver to fit nicely into a backpack Land Survey system with only an external RF cable to the pole-mounted antenna. In addition, the built-in, high-speed data ports (USB and Ethernet) enable high-speed data transfer or remote communication to the receiver.

The SF-3050S sensor meets the needs of a large number of applications including, but not limited to:

- ✓ Topographical Surveys in Rough Terrain
- ✓ High-Accuracy Data Collection for Post-Processing
- ✓ Real-time Positioning Application

☐ Dependent on software bundle

### SF-3050M

With 25Hz data rate output, 1PPS, and Event Marker features standard, the SF-3050M is a hard-working GNSS receiver targeted towards any application requiring high-precision data at a high rate. Users with machine control and aerial survey applications will appreciate the compact form-factor, powerful GNSS performance, and critical coordination signals (1PPS and Event Marker).

The SF-3050M is ideal for vehicle mounting to suit a wide variety of machine guidance and control applications:

- ✓ Towed Implement Guidance
- ✓ Construction Machine Control – Blade Control and Grading
- ✓ Railway, Ship, and Aircraft Precision Tracking
- ✓ Port Operations and Container Tracking

## Bluetooth

The SF-3050 GNSS receiver is Bluetooth capable in all software bundle configurations. The Bluetooth module permits cable-less operation between the sensor and a Bluetooth equipped controller. Wireless connectivity is provided within a range of 10 m (32 ft), and a data rate of 230.4Kbps is supported, 10 Hz maximum. The Bluetooth module contains Bluetooth certified components and is FCC and CE certified. Communications performance is dependent on the user Bluetooth device used.

Refer to Chapter 3 for setup instructions via the supplied NavCom software utility, StarUtil 3000 or via the Input Terminal using the [BTSET] command.

## Ethernet Connection

An Ethernet connection may be set up for the SF-3050 receiver. Refer to Chapter 2 of the *StarUtil 3000 User Guide* and to the *Sapphire Technical Reference Manual* [ETHCONFIG] and [ETHVCOM] commands for detailed instructions on configuring and establishing an Ethernet connection.

## Antennae

The SF-3050 GNSS sensor must be ordered with the Rover, Base, or Airborne antenna. Each antenna is described below.

### Rover

The Rover integrated GNSS antenna (PN: 82-001020-3001LF) tracks GPS (L1, L2, L2C, L5), GLONASS (G1, G2), StarFire (L-Band differential corrections), and SBAS (WAAS/EGNOS/MSAS/ GAGAN) signals. The compact GNSS antenna has excellent tracking performance and a stable phase center. This antenna is listed in the [Antenna Calibration Values](#) available from the National Geodetic Survey (NGS) calibration table hyperlinked to this text, as [NAV-ANT3001R](#).



The robust housing assembly features a standard 5/8" BSW thread for mounting directly to a surveyor's pole, tripod, or mast and is certified to 70,000 feet, (see *Specifications* for restrictions).

### Base

The Base integrated GNSS antenna (PN: 82-001021-3001LF) tracks GPS (L1, L2, L2C, L5), GLONASS (G1, G2), StarFire (L-Band differential corrections), and SBAS (WAAS/EGNOS/MSAS/ GAGAN) signals. The Base GNSS antenna is designed to reduce multipath error to provide better RTK corrections to the rover network. It has excellent tracking performance and a stable phase center. The NGS calibration table for this product is available on the following link:



<http://www.ngs.noaa.gov/ANTCAL/Antennas.jsp;jsessionid=3DE81666766F189AFA9D57D343082098?manu=NavCom> This antenna is listed in the NOAA GNSS Antenna Calibration tables, as [NAV-ANT3001B](#). The robust housing assembly features a standard 5/8" BSW thread to permanently install the antenna. It is certified to 70,000 feet (see *Specifications* for restrictions).

## Airborne

The Airborne integrated antenna (PN: 82-001022-3001LF) tracks all GNSS, WAAS/EGNOS/MSAS/GAGAN and StarFire signals. The compact GNSS antenna has excellent tracking performance and a stable phase center for GPS (L1, L2, L2C, L5), and GLONASS (G1, G2). This antenna is listed in the NOAA GPS Antenna Calibration tables, as NCT-ANT3001A. The robust housing assembly features a flat mounting surface with four mounting holes and a downward facing TNC connector. This antenna is also certified to 70,000 feet, and is TSO-C144 certified (see *Specifications* for restrictions).



## Controller

The SF-3050 GNSS sensor is designed for use with an external controller solution connected via one of two Positronic COM ports<sup>1</sup> or Bluetooth.

This may be accomplished using a PC, Tablet PC, or Personal Digital Assistant (PDA) and a software program that implements the rich control language defined for NavCom GNSS products. Refer to the user guide of your controller solution for further information. NavCom lists several application software solutions on our website:

<http://www.navcomtech.com/Support/ApplicationSoftware.cfm>

In addition, NavCom provides a Windows™ based software utility, StarUtil 3000, with the receiver.

The *StarUtil 3000 User Guide*, P/N 96-310029-3001, is available on-line at <http://www.navcomtech.com/Support/DownloadCenter.cfm?category=manuals>.

<sup>1</sup>For initial configuration

Included Items



Figure 46: SF-3050 Supplied Equipment

Table 5: Supplied Equipment


1	SF-3050 GNSS Sensor (P/N 92-310413-3001LF)
2	SF-3050 GNSS Sensor (w/out Bluetooth) (P/N 92-310413-3003LF)
3	GNSS Antenna Cable, 12 ft (P/N 94-310261-3012LF)
4	Positronic 9-Pin Female Universal AC/DC Power Adapter 110-220VAC, 12VDC, 1.50A. (P/N 82-020007-3001LF)
5	Positronic 9-Pin Male to DB9S (RS-232/RS-422/1PPS) Data Cable, 6 ft. (P/N 94-310260-3006LF)
6	Positronic 9-Pin Male to USB 2.0 Device Plug, 6 ft (P/N 94-310266-3006LF)
7	Mounting Brackets, 2. (P/N 88-310442-3001LF)
8	Early Production Units: Positronic 9-Pin Female Unterminated Power Cable Without Filter, 10ft (P/N 94-310262-3010LF) {Not Shown} Later Production Units: Positronic 9-Pin Female Unterminated Power Cable With Filter, 10ft (P/N 94-310274-3010LF) {Not Shown}
9	SF-3050 Product Configuration USB Flash Drive. Contains: Software Options file, Firmware file, User Profiles, User Guides, Brochures, Software Utilities, Technical Papers, and if purchased, a StarFire License file. (P/N 82-043000-0001) {Not Shown} <i>Important:</i> Refer to Chapter 1 for steps to enable the functionality of the SF-3050 via the USB flash drive.
10	Quick Start Guide (P/N 96-310033-3001) {Not Shown}
11	American 2-Pin AC power Cord, 10 ft (P/N 73-200002-0001LF) {Not Shown}



*Figure 47: Rover, Base, and Airborne Antennae*

*Table 6: SF-3050 Antennae*

1	Rover GNSS Antenna (P/N 82-001020-3001LF)
2	Airborne GNSS Antenna (P/N 82-001022-3001LF)
3	Base GNSS Antenna (P/N 82-001021-3001LF)

 The SF-3050 GNSS sensor must be ordered with the Rover, Base, or Airborne antenna.

## Applications

The SF-3050 GNSS receiver meets the needs of a large number of applications. Depending on the purchased software bundle or individual options, the applications include, but are not limited to:

### ■ Offshore

- ✓ Nautical Stationkeeping
- ✓ Dynamic Positioning
- ✓ Dredging and Offshore Construction
- ✓ Deep Water Survey

### ■ Machine Control and Vehicle Navigation

- ✓ Towed Implement Guidance
- ✓ Construction Machine Control – Blade Control and Grading
- ✓ Railway, Ship, and Aircraft Precision Tracking
- ✓ Port Operations and Container Tracking

### ■ Land Survey and GIS

- ✓ Boundary Survey
- ✓ Topographical Surveys in Rough Terrain
- ✓ Construction Site Stake-out
- ✓ High-Accuracy Data Collection for Post-Processing
- ✓ Hydrographic Survey

### ■ Military Applications

- ✓ Non-Weaponized Military Positioning Applications
- ✓ Unmanned Systems
- ✓ Oceanographic Survey and Research

### ■ Specialty Applications

- ✓ Aerial – Photogrammetric Survey
- ✓ High-Value Asset Location and Tracking
- ✓ Positioning in Mining Applications
- ✓ Continuously Operating Reference Stations
- ✓ Structural Monitoring
- ✓ Real-time Positioning Applications
- ✓ OEM Integration

NavCom lists several application software solutions on our website:

<http://www.navcomtech.com/Support/ApplicationSoftware.cfm>

## Unique Features

The SF-3050 GNSS sensor has many unique features:

### ■ Performance Upgrade Path

The SF-3050 is designed with a robust and long-term performance upgrade path to meet changing needs via software upgrades. Increased functionality does not typically require



the costly purchase of additional hardware. The SF-3050 software-enabled features, bundled or purchased individually, cover a wide variety of applications.

#### ■ StarFire

The ability to receive NavCom's unique StarFire<sup>1</sup> correction service is fully integrated within each unit (no additional equipment required). StarFire has several performance levels. Modes include: GPS, GNSS, or LP (see Specifications). A single set of corrections are used globally enabling a user to achieve sub-decimeter level positioning accuracy without the need to deploy a separate base station, thus saving time and capital expenditure.

StarFire position outputs are referenced to the ITRF-2014 datum (default) and can be steered to WGS-84.

#### ■ StarFire Over IP

StarFire corrections can also be received via the internet (requires v3.2.10 or later firmware). This feature allows the user to request messages from an independent StarFire server/caster by means of Ethernet interface. The user can select four mount points and can choose between three data delivery rates for maximum reliability.

#### ■ Over The Air StarFire Licensing

Over The Air StarFire Licensing is the easiest way to install a StarFire license. The installation of a purchased license is accomplished via radio broadcast. Over The Air StarFire Licensing is especially convenient for receivers in remote locations in the field.

#### ■ Web Server

The Web Server feature allows the user to access positioning information and control the receiver via a standard web browser (requires v3.3.7 or later firmware). Each receiver comes with a unique IP address that can be accessed from any computer using Firefox, Chrome, Safari or Internet Explorer. Easily accessible web pages can be used to view satellite data and configure a variety of functions.

#### ■ NCT RTK/UltraRTK

The RTK/UltraRTK algorithm developed by NavCom provides fast initialization and the NCT ultra compact binary data format for RTK/UltraRTK ensures robust data throughput.

The SF-3050 is capable of outputting or accepting legacy 0x5B (RTK) or 0x5E (UltraRTK) binary formats. Refer to the TRM for more details (see *Related Documents* in the fore-matter).

#### ■ Positioning Flexibility

The SF-3050 is capable of using WAAS, EGNOS, MSAS, GAGAN (RTCA/DO-229D compliant) code corrections via two internal Satellite Based Augmentation System (SBAS) channels. The SF-3050 automatically configures to use the most suitable correction source available and changes as the survey dictates (this feature can be overridden).

### ■ RTK Extend™

RTK Extend (separate software option required) enables continuous real-RTK/RTK level positioning accuracy during radio communication outages by utilizing NavCom's global StarFire corrections.

Traditionally, when an RTK rover loses communication with the base station, it is unable to provide centimeter position updates for more than a few seconds, resulting in user down-time and reduced productivity. With RTK Extend, a NavCom StarFire receiver operating in RTK mode can transition to RTK Extend mode and maintain centimeter level positioning during communication loss for up to 15 minutes. RTK Extend allows more efficient and uninterrupted work, enabling focused concentration on the work rather than the tools.

RTK Extend is a unique patented technique, not available on any other manufacturer's receivers.

### ■ Multi-Format RTK

Refer to Appendix E, Base Network RTK Configuration, in the *Sapphire Technical Reference Manual* for detailed instructions.

### ■ User-Defined Datum

Users can check the current datum (a reference surface to be used in defining the 3D coordinates of a position) or set a specific datum to be used as the position for all PVT data output. Refer to the *Sapphire Technical Reference Manual* and the *StarUtil 3000 User Guide* for detailed instructions on the use of the [DATUM] command.

### ■ Heading

The SF-3050 heading system consists of two SF-3050 receivers connected via a serial cable. Each receiver's antenna is located on the platform at the maximum possible separation. One of the units is configured as a moving base and computes its position 10 times a second using any available augmentation signal. The moving base outputs position and RTK measurement corrections to the other unit, which is configured as a heading rover. The heading rover computes the heading looking from the base antenna to the rover antenna and outputs the heading and position of both antennae up to a rate of 10 Hz. Applications include construction equipment such as excavators and marine applications such as dredging.

### ■ Coordinated Machines

An SF-3050 configured as a moving base is located on a reference platform. An SF-3050 configured as a rover is located on one or more additional platforms. All of the SF-3050 rovers are connected to the moving base via a wireless communication link. The moving base computes its position 10 times a second using any available augmentation signal. The moving base outputs position and RTK measurement corrections to the rovers. The rovers compute the range and bearing to the moving base and output the range and bearing, plus their position and the position of the moving base, at up to 10 times a second. Applications include those requiring the relative positions of two or more moving platforms, such as leader-follower vehicle applications or the relative positions of planes or marine vessels.

---

<sup>1</sup>Dependent on Bundle Options: Subscription and Software Option Required.

## ■ Data Sampling

GPS (L1, L2, L2C, L5), GLONASS (G1, G2), and SBAS (WAAS, EGNOS, MSAS, GAGAN) raw measurement data is up to 5Hz in the standard configuration for the SF-3050G and SF-3050S. An optional upgrade allows 10, 25, 50, and 100Hz raw measurement data via high speed ports.

For the SF-3050M, the raw measurement data is up to 25Hz in the standard configuration, with the optional upgrade of 50 and 100Hz.

The PVT (Position, Velocity, & Time) data is output at up to 5Hz in the standard configuration for the SF-3050G and SF-3050S. An optional upgrade allows 10, 25, 50, and 100Hz position updates for highly dynamic applications.

For the SF-3050M, the PVT data is output at up to 25Hz in the standard configuration, with the optional upgrade of 50 and 100Hz.

## ■ Internal Memory

See the *Sapphire Technical Reference Manual* and the *StarUtil 3000 User Guide* for detailed instructions on utilizing the SF-3050 internal memory flash drive.

## ■ Control of Power Consumption

Power consumption may be immediately reduced on the SF-3050 by disabling signals, as necessary, using the [TRACKINGMODE] command. Refer to the *Sapphire Technical Reference Manual* for instructions on using this command.

## ■ Continuously Operating Reference Station (CORS) Support

When optioned as an RTK Base Station, the SF-3050 is capable of computing and outputting RTK message streams in multiple formats and raw satellite measurement data for post-processing simultaneously. All message formats can be output on one of the high-speed USB or Ethernet ports, or messages can be distributed among any of the eight user ports. The following is an example of a real world application:

- ✓ Com 1: NavCom proprietary corrections (x5B, x5C, etc.); transmit via 900 or 400MHz radios
- ✓ Com 2: CMR+; transmit via 900 or 400MHz radios
- ✓ USB: Command and Control (StarUtil Interface)
- ✓ Bluetooth: Command and Control (StarUtil Interface)
- ✓ Ethernet Port 1: Command and Control (StarUtil Interface)
- ✓ Ethernet Port 2: RTCM v2.3
- ✓ Ethernet Port 3: CMR+
- ✓ Ethernet Port 4: RTCM v3.1 (can include Ntrip)

Refer to the *Sapphire Technical Reference Manual*, Appendix E, for RTK operation information.

For IGS or similar permanent Base applications, NavCom offers a Choke Ring antenna option to significantly reduce multipath errors on signal reception.

## ■ NTRIP Support

The generation of differential GPS correction data is usually done directly on the GPS receiver of a reference station, but this data can also be derived from observations obtained by networked reference stations. The combined data stream is then fed into a network computer and made available on the Internet.

Refer to Appendix E, RTCM Internet Protocol (NTRIP).

Also see the [NTRIPCLIENT], [NTRIPCONFIG], and [NTRIPSERVER] commands in the *Sapphire Technical Reference Manual* for detailed instructions.

## ■ GNSS Performance

The SF-3050 utilizes NavCom's Sapphire GNSS engine, which incorporates several patented innovations. Sapphire's industry leading receiver sensitivity provides more than 50% signal to noise ratio advantage over competing technologies. This results in improved real time positioning, proven through independent tests, when facing various multipath environments.

## ■ Rugged Design

Units have been tested to conform to MIL-STD-810F for low pressure, solar radiation, rain, humidity, salt-fog, sand, and dust. In addition, the unit is IP certified to the IP67 level (compliant only when cables are connected).

The SF-3050 is also certified<sup>1</sup> to comply with the relevant type approval procedures for marine equipment of the Marine Equipment Directive (MED) 96/98/EC.

The rugged design of the SF-3050 system components provides protection against the harsh environments common to areas such as construction sites, offshore vessels, and mines. In some extreme shock and vibration applications, additional isolation hardware may be required.

<sup>1</sup>Requires use of NavCom's supplied AC/DC converter.



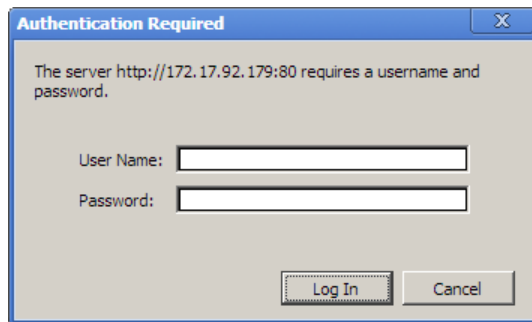
## Chapter 3..... Web Server

This chapter details the use of the Web Server, the internet-based interface between the SF-3050 and the user. This interface can be used instead of the StarUtil software if desired.

- ☐ WebServer pages can be viewed using several different browsers and vary slightly based on the browser in use. Optimal results are obtained by using Mozilla Firefox® or Google Chrome®. The illustrations in this chapter were made using Google Chrome® as the browser.

### Accessing the WebServer

Each SF-3050 receiver comes with a unique IP address. See Chapter 1 setup Web Server. Typing the IP address into the Address box on the browser page will open a security screen.



*Figure 48: Windows Security Screen*

A default user name and password is pre-programmed into the receiver’s memory consisting of the following:

- User Name: admin
- Password: admin

This default user name automatically has ADMIN level access, which enables the user to view all webpages including the Input Terminal page and the Manage Accounts page. The user name and password for this default account can be changed in the Manage Accounts page. The password can be changed in the Change Password page. New user names, passwords and access levels (USER and TECH) can be added in the Manage Accounts page.

- ☐ This ADMIN account cannot be deleted or given a different access level in the Manage Accounts page.

## Welcome Page

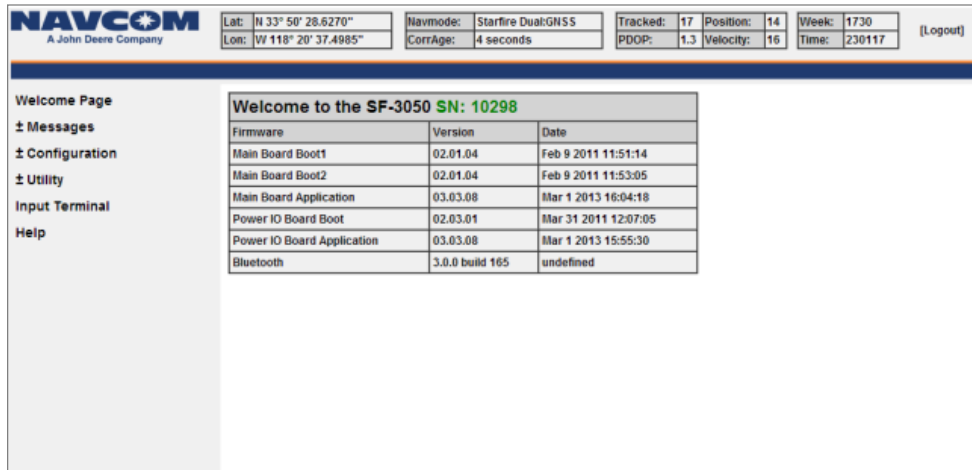


Figure 49: Welcome Page

The Welcome Page shows the following information:

- ✓ Serial Number of the SF-3050 receiver
- ✓ Firmware with version and date installed
- ✓ Bluetooth version

## Receiver Location Bar

A bar across the top of the screen displays the current position and status of the receiver. This status is continually updated as new information is received from the satellites.

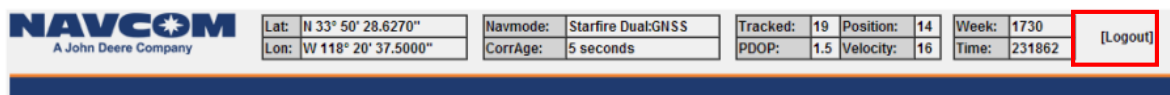


Figure 50: Location Bar



This bar appears across the top of every WebPage.

A Logout button is located in the upper right hand corner of the bar. The Logout function will allow the user to perform the following:

- ✓ Close out the web page feature without having to exit the browser.
- ✓ Log out of one user name and access level and log in with another user name and access level.
- ✓ Access another internet webpage while the webserver webpage is still active.



## Main Menu

The main menu located on the left hand side of the welcome page shows links to the web pages available on the WebServer. Click each heading to open the desired menu.

The screenshot shows the web interface for the SF-3050 GNSS. At the top, there is a header with the NAVCOM logo and a status bar containing the following information:

- Lat: N 33° 50' 28.6274"
- Long: W 118° 20' 37.4990"
- Basemode: Starfire Dual:GNSS
- ContAge: 3 seconds
- Tracked: 17
- Position: 15
- Week: 1730
- PDOP: 1.2
- Velocity: 16
- Time: 2/20/11
- [Logout]

Below the header, the main content area is divided into two sections:

- Left Section (Expanded Menu Bar):** A vertical list of menu items, each preceded by a minus sign. The items are: Welcome Page, Messages, PVT Data, Channel Status, Measurements, StarFire Status, StarFire Almanac, NMEA View, Skyplot, Configuration, Schedule Messages, NTRIP Config, Navigation Modes, RTK Mode, Self Survey, Antenna, Utility, View / Load Profile, Firmware Update, Data Logging, Almanac Loader, Options and License, Change Password, Manage Accounts, Input Terminal, and Help. The entire menu bar is enclosed in a red rectangular border.
- Right Section (Welcome Message):** A table titled "Welcome to the SF-3050 SN: 10298" with the following data:

Firmware	Version	Date
Main Board Boot	02.01.04	Feb 9 2011 11:51:14
Main Board Boot2	02.01.04	Feb 9 2011 11:53:05
Main Board Application	03.03.09	Mar 1 2013 16:04:19
Power IO Board Boot	02.03.01	Mar 31 2011 12:07:05
Power IO Board Application	03.03.08	Mar 1 2013 15:55:30
Bluetooth	3.0.0 build 165	undefined

Figure 51: Welcome Page with Expanded Menu Bar

- Welcome Page
- Messages
- ✓ PVT Data
- ✓ Channel Status
- ✓ Measurements
- ✓ StarFire Status
- ✓ StarFire Almanac
- ✓ NMEA View
- ✓ Skyplot
- Configuration
- ✓ Schedule Messages
- ✓ NTRIP Config
- ✓ Navigation Modes
- ✓ RTK Mode
- ✓ Self Survey
- ✓ Antenna

- Utility
  - ✓ View/Load Profile
  - ✓ Firmware Update
  - ✓ Data Logging
  - ✓ Almanac Loader
  - ✓ Options and License
  - ✓ Change Password
  - ✓ Manage Accounts
- Input Terminal
- Help

Messages

■ PVT Data

The PVT Data screen provides a quick view of the receiver’s current position, velocity, estimated error, navigation status, antenna offset and solid earth tide.

Position			Velocity			Error Estimate			
Lat:	N 33° 50' 28.2412"		East:	0.0010 m/s		Position FOM:	42 cm		
Lon:	W 118° 20' 37.0239"		North:	0.0000 m/s		Time FOM:	5		
Ht:	8.682 m		Up:	0.0010 m/s		NORTH:	0.27 m	PDOP:	1.2
Alt:	44.671 m		Ground Speed:	0.0010 m/s		EAST:	0.32 m	HDOP:	0.6
Datum:	ITRF 2008 - GGM02		Ground Track:	0.00°		UP:	0.53 m	VDOP:	1.0
Navigation Status			Antenna Offset						
Summary Nav Status:	Nav valid / No Doppler		Phase Center(H1):	Not Applied					
Nav Mode:	Starfire Dual:GNSS : 3D : Dual freq		Slant Range:	Not Applied					
Constellation:	GPS / GLONASS		Radius Antenna Body:	Not Applied					
Starfire Engine Mode:	GPS and GNSS Modes; GNSS Takes Priority		Solid Earth Tide						
Starfire Source:	INTERNAL		North:	.50 mm					
Correction Age:	6 sec		East:	10 mm					
Age Limit:	1200 sec		Up:	120 mm					

Figure 52: PVT Screen

The PVT screen shows the following information:

- ✓ *Position*: Displays altitude, Longitude, Height, Altitude and Datum. Datum displays the selected reference model.
- ✓ *Velocity*: The speed over ground and direction of travel (true, not magnetic).
- ✓ *Navigation Status*: Displays Summary Nav Status, Nav Mode, Constellation (either GPS or GPS/GLONASS), StarFire Engine Mode, StarFire Source, Correction Age and Age Limit
  - *Summary Nav Status*: Various indications of nav status, including Nav valid, Nav invalid, No Doppler, Doppler Used, etc.

- *Nav Mode*: Various indications of nav mode, for example, StarFire Dual:RTG; 3D: Dual freq; Non differential: 3D: Dual freq, etc.
  - *Constellation*: GPS or GPS/GLONASS
  - *Correction Age*: The age of the current aided navigation correction in seconds. This value changes depending on the correction source and the correction interval. A few seconds is okay, but many seconds indicate the fix is degrading over time, and becoming less and less accurate.
  - *Age Limit*: The maximum amount of time in seconds the received correction will be used in case of an outage or drop in the reception of corrections. The maximum age limit is 100 seconds. The default is 300 seconds for SBAS (WAAS, EGNOS, MSAS, GAGAN) and RTCM type 1 or 9. The default is 1200 seconds for RTG (StarFire).
- ✓ *Error Estimate*
- *Position FOM*: The position Figure Of Merit is the estimated uncertainty in the navigation solution. FOM is the same as the One sigma error estimate. Refer to the Sapphire Technical Reference Manual (see Related Documents in the formatter).
  - *Time FOM*: 10x TDOP
  - *DOP*: Dilution of Precision. A class of measures of the magnitude of error in GPS position fixes due to the orientation of the GPS satellites with respect to the GPS receiver. There are several DOPs to measure different components of the error: GDOP (Position and Time), PDOP (Dimensional Position), HDOP (Horizontal Position), VDOP (Vertical Position), and TDOP (Time).
- ✓ *Antenna Offset*: If applicable.
- ✓ *Solid Earth Tide*: Displays earth's deformation vector in three dimensions, north, east and vertical.

## ■ Channel Status

The Channel Status screen provides instantaneous diagnosis of signal quality and performance for the tracked satellites in three constellations: GPS, GLONASS, and SBAS.

CHNL STATUS1B - GPS Constellation																				
PRN	AZ	EL	CH (L1CA)	ST	C/N0	CR	AL	TM	CH (L1P1)	ST	C/N0	CR	AL	TM	CH (L2)	ST	C/N0	CR	AL	TM
1	282	51	8	LOCK	52.25	1	N	3	8	LOCK	51	0.94	N	3	9	COHY	47.75	0.99	N	3
11	245	41	4	LOCK	52.5	0.99	N	3	4	LOCK	51	0.88	N	3	5	COHY	46	1	N	3
14	52	26	10	LOCK	46	0.97	N	3	10	LOCK	44.5	0.75	N	3	11	COHY	40.75	1	N	3
20	310	29	14	LOCK	49	1	N	3	14	LOCK	48	0.8	N	3	15	COHY	42	0.98	N	3
22	111	22	16	LOCK	49.25	0.97	N	3	16	LOCK	48.5	0.95	N	3	17	COHY	44	1	N	3
23	260	15	6	LOCK	46.75	0.99	N	3	6	LOCK	44.25	0.83	N	3	7	COHY	41.25	0.97	N	3
25	59	10	18	LOCK	42.25	1	N	3	18	LOCK	39.25	0.41	N	3	19	COHY	37	0.9	N	3
30	149	13	20	LOCK	46	0.97	N	3	20	LOCK	45	0.75	N	3	21	COHY	39.25	0.92	N	3
31	109	71	0	LOCK	54.25	1	N	3	0	LOCK	53.25	0.92	N	3	1	COHY	50	0.99	N	3
32	325	54	2	LOCK	51.5	1	N	3	2	LOCK	50.25	0.91	N	3	3	COHY	48.25	0.96	N	3

CHNL STATUS1B - GLONASS Constellation																				
PRN	AZ	EL	CH (G1C)	ST	C/N0	CR	AL	TM	CH (G2C)	ST	C/N0	CR	AL	TM	CH (G1P)	ST	C/N0	CR	AL	TM
1	16	55	25	LOCK	52	0.98	N	3	40	LOCK	36	0.99	N	3	-	-	-	-	-	-
2	313	21	26	LOCK	47.75	0.99	N	3	41	LOCK	33.75	1	N	3	-	-	-	-	-	-
10	31	22	29	LOCK	47	0.98	N	3	30	LOCK	30.75	0.99	N	3	-	-	-	-	-	-
11	86	64	33	LOCK	51.75	0.99	N	3	42	LOCK	37	0.99	N	3	-	-	-	-	-	-
12	176	34	24	LOCK	51.5	1	N	3	43	LOCK	41.5	0.99	N	3	-	-	-	-	-	-
17	294	17	31	LOCK	45.5	0.99	N	3	27	LOCK	35.75	0.98	N	3	-	-	-	-	-	-
24	240	14	38	LOCK	45	0.98	N	3	39	LOCK	36	0.99	N	3	-	-	-	-	-	-

CHNL STATUS1B - SBAS Constellation																				
PRN	AZ	EL	CH (L1CA)	ST	C/N0	CR	AL	TM	CH (L1P1)	ST	C/N0	CR	AL	TM	CH (L2)	ST	C/N0	CR	AL	TM
135	205	47	49	LOCK	53.25	0.99	N	15	-	-	-	-	-	-	-	-	-	-	-	-
138	160	48	50	LOCK	52.75	0.95	N	15	-	-	-	-	-	-	-	-	-	-	-	-

Figure 53: Channel Status Screen

The data below is displayed for each channel on the GPS, GLONASS, and SBAS windows. Differences between the constellations are identified.

- ✓ **PRN:** The satellite number assigned to each channel.
- ✓ **GPS:** The valid range is 1-32. (The receiver allocates the range of 1-37, with 33-37 reserved for expansion.)
- ✓ **GLONASS:** The valid range is 1-24.
- ✓ **SBAS:** The valid range is 120-138.
- ✓ **AZ:** Azimuth. The horizontal angle of the satellite relative to the receiver position in reference to North ranging from 0 (360) to 359 degrees.+
- ✓ **EL:** Elevation. The vertical angle of the satellite off the horizon ranging from 0 degrees to a zenith of 90 degrees.
- ✓ **CH (Code Type):** The channel number of the receiver, within a range of 0 – 53. The code types tracked by the channel are:
  - **GPS:** L1CA, L1P1, L2, L2C, and L5 based on the [TRACKINGMODE] command settings
  - **GLONASS:** G1C, G2C, G1P, and G2P based on the [TRACKINGMODE] command settings
  - **SBAS:** L1CA (These code types are displayed, but don't apply: L1P1, L2, L2C, and L5.)
- ✓ **ST:** Status. The channel tracking status of each channel. The status code LOCK means the channel is locked up for measurement type and satellite, measurements are ready.
- ✓ **C/No:** Signal-to-Noise. The signal-to-noise value varies depending on satellite elevation and any obstructions between the satellites and the receiver. The typical

performance range for C/N0 for all displayed L1/G1 (GPS/GLONASS) channels is 46dB to 52dB, although higher and lower values can be noted. The C/N0 for C/A and G1 is the same. G2 is similar to P2 C/No (6 [dB-Hz] less than G1). L1P is 3dB lower than CA, and L2 is 6dB lower than CA. A value > 50 is typical of a satellite with 50° elevation or higher and a clear view of the sky.

- ✓ **CR:** Costas Ratio: the estimate of maximum error in phase measurement. The Costas Ratio value has a range of 100 to -100.
- ✓ **AL:** Almanac. Y = almanac is available for the position solution. N = no almanac
- ✓ **TM:** The search timeout; i.e. the number of seconds before the search for the satellite is stopped.

■ **Measurements**

The MEAS1B output stream contains raw measurement data collected from the receiver’s tracking channels. Measurements are tracked from both the GPS/SBAS constellation and the GLONASS Constellation. Raw measurements can be post-processed to achieve precise point positions.

MEAS1B - GPS Constellation															
PRN	CA (m)	L1-CA (m)	P1-CA (m)	P2-CA (m)	L2-CA (m)	L2C-CA (m)	L2C (code)-CA (m)	CA C/No (dB)	P2 C/No (dB)	L1CA Doppler (c/s)	L2P Doppler (c/s)	L5Q-CA (m)	L5-CA (m)	L5Q C/No (dB)	L5Q Doppler (c/s)
1	21215637.530	-1.509	-0.070	3.770	-5.966	-	-	52.000	48.000	467.803	364.522	-	-	-	-
11	22051174.850	-2.293	0.330	0.580	-23.583	-	-	53.000	46.000	-1579.795	-1231.009	-	-	-	-
14	23207375.210	-0.810	0.500	1.100	-24.149	-	-	47.000	41.000	-2450.975	-1909.851	-	-	-	-
20	22659226.110	-0.335	0.220	0.990	-20.201	-	-	49.000	42.000	2842.291	2214.772	-	-	-	-
22	23360605.380	-0.690	-0.330	-0.250	-17.220	-	-	50.000	44.000	-2547.562	-1985.114	-	-	-	-
23	24265383.900	2.901	0.250	0.720	-21.509	-	-	47.000	41.000	2385.234	1858.624	-	-	-	-
25	24589618.610	-5.032	0.500	6.400	-12.574	-	-	42.000	37.000	-45.036	-35.093	-	-	-	-
30	24516011.710	1.888	-0.820	3.310	-17.001	-	-	46.000	39.000	3125.774	2435.668	-	-	-	-
31	20294894.650	-0.582	0.610	-0.040	-23.410	-	-	55.000	50.000	62.246	48.503	-	-	-	-
32	21404191.940	-0.307	-0.280	1.340	0.468	-	-	52.000	46.000	1503.124	1171.245	-	-	-	-

MEAS1B - GLONASS Constellation													
PRN	G1C (m)	L1C-G1C (m)	L1P-G1C (m)	P1-G1C (m)	P2-G1C (m)	G2C-G1C (m)	L2-G1C (m)	G1C C/No (dB)	G2C C/No (dB)	G1 Doppler (c/s)	G2 Doppler (c/s)	P1 Doppler (c/s)	P2 Doppler (c/s)
1	20067983.320	-1.265	-	-	-	4.470	3.160	52.000	37.000	651.263	506.538	-	-
2	22533912.800	-2.255	-	-	-	7.740	5.023	48.000	34.000	2743.363	2133.727	-	-
10	22439719.010	2.662	-	-	-	8.740	1.905	47.000	31.000	-3512.254	-2731.753	-	-
11	19596722.100	0.106	-	-	-	5.630	0.878	52.000	38.000	11.997	9.331	-	-
12	21374540.640	0.578	-	-	-	8.290	5.293	51.000	42.000	3858.470	3001.032	-	-
17	22830297.740	1.626	-	-	-	2.040	-2.603	47.000	37.000	-896.219	-697.059	-	-
24	23269080.890	-1.657	-	-	-	10.970	-2.179	44.000	37.000	-3353.519	-2608.293	-	-

Figure 54: Measurements Screen

GPS/SBAS Constellation

- ✓ **PRN:** The satellite number assigned to each channel.
  - GPS: The valid range is 1-32. (The receiver allocates the range of 1-37, with 33-37 reserved for expansion.)
  - SBAS: The valid range is 120-138.
- ✓ **CA (m):** Coarse / Acquisition code. The number of meters (range measurement) to the satellite.
- ✓ **L1-CA (m):** The L1 frequency minus the CA measurement.

- ✓ P1-CA (m): The P1 pseudorange minus the CA measurement.
- ✓ P2-CA (m): The P2 pseudorange minus the CA measurement.
- ✓ L2-CA (m): The L2 frequency minus the CA measurement.
- ✓ L2C-CA (m): The L2C frequency minus the CA measurement.
- ✓ L2C(code)-CA (m): The L2C code measurement minus the CA measurement.
- ✓ CA C/No (dB): Carrier-to-noise ratio. The signal strength indicator.
- ✓ P2 C/No (dB): The P2 measurement Carrier-to-noise ratio. The signal strength indicator.
- ✓ L1CA Doppler (c/s): The representation (in cycles per second) of the motion toward or away from the L1CA signal.
- ✓ L2P Doppler (c/s): The representation (in cycles per second) of the motion toward or away from the L2P signal.
- ✓ L5Q-CA (m): The L5Q measurement minus the CA measurement.
- ✓ L5-CA (m): The L5 measurement minus the CA measurement.
- ✓ L5Q C/No (dB): The L5Q measurement Carrier-to-noise ratio. The signal strength indicator.
- ✓ L5Q Doppler (c/s): The representation (in cycles per second) of the motion toward or away from the L5Q signal.

Normally, the SF-3050 receiver locates and tracks SBAS satellites at run-time, periodically building a list of the satellites that will contribute to the navigation solution. However, a user can create a fixed list of SBAS satellites to track. Creating a list that does not contain any visible satellites disables the use of SBAS corrections in the navigation solution.

#### GLONASS Constellation

- ✓ PRN: The satellite number assigned to each channel. The valid range for GLONASS is 1-24.
- ✓ G1C (m): The civilian G1 code.
- ✓ L1-G1C (m): The L1 frequency minus the G1C measurement.
- ✓ P1-G1C (m): The P1 pseudorange minus the G1C measurement.
- ✓ P2-G1C (m): The P2 pseudorange minus the G1C measurement.
- ✓ G2C-G1C (m): The civilian G2 code measurement minus the G1C measurement.
- ✓ L2-G1C (m): The L2 frequency minus the G1C measurement.
- ✓ G1C C/No (dB): The G1C measurement Carrier-to-noise ratio. The signal strength indicator.
- ✓ G2C C/No (dB): The G2C measurement Carrier-to-noise ratio. The signal strength indicator.
- ✓ G1 Doppler (c/s): The representation (in cycles per second) of the motion toward or

away from the G1 signal.

- ✓ G2 Doppler (c/s): The representation (in cycles per second) of the motion toward or away from the G2 signal.
- ✓ P1 Doppler (c/s): The representation (in cycles per second) of the motion toward or away from the P1 signal.
- ✓ P2 Doppler (c/s): The representation (in cycles per second) of the motion toward or away from the P2 signal.



Doppler consists of the coarse Doppler from the satellite block adjusted by the delta Doppler in each of the associated signal blocks. To generate the true Doppler, add the coarse Doppler to the delta Doppler. Refer to the Sapphire Technical Reference manual (see Related Documents in the fore-matter).

■ **StarFire Status**

The SFSTATUS1B message tracks the status of each of the StarFire Satellite signals.

SFSTATUS1B Message	
Signal Strength:	11.72
Good Packet Percentage:	100.00 %
Idle Packet Percentage:	11.08 %
Re-synchronization Counts:	5
Signal Status:	TRCK
StarFire License Status:	Active
Frequency Offset:	188 Hz
AGC Voltage:	0.86 V
Satellite ID:	402

*Figure 55: StarFire Status Screen*

- ✓ Signal Strength: This field represents the signal to noise ratio for the StarFire channel in dB/Hz. The LSB represents 0.25 dB/Hz.
- ✓ Good Packet Percentage: This field displays percentage of good packets in received StarFire data. It is updated every 20 seconds.
- ✓ Idle Packet Percentage: This field displays percentage of idle packets in received StarFire data. It is updated every 20 seconds.
- ✓ Re-synchronization Counts: This field represents the StarFire parser packet framing re-synchronization count.
- ✓ Signal Status: Indicates if the signal is being tracked.
  - TRCK (green background) indicates that the signal is locked in.
  - IDLE indicates that the signal is not being tracked.
  - SGDP indicates that the signal is being detected.
  - SGDF (red background) indicates that the signal has failed.
  - ACQ indicates that the signal is being acquired.
  - PLIN indicates the signal is being pulled in.

- ✓ StarFire License Status: Active indicates StarFire option is licensed and enabled.
- ✓ Frequency Offset: This field displays the difference between the expected baseband frequency and the tracked baseband frequency, in Hz.
- ✓ AGC Voltage: Automatic Gain Control. Indicates the strength of the signal. The higher the voltage, the weaker the strength. The desired range is 0.8 to 1.2. Maximum is 2.5.
- ✓ Satellite ID: This field represents the current StarFire satellite ID, in the range 320 to 680.

■ **StarFire Almanac**

This message outputs the StarFire over the air (OTA) almanac that is currently in use.

STARFIREALM1B						
Set Num	16					
Number of Records	7					
STARFIREALM1B Records						
Record Id	Health	NetID	Longitude			
0	1	0	-98	-	-	-
1	1	1	-54	-	-	-
2	1	1	-15.5	-	-	-
3	1	0	25	-	-	-
4	1	1	64	-	-	-
5	1	0	143.5	-	-	-
6	1	1	178	-	-	-

Figure 56: StarFire Almanac screen

- ✓ Record ID: Satellite record identifier number. Describes the ordering of the records in a set. Records with the same record ID imply no particular order. Almanac updates are delivered every hour.
- ✓ Health: Indicates health and status of satellite:
  - 0 = Unhealthy
  - 1 = Healthy
- ✓ NetID: Network identification number.
  - 0 = Net 1
  - 1 = Net 2
- ✓ Longitude: Indicates the position of the satellite in degrees of longitude. (Range = -180 to +180)

■ **NMEA View**

The SF-3050 does not output NMEA messages by default. They must be scheduled by the user.

- ☐ NMEA messages are scheduled using the Schedule Messages page located under the Configuration tab on the Welcome Page.






Clicking the Enable box beside the desired NMEA message under the Sentence ID column will show the message output. The format of the message will appear under the Sentence Contents column.

NMEA Sentences		
Sentence ID	Enable	Sentence Contents
DTM	<input checked="" type="checkbox"/>	GNDTM,999,.....,999*54
GBS	<input type="checkbox"/>	-
GFA	<input type="checkbox"/>	-
GGA	<input type="checkbox"/>	-
GLL	<input type="checkbox"/>	-
GNS	<input type="checkbox"/>	-
GRS	<input type="checkbox"/>	-
GSA	<input type="checkbox"/>	-
GST	<input type="checkbox"/>	-
GSV	<input type="checkbox"/>	-
HDT	<input type="checkbox"/>	-
RMC	<input type="checkbox"/>	-
ROT	<input type="checkbox"/>	-
RRE	<input type="checkbox"/>	-
VTG	<input type="checkbox"/>	-
ZDA	<input type="checkbox"/>	-
PNCTDTM	<input type="checkbox"/>	-
PNCTGGA	<input type="checkbox"/>	-
PNCTGST	<input type="checkbox"/>	-
PNCTMDE	<input type="checkbox"/>	-
PNCTSET	<input type="checkbox"/>	-

Note: This NMEA page updates each message sequentially.

Figure 57: NMEA View Screen

-  The DTM message automatically displays at the same rate as the GGA.
-  Refer to the *Sapphire Technical Reference Manual (TRM)* for detailed information on the output formats of NMEA messages and NavCom proprietary NMEA type messages (see *Related Documents* in the fore-matter). In addition, refer to the section, *NMEA Messages Overview*, in the TRM.
-  The NMEA View Screen page does not contain MLA or ALM due to the way they are output.

■ **Skyplot**

The Sky Plot tab displays the tracked satellite locations for each visible constellation. It provides an interface to select the constellations to be displayed. Each satellite is displayed on the Sky Plot by color and PRN: GPS = Green, GLONASS = Grey, SBAS = Orange, STARFIRE = Blue.

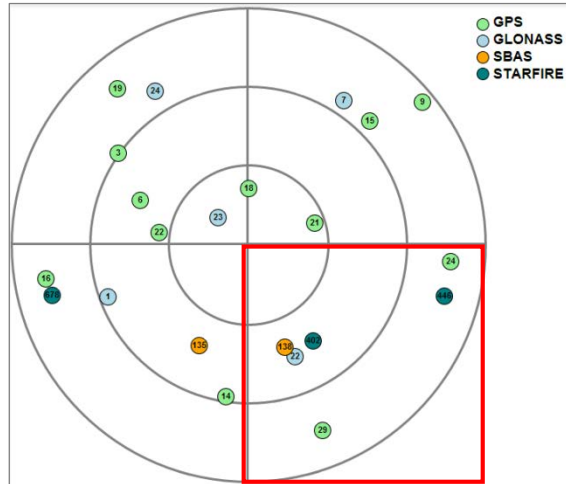


Figure 58: Skyplot Screen

Roll over a satellite (colored circle) to view a pop-up window showing PRN number (PRN), Elevation (Elev), and Azimuth (Azim).

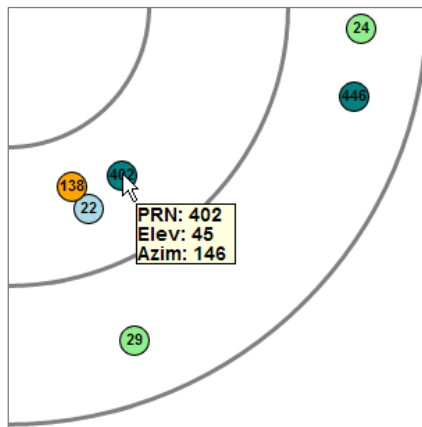


Figure 59: Skyplot Rollover Info

## Configuration

### ■ Schedule Messages

Output messages can be individually scheduled by highlighting the desired message and selecting port and rate of output.

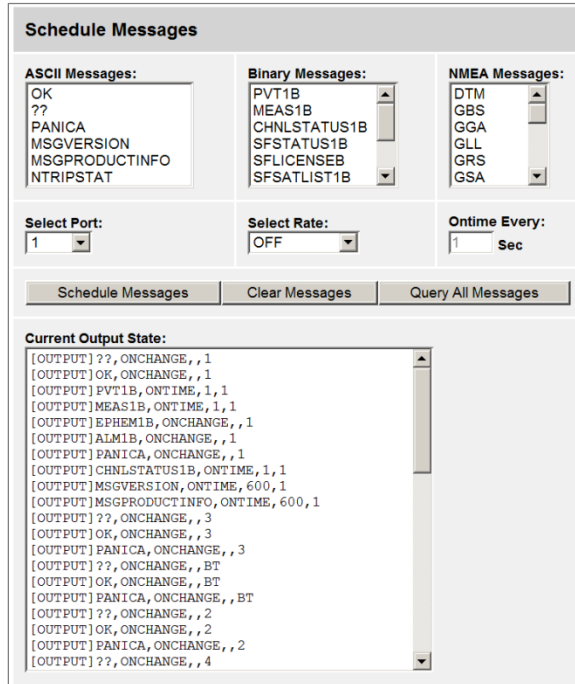


Figure 60: Schedule Messages Screen

- ✓ ASCII Messages: Click to highlight. Use the Select Port pulldown list to select the desired port or to display the current output on that port.
- ✓ Binary Messages: Click to highlight, then Select Rate: OFF, ONCHANGE or ONTIME
- ✓ NMEA Messages: Click to highlight, then enter Ontime rate in seconds.

Click one of the following buttons to complete the scheduling process:

- Schedule Message: Schedules the selected messages.
- Clear Message: Deselects all selected messages
- Query All Messages:



Only one message from each list can be selected at a time.

■ NTRIP Config

NTRIP CONFIG		
Caster Preset:	<input type="text" value="Starfire Settings"/>	CURRENT CONFIGURATION
Caster:	<input type="text"/>	
Port:	<input type="text" value="0"/>	0
Mount Point:	<input type="text"/>	
Username:	<input type="text"/>	
Password:	<input type="text"/>	
Send NMEA GGA:	<input type="text" value="Off"/>	OFF
Auto Connect As:	<input type="text" value="Off"/>	OFF
Corrections Port:	<input type="text" value="Eth"/>	ETH
Authentication:	<input type="text" value="Basic"/>	BASIC
<input type="button" value="Send Ntrip Config"/>		<input type="button" value="Refresh Current"/>
NTRIP CLIENT		
<input type="button" value="Connect"/>	<input type="button" value="Disconnect"/>	IDLE
NTRIP SERVER		
<input type="button" value="Connect"/>	<input type="button" value="Disconnect"/>	IDLE

Figure 61: NTRIP Config Screen

This screen configures the information that the NTRIP client or server needs to connect to an NTRIP caster. If no configuration information is specified, the current settings will be displayed.

- ✓ *Caster Preset*: Enables StarFire Settings.
- ✓ *Caster*: Specifies name of the NTRIP caster to connect to.
- ✓ *Port*: Specifies caster port number to connect to
- ✓ *Mount Point*: Specifies the name of the mount point to connect to.
- ✓ *User Name*: Required for authentication
- ✓ *Password*: Required for authentication
- ✓ *Send NMEA GGA*: Indicates whether transmission of NMEA GGA message is required.
- ✓ *Auto Connect*: Indicates whether or not NTRIP should try to connect automatically to a client or a server.
- ✓ *Correction Port*: Indicates name of local port to use for NTRIP connection.
- ✓ *Authentication*: Indicates whether to use BASIC or DIGEST authentication.
- ✓ *NTRIP CLIENT*: Connects/disconnects to NTRIP client mount point.

✓ **NTRIP SERVER:** Connects/disconnects to NTRIP server mount point.



The NTRIP client and server cannot both be active at the same time. An error message will be displayed if any keyword other than a status request or DISCONNECT is issued to one while the other is active.

Click the StarFire Settings button to automatically configure the NTRIP StarFireNetwork Caster.

NTRIP CONFIG	
Caster Preset:	Starfire Settings <span style="float: right;">CURRENT CONFIGURATION</span>
Caster:	NTRIP.StarfireNetwork.co
Port:	2101 0
Mount Point:	SFGNSS.15
Username:	
Password:	
Send NMEA GGA:	Off OFF
Auto Connect As:	Cient OFF
Corrections Port:	Eth ETH
Authentication:	Digest BASIC
<input type="button" value="Send Ntrip Config"/> <input type="button" value="Refresh Current"/>	
NTRIP CLIENT	
<input type="button" value="Connect"/> <input type="button" value="Disconnect"/> <span>IDLE</span>	
NTRIP SERVER	
<input type="button" value="Connect"/> <input type="button" value="Disconnect"/> <span>IDLE</span>	

Figure 62: NTRIP Config Screen with StarFire Settings enabled

Click the Send Ntrip Config button to enable the settings or click the Refresh Current button to return to the previous settings.

■ **Navigation Modes**

Provides access to navigation mode settings for the following modes:

- ✓ RTCM Code: Select On/Off
- ✓ SBAS: Select On/Off
- ✓ StarFire: Select On/Off and Internal/External.

SET NAVIGATION MODES		
		CURRENT NAVIGATION SETTING
RTCM Code:	On ▾	ON
SBAS:	On ▾	ON
StarFire:	On ▾ Internal ▾	ON , INTERNAL
<input type="button" value="Apply Navigation Settings to the Receiver"/>		

*Figure 63: Navigation Modes Screen*

Click Apply Navigation Settings to the Receiver button to enable the settings.

■ **RTK Mode**

Configures the RTK mode as follows:

RTKMODE CONFIG		
		CURRENT CONFIGURATION
Mode:	BaseRTCM1004 ▾	BASERTCM1004
Type:	▾	
ID:	1	1
Port:	2 ▾	2
Dynamics:	Static ▾	STATIC
Scheduling Type:	Auto ▾	AUTO
RTK-X Mode:	none specified ▾	not applicable
<input type="button" value="Set RTKMODE"/> <input type="button" value="Refresh Current"/>		

*Figure 64: RTK Mode Screen*

- ✓ Mode: Configures the mode as Rover or Base
- ✓ Type: For a rover, this is a required field. It is used to validate the Site ID based on the correction type. For a base, this field must be empty.
- ✓ ID: Set ID range for rover site ID and base station. Receiver will use default value if this field is empty.
- ✓ Port: Enter port number if base. This field must be empty for rover mode.
- ✓ Dynamics: This is an optional field. The default is static or none specified. When setting the base station to output moving base DGPS/RTK corrections or setting the moving base RTK rover, set this field to Dynamic.
- ✓ Scheduling Type: This is an optional field specifying if messages are automatically scheduled. The default setting is AUTO.
- ✓ RTK-X: This is an optional field specifying whether or not the user would like the receiver to transition into RTK-X mode. If the user does not specify this keyword, nothing changes and the receiver will stay in the current mode. ON indicates RTK-X is enabled. This is the default mode. OFF indicates RTK is disabled.

Click Set RTKMODE to change settings or Refresh Current to return to current settings.

■ **Self Survey**

This command performs a self survey operation by averaging the GPS receiver’s position over time and then applying that averaged position as the reference station position.

The receiver waits for a period of time (nominally 1400 minutes or 24 hours) to allow the RTG readings to “settle.” This means there will be no valid survey results until this time has passed. However, if the user specifies less than this value as the time limit, the survey will continue until complete.

The user can set the duration of the survey in minutes then, click the Start button to begin the survey, the Stop/Apply button to end the survey and the Cancel/Discard button to stop the survey and eliminate any results.

Self Survey Control			
Duration (min):	<input type="text" value="1440"/>	<input type="button" value="Start"/>	<input type="button" value="Stop/Apply"/>
<input type="button" value="Cancel/Discard"/>			
Self Survey Status			
Time:	503114.0000 sec	Current State:	off
Lat:	0.0000°	Sampled Positions:	0
Lon:	0.0000°	Duration to Survey:	0 sec
Ht:	0.0000 m	Remaining Time:	0 sec

Figure 65: Self Survey Screen



After the self survey is completed, the user must save the current profile. If the receiver reboots without saving the profile, the self survey position will be lost.

■ **Antenna**

Displays the appropriate bias adjustment values for the antenna model in use.

ANTENNA HEIGHT ADJUSTMENT		
		CURRENT ANTENNA HEIGHT SETTING
Enable/Disable Antenna Height Adjustment:	Disable ▾	OFF
- Antenna Phase Center Adjustment:	<input type="text"/>	none (-128 to +127 mm)
- Slant Range of Antenna Body:	<input type="text"/>	none (-32768 to +32767 mm)
- Radius of Antenna Body:	<input type="text"/>	none (-32768 to +32767 mm)
<input type="button" value="Configure Antenna Height"/>		

Figure 66: Antenna Height Adjustment Screen

- ✓ Height Adjustment: Indicates whether or not the antenna offset is applied.
- ✓ Phase Center Adjustment: The offset in millimeters from the physical center of the antenna (the element) to the Mechanical Reference Plane (MRP). The MRP is at the bottom of the BSW antenna mount. The range limits are -128 to 127mm.
- ✓ Slant Range of Antenna Body: For a pole, the vertical measurement in millimeters from the Mechanical Reference Plane (MRP) to the control point. For a tripod, the

measurement in millimeters from the edge of the antenna to the control point. The range limits are -32768 to 32767mm.

- ✓ Radius of Antenna Body: The measurement in millimeters from the physical center of the antenna to the edge of the antenna. For a pole, enter 0. For a tripod, the range limits are -32768 to 32767mm.

Utility

■ View/Load Profile

The SF-3050 receiver provides for storage of up to 20 user profiles in its non-volatile memory. Each user profile is stored with a name and contains a complete set of user-controlled configuration parameters. A profile can be selected from a profile list or retrieved from a computer file using the Choose File button. Once selected, a profile can be, saved, used or deleted.

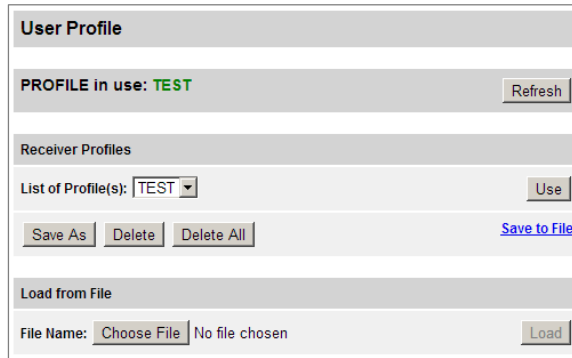
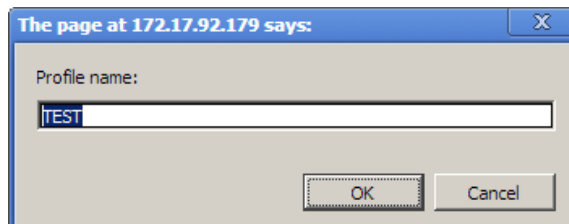


Figure 67: View/Load Profile Screen

- ✓ PROFILE in use: shows the name of the current profile in **green text**. Use the Refresh button to update the profile already in use.
- ✓ Receiver Profiles: Profiles can be selected from the List of Profile(s) pulldown list. Click the Use button to enable the selected profile. A selected profile can be deleted by clicking the Delete button. The Delete All button will delete all the profiles in the receiver’s memory.

☐ Once a profile has been deleted, its contents cannot be retrieved. There is no way to undelete it.

A new profile can be saved using the Save As function. Click the Save As button. A dialog box will open allowing the new profile to be named. Enter a name and click OK.





*Figure 68: View/Load Profile Screen*

The profile can also be saved to a browser file by clicking the Save to File link.



The Save to File function is only available with Firefox and Chrome browsers. This function will not work with Internet Explorer.

- ✓ Load from File: This function allows a profile to be uploaded to the receiver from a computer library. Click the Choose File button and select a file from the desired folder and click Load.

■ **Firmware Update**

This function allows firmware to be updated by uploading the most recent version from an external file, such as a USB drive.

Click the Choose File button to select the desired file. Click the Start Firmware Update button to initiate the upload process.

The progress of the upload will appear in the Firmware Update Status section.

Firmware File		
Product	Version	Date

Firmware Update Status	
Progress	
Bytes Loaded	
Status	

*Figure 69: Firmware Update Screen*


■ **Data Logging**

This feature allows data to be logged onto one of two internal memory drives, either an internal memory drive (Drive A) or an external USB memory device (Drive B).

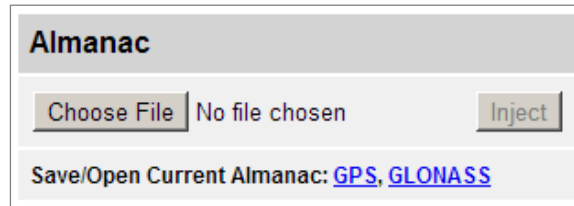
CONFIGURE INTERNAL LOGGING			
CURRENT INTERNAL FILE LOGGING STATUS			
Drive A:	Start	STOPPED	SD FLASH IS GOOD
Log On Drive A:			
Drive B:	Start	B: STOPPED	-
Log On Drive B:			

*Figure 70: Data Logging Screen*

- ✓ Drive A consists of the internal memory card of the SF-3050. It is formatted and segmented by using the [FSFORMAT] command (see [Upload WebPages](#) section in Chapter 1).
- ✓ Drive B consists of a USB memory device that can be configured as follows:
  1. Connect the 9-pin Male end of the USB Host cable (94-310271-3006LF) to the COM-2 port on the SF-3050. Plug a USB flash drive into the USB Female end of the cable.
  2. Type [USBMODE]DEVICE, MASS STORAGE in the Input Terminal screen. This command will format the USB device as Drive B.

 The USBMODE command automatically defaults to COMPORT. In order to log data onto a USB device, this command needs to be changed to MASS STORAGE.


■ **Almanac Loader**



*Figure 71: Almanac Loader Screen*

Click Choose File button to select a file from the desired directory. Click Inject to install the almanac in the receiver memory.

Click the GPS link to download the current GPS almanac into the browser. The GLONASS almanac can be downloaded the same way.

 The Save/Open Current Almanac feature is only available in Firefox and Chrome browsers.


■ **Options and License**

This screen lists the Software Options loaded into the receiver and the status of the primary and secondary license.

It is also possible for the user to upload current license software as well as other software options by using the File Upload feature.

Receiver Options and License				
<b>Software Options</b>		<b>Starfire License</b>	<b>Primary License</b>	<b>Secondary License</b>
Model:	SF-3050	License Active?:	Active	n/a
Serial No:	10298	Time Period:	Calendar	n/a
GPS:	L1 L2 L2C L5	Precision Type:	Precise	n/a
GLONASS:	G1 G2	Net Authorization:	All	n/a
StarFire:	Enabled	Issue Date:	8/31/2012 16:49:0	n/a
Nav:	100 Hz	Start Date:	8/31/2012	n/a
Data:	100 Hz	End Date:	8/31/2015	n/a
1PPS/Event Latch:	Enabled	Regional Selection:	World Wide	n/a
SBAS Corrections:	Enabled	Days Issued:	0	n/a
RTK Base:	Enabled	Days Remaining:	n/a	n/a
RTK Moving Base:	Enabled	<b>Starfire License</b>		<b>Point Radius</b>
RTK Rover:	Enabled	Latitude:	N 33° 50' 20"	
RTK Extend:	Enabled	Longitude:	W 118° 20' 30"	
Network RTK:	Enabled	Radius:	50 km	
Starfire Over IP:	Disabled			
<b>File Upload</b>				
<input checked="" type="radio"/> Key <input type="radio"/> File <input type="text"/>				
<input checked="" type="radio"/> Starfire License <input type="radio"/> Software Options <input type="button" value="Upload"/>				

Figure 72: Options and License Screen

 License updates and software options should be performed on a regular basis to ensure that the latest files are available for optimal use.

■ **Change Password**

This screen allows a user to change the password for the desired username as needed. The current user name is listed after Change Password. Only the password for that username can be changed with this feature. For other usernames and passwords, select the Manage Accounts screen.

Change Password: admin	
Old Password:	<input type="text"/>
New Password:	<input type="text"/>
Confirm Password:	<input type="text"/>
<input type="button" value="Change Password"/>	

Figure 73: Change Password Screen

 User names and passwords are both case sensitive.

■ **Manage Accounts**

Allows user to add, Remove or update users, change access levels and change usernames and passwords as needed.

Figure 74: Manage Accounts Screen

- ✓ There are three levels of access:
  - USER: Able to view all webpages with the exception of Input Terminal and Manage Accounts
  - TECH: Same as USER but is able to view Input Terminal
  - ADMIN: Able to view all pages and modify user accounts
- ✓ There can be at least 1 and at most 9 accounts consisting of:
  - 1 ADMIN
  - 0-8 USER or TECH
- ✓ The default ADMIN account programmed into the receiver is stored in the NVRAM but not stored in the profile.
- ✓ All accounts (with the exception of the admin account) must only be modified by using the web pages. They cannot be modified by using StarUtil3000. Only the admin account can have its password updated by StarUtil3000.
- ✓ Using the [NVCLEAR] command in the Input Terminal Screen will wipe out all user accounts except for the admin and will return the admin to the default password.
- ✓ The Manage Accounts screen is only available to Level Access TECH and ADMIN.

### Input Terminal

The Input Terminal provides a text box for the input of NavCom proprietary commands and queries.

With a user profile loaded and in use, the receiver configuration may be changed with individual commands via the Input Terminal. Commands entered via the Input Terminal

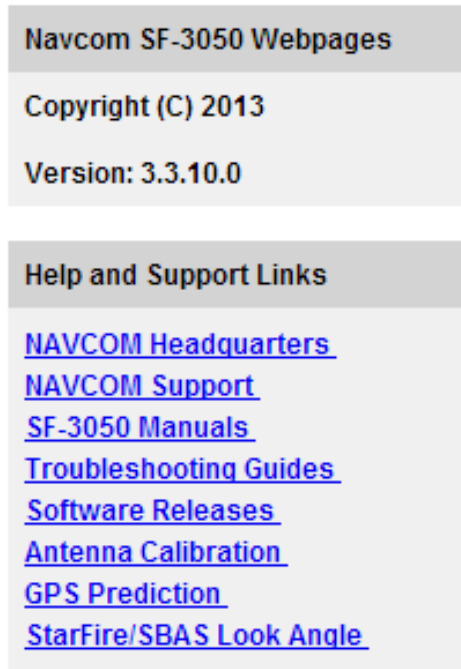
are not saved to NVRAM through a receiver power cycle. To maintain the new settings entered through the Input Terminal, the current settings must be retrieved and saved as a new user profile, or overwrite an existing profile before cycling receiver power.



*Figure 75: Input Terminal Screen*

**Help**

The Help function provides links to resources that can be useful in using the SF-3050 Webpages.



*Figure 76: Help Screen*

## Chapter 4..... Interfacing

This chapter details the SF-3050 GNSS sensor connectors, LED display, appropriate sources of electrical power, and how to interface the communication ports.

### Electrical Power

A rear panel 9-pin Positronic male connector provides electrical power to the SF-3050. Pin assignments are given in Table 7; see Figure 80 for pin location on the connector.

*Table 7: External Power Cable Pin-Out*

Pin	Signal
1	1PPS Out
2	Ignition
3	Event
4	Power Input 9 to 32VDC, 6W typical
5	Power Return
6	Power Input 9 to 32VDC, 6W typical
7	Not Used
8	Not Used
9	Signal GND

 Power may be applied to Pins 6 and 4. Pin 6 is primarily used.

The SF-3050 is supplied with:

- ✓ Universal AC/DC, 12V, 1.5A power adapter (P/N 82-020007-3001LF). See Figure 77.
- ✓ One of these Unterminated DC Power Cables:

- Early Production Units:

Positronic 9-Pin Female Unterminated Power Cable Without Filter, 10ft (P/N 94-310262-3010LF). See Figure 79.

- Later Production Units:

Positronic 9-Pin Female Unterminated Power Cable With Filter, 10ft (P/N 94-310274-3010LF). Not shown.



*Figure 77: Universal Power Adapter*

- ☐ Where MED type approved installations are required, the SF-3050 must be powered by the supplied AC/DC power adapter, or an approved DC to DC power converter.

This equipment is required to pass the conducted MED type emission criteria:

- Unterminated DC power cable with filter (P/N 94-310274-3010LF); supplied only with later SF-3050 production units.
- Approved DC to DC power converter. The converter isolates the SF-3050 power and chassis grounds.

Contact NavCom Customer Support for more information:

<http://www.navcomtech.com/Contact/ContactSupport.cfm>

- ☐ Replacement AC power cords are available through small appliance retailers (Radio Shack, Walmart, Best Buy, etc.). AC power cords for non-110VAC locales must be purchased locally.



*Figure 78: AC Power Cord*



*Figure 79: Unterminated Power Cable without Filter*

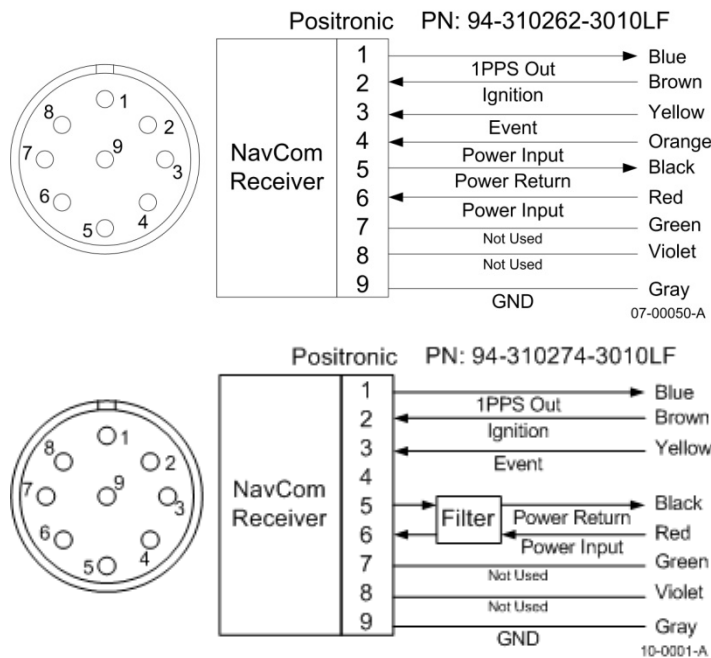
P/N 94-310262-3010LF is supplied with early SF-3050 production units (see Figure 79). It is a 10ft (3m) unterminated power cable without a filter used to connect directly to a DC source.

P/N 94-310274-3010LF is supplied with later SF-3050 production units. It is a 10ft (3m) unterminated power cable with a filter used to connect directly to a DC source.

Both unterminated power cables are fitted with a Positronic socket type (connector: FR11FP922LM0/AA; pin: FC422N6/AA). The wiring color code and pin assignments provided below apply to both cables.


*Table 8: DC Power Cable Pin Assignments*

Color	Signal	Pin No
Blue	1PPS Out	1
Brown	Ignition	2
Yellow	Event	3
Orange	Power Input	4
Black	Power Return	5
Red	Power Input	6
Green	Not Used	7
Violet	Not Used	8
Gray	GND	9



*Figure 80: Power Cable Pin Assignment*

The GNSS sensor is protected from reverse polarity with an inline diode. It will operate on any DC voltage between 9 and 32 VDC, 6 watts typical.

 Voltages less than approximately 6VDC will turn the unit off. Voltages from approximately 5VDC to < 7VDC will create a brown-out. In such case, power the unit on as follows:

1. *Ignition Pin:* Provide power  $\geq 9$  to 32 VDC



2. *Front Panel On/Off Switch*: Press the On/Off switch to turn the unit off. Then press and hold the On/Off switch in for more than 2 seconds to turn the unit on.



To set the receiver to power up as soon as power is applied to the DC Input port, use the ignition pin (2) in conjunction with DC power.



Voltages in excess of 34VDC will damage the unit. The power supply must be well conditioned with surge protection. Vehicular electrical systems which create voltage spikes in excess of 34VDC will benefit from providing power protection during vehicle engine power-up. This can be accomplished through a relay power-on sequence and/or power conditioning (such as a DC to DC converter). Do not connect equipment directly to the vehicles battery without in-line protection (such as a DC to DC converter).

### Proper Shutdown of SF-3050

To turn off the SF-3050 properly:

- ✓ Press the On/Off switch on the front panel (see Figure 82). There may be a delay of approximately 2 seconds before the unit turns off.

Or

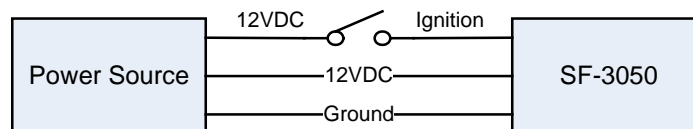
- ✓ Switch off power to the ignition pin.



The SF-3050 will not shut down properly unless the external power source is correctly connected to the SF-3050 as displayed in Figure 81.

The connection of the ignition wire directly to the power wire is not recommended, and may result in the corruption of data at shutdown of the SF-3050.

Do not unplug the positronic end of the supplied unterminated power cable before switching off power to the ignition pin. The receiver may not shutdown properly.



*Figure 81: Proper External Power Source Setup*

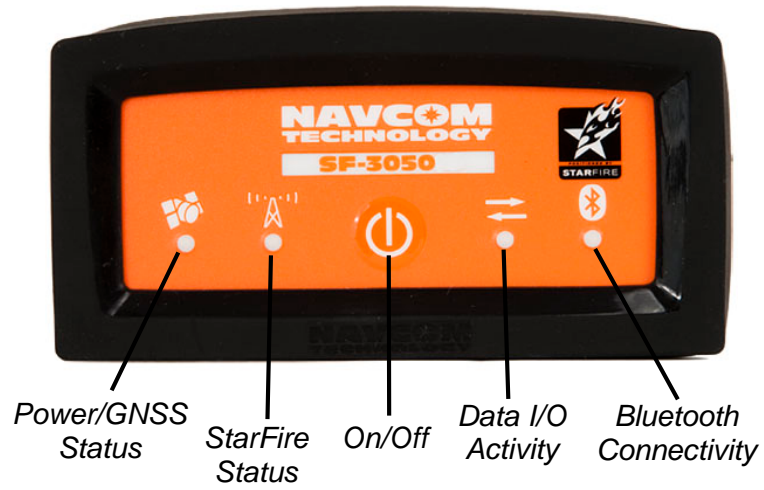


Figure 82: SF-3050 Front View

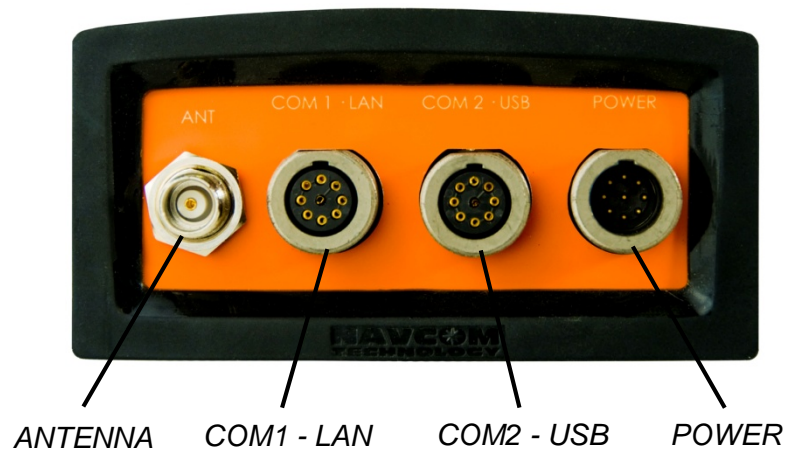


Figure 83: SF-3050 Rear View

## Communication Ports

The SF-3050 provides two 9-pin female Positronic connector communication ports labeled COM1 - LAN and COM2 - USB located at the rear of the sensor, as shown in Figure 83 above.

COM1 - LAN conforms to the EIA RS-232 standard with data rates from 9.6 to 115.2kbps max. It also conforms to the IEEE 802.3 Ethernet standard with data rates from 10 to 100Mbps.

The COM1 - LAN connector pin-outs are described in these tables:

- ✓ RS-232/1PPS: Table 9
- ✓ Ethernet (LAN): Table 15
- ✓ Ethernet (LAN)/RS-232 Y-Cable: Table 17

COM2 - USB conforms to the EIA RS-232/RS-422 standard with data rates from 9.6 to 115.2kbps max. It is also USB 2.0 compliant with 12Mbps maximum data rate.

The COM2 - USB connector pin-outs are described in these tables:

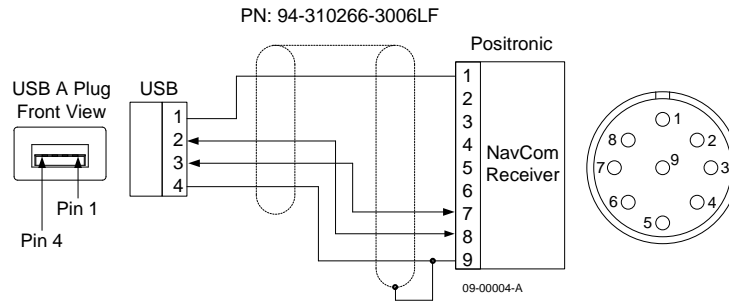
- ✓ RS-232/RS-422: Table 10
- ✓ USB 2.0 Device: Table 11
- ✓ USB 2.0 Host: Table 14
- ✓ USB 2.0 Device/RS-232/RS-422: Table 16

The SF-3050 is configured as a DCE device. Laptop and desktop computers are configured as DTE devices. If the supplied cable is not long enough, a straight-through cable will provide proper connectivity

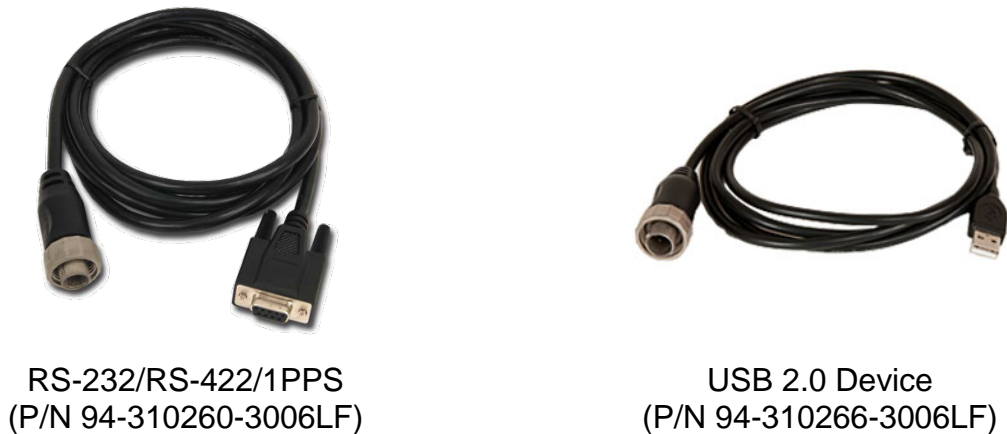
The SF-3050 provides Bluetooth wireless connectivity within a range of 10 meters (32 feet). The Bluetooth module contains Bluetooth-certified components. The data rate for Bluetooth communications is 230.4Kbps. Refer to the section below Bluetooth Communications Setup.

There are two supplied interface data cables:

- ✓ Positronic 9-Pin Male to DB9S (RS-232/RS-422/ 1PPS) (P/N 94-310260-3006LF): constructed as described in Figure 85 and Figure 86.
- ✓ Positronic 9-Pin Male to USB 2.0 Device Plug (P/N 94-310266-3006LF): constructed as described in Figure 87.



The part number for the Positronic plug on both data cables is FR11MP922LM0/AA, with the pin type: MC422N/AA.



*Figure 84: Supplied Data Cables*

The optional interface data cables support USB 2.0 Device and Host, Ethernet, and RS-232 and RS-422 (refer to Table 13).

*Table 9: COM1 Serial Cable Pin-Outs  
(P/N 94-310260-3006LF)*

<b>Positronic Pins</b>	<b>Signal Nomenclature [DCE w/respect to DB9]</b>	<b>DB9S Pins</b>
1	Not connected	-
2	Not connected	-
3	1PPS Out	8
4	RXD RS-232 COM1	3
5	TXD RS-232 COM1	2
6	Not connected	7
7	Not connected	-
8	Not connected	-
9	GND	5

*Table 10: COM2 Serial Cable Pin-Outs  
(P/N 94-310260-3006LF)*

<b>Positronic Pins</b>	<b>Signal Nomenclature [DCE w/respect to DB9]</b>	<b>DB9S Pins</b>
1	Not connected	-
2	Not connected	-
3	RXD+ RS-422	8
4	RXD RS-232 COM2/ RXD- RS-422	3
5	TXD RS-232 COM2/ TXD- RS-422	2
6	TXD+ RS-422	7
7	Not connected	-
8	Not connected	-
9	GND	5

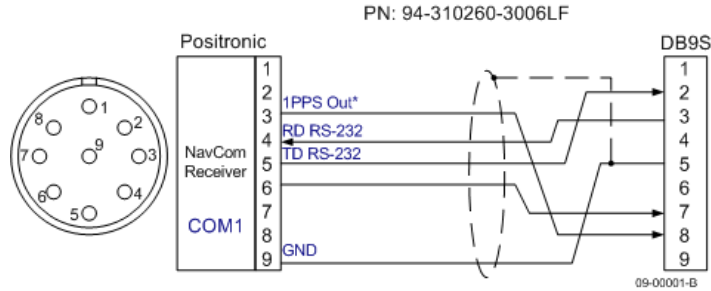


Figure 85: COM1 Serial Cable Pin Assignment

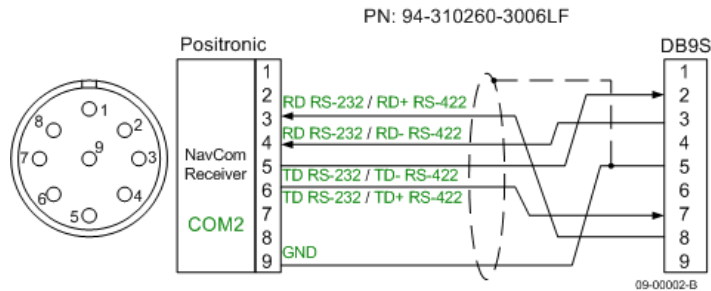



Figure 86: COM2 Serial Cable Pin Assignment

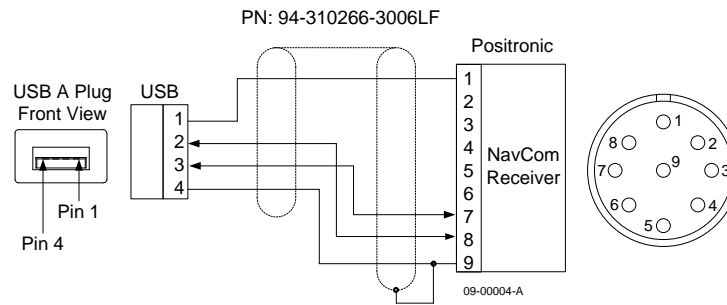
### Supplied USB Device Cable

P/N 94-310266-3006LF is the supplied 6ft (1.83m) data cable fitted with a Positronic plug type and a USB A plug type, used to connect as Device directly to a USB 2.0 connector. The pin assignments are provided below.

 COM2 - USB is the only USB compliant port.

*Table 11: USB Device Cable Pin Assignment  
(P/N 94-310266-3006LF)*

USB Pins	Signal	Positronic Pins
1	VCC	1
2	Data-	8
3	Data+	7
4	GND	9



*Figure 87: USB Device Cable Pin Assignment*

## Bluetooth Communications Setup

This section provides instructions to determine the Bluetooth Virtual COM port on a PC and connect to the SF-3050 via Bluetooth.

The SF-3050 Bluetooth Baud rate is fixed at 230400 Baud. It will not connect at any other speed. The data rate is 10 Hz maximum. Communications performance is dependent on the user's Bluetooth device used.

1. Write down the SF-3050 serial number (from the label on the receiver).
2. Turn on the SF-3050.
3. Plug the Bluetooth dongle (if one is being used<sup>1</sup>) into the proper port on the PC.



<sup>1</sup>Many laptops incorporate Bluetooth, but not all will work; a dongle is an option.

4. Right-click the Bluetooth icon on the Windows taskbar and select *Explore My Bluetooth Places* from the pop-up menu to open the *My Bluetooth Places* dialog box (refer to Figure 88).
5. Double-click *Search for devices in range* on the *My Bluetooth Places* dialog box to display a list of the Bluetooth devices in range (refer to Figure 89).

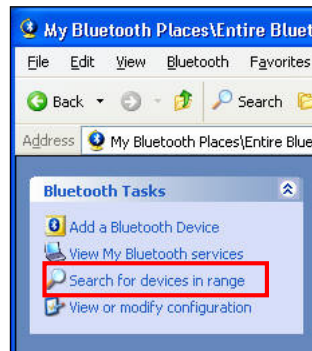


Figure 88: Search for devices in range

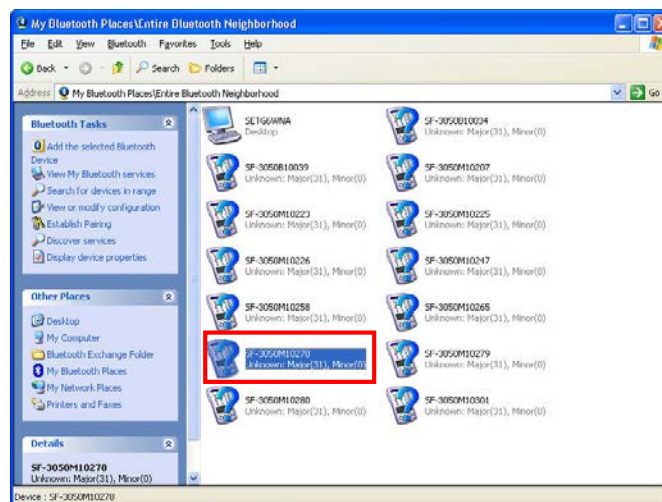


Figure 89: Bluetooth Devices in Range



- ☐ The naming convention for the SF-3050 is SF-3050ProductTypeSerialNumber. Example: SF-3050, 10280,2
  - ☐ The SF-3050 product types are SF-3050, 3050A, SF-3050G, SF-3050S, and SF-3050M in StarUtil 3000 ver. 1.0.1.5 and earlier. Later versions will simply report SF-3050.
6. Double-click the desired SF-3050 in the Bluetooth device list (see Figure 89). A Bluetooth serial port icon for the selected receiver is displayed (see Figure 90).

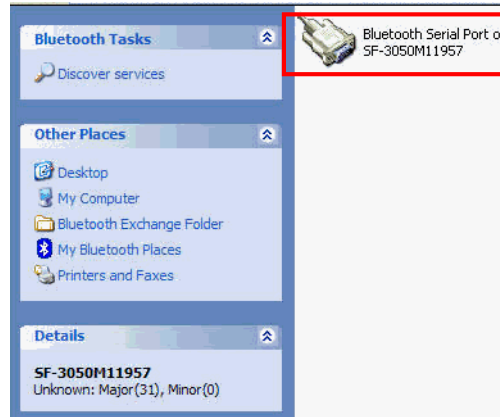


Figure 90: Bluetooth Serial Port Icon

7. Double-click the Bluetooth serial port icon. A graphic with green arrows indicates a connection is established between the Bluetooth Virtual COM port on the PC and the Bluetooth dongle (see Figure 91).

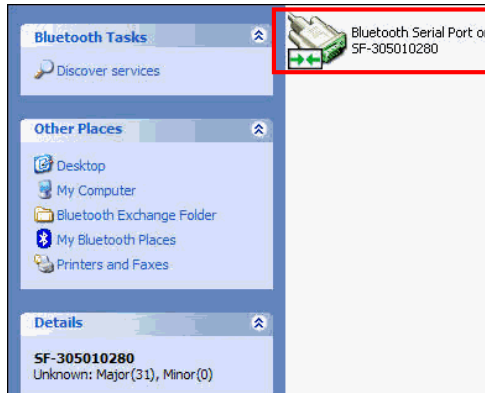



Figure 91: Bluetooth Serial Port Connection

- ☐ If the PC requests a Bluetooth passcode, click *OK*. There is no passcode for the SF-3050 Bluetooth device; use the BTSET command on the *Input Terminal* to create or delete a passcode in the receiver over the serial port if the computer requires a passcode. Refer to the BTSET command in the *Sapphire Technical Reference Manual*.

 Not all Bluetooth devices are compatible with the SF-3050. Refer to NavCom’s [Support/Troubleshooting Guides](#) Web page for additional information.

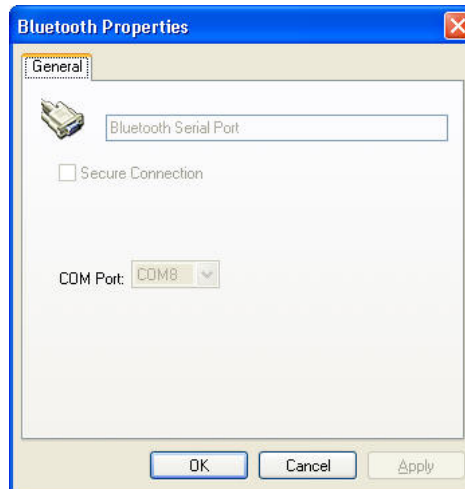
8. Double-click the Bluetooth serial port icon shown in Figure 91 to display the *Bluetooth Serial Port* dialog box (see Figure 92), which confirms the configured COM port.
9. Click OK.



*Figure 92: Bluetooth Serial Port*


10. To verify the assigned COM port, right-click the Bluetooth serial port icon (refer to Figure 91) and select *Properties* on the pop-up menu (the *Bluetooth Properties* dialog box opens).




The *Bluetooth Properties* dialog box (refer to Figure 93) displays the Bluetooth virtual COM port assigned to the Bluetooth dongle. (Notate the COM port number for use in step 15, below.)



*Figure 93: Bluetooth Properties*

11. Click OK on the *Bluetooth Properties* dialog box.
12. Open StarUtil 3000 on the PC.
13. Click the *Connections* button on the Shortcut bar to open the *Port Configuration* dialog box (see Figure 94).

-  The Bluetooth module can be in one of two modes:

  - Command mode. It has no active connection. It can receive commands from any other port via an onboard processor (Atmel).
  - Data Mode – Once another device has been connected to the receiver via Bluetooth, an active connection has been established and Bluetooth is in data mode, meaning it maintains an active connection and can receive/send data via the Bluetooth port. (An example would be a user creating a serial port using Bluetooth management software on his laptop and then using StarUtil 3000 to connect to the receiver via that serial port.) In this mode, the module has an active data connection with a connected device; it does not receive commands because commands would be interpreted as data that need to be passed to the connected device.
  
-  The only way to return Bluetooth to command mode once it is in data mode is to issue a [BTSET]DISCONNECT command, but keep in mind that issuing this command drops any active connection.
  
-  When the Bluetooth module is in “data mode,” the keywords are ON/OFF/DISCONNECT. The remaining keywords return NAK - “BT module in data mode”.
  
-  Turning on Bluetooth is associated with a software reset of the Bluetooth firmware, so the system returns the same output as when the RESET command is issued (see details on the use of the [RESET] command in the *Sapphire Technical Reference Manual*). When Bluetooth is ON, another in-range Bluetooth electronic device should be able to detect the existence of the system.

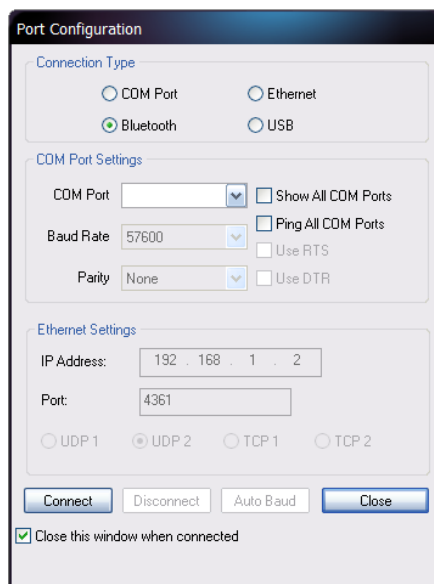




Figure 94: Port Configuration – Bluetooth

Refer to Figure 94 for the steps below:

14. Select Bluetooth as the Connection Type.
15. Under *COM Port Settings*, select the appropriate COM Port (refer to Figure 92, above).
16. Click  to connect to the SF-3050.
17. Verify Bluetooth connectivity:
  - View the Bluetooth LED on the SF-3050 front panel (refer to Table 12).


*Table 12: Bluetooth Connectivity LED Indication*

Icon	Indicator	Status	Description
	<i>Bluetooth</i>	<b>Off</b>	Bluetooth off
		<b>Blue Blinking</b>	Bluetooth on, no connection
		<b>Blue</b>	Bluetooth connected

- Type [PING] in the *Input Terminal* and click the *Send* button. If properly connected, the response is [PING]BT(see Figure 95).



*Figure 95: Input Terminal – PING Command and Response*

-  To use an input terminal to determine the Bluetooth Virtual COM port on a PC and connect to the SF-3050 via Bluetooth, refer to the BTSET message in the *Sapphire Technical Reference Manual* and to the section “Establish Bluetooth via the Input Terminal” in the *StarUtil 3000 User Guide*.

Accessories


Optional Data Cables



Figure 96: SF-3050 Optional Data Cables




Table 13: Optional Data Cables

1	Positronic 9-Pin Male to USB 2.0 Host Receptacle, 6 ft (P/N 94-310271-3006LF)
2	Positronic 9-Pin Male to Ethernet RJ45 Plug, 6 ft (P/N 94-310265-3006LF)
3	Y-Cable, Positronic 9-Pin Male to USB 2.0 Device Plug & DB9S (RS-232/RS-422), 6 ft (P/N 94-310273-3006LF)
4	Y-Cable, Positronic 9-Pin Male to Ethernet RJ45 Plug & DB9S (RS-232/1PPS), 6 ft (P/N 94-310272-3006LF)

 Refer to Table 5 for the list of supplied equipment.

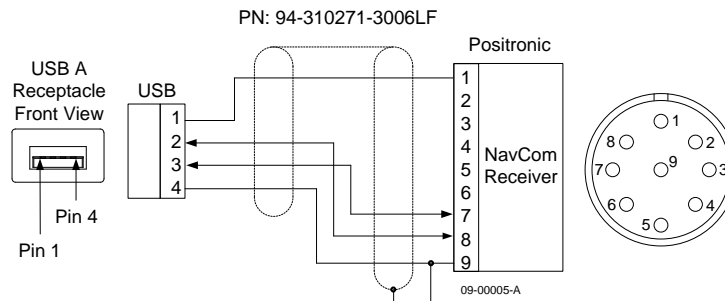
USB Host Cable (Option)

P/N 94-310271-3006LF is an optional 6ft (1.83m) data cable fitted with a Positronic plug type and a USB A receptacle type, used to connect as Host directly to a USB 2.0 connector. The pin assignments are provided below.

-  COM2 – USB is the only USB-compliant port.
-  Refer to the section below, *Unused pins are commonly missing from cables.* This is a typical cost-saving practice of cable manufacturers.
-  Logging to USB Flash Drive via USB Host Cable, for setup and logging instructions.

*Table 14: Optional USB Host Cable Pin Assignment*

USB Pins	Signal	Positronic Pins
1	USB PWR	1
2	USB D-	8
3	USB D+	7
4	GND/SHIELD	9





*Figure 97: Optional USB Host Cable Pin Assignment*

**Ethernet Cable (Option)**

P/N 94-310265-3006LF is an optional 6ft (1.83m) data cable fitted with a Positronic plug type and a

Ethernet RJ45 plug type, used to connect directly to an Ethernet connector. The pin assignments are provided below.

-  COM1 - LAN is the only Ethernet (LAN) compliant port.
-  Refer to the section below, *Direct Ethernet Connection via Static IP Address*, for setup instructions.

*Table 15: Optional Ethernet Cable Pin Assignment*

Ethernet Pins	Signal	Positronic Pins
1	TX+	6
2	TX-	7
3	RX+	2
6	RX-	1

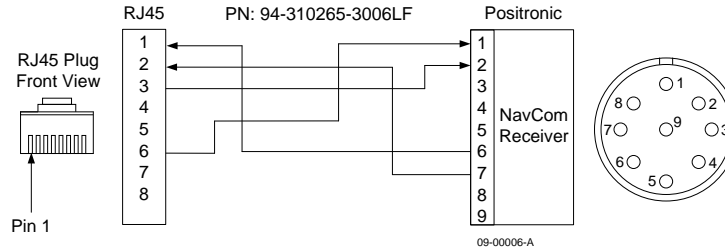


Figure 98: Optional Ethernet Cable Pin Assignment

### USB Device/RS-232/RS-422 Y-Cable (Option)

P/N 94-310273-3006LF is an optional 6ft (1.83m) Y-cable fitted with a Positronic plug type on one end. A USB A plug type and a DB9S female RS-232/

RS-422 connector are fitted on the ends of the Y-cable. It is used to connect as Device directly to a USB 2.0 connector or to a DB9S male connector. The pin assignments are provided below.


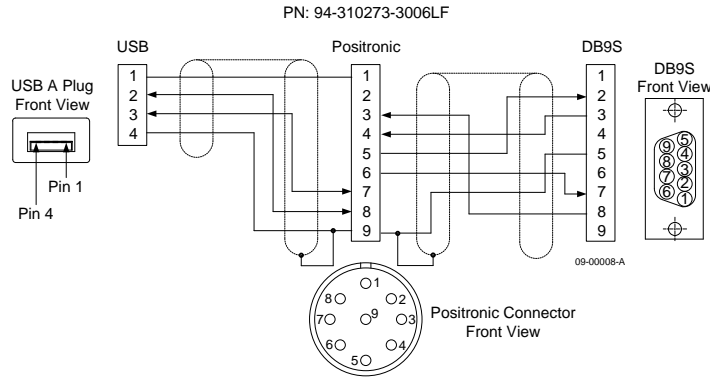
 COM2 - USB is the only USB compliant port.

Table 16: Optional USB Device/RS-232/RS-422 Y-Cable Pin Assignment



Signal	USB Pins	Positronic Pins	DB9S Pins
USB Power	1	1	
		2	
COM2 RXD+		3	8
COM2 RXD-		4	3
COM2 TXD-		5	2
COM2 TXD+		6	7
USB D+	3	7	
USB D-	2	8	
GND/Shield	4	9	5



*Figure 99: Optional USB Device/RS-232/RS-422 Y-Cable Pin Assignment*

**Ethernet/RS-232/1PPS Y-Cable (Option)**

P/N 94-310272-3006LF is an optional 6ft (1.83m) Y-cable fitted with a Positronic plug type on one end. An Ethernet RJ45 plug type and a DB9S female RS-232 connector are fitted on the ends of the Y-cable. It is used to connect directly to an Ethernet connector or to a DB9S male connector. The pin assignments are provided below.

-  COM1 - LAN is the only Ethernet (LAN) compliant port.
-  Refer to the section below, *Direct Ethernet Connection via Static IP Address*, for setup instructions.

*Table 17: Optional Ethernet (LAN)/RS-232/1PPS Y-Cable Pin Assignment*

Signal	Ethernet Pins	Positronic Pins	DB9S Pins
RX-	6	1	
RX+	3	2	
1PPS		3	8
COM1 RXD		4	3
COM1 TXD		5	2
TX+	1	6	
TX-	2	7	
		8	
GND		9	5



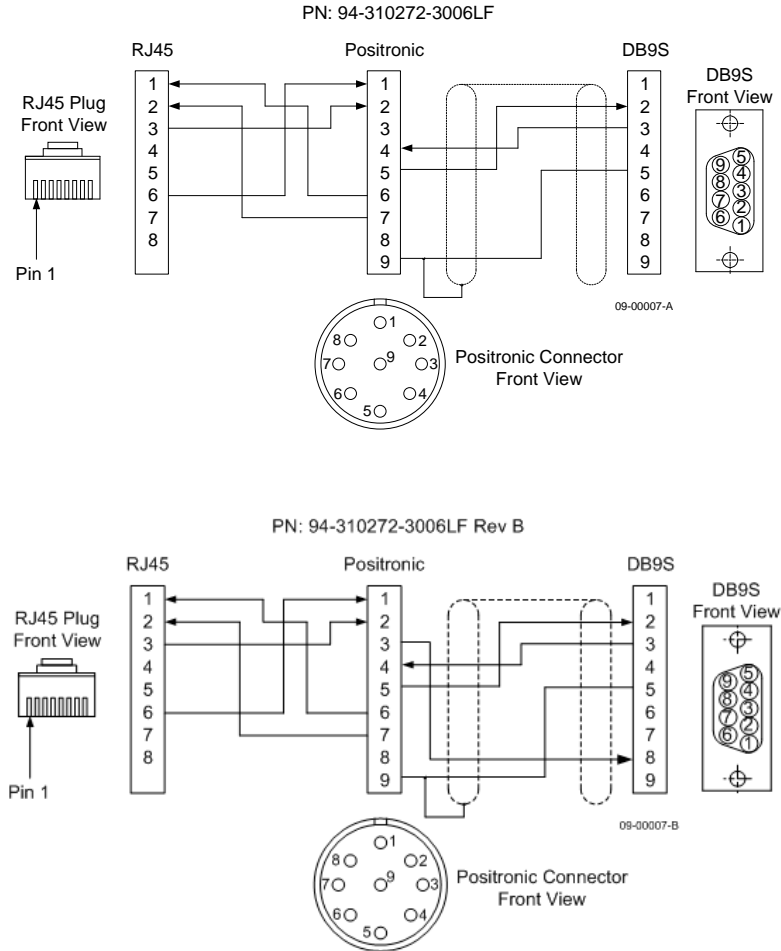





Figure 100: Optional Ethernet/RS-232/1PPS Y-Cable Pin Assignment

 Unused pins are commonly missing from cables. This is a typical cost-saving practice of cable manufacturers.

### Logging to USB Flash Drive via USB Host Cable

 Refer to the *Sapphire Technical Reference Manual* for details on the commands used in this section (see *Related Documents* in the fore-matter).

 The [LOGFILE] command used in this procedure does not work with USB flash drives that have a write-protected primary partition. The partition will not mount properly. The most common examples of this are drives with U3 software installed. In order to log using these drives, this partition must be removed. Reformatting the drive is not sufficient. According to the U3 web site:

“Most U3 smart drives come with an uninstall utility that converts the U3 smart drive into a regular USB flash drive. This utility can be accessed from the U3 Launchpad. Open the U3 Launchpad and click on Settings, then select U3 Launchpad Settings and click on the Uninstall tab. Some devices have a link to the Uninstall utility under Help and Support.”

- ☐ The [LOGFILE] command requires that at least 10% of the drive be free before it begins logging, and it automatically stops logging when free space drops below 1 MByte.
- ☐ To view the directory structure and logged files, the USB drive must be dismounted and moved to a PC.

To connect as Host directly to a USB flash drive requires the following:

- ✓ StarUtil 3000: NavCom’s Windows™ based control program, included on the supplied USB Flash Drive (P/N 82-043000-0001). It is also available on NavCom’s Web site or via Customer Support.
- ✓ Supplied Positronic 9-Pin Male to DB9S Data Cable (P/N 94-310260-3006LF)
- ✓ Positronic 9-Pin Male to USB 2.0 Host Receptacle Data Cable (P/N 94-310271-3006LF). This cable is not supplied with the SF-3050.
- ☐ The USB Host Data Cable is available via a NavCom authorized representative, or by contacting the [NavCom Sales Department](#).
- ☐ Refer to the section above, *USB Host Cable (Option)*, for a detailed description of the cable.

## Setup

The SF-3050 must be configured in USB Host Mode to log data to a USB flash drive.

1. Connect the Positronic connector of the supplied DB9S cable (P/N 94-310260-3006LF) to COM1 - LAN of the SF-3050. Connect the DB9S end to the computer.
2. Connect the Positronic connector of the USB Host cable (P/N 94-310271-3006LF) to COM 2 - USB of the SF-3050. Plug a USB flash drive into the USB Host end of the cable.
3. Open StarUtil 3000 on the PC.
4. Locate the *Input Terminal* window on the bottom right.
5. Type the command [USBMODE] in the field at the bottom of the window (see Figure 101).



*Figure 101: Input Terminal – USBMODE*

6. Click the *Send* button. The receiver returns the current USB Mode, Device or Host.
7. If the SF-3050 is not in USB Host Mode, type the command [USBMODE]host.
8. Click the *Send* button.

9. Type the command [USBMODE] to verify that the receiver is in USB Host Mode. Click the *Send* button. The receiver returns Host as the current USB Mode.

### Data Logging

To log data to the USB flash drive, the messages to be logged are first scheduled on a special port, fh1. “fh” means “file handler”. The command [OUTPUT] is used to schedule the messages.


1. Open StarUtil 3000, if not already open.
2. Schedule a message to be logged:
3. Type the appropriate [OUTPUT] command string in the field at the bottom of the *Input Terminal* window:

[OUTPUT](message), (timing), (interval), fh1


For example, to output PVT1B at 10Hz, the command is:

[OUTPUT]PVT1B, ontime, 0.1, fh1


4. Click the *Send* button.
5. Repeat Step 2 to schedule all necessary messages.

 To simplify this process, a profile can be configured to begin and end data logging to the USB flash drive.


6. Type the command '[LOGFILE]start'.
7. Click the *Send* button to start logging the scheduled messages. Messages are logged in .dat format to the USB flash drive.

 If an error message appears, it may be related to the compatibility of the USB flash drive. Contact NavCom Customer Support:


<http://www.navcomtech.com/Contact/ContactSupport.cfm>

 The logging commands are: [LOGFILE]start, [LOGFILE]stop, [LOGFILE]pause, [LOGFILE]resume, [LOGFILE]forstart, and [LOGFILE] (returns current logging status). After power cycle, the file logging is in Stopped status.

 For detailed instructions on logging data to the SF-3050 internal memory device via an Input Terminal, see Appendix C of the *Sapphire Technical Reference Manual*.

 To avoid file system corruption on the USB flash drive, always stop file logging before removing the drive.


### Direct Ethernet Connection via Static IP Address


 The SF-3050 supports both UDP and TCP connections. This section provides only the basic configuration for a direct Ethernet connection between the SF-3050 and a PC. Refer to Chapter 2 of the *StarUtil 3000*

*User Guide* for detailed instructions on configuring and establishing Ethernet communications.

Ethernet cables are not supplied with the SF-3050. These cables are available via a NavCom authorized representative, or by contacting the [NavCom Sales Department](#):

- ✓ Positronic 9-Pin Male to Ethernet RJ45 Plug (P/N 94-310265-3006LF). This cable is used in the setup described below.
- ✓ Y-Cable, Positronic 9-Pin Male to Ethernet RJ45 Plug & DB9S (RS-232/1PPS) (P/N 94-310272-3006LF)




 Refer to the sections above, *Ethernet Cable (Option)* and

 *Ethernet/RS-232/1PPS Y-Cable (Option)*, for detailed descriptions of the cables.

### Setup

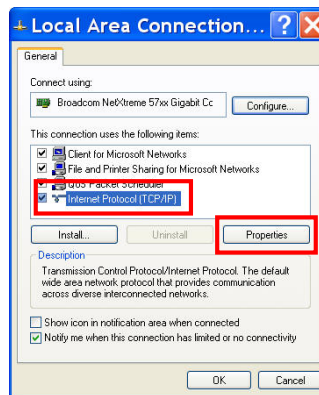
This setup uses the factory default IP address of the SF-3050:

192.168.0.2, 255.255.255.0, 0.0.0.0



  
 IP Address    Network Mask    Gateway

The PC IP address is set manually in Windows.

1. Connect the Positronic 9-Pin connector of the Ethernet cable (P/N 94-310265-3006LF) to COM1 - LAN of the SF-3050. Connect the RJ45 plug end to the computer.
2. In Windows, right-click *My Network Places* and select *Properties* from the pop-up menu. The *Network Connections* window opens.
3. Right-click *Local Area Connection* (or the equivalent) and click *Properties* from the pop-up menu. The *Local Area Connection* window opens.
4. Click on *Internet Protocol (TCP/IP)*. See Figure 102.



*Figure 102: Local Area Connection Window*

5. Click the *Properties* button. The *Internet Protocol* window opens.
6. Select the option, *Use the following IP address* (see Figure 103).

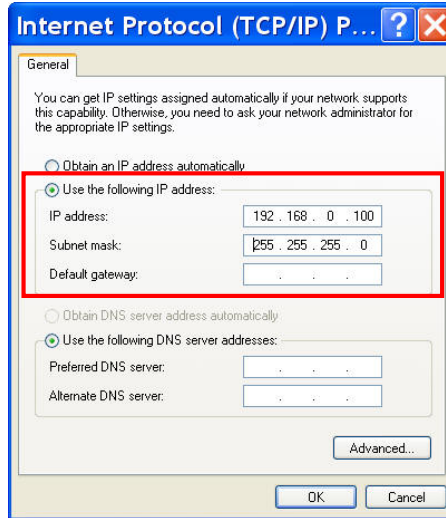



Figure 103: Internet Protocol Window

7. Enter the *IP address* for the PC. In this case, enter 192.168.0.100

 The first part of the IP address, 192.168.0, is the same for both the SF-3050 and the PC. The last part of the IP address must be unique for every device. In this case, it is 100 for the PC.


8. Press the *Tab* button on the keyboard. The *Subnet mask* is automatically populated.
9. Click the *OK* button in this window and also in the *Local Area Connection* window.
10. Continue to the next section for connection instructions.

### Connect SF-3050 to PC

1. Open StarUtil 3000 on the PC.
2. Click the *Connections* button to establish communications between the PC and the SF-3050. The *Port Configuration* dialog box opens.

Refer to Figure 104 for the steps below:

3. Select Ethernet as the Connection Type.

 Do not change the default *Ethernet Settings*: 192.168.0.2 is the factory default IP address of the SF-3050. The default virtual COM port is 4361.

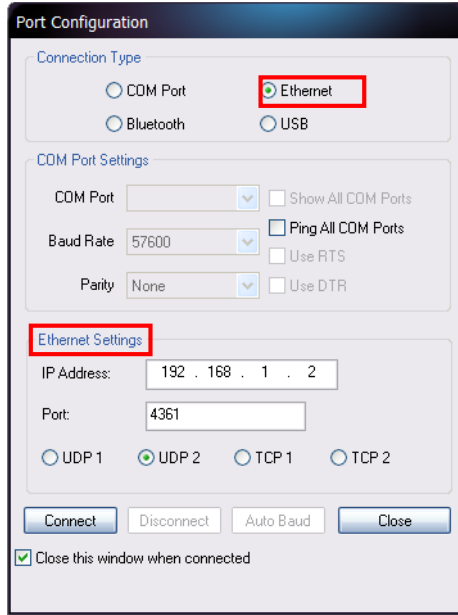



Figure 104: Ethernet Port Configuration

4. Click the *Connect* button.
5. Verify that the SF-3050 is connected to the PC. Messages scrolling in the *Communication* window indicate that the connection is established (see Figure 5).

 If an Ethernet connection is not established, use StarUtil 3000 to verify the IP address of the SF-3050. A serial connection must be used to determine the receiver's IP address.

## Event

The SF-3050 accepts an event input pulse to synchronize external incidents requiring precise GNSS time tagging, such as aerial photography. For example, the action of a camera's shutter creates an input pulse to the Event port. The SF-3050M outputs position and time information relative to each event received.


The Event is input on Pin 3 of the 9-pin male Positronic connector power port on the rear of the sensor (refer to Table 7).

Specifications:

Selectable Input Voltage, 5V or 12V

Minimum pulse width, 100nS

Rising or Falling edge Synchronization

 Detailed specifications of the Event Input, cable wiring, and configuration may be found in Appendix D of this User Guide.

## 1 PPS

A pulse is available from the SF-3050 at an output rate of once per second. This pulse can be used for a variety of Time/ Mark applications where relative timing is required.

Specifications:

- ✓ 25ns relative accuracy
- ✓ Better than 100ns absolute accuracy
- ✓ 5V TTL Logic level output
- ✓ 1 PPS Output Impedance > 50 Ohms
- ✓ Pulse width, default 1mS
- ✓ Pulse delay, default 0mS
- ✓ Rising or Falling Edge Synchronization


## Indicator Panel



Figure 105: SF-3050 Indicator Panel


The indicator panel provides a quick status view of the GNSS navigation/operating mode, StarFire signal strength, the On/Off (I/O) switch, data I/O and logging, and Bluetooth connectivity, respectively.

To power the unit on or off, depress the I/O switch for more than 2 seconds. All LEDs illuminate for a period of 3-5 seconds during power-up of the GNSS sensor.

 In this chapter, refer to the section, *Proper Shutdown of SF-3050*, for details on powering off the unit.


## ■ GNSS LEDs

Table 18: GNSS LED Indication

Icon	Indicator	Status	Description
	<b>Power/GNSS</b>	<b>Off</b>	Power off
		<b>Red</b>	Power on but not tracking
		<b>Green Blinking</b>	Acquiring or tracking GNSS satellites (no position fix yet)
		<b>Green</b>	Using GNSS satellites (position fix)


■ StarFire Link LEDs

*Table 19: StarFire Link LED Indication*

Icon	Indicator	Status	Description
	<b>StarFire Link</b>	<b>Red</b>	No StarFire signal
		<b>Red Blinking</b>	No StarFire License (or expired)
		<b>Green Blinking</b>	Acquiring StarFire signal
		<b>Green</b>	Tracking StarFire signal

Data I/O Active LEDs

*Table 20: Data I/O Active LED Indication*

Icon	Indicator	Status	Description
	<b>Data</b>	<b>Off</b>	Data I/O inactive
		<b>Green Blinking</b>	Data I/O active
		<b>Green</b>	Logging data to internal memory



The LEDs do not indicate the status of Data I/O via Ethernet or USB connections

■ Bluetooth Connectivity LEDs

Refer to Table 12.





## Chapter 5..... Installation

This chapter provides guidance on hardware installation for optimum performance.

### Antennae

The 5/8 inch BSW threaded antenna mount has a depth of 16mm (0.63 inch).

It is possible to remove the 5/8 inch BSW threaded alloy insert to reveal a secondary means of mounting the antenna, a 1-14UNS-2B thread with a depth of 16mm (0.63 inch). This is a typical marine industry mount for navigation antennas. See Table 6 for P/Ns.

- ☐ The BSW insert is secured in-place with an adhesive, and its removal will change the shock and vibration sustainability characteristics of the antenna mount.



*Figure 106: Rover, Base, Airborne GNSS Antennae*

- ☐ Do not loosen or remove the Phillips screws on the base of the antenna for mounting purposes. This will VOID the warranty and compromise the environmental seal of the antenna, leading to internal damage.

Antenna placement is critical to good system performance. Avoid antenna shading by buildings, rooftop structures, foliage, hills/mountains, etc.

Locate the antenna where it has a clear view of the sky, to an elevation angle of 7° if possible. Obstructions below 15° elevation generally are not a problem, though this is dependent on satellite availability for the local region.

Avoid placing the antenna where more than 90° azimuth of the sky is obstructed. When more than 90° of azimuth is shaded, it is often still possible for the receiver to navigate; however, poor satellite geometry (due to satellite shading) will provide poor positioning results. Even 10° of shading can have a negative effect on performance, though this generally is not the case.

Avoid placing the antenna on or near metal or other electrically reflective surfaces.

Do not paint the antenna enclosure with a metallic-based paint.

Avoid placing the antenna near electrical motors (elevator, air conditioner, compressor, etc.)

Do not place the antenna too close to other active antennas. The wavelength of L5 is 0.255m and G1 is 0.187m. The minimum acceptable separation between antennas is 1m (39 in), which provides 5.9dB of isolation. For 10 dB of isolation, separate the GNSS antennas by 2.55m, and for 13dB of isolation (recommended) separate the antennas by 5.1m.

Active antennas (those with LNA's or amplifiers) create an electrical field around the antenna. These radiated emissions can interfere with other nearby antennas. Multiple GNSS antennas in close proximity to each other can create multipath and oscillations between the antennas. These add to position error or the inability to process the satellite signals.

Most antenna's have better gain when the satellite is high in elevation. Expect tracking performance to fade as the satellite lowers in elevation. It is not unusual to see 10dB difference in antenna gain (which translates into signal strength) throughout the entire elevation tracking path.


Map obstructions above the horizon using a compass and inclinometer. Use satellite prediction software with a recent satellite almanac to assess the impact on satellite visibility at that location (available on NavCom's web site).

A clear line of sight between the antenna and the local INMARSAT satellite is required to track the StarFire signal. INMARSAT satellites are geo-synchronized 35,768kms above the Equator, currently at Longitudes 15.5° West, 97.65° West, 142° West, 025° East, 109° East, and 178° East. An inclination and bearing estimation tool is available on NavCom's website to aid in determining potential obstructions to StarFire signal.



### GNSS Sensor

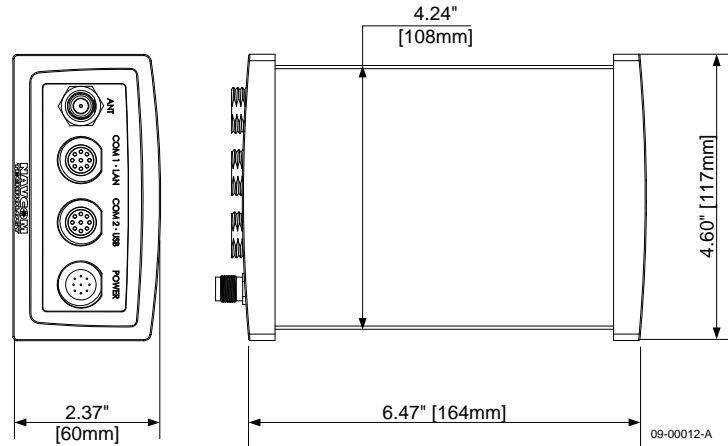
Mount the SF-3050 GNSS sensor on a flat surface. Shock isolators suitable for 0.50kg (1.1 lbs) may be necessary for environments with high vibration, i.e., earth-moving equipment or aircraft.

Do not place the sensor in a confined space or where it may be exposed to excessive heat, moisture, or humidity.

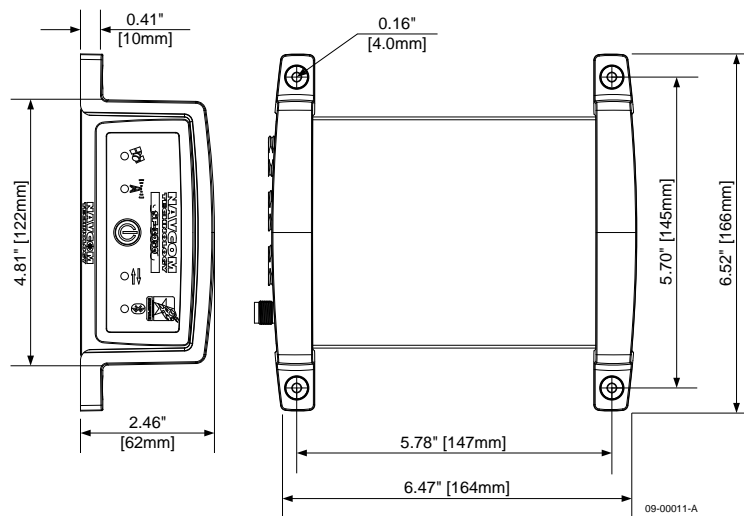
-  **MED Compass Safe Distance:** The SF-3050 receiver may not be installed closer than 250mm to the ship's compass.

The SF-3050 can be installed in a backpack for mobile surveying applications.

-  There are no user serviceable parts inside the SF-3050 GNSS sensor. Removing the screws that secure the front end and rear end plates will void the equipment warranty.
-  If the receiver will be used or transported above 40,000 ft (12.2. km), it must be located in a pressurized compartment.



*Figure 107: SF-3050 Base Plate Dimensions Without Mounting Brackets*



*Figure 108: SF-3050 Base Plate Dimensions with Mounting Brackets*

### Communication Port Connectivity

There is no default control port or data port on the receiver. COM1 - LAN is the only Ethernet (LAN) compliant port. COM2 - USB is the only USB compliant port.

Establish communications via Bluetooth or a data cable:

- ✓ Setup Bluetooth communications via either the supplied StarUtil 3000 utility or a third party software/utility.
- ✓ Connect the Positronic 9-Pin connector of the supplied DB9S cable (P/N 94-310260-3006LF) to COM1 - LAN (RS-232/1PPS) or COM2 - USB (RS-232/RS-422) of the SF-3050. Connect the DB9S end to the control device.
- ✓ Connect the Positronic 9-Pin connector of the supplied USB 2.0 Device cable (P/N 94-310266-3006LF) to COM2 - USB of the SF-3050. Connect the USB plug end to the control device.

- ☐ Figure 109 shows a common configuration with the control device connected to COM1 - LAN and an auxiliary device connected to COM2 - USB for data logging.
- ☐ Some devices may require an additional adapter. The optional interface data cables support USB 2.0 Device and Host, Ethernet, and RS-232 and RS-422 (refer to Table 13). The receiver is configured as a DCE device.



*Figure 109: Communication Port Connections*

### GNSS Antenna Connector

The connector used on the SF-3050 is a TNC female, labeled *ANT* on the rear panel of the sensor as shown in Figure 83.


- ☐ The GNSS antenna connector provides  $+5V \pm 0.5V$  at 100mA. Do not disconnect the antenna when the GNSS unit is powered on.
- ☐ The system is supplied with 12ft (3.6m) of RG58/U cable (P/N 94-310261-3012LF). The cable is fitted with two straight male TNC connectors.


The cable length between the antenna and SF-3050 should not exceed 7dB loss at 1.575GHz for optimum performance, though the system may tolerate up to 10dB of cable loss with minimal performance. Lower elevation satellite tracking suffers the most with more than 7dB insertion loss.

*Table 21: Acceptable Cable Lengths*

Cable Type	Atten. (dB) per 100 Ft.	Cable Length in Feet	Loss in dB	Atten. (dB) per 100 m	Cable Length in Meters	Loss in dB
RG-58C	19.605	36.00	7.06	64.32	11.00	7.08
RG-142	16.494	43.00	7.09	54.12	13.00	7.04
RG-213	9.564	74.00	7.08	31.38	22.50	7.06
RG-223	17.224	41.00	7.06	56.51	12.50	7.06
LMR600	3.407	207.00	7.05	11.18	63.00	7.04
LMR400	5.262	133.00	7.00	17.26	41.00	7.08
LMR240	10.127	70.00	7.09	33.23	21.00	6.98
LMR195	14.902	47.00	7.00	48.89	14.00	6.85

In-line amplifiers suitable for all GNSS frequencies may be used to increase the length of the antenna cable, but care should be exercised that tracking performance is not degraded due to multiple connections, noise from the amplifier, and possible ingress of moisture and dust to the in-line amplifier. In-line amplifier or splitter devices must pass DC power from the receiver to the antenna, or source the appropriate voltage and current to the antenna (see *Antenna Specifications*). In-line amplifiers may also over-saturate the receiver front-end if improperly used.

 The antenna cable can degrade signal quality if incorrectly installed, or the cable loss exceeds NavCom specifications. Take care not to kink, stretch, distort, or damage the antenna cable. Do not place the cable adjacent to cables carrying electrical power or radio frequencies. In these instances, attempt to cross cables at 90° angles in an effort to reduce cross-coupling of RF signals.

 Where the GNSS antenna is exposed to sources of electromagnetic discharge such as lightning, install a properly grounded in-line electrical surge suppressor between the GNSS sensor and antenna. Install protective devices in compliance with local regulatory codes and practices. Protective devices must pass DC power from the receiver to the antenna.

## Basics of RTK Surveying

RTK (Real-Time Kinematic) is a GNSS system that yields very accurate 3D position fixes immediately in real-time.

A reference station (base station) transmits its GNSS position to roving receivers as the base receiver generates them. The roving receivers use the reference station readings to differentially correct their own positions. Accuracies of a few centimeters in all three dimensions are possible. RTK requires multi-frequency GNSS receivers and high speed radio modems.

Proper setup of a reference station minimizes GNSS errors in the rover. The reference GNSS sensor is set up at a known surveyed location. With this position locked in, it transmits its code, clock, and reference station coordinate information to the roving sensor(s). The roving sensor(s) uses this information to correct each GNSS measurement it receives.

The SF-3050S, when configured as a reference station, can transmit corrections to any number of roving receivers capable of picking up the radio signal and decoding one of these correction formats: NavCom proprietary, RTCM 2.3/3.1 for Network RTK<sup>1</sup>, CMR, or CMR+. The signal can be received in less than ideal environments, though some data loss may occur.

Setup of the reference station sensor above the roving sensors is recommended to enable transmission to all rovers in all directions with minimal obstruction. High frequency radio signals generally travel a shorter distance than lower frequency signals, and do not penetrate obstructions as well over distance. Figure 110 and Figure 111 illustrate proper and improper RTK reference station installation.

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<sup>1</sup>Network RTK is not supported in software version 1.0. The Network RTK software option allows the receiver to generate and receive RTCM 1000-series messages. The navigation algorithms are designed to support single-base correction configurations. Network adjusted RTK formats are not currently supported.



*Figure 110: RTK Setup – Good Line of Sight*



*Figure 111: RTK Setup – Poor Line of Sight*



Refer to Chapter 8, RTK Setup, in the *StarUtil 3000 User Guide* for detailed instructions.



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## Chapter 6.....Configuration

The SF-3050 has a rich interface and detailed control language, allowing each unit to be individually programmed to a specific application.

There are essentially three methods available to configure and control the SF-3050:

- ✓ StarUtil 3000 – This program is a NavCom- developed utility designed to configure and view many (but not all) of the SF-3050 functions. In addition to its setup capabilities, StarUtil 3000 can capture and log data, upload new software and licenses to the internal processor, and query and display various receiver performance functions. Though it is developed as an Engineering tool, it has its own place in the commercial market as well. The program is provided on the SF-3050 Product USB Flash Drive.
- ✓ 3<sup>rd</sup> party controller – Some manufacturers have already integrated NavCom’s control features in their bundled hardware and software solution kits in a variety of applications including GIS, Machine Control, Aerial Photogrammetry, Land & Oceanographic Survey, Agriculture, and Military products. Information on these applications is available from the NavCom web site and customer service.
- ✓ User Program – Users may develop unique operating programs to control the SF-3050 (potentially in conjunction with other devices or utilities). To facilitate this effort, NavCom provides the Sapphire Technical Reference Manual (TRM). Information on this tool is available from the NavCom web site and customer service.

There is no default control port on the receiver. When either port is connected to control software, such as StarUtil 3000, that port becomes the control port.

### ■ COM1 - LAN

- ✓ Configuration – Control or Data Port
  - ✓ Rate – RS-232: 9.6 to 115.2kbps
- Ethernet: 10 to 100Mbps

This port is normally used to input and output proprietary messages used for navigation and receiver setup. Table 22 describes the default messages needed to best initiate surveying with minimal effort.

The user has full control over the utilized message types and their associated rates via either StarUtil 3000 or a third party software/utility.

### ■ COM2 - USB

- ✓ Configuration – Control or Data Port
  - ✓ Rate – RS-232/RS-422: 9.6 to 115.2kbps
- USB 2.0: 12Mbps

This port is normally used to output data to other devices or machines that can make immediate use of the precise positioning data available from the SF-3050. The data port outputs NCT Binary Messages and NMEA Messages, and when applying external dGNSS corrections, also serves as the dGNSS correction input port.

■ **BLUETOOTH VIRTUAL COM PORT**

- ✓ Configuration – Control Port
- ✓ Rate – 230.4kbps

The PC’s virtual COM port is used to input and output proprietary messages used for navigation and receiver setup. Table 22 describes the default messages needed to best initiate surveying with minimal effort.

- ☐ The user has full control over the utilized message types and their associated rates via either StarUtil 3000 or a third-party software/utility.

**Factory Default Output Messages**

■ **NCT Messages**

*Table 22: Factory Default NCT Messages/Responses*

Output on Ports COM1 and USB1		
Message	Rate	Description
ALM1B	On Change	Satellite Almanac
CHNLSTATUS1B	On Time 1Hz	ASIC & StarFire Channel Status
EPHEM1B	On Change	Satellite Ephemeris
MEAS1B	On Time 1Hz	Raw Satellite Measurement Data
MSGPRODUCTINFO	On Time 600 Sec	Product Type, Digital Serial Number, and System Revision Number
MSGVERSION	On Time 600 Sec	Firmware Identification Block
PVT1B	On Time 1Hz	Position, Velocity, and Time (PVT) Solution
PANICA	On Change	Factory Use
Output on All Ports		
Message	Rate	Description
OK (mnemonic)	On Change	Ack (“Acknowledged”). Ack indicates a successful input message operation.
?? (mnemonic) {argument error}	On Change	Nak (“Not Acknowledged”). NAK indicates a failure in executing a command.
PANICA	On Change	Factory Use



These settings indicate the following:

- On Change: The receiver outputs the specified message at the highest rate the system can output. The rate must be purchased. For example, if the receiver has a purchased rate of 25 Hz, the messages set at On Change are output at 25 Hz. (This rate applies only to MEAS1B and PVT1B.) Some messages, like satellite almanac, are output after an update is received over the air.
- On Time: The receiver outputs the specified message at a rate  $\leq$  the purchased rate. For example, if the receiver has a purchased rate of 25 Hz, a message may be set at a lower output rate, such as On Time, 10 Hz, or 0.1 seconds.

## Message Descriptions

The following message descriptions are fully defined in the *Sapphire Technical Reference Manual* (see *Related Documents* in the fore-matter).

- ✓ ALM1B Packed Almanac:  
Data corresponding to each satellite in the GPS constellation, including: GPS Week number of collected almanac, GPS Time of week [in seconds] of collected almanac, almanac reference week, almanac reference time, almanac source, almanac health, pages 1-25, and sub-frames 4 and 5. Packed almanac data for 32 GPS or 24 GLONASS satellites.
- ✓ CHNLSTATUS1B Channel Status:  
Receiver channel status information containing: Sapphire engine status, number of satellites viewed/tracked, PDOP, tracked satellite identity, satellite elevation and azimuth, C/No for the track signals, and correction age for each satellite.
- ✓ EPHEM1B Packed Ephemeris:  
Individual satellite tracking information including: GPS Week number of collected ephemeris, GPS Time of week [in seconds] of collected ephemeris, IODC, and sub-frame 1, 2, and 3 data. Packed ephemeris data for 32 GPS or 24 GLONASS satellites.
- ✓ MEAS1B Raw Measurement Data:  
Raw Measurement Data Block containing: Raw measurements from satellites so measurements can be post-processed to achieve precise point positions, the GPS Week, GPS Time of Week, Time Slew Indicator, Status, Channel Status, CA Pseudorange, L1 Phase, P1-CA Pseudorange, P2-CA Pseudorange, L2 Phase, GPS L5, GLONASS G1 and G1 Code and Phase, and SBAS Code and Phase. This data stream is repeated for each individual tracked satellite.
- ✓ MSGPRODUCTINFO Product Information:  
Product type, digital serial number, and system revision number (incremented at every hardware change).
- ✓ MSGVERSION Firmware Version:  
Version number, date and time stamp for the requested firmware component.
- ✓ PVT1B (Position, Velocity, and Time):  
Provides: GPS Week number, GNSS satellites used, latitude, longitude, navigation

mode, and DOP information.

- ✓ PANICA Alert Text Message:  
Details message receipt and processing.

### ■ NMEA Messages



The SF-3050 provides support both for selected standard NMEA messages and for nonstandard proprietary NMEA-type messages. These messages must be scheduled by the user.

### ■ Base and Rover Navigation Setup

NavCom's StarUtil 3000 provides Base and Rover setup capabilities. Refer to the *StarUtil 3000 User Guide* for details. The guide is included on the supplied SF-3050 Product Configuration USB Flash Drive and is also available on the NavCom web site.

## User Profiles

The SF-3050 utilizes commands or groups of commands, known as User Profiles, to set the various port assignments/parameters, navigation parameters, and output message lists. The SF-3050 provides for storage of up to 20 user profiles. A file with commonly used user profiles is included on the supplied USB flash drive.

- ✓ The SF-3050 provides for storage of up to 20 user profiles. Profiles may also be stored on a PC. Each user profile is stored with a name. The user profile extension is \*.npt.
- ✓ StarUtil 3000, or another controller solution, is used to upload a user profile by its name.
- ✓ The SF-3050 may be initially configured with the factory default user profile or a profile customized for the user by an authorized dealer.
- ✓ Predefined, commonly used profiles are included on the supplied SF-3050 Product Configuration USB Flash Drive or available by email.
- ✓ To save the current configuration settings in the receiver for future use, the user creates a profile and assigns it a name.
  -  The user may reset all of the user-controlled configuration parameters to the factory default values (see the next section, *Profile NONE*).
  -  A new profile sent to the receiver replaces the currently used profile, but it does not necessarily replace all of the current parameter settings. The new profile replaces only those parameter settings that it specifies.

For example:

The default navigation elevation mask is 7°.

The user changes the elevation mask to 12° in a profile named “Test”. The user subsequently sends profile “RTK” to the receiver. It replaces “Test” and changes navigation mode settings and port assignments.

But profile “RTK” does not specify a setting for the navigation elevation mask. So, the elevation mask remains at 12°, as previously set by the “Test” profile.

 Refer to the *Sapphire Technical Reference Manual* for detailed information on the [PROFILE] and [USEPROFILE] commands (see *Related Documents* in the fore-matter).

### Profile NONE

The command [USEPROFILE] NONE resets all of the user-controlled configuration parameters to the factory default values. The receiver’s profile remains set to NONE until another profile is successfully input.

 The profile NONE is subject to change.

### Avoiding User Profile Loading Errors

StarUtil 3000 v.1.0.0 and later scans user profiles before loading them to adjust port settings and reduce the likelihood of communication errors. Communication errors still occur, and this section aids in resolving common issues.

As a user profile is loaded into the receiver, each command line is acted upon as it is received. A profile loading error occurs if the communication link between the PC and the receiver is broken before all command lines are received. To avoid this loading error, the best practice is to preview the control port baud rate in a user profile before loading the profile. Refer to the *StarUtil 3000 User Guide* for detailed instructions.

### Third-Party Controller Configuration Settings

Refer to the third-party controller solution manual/user guide if your SF-3050 GNSS sensor is part of an integrated solution.

### Over the Air StarFire Licensing

Over the Air (OTA) StarFire Licensing is the easiest way to install a StarFire license. The installation of a purchased license is accomplished via radio broadcast. Over the Air StarFire Licensing is especially convenient for receivers in remote locations in the field.

These are the requirements for obtaining a StarFire license:

- ✓ Valid Purchase Order
- ✓ Signed License Agreement
- ✓ Appropriate Credit Terms with NavCom Technology or an Authorized Dealer; including a valid P.O.



NavCom recommends that customers process new StarFire license requests through an authorized dealer or NavCom Sales 15 to 30 days before the expiration of the current license.

The customer selects the date and time in GMT for the Over the Air broadcast of the StarFire License.

- ✓ The scheduled broadcast must occur at least 3 business days after a valid P.O. is received by NavCom Sales.
- ✓ Specify broadcast date and time in GMT on the P.O.
- ✓ NavCom confirms the date & time of broadcast via email.

#### Over the Air Broadcast

The StarFire license is broadcast at the scheduled time and 5 minutes later as a backup.

-  To ensure reception, turn on the receiver before the specified broadcast time. Do not turn off the receiver until verifying that the license is saved.
-  The receiver must be tracking StarFire satellites at the broadcast times, though the receiver is not required to be operating in StarFire mode during the broadcasts.

#### Verify License Is Saved

There are two ways to view StarFire license data to verify that the license is saved:

- ✓ StarUtil 3000
- ✓ Sapphire Message SFLICENSEB (described in the Sapphire Technical Reference Manual)

(Refer to *Related Documents* in the fore-matter.)


Verify this StarFire license data:

- ✓ The StarFire license is saved as one of these license types:
  - Primary StarFire License: Currently active license

OR

- Secondary (Backup) StarFire License: Inactive license that becomes active at the expiration of the Primary StarFire license
- ✓ Duration of the saved license and the valid areas of operation


For special-case scenarios, customers may request to receive the StarFire license via email to manually upload via StarUtil 3000. The request must be specified in the P.O.


-  The broadcast procedure for Over the Air StarFire Licensing is subject to change.


## Setting Up a StarFire Priority Network

The SF-3050 defaults to using the highest available satellite between both networks. If multiple receivers are used on one platform, the user may force one to use Net1 and the other to use Net2.

1. On the *Input Terminal*, type [SFNETPRIORITY] to view the current priority net settings.
2. Perform one of the following:
  - Type [SFNETPRIORITY]DEFAULT to command the system to automatically select the StarFire satellite with the highest elevation angle, regardless of Net1 or Net2, but subject to authorized nets.
  - Type [SFNETPRIORITY]NET1<sup>1</sup> to set Net1 as the priority net, which commands the receiver to select the Net1 StarFire satellite with the highest elevation angle.
  - Type [SFNETPRIORITY]NET2<sup>2</sup> to set Net1 as the priority net, which commands the receiver to select the Net2 StarFire satellite with the highest elevation angle.

 <sup>1</sup> If there are no visible Net1 satellites, or if the receiver is licensed as Net2 only, the receiver will select the Net2 StarFire satellite with the highest elevation angle.

 <sup>2</sup> If there are no visible Net2 satellites, or if the receiver is licensed as Net1 only, the receiver will select the Net1 satellite with the highest elevation angle.

 Refer to the *Sapphire Technical Reference Manual* for detailed information on the [SFNETPRIORITY] command.

## RapidRecovery

Rapid Recovery is a feature designed for NavCom's Sapphire GNSS engine generation of products, which includes the SF-3040 and SF-3050 GNSS receivers. Rapid Recovery is to StarFire operation as RTK-Extend is to RTK operation. Rapid Recovery is a StarFire operating feature to improve navigation capability after a brief StarFire outage.

### *Background*

While StarFire satellite delivered augmentation signals for precision positioning has been available since the year 2000, interruption of the GNSS navigation signal from navigation satellites by natural or man-made structures causes full re-convergence of StarFire navigation without Rapid Recovery to the final precision capability. The timeframe required to re-converge after such a shading event made StarFire undesirable for many operational applications. Hence, the develop need and opportunity for Rapid Recovery.

Rapid Recovery seeks to mitigate the full re-convergence time associated with brief interruptions in satellite navigation caused by bridges, short tunnels, entry and exit from tree-lines and other similar operational environments. The technology takes advantage of lessons learned from introducing moving base RTK which produces highly accurate relative positioning between two moving platforms, whether moving in the same direction at similar speeds or moving in different directions at different speeds.



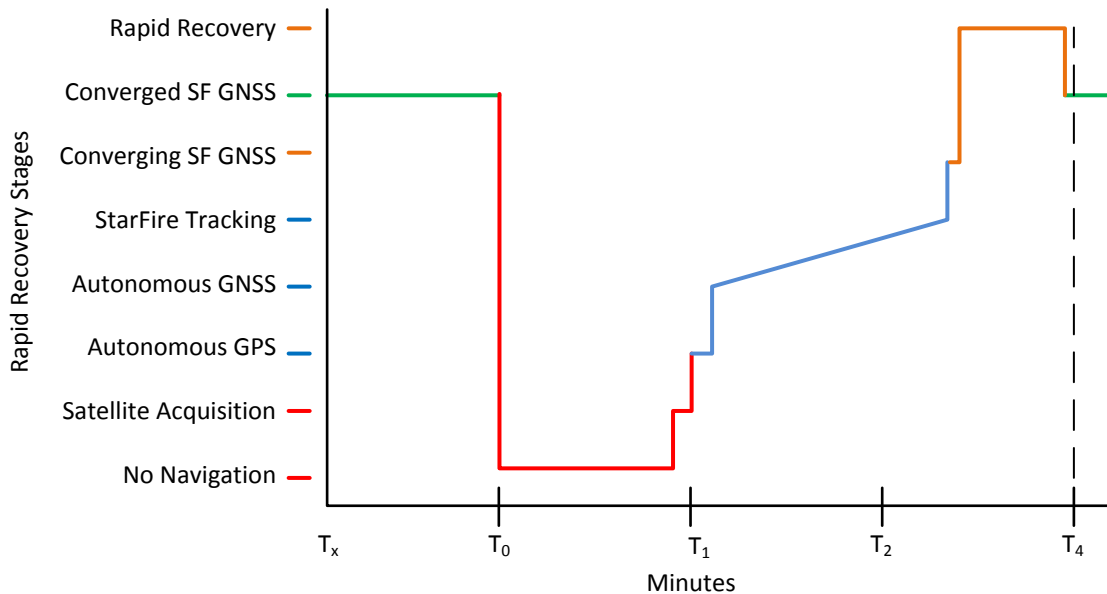
### Rapid Recovery Process

Rapid Recovery is successful more than 90% of the time under certain operating conditions. Generally speaking, Rapid Recovery is successful under the following conditions:

- The StarFire receiver is fully converged (final accuracy attained; i.e. 5-7cm horizontal)
  - This normally occurs after approximately 45-minutes of normal operation
- The navigation outage or shading event duration is less than 55-seconds
  - Navigation satellite reacquisition and navigation resumption occurs quickly
- The entire outage event and Rapid Recovery process is completed in less than 4-minutes

Rapid Recovery works best for short outages such as passing under bridge. The recovery interval is also determined by the duration and distance separation of the event origin and reacquisition point.

The illustration below depicts the stages of Rapid Recovery.



$T_x$  – the receiver has been operating normally and is fully converged for some period of time before the outage event.

$T_0$  – the receiver encounters an obstruction of navigation satellites. This also likely interrupts the StarFire correction signal as well.

If the StarFire signal is not lost during the obstruction event (i.e. a receiver in the northern hemisphere is travelling along a tree line to the north obstructing a significant portion of the navigation satellites, but not the StarFire satellite to the south), then the recovery time is improved.

$T_1$  – the receiver exits the shading event (duration must be 55-seconds or less) and begins reacquiring navigation satellites.

After a number of seconds, it begins autonomous (un-aided) satellite navigation (accuracy in the meters range); beginning with GPS first followed by GLONASS (GNSS combined navigation).

Once navigation is restarted, the receiver begins looking for the StarFire satellite if that satellite was also dropped.

T<sub>2+</sub> – the receiver reacquires the StarFire satellite.

After processing a certain amount of data from visible satellites, the receiver begins the Rapid Recovery process by first applying a moving base RTK-like correction to initiate the StarFire process. The duration of this process is dependent on

- The duration of the event up until the initialization of the Rapid Recovery process
- The distance traveled from T<sub>0</sub>
- The quality of the positioning data at the initialization of the Rapid Recovery process

T<sub>4</sub> – if the receiver completes the Rapid Recover process successfully within the 4-minute window between T<sub>0</sub> and T<sub>4</sub>, it will set a valid flag in the PVT1B data record for 10-seconds indicating success. Until this point, the receiver will demonstrate normal re-convergence; thereafter, it will indicate at or very near the same convergence as prior to the event. Variances from the pre-event condition are normal based on differences in number of satellites tracked and satellite geometry.

If the receiver fails Rapid Recovery, no indication is given and the receiver will continue to demonstrate normal re-convergence.

- ✓ NavCom recommends using a FOM value in the range of 5-10.
- ✓ This feature is available only on the GPS portion of the StarFire correction, which constitutes the larger weighted component of the correction.

### RapidRecovery with QuickStart

StarFire QuickStart enables Rapid Recovery when an accurately known ITRF14 position is used to initialize StarFire navigation. This is typically a position previously surveyed and converted to ITRF14 prior to initialization.

- ✓ This feature is available for StarFire GNSS only.
- ✓ The receiver must have a StarFire Dual Frequency solution prior to initiating QuickStart
- ✓ RapidRecovery is available only on the GPS portion of the StarFire correction, which constitutes the larger weighted component of the correction
- ✓ RapidRecovery is not available for the first 5 minutes after a successful quick start is completed
- ✓ When a lower FOM\_limit value is input, the receiver is more constrained in completing a Rapid Recovery process
- ✓ In order for RapidRecovery to function, the outages must not exceed 55 seconds.
- ✓ Requires up to three minutes to complete after navigation restarts

- ✓ Option to manually enter coordinates to initiate feature

**Failed Search**

Whether from loss of reception or lack of initial acquisition, after a 5-minute failed search for a StarFire satellite, the receiver automatically searches for another available StarFire satellite.

This functionality only applies to:

- ✓ Receivers licensed for both StarFire Net 1 and Net 2
- ✓ Receivers only licensed for StarFire Net 1 in areas where signals from 2 StarFire satellites overlap and may be available.

**Reassignment of StarFire Network List**

Satellites 609 and 643 have been reassigned to provide improved reception. Satellite 609, which was in Net1, is now in Net2, and satellite 643, which was in Net2, is now in Net1 (See Tables 23 and 24).

*Table 23: StarFire Satellites v.2.0.15.0 and Later*

Network	Satellite ID	Longitude	Satellite Name	Uplink Site
Net 1	402	97.65W	PAC-E	Laurentides
	643	143.5E	PAC-W	Perth
	525	25E	IND-W	Burum
Net 2	358	142W	PAC-C	Santa Paula
	609	109E	IND-E	Auckland
	484	15.5W	AOR-E	Southbury

*Table 24: StarFire Satellites v.3.0.12.0 and Later*

Network	Satellite ID	Longitude	Satellite Name	Uplink Site
Net 1	402	97.65W	PAC-E	Laurentides
	643	143.5E	PAC-W	Auckland
	525	25E	IND-W	Burum
Net 2	678	178E	POR	Santa Paula
	564	64E	IND-E	Perth
	446	54W	AOR-W	Southbury
	484	15.5W	AOR-E	Southbury

## Chapter 7..... Safety Instructions

The SF-3050 GNSS sensor is designed for precise navigation and positioning using the Global Positioning System, GLONASS. Users must be familiar with the use of portable GNSS equipment, the limitations thereof and these safety instructions prior to use of this equipment.

### Transport

Always carry the NavCom equipment in either the original packing material or packaging which provides protection to the receiver and antenna against shock and vibration.

Utilize all original packaging when transporting via rail, ship, or air.

### Maintenance

The NavCom equipment may be cleaned using a new lint free cloth moistened with pure alcohol.

Connectors must be inspected, and if necessary cleaned before use. Always use the provided connector protective caps to minimize moisture and dirt ingress.

Inspect cables regularly for kinks and cuts as these may cause interference and equipment failure.

Damp equipment must be dried at a temperature less than +40°C (104°F), but greater than 5°C (41°F) at the earliest opportunity.

### External Power Source

Early SF-3050 production units are supplied with an external power cable without a filter (P/N 94-310262-3010LF). Later SF-3050 production units are supplied with an external power cable with a filter (P/N 94-310274-3010LF)

The power cable must be connected to the chosen external power solution in accordance with Chapter 3 Interfacing/Electrical Power. It is important that the external power source allow sufficient current draw for proper operation. Insufficient supplied current will cause damage to your external power source.

If your chosen external power source is a disposable battery, please dispose of the battery in accordance with your local regulations.

### Safety First

The owner of this equipment must ensure that all users are properly trained prior to using the equipment and are aware of the potential hazards and how to avoid them.

Other manufacturer's equipment must be used in accordance with the safety instructions issued by that manufacturer. This includes other manufacturer's equipment that may be attached to NavCom Technology, Inc. manufactured equipment.

Always use the equipment in accordance with local regulatory practices for safety and health at work.

There are no user serviceable parts inside the SF-3050 GNSS sensor. Accessing the inside of the equipment will void the equipment warranty.

Take care to ensure the SF-3050 does not come into contact with electrical power installations, the unit is securely fastened and there is protection against electromagnetic discharge in accordance with local regulations.

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## A ..... GNSS Module Specifications

The technical specifications of this unit are detailed below. NavCom Technology, Inc. is constantly improving, and updating our technology. For the latest technical specifications for all products go to: <http://www.navcomtech.com/Support/>

This GNSS sensor is fitted with an internal Lithium cell battery used to maintain GNSS time when power is removed from the unit. This allows faster satellite acquisition upon unit power up. The cell has been designed to meet over 5 years of service life before requiring replacement at a NavCom approved maintenance facility.

### Features

- ✓ Full constellation coverage with up to 66 signals tracked simultaneously, plus the StarFire channel
- ✓ SBAS (WAAS, EGNOS, MSAS, GAGAN) tracking
- ✓ Built in StarFire receiver and demodulator
- ✓ L1, L2, L2C, L5, G1, G2, E1, E5A (GPS/ GLONASS) code and full wavelength carrier phase tracking
- ✓ High sensitivity/low signal level tracking
- ✓ Fast acquisition/re-acquisition
- ✓ Superior interference suppression (both in-band & out-of-band)
- ✓ Patented multipath rejection
- ✓ Minimal data latency
- ✓ 2 GB of internal memory (Not supported in version 1.0 software)
- ✓ NavCom Ultra Compact RTK format, RTCM 2.3 and 3.0 (code & carrier), and CMR/CMR+.
- ✓ Output NMEA 0183, NavCom Binary, NavCom ASCII formats
- ✓ Configurable as RTK base or rover
- ✓ MBRTK
- ✓ RTK Extend
- ✓ Heading
- ✓ Programmable output rates
- ✓ Event Marker input
- ✓ 1PPS Output
- ✓ Communications Ports: RS-232, RS-422, USB 2.0 (Device & Host), Bluetooth, and Ethernet
- ✓ StarFire over IP corrections via the Internet

## Performance

SF-3050 performance is dependent on location, satellite geometry, atmospheric conditions, and GNSS correction.

## Tracking Characteristics

The SF-3050 engine has 67 signal channels with the required flexibility to track all civilian GNSS and SBAS signals. The SF-3050 engine is also capable of tracking the code and carrier from all GNSS signals.

- ☐ L5 and G2 are not available simultaneously due to hardware resource sharing. Select a signal according to these environmental considerations:
  - Shade: G2 provides the best results, though positioning is less accurate in shade.
  - Open Sky: L5 provides the best positioning accuracy.
- ☐ Refer to the TRACKINGMODE command in the *Sapphire Technical Reference Manual* for details (see *Related Documents* in the fore-matter).

## Signals Tracked

Navigation & Public Correction Signals	
Services include: GPS L1, and SBAS (WAAS, EGNOS, MSAS, GAGAN); all at the same frequency:	1575.42MHz, ±16MHz
Services include: GPS (L2, L2C); all at the same frequency:	1227.60MHz, ±16MHz
Services include: GPS L5	GPS: 1176.45MHz, ±16MHz
G1 services include: GLONASS	1603.00MHz, ±6.5MHz
G2 services include: GLONASS	1247.00MHz, ±5MHz
StarFire Signals	
L-Band Differential Correction:	1525 to 1585MHz

Tracking of newer navigation satellite signals (L2C and L5) is subject to:

- ✓ The availability of the signals from newer satellites
- ✓ The "health bit" set to "healthy"
- ✓ The SF-3050 navigation software updated to a version compatible with the signals

### Receiver Noise Figure

17.0dB +0.5dB @ 290° Kelvin; 1Hz RBW
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### Time-to-First-Fix

Cold Start:	< 60 seconds	No valid Almanac or Ephemeris data available
Warm Start:	< 50 seconds	Valid Almanac available (less than one year old)
Hot Start:	< 20 seconds	Valid Ephemeris available (less than 4 hours old)

Typical values measured per ION-STD 101

### Signal Reacquisition

< 30 second loss:	< 2 seconds
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### Dynamics

Acceleration:	Up to 6g
Speed:	< 515m/s <sup>1</sup> (1,000 knots)
Altitude:	< 18.3km <sup>1,2</sup> (60,000 ft)


<sup>1</sup>Restricted by USA export laws


<sup>2</sup>Supported in software. The receiver hardware must be placed in a pressurized environment for altitudes >12.2km (40,000 ft.)




## Measurement Performance

Measurement Precision (RMS)	
Raw C/A code:	7.50cm
Raw Carrier Phase Noise:	L1: 0.7mm L2: 0.9mm
RTK Positioning – Multi-Frequency <40kms (RMS)	
Position (H):	$\pm 1\text{cm} +0.5\text{ppm}$
Position (V):	$\pm 2\text{cm} +1\text{ppm}$
RTK WL Positioning – Multi-Frequency <40kms (RMS) (see note below)	
Position (H):	$\pm 5\text{cm} +2\text{ppm}$
Position (V):	$\pm 10\text{cm} +2\text{ppm}$
RTK Extend (see note below)	
Position (H):	$\pm 3\text{cm} +1\text{ppm}$
Position (V):	$\pm 6\text{cm} +2\text{ppm}$
RTK Float	
Position (H):	$\pm 20\text{cm} +3\text{ppm}$
Position (V):	$\pm 40\text{cm} +3\text{ppm}$
StarFire-LP	
Position (H):	50cm
Position (V):	100cm
StarFire (multi)	
Position (H):	$\pm 5\text{cm GNSS}, \pm 10\text{cm GPS}$
Position (V):	$\pm 10\text{cm GNSS}, \pm 15\text{cm GPS}$
Code Differential GPS <200kms (RMS)	
Position (H):	$\pm 45\text{cm} +3\text{ppm}$
Position (V):	$\pm 90\text{cm} +3\text{ppm}$
Heading – Multi-Frequency	.1 degrees Requires 10Hz update rate
Velocity (for all DGPS described above)	
Velocity:	0.01m/s
Enhanced SBAS (WAAS/EGNOS/MSAS/GAGAN) Position Accuracy (RMS)	
Position (H):	$\pm 30\text{cm}$
Position (V):	$\pm 60\text{cm}$

 The specifications herein are based on the following: PDOP <4, 1-sigma (65%), 24-hour averaged set of data. Further, performance is dependent upon, but not limited to location, satellite geometry, atmospheric conditions (i.e., solar storm activity), local interference, DoD signal degradation (i.e., Selective Availability or similar techniques), satellite messaging or timing errors, and augmentation correction messages.

 RTK WL is a positioning mode that is necessary for phase ambiguity resolution. However when this navigation mode is indicated, it is likely that the receiver is in a corner case navigation condition. As such, it is likely that the end user will not wish to use it as a valid navigation mode.

If the above conditions are met, then the receiver will not need to be put into RTK-WL mode.

 RTK Extend is a purchased software option that uses StarFire to provide continuous RTK positioning during non-reception of RTK corrections. When a StarFire-enabled receiver with RTK Extend falls out of RTK mode, the system automatically transitions to RTK Extend mode. Positioning is maintained because of the close correlation in phase measurement corrections between RTK and StarFire.

Depending on how long the RTK base station has been running and is StarFire fixed, the duration of RTK Extend is limited to:

- 2 to 15 minutes for an NCT base station
- 2 to 15 minutes for a non-NCT base station

For RTK Extend to achieve maximum performance, the rover must be fully converged, which typically requires one (1) hour of operation.

The correlation between RTK and StarFire phase measurement corrections decreases over time, until the system automatically transitions out of RTK Extend mode to the next available dGPS mode.

This option is only required on the Rover receiver. If a Base receiver may be used as a Rover at a future date, it should be optioned for RTK Extend as well.

Refer to the *StarUtil 3000 User Guide*, Chapter 5, for more information on RTK Extend.

### Pull-in Times

StarFire LP	10 minutes, typical
StarFire GPS	45 minutes, typical
StarFire GNSS	45 minutes, typical

### User-Programmable Output Rates

Rate	SF-3050 Bundles		
	G	S	M
Position, Velocity, and Time			
1, 5*Hz	Std	Std	Std
10Hz	Opt	Opt	Std
25*Hz	Opt	Opt	Std
50, 100Hz	Opt	Opt	Opt
Raw Data			
1, 5*Hz	Std	Std	Std
10Hz	Opt	Opt	Std
25*Hz	Opt	Opt	Std
50, 100Hz	Opt	Opt	Opt



\*5 Hz is the default PVT and Raw Data Rate for software bundles G and S.  
25 Hz is the default PVT and Raw Data Rate for Bundle M.

### Data Latency and Memory

PVT:	< 10 ms
Raw Data:	< 10 ms
Internal Memory <sup>1</sup>	2 GB

<sup>1</sup>Not available for v1.0 software

### 1PPS

Accuracy:	±13 ns (Relative; User Configurable)
Pulse Width:	user defined from 25 to 1600000 nS inclusive; 1000000 default

## Connector Assignments

ANT:	TNC (female) RF Input, RF Ground
COM 1 – LAN: (connector: FR11MP922LM0/AA pin: MC422N/AA)	Positronic (female) RS-232, from 9.6 to 115.2 kbps Ethernet, from 10 to 100 Mbps 1PPS
COM 2 – USB: (connect same as COM1)	Positronic (female) RS-232/RS-422, from 9.6 to 115.2 kbps, USB 2.0, 12 Mbps max data rate
POWER: (connector: FR11FP922LM0/AA; pin: FC422N6/AA).	Positronic (male) Power port, from 9 to 32 VDC, 6 W typical, Power Input 1,2; Power Ground 1PPS / Event Marker
BLUETOOTH:	1 Serial Port Service, 230.4 kbps 10 m (32 ft) range



By default, the two female Positronic ports are available for command inputs and data input/output. Refer to Chapter 4, Interfacing, for I/O connector pin assignments.

## Input/Output Data Messages

Control Commands (Input Only):	NavCom proprietary commands (refer to TRM)
Differential Correction (I/O):	RTCM 2.3 and 3.0, RTCM types 1, 3, and 9, SBAS (WAAS/EGNOS/ MSAS/ GAGAN), and StarFire
RTK Correction Data (I/O):	CMR/CMR+, RTCM types 3, 18-22, and 1001-1012, 1019-1020, 1033; NCT types 0x5B, 0x5C, and 0x5E (hex)
NMEA-0183 Messages (Output Only):	ALM, DTM, GFA, GNS, MLA, GBS, GGA, GLL, GRS, GSA, GST, GSV, HDT, RMC, RRE, ROT, TTM, VTG, ZDA

- ☐ See *Related Standards* at the front of this manual for information on the various data formats.
- ☐ In the most current version of the software, the DTM message will automatically display before the most frequently scheduled NAV message.
- ☐ In older versions of the software (v3.0.13 and earlier), the DTM message must be manually scheduled to display at the same rate as the most frequent NAV message to meet IMO and MED certification requirements. v.3.0.14 and later software support NMEA-0183 v.1.4.1. See *Sapphire Technical Reference Manual* for details.

**Satellite-Based Augmentation System Signals**

Publicly broadcast services:	SBAS (WAAS/EGNOS/MSAS/GAGAN)
Private subscription service:	StarFire

**StarFire Rapid Recovery**

Outage duration	Up to 55 seconds
Maximum outage distance	10km
PDOP Limit HDOP Limit	<4 <3
Recovery time	<3 minutes after re-entering StarFire navigation mode

**Physical and Environmental**

Size (L x W x H):	Without Mounting Brackets: 164 x 117 x 60mm (6.47 x 4.60 x 2.37in) With Mounting Brackets: 164 x 166 x 62mm (6.47 x 6.52 x 2.46in)
Weight:	1.1 lbs (0.50 kg)
External Power: Input Voltage: Output Voltage:	9 to 32VDC, 6W typical +5V ± 0.5V (up to 100mA available for antenna bias via RF connector)
Temperature(ambient) Operating: Storage:	-40°C to +70°C (-40° to +158° F) -40°C to +85°C (-40° to +185° F)
Humidity:	95% Non-Condensing

Vibration:	MIL-STD-810F Method 514.5
Shock:	MIL-STD-810F Method 516.5
Ingress Protection:	IP67*
Marine Equipment:	Marine Equipment Directive (MED) 96/98/EC IEC 60945, IEC 61108-1 IEC 61162-1, IEC 61162-2
MED Compass Safe Distance:	250mm

\* Compliant only when cables are connected

### LED Display Functions

GNSS	Acquiring/Tracking GNSS Satellites
StarFire	Verifying StarFire License Acquiring/Tracking StarFire Satellites
Data I/O	Data I/O Activity
Bluetooth	Bluetooth Connectivity




**B..... Antenna Specifications**

*Table 25: Rover, Base, and Airborne GNSS Antenna*

Part Numbers	Rover: 82-001020-3001LF Base: 82-001021-3001LF Airborne: 82-001022-3001LF
Frequency (Frequency is dependent on software bundle options.)	GPS L1: 1575.42MHz, ±16MHz GPS L2: 1227.60MHz, ±16MHz GPS L2C: 1227.60MHz, ±16MHz GPS L5: 1176.45MHz, ±16MHz StarFire L-Band: 1525 -1585 MHz GLONASS G1: 1603.00MHz, ±6.5MHz GLONASS G2: 1247.00MHz, ±5MHz
Phase Center (see Figure 112)	GPS L1: 66mm (2.60in) GPS L2: 65mm (2.56in)
Polarization	Right Hand Circular (RHCP)
Pre-Amplifier	39dB gain (+/-2dB)
Noise Figure	2.6dB max
Impedance	50 Ohms
VSWR / RL	≤ 2.0:1 (14dB return loss)
Band Rejection	20dB @ 250MHz
RF Power Handling	1 Watt
Input Voltage	4.2 to 15.0 VDC
Power Consumption	0.3W 46mA typical, 50mA max @ 5VDC
Vibration	RTCA D0-160 E, Section 8, Curve D (Does not apply to the Base antenna)
Immersion	MIL-STD-810F, Method 512.4
Cable Connector	TNC Female
Antenna Operating Temperature	-55°C to +85°C
Altitude	70,000ft; 21,336m
Rover/Airborne Antenna Finish	Fluid resistant Ultem, UV stable

 Designed to DO-160D Standard

 NavCom P/N 82-001022-3001LF is the aircraft mount antenna, also rated to 70,000 feet (21,336m), and is TSO-C144 certified.



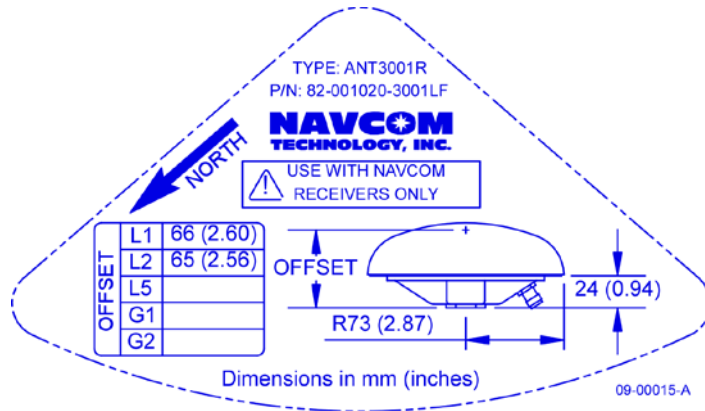



Figure 112: Rover GNSS Antenna Offset

 Figure 112 is a drawing of the label on the Rover GNSS antenna (P/N 82-001020-3001LF). The phase center provided is based on [NGS test results](#). NGS does not currently provide GLONASS calibrated values.

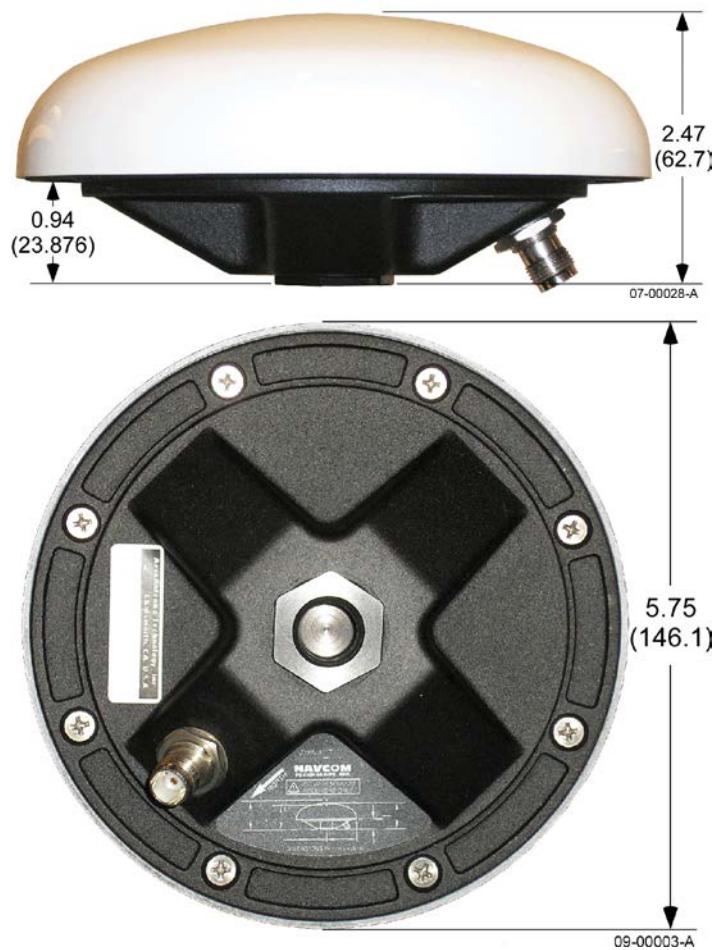


Figure 113: Rover (P/N 82-001020-3001) Antenna Dimensions

- To achieve the greatest level of accuracy, the absolute phase center values must be incorporated into your processing. Phase center information on this antenna is found on our web site:  
<http://www.navcomtech.com/Support/DownloadCenter.cfm?category=antenna>

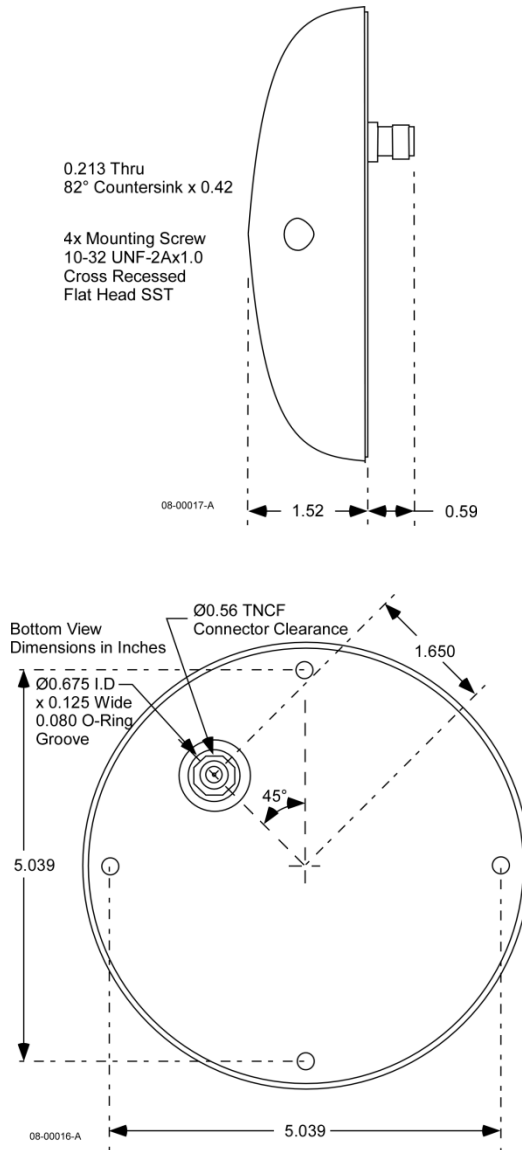


Figure 114: Airborne (P/N 82-001022-3001LF) Antenna Dimensions

### Rover/Airborne Antennae Radiation Pattern

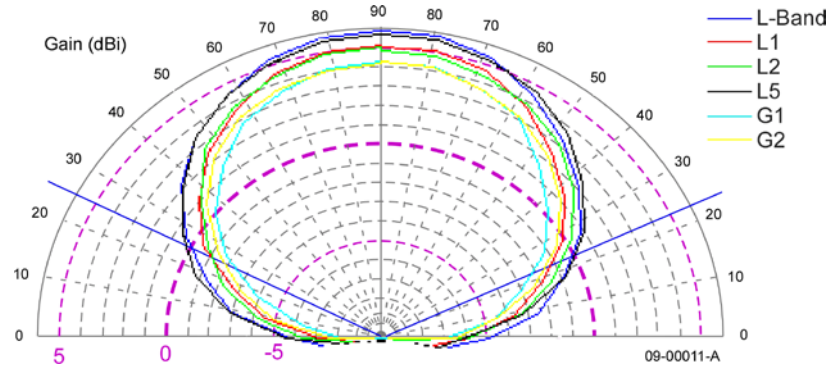


Figure 115: Rover/Airborne GNSS Antenna Radiation Pattern

Optimal antenna performance is realized at elevations greater than 25°.

There is a 10dB variation between 0° and 90° elevation (factor 10x); therefore, lower elevation satellites are always more difficult to track.

There is a 5dB variation between ~35° and 0° elevation (factor >3x)

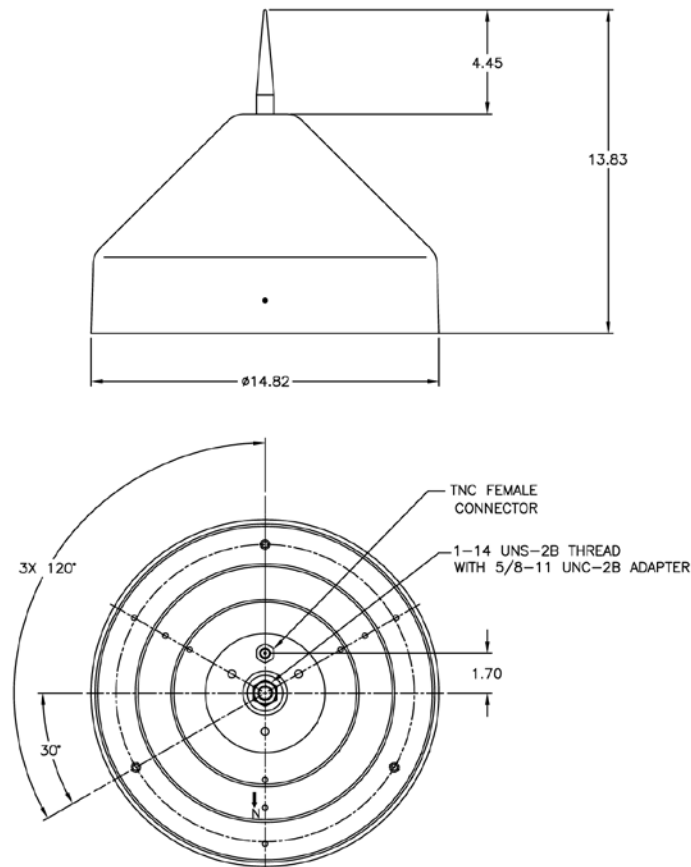
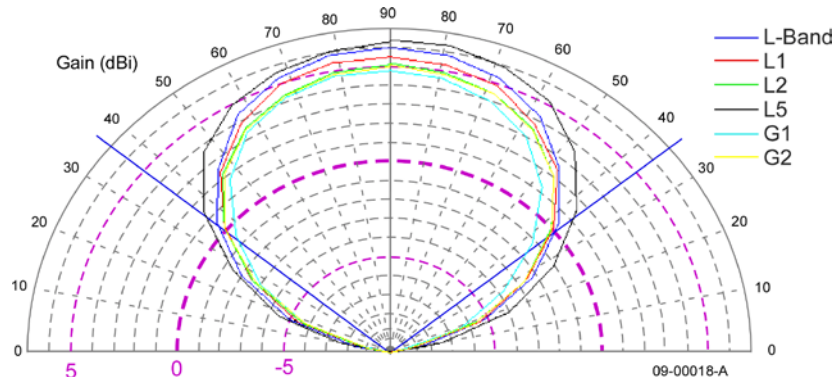


Figure 116: Base (P/N 82-001021-3001LF) Antenna Dimensions

Base Antenna Radiation Pattern



*Figure 117: Base GNSS Antenna Radiation Pattern*

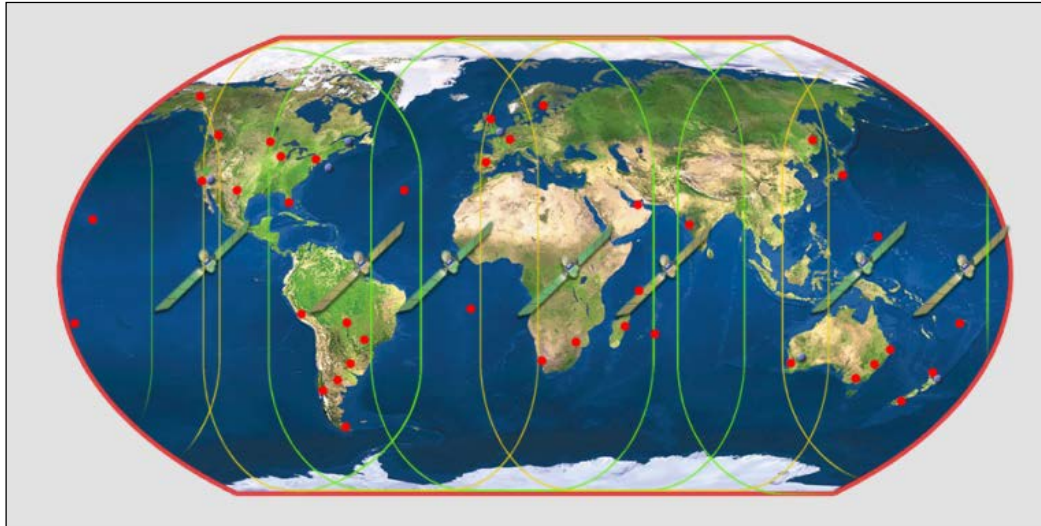
Optimal antenna performance is realized at elevations greater than 35°.

There is an 11dB variation between 15° and 90° elevation (factor >10x); therefore, lower elevation satellites are always more difficult to track.

There is a 9dB variation between ~35° and 0° elevation (factor >8x)



C ..... StarFire



**Description**

The StarFire Network is a global system for the distribution of SBAS corrections giving the user the ability to measure their position anywhere in the world with exceptional reliability and unprecedented accuracy of better than 5cm (2 inches). Because the SBAS corrections are broadcast via INMARSAT geo-stationary satellites, the user needs no local reference stations or post-processing to get this exceptional accuracy. Furthermore, the same accuracy is available virtually anywhere on the earth's surface on land or sea from a 10 degree look angle, due to the worldwide coverage of these geo-stationary satellites.

**Infrastructure**

The system utilizes the GPS satellite system, L-Band communication satellites, and a worldwide network of reference stations, to deliver real-time high-precision positioning.

To provide this unique service, NavCom has built a global network of dual-frequency reference stations, which constantly receive signals from the GPS satellites as they orbit the earth. Data from these reference stations is fed to two USA processing centers, in Torrance, California and Moline, Illinois, where they are processed to generate the differential corrections.

From the two processing centers, the correction data is fed via redundant and independent communication links to satellite uplink stations at Laurentides, Canada; Perth, Australia; Burum, The Netherlands; Santa Paula, California; Auckland, New Zealand; and Southbury, Connecticut for rebroadcast via the geo-stationary satellites.

The key to the accuracy and convenience of the StarFire system is the source of SBAS corrections. GPS satellites transmit navigation data on several L-Band frequencies. The StarFire reference stations are all equipped with geodetic-quality, multi-frequency receivers. These reference receivers decode GPS signals and send precise, high quality,

multi-frequency pseudorange and carrier phase measurements back to the processing centers together with the data messages, which all GPS satellites broadcast.

At the processing centers, NavCom's proprietary differential processing techniques are used to generate real-time precise orbits and clock correction data for each satellite in the GPS constellation. This proprietary Wide Area DGPS (WADGPS) algorithm is optimized for a multi-frequency system such as StarFire, in which multi-frequency ionospheric measurements are available at both the reference receivers and the user receivers. It is the use of multi-frequency receivers at both the reference stations and the user equipment, together with the advanced processing algorithms, which makes the exceptional accuracy of the StarFire system possible.

Creating the corrections is just the first part. From our two processing centers, the differential corrections are then sent to the Land Earth Station (LES) for uplink to L-Band communications satellites. The uplink sites for the network are equipped with NavCom-built modulation equipment, which interfaces with the satellite system transmitter and uplinks the correction data stream to the satellite that broadcasts it over the coverage area. Each L-Band satellite covers more than a third of the earth.

Users equipped with a StarFire precision GPS receiver actually have two receivers in a single package, a GPS receiver and an L-Band communications receiver, both designed by NavCom for this system. The GPS receiver tracks all the satellites in view and makes pseudorange measurements to the GPS satellites. Simultaneously, the L-Band receiver receives the correction messages broadcast via the L-Band satellite. When the corrections are applied to the GPS measurements, a position measurement of unprecedented real-time accuracy is produced.

The StarFire network was originally formed on the ITRF-2000 datum (WGS-84 G1150) and transitioned to ITRF-2008 (WGS-84 G1674) on January 21, 2014. Users may need to transition through ITRF-2005 to get from ITRF-2000 to ITRF-2008. Transformation parameters and methodologies are provided [here](#). The StarFire network transitioned from ITRF-2008 to ITRF-2014 on March 31, 2017 for StarFire GNSS and April 1, 2017 for StarFire GPS.

## Reliability

The entire system meets or exceeds a target availability of 99.99%. To achieve this, every part of the infrastructure has a built-in backup system.

All of the reference stations are built with duplicate receivers, processors, and communication interfaces, which switch automatically or in response to a remote control signal from the processing centers. The data links from the reference stations use the Internet as the primary data link and are backed up by dedicated communications lines, but in fact the network is sufficiently dense that the reference stations effectively act as backup for each other. If one or several fail, the net effect on the correction accuracy is not impaired.

There are two continuously running processing centers, each receiving all of the reference site inputs and each with redundant communications links to the uplink LES. The LESs are equipped with two complete and continuously operating sets of uplink equipment arbitrated by an automatic fail over switch. Finally, a comprehensive team of support engineers maintains round the clock monitoring and control of the system.

The network is a fully automated self-monitoring system. To ensure overall system integrity, an independent integrity monitor receiver, similar to a standard StarFire user receiver, is installed at every reference station to monitor service quality. Data from these integrity monitors is sent to the two independent processing hubs in Torrance, California and Moline, Illinois. Through these integrity monitors, the network is continuously checked for overall SBAS positioning accuracy, L-Band signal strength, data integrity, and other essential operational parameters.

- ☐ The number of StarFire broadcasting satellites and their locations are subject to change without notice.

### StarFire Satellites

*Table 26: StarFire Satellites v. 1.0.1.5 and Earlier*

Network	Satellite ID	Longitude	Satellite Name	Uplink Site
Net 1	402	97.65W	PAC-E	Laurentides
	609	109E	IND-E	Auckland
	525	25E	IND-W	Burum
Net 2	358	142W	PAC-C	Santa Paula
	643	143.5E	PAC-W	Perth
	484	15.5W	AOR-E	Southbury

*Table 27: StarFire Satellites v. 2.0.15.0 and Later*

Network	Satellite ID	Longitude	Satellite Name	Uplink Site
Net 1	402	97.65W	PAC-E	Laurentides
	643	143.5E	PAC-W	Perth
	525	25E	IND-W	Burum
Net 2	358	142W	PAC-C	Santa Paula
	609	109E	IND-E	Auckland
	484	15.5W	AOR-E	Southbury

- ☐ Satellites 609 and 643 have been reassigned to provide improved reception. Satellite 609, which was in Net1, is now in Net2, and satellite 643, which was in Net2, is now in Net1.

*Table 28: StarFire Satellites v.3.0.12.0 and Later*

Network	Satellite ID	Longitude	Satellite Name	Uplink Site
Net 1	402	97.65W	PAC-E	Laurentides
	643	143.5E	PAC-W	Auckland
	525	25E	IND-W	Burum
Net 2	678	178E	POR	Santa Paula
	564	64E	IND-E	Perth
	446	54W	AOR-W	Southbury
	484	15.5W	AOR-E	Southbury



## How to Access the StarFire Service

StarFire is a subscription service. The user pays a subscription, which licenses the use of the service for a predetermined period of time. In addition to the StarFire license, the SF-3050 receiver requires a StarFire Software Option<sup>1</sup>. This is not a requirement for other NavCom receivers.

StarFire subscriptions can be purchased for quarterly, biannual, or annual periods and are available via a NavCom authorized representative, or by contacting [NavCom Sales Department](#).

An authorized subscription will provide an encrypted keyword, which is specific to the Serial Number of the NavCom receiver to be authorized. This is entered into the receiver using the provided controller solution.

For the SF-3050 receiver only, the initial StarFire license and StarFire Software Option are installed by an authorized dealer or the user.

Former NavCom receivers were delivered with the initial StarFire license preinstalled at the factory, and subsequent licenses were installed by the user. NavCom's order fulfillment center has changed, necessitating a change in initial license installation as detailed above.

For the SF-3050 receiver only, subsequent renewals of the license can be transmitted to the receiver via satellite.

The only piece of equipment needed to use the StarFire system is a StarFire receiver. NavCom offers a variety of receivers configured for different applications. Details of all the StarFire receivers are available from the NavCom authorized local representative or the NavCom website at: [www.NavComtech.com](http://www.NavComtech.com)

StarFire receivers include a multi-frequency GNSS receiver and an L-Band receiver integrated into a single unit to provide the exceptional precise positioning capability of the StarFire Network, anywhere, anytime.

<sup>1</sup> Dependent on Bundle Options: Standard or Optional

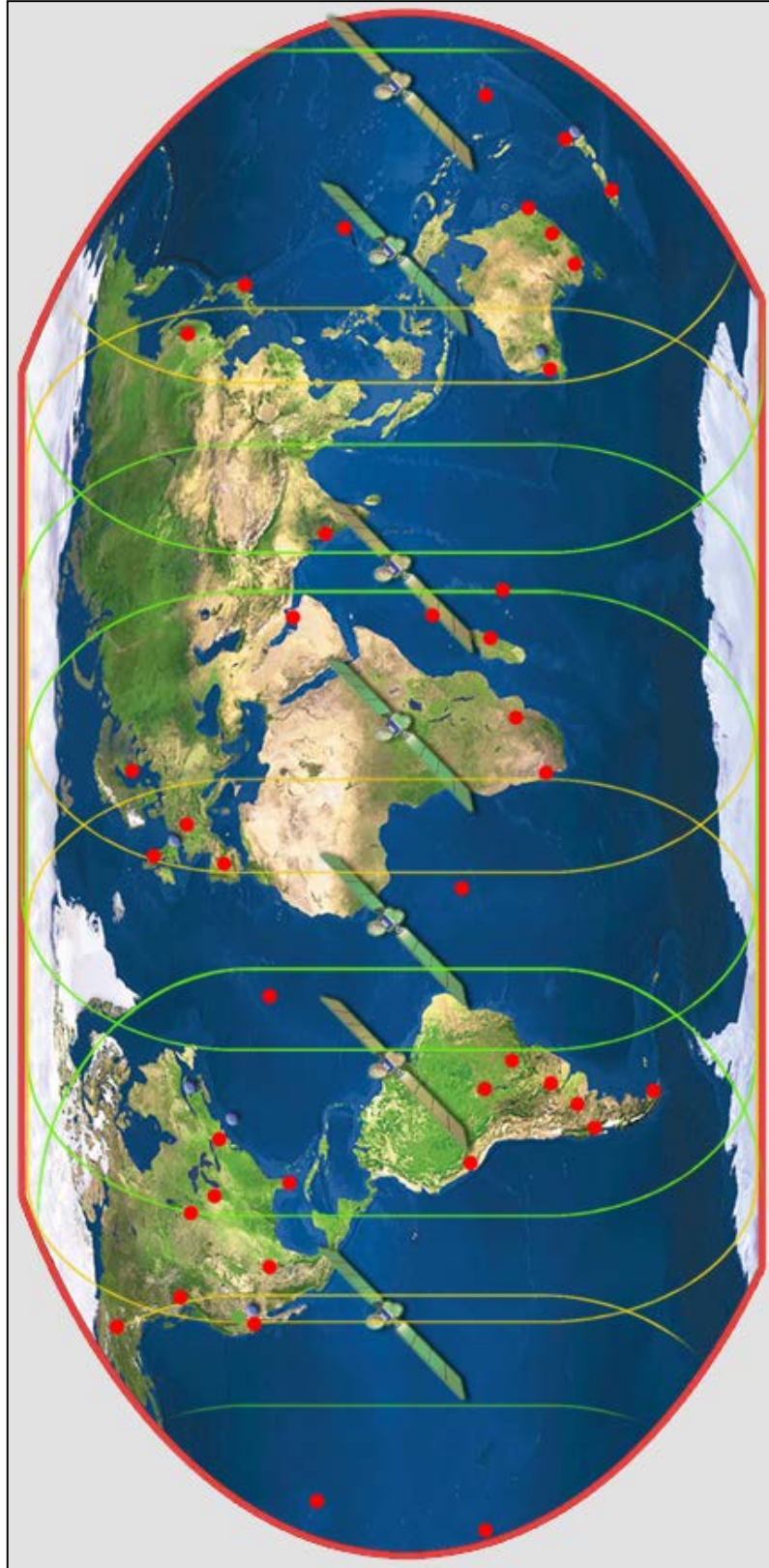


Figure 118: StarFire Network

\*The number of StarFire broadcasting satellites and their locations are subject to change without notice.



## D..... Event Input Configuration

Figure 121 details the wiring of the supplied Event cable assembly. NavCom part number P/N 94-310262-3010LF is supplied with earlier SF-3050 production units. P/N 94-310274-3010LF is supplied with later SF-3050 production units.

Refer to Chapter 3/Event for detailed electrical specifications.

Table 31 details the wiring configuration required for Event pulse sensing.

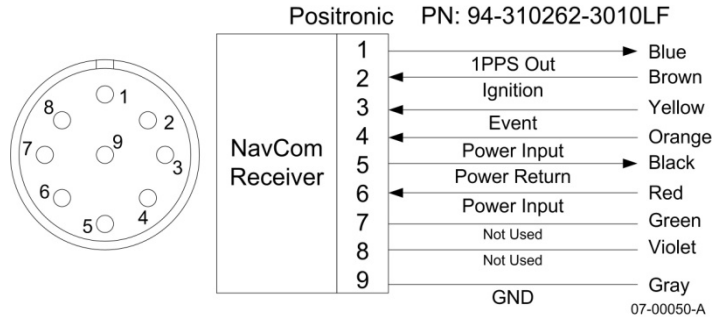


Figure 119: Event Cable Wiring Diagram

Table 29: Event Wiring Connections

Pin #	Signal Name	Event Sync Wiring
3	Event	Tie Event to Ground
9	Ground	N/A

Once the cable is wired to correspond with the event pulse requirements, configure the receiver to output the message containing a time mark – referenced to the time kept within the receiver indicating when the event is sensed (EVENTLATCH, EVENTLATCHA).

 The EVENTLATCH and EVENTLATCHA messages are described in the *Sapphire Technical Reference Manual* (see *Related Documents* in the fore-matter).

The Event Input can be triggered on the Rising or Falling edge of the input pulse. Configuration is possible through the StarUtil 3000 program.



## E . Networked Transport of RTCM Internet Protocol (NTRIP) Setup

### Configure the SF-3050 for Wireless Connection

Perform these steps:

1. Connect the SF-3050 to the computer either on the USB port or the COM1 port.
2. Start StarUtil 3000 or another application that provides an *Input Terminal*.
3. Configure the SF-3050 as a rover:

```
[RTKMODE]ROVER, RTCM, 1
```

4. Schedule the following messages:

```
[OUTPUT]PVT1B,ONTIME,1,USB1
[OUTPUT]ECHODGPSB,ONCHANGE,,USB1
[OUTPUT]RTKSTATUS1B,ONTIME,1,USB1
```

1. Configure the modem control parameters; for example, assuming T-Mobile as service provider, enter the following command on the Input Terminal

```
[MODEMCONFIG] """, """, "1, 'IP', 'internet2.voicestream.com'"
```



For providers other than T-Mobile, the APN 'internet2.voicestream.com' should be changed to the appropriate APN. If in doubt, sometimes a blank APN works.

### Configure the NTRIP Server

Perform these steps:

1. Configure the SF-3050 to send corrections to the caster via the modem.
2. Connect to the caster:

```
[NTRIPSERVER]CONNECT
```

3. Set RTKMODE to use the NTRIP virtual port as the port for sending the corrections:

```
[RTKMODE]BASERTCM1004,,1,NTRIP,STATIC,AUTO
```



BASERTCM1004 indicates the type of corrections to send.

4. Enter the following command to disconnect from the caster:

```
[NTRIPSERVER]DISCONNECT
```



Refer to the *Sapphire Technical Reference Manual* for detailed instructions on the [ECHODGPSB], [MODEMCONFIG], [NTRIPSERVER], [NTRIPCLIENT], [OUTPUT], and [RTKMODE] commands.

### Configure the NTRIP Client

Perform these steps:

1. Configure the SF-3050 to receive corrections from the caster via the modem.
2. Connect to the caster:  
[NTRIPCLIENT]CONNECT
3. Verify that the ECHODGPSB message indicates that RTCM 3.0 corrections are being received.
4. Verify that both the PVT1B and RTKSTATUS1B screens indicate that the navigation status achieves “RTK Dual Fixed: RTCM3-Dual Full”. This may take several seconds.
5. Enter the following command to disconnect from the caster:  
[NTRIPCLIENT]DISCONNECT

Refer to the *Sapphire Technical Reference Manual* for detailed instructions on the [ECHODGPSB], [MODEMCONFIG], [NTRIPCLIENT], [NTRIPSERVER], [OUTPUT], and [RTKMODE] commands.

-  The NTRIP client and server cannot both be active at the same time. An error message will be displayed if any keyword other than a status request or DISCONNECT is issued to one while the other is active.
-  To send or receive corrections via Ethernet instead of a modem, configure the SF-3050 for Ethernet.

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## F ..... Software License Agreement

### Software License Agreement for NavCom Technology, Inc. GNSS StarFire™ Receiver

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## G..... RoHS Certification

### Description

RoHS (Restriction of Use of Hazardous Substances) regulations limit or ban specific substances – lead, cadmium, polybrominated biphenyl (PBB), mercury, hexavalent chromium, and polybrominated diphenyl ether (PBDE) flame retardants – in new electronic and electric equipment.

For Cadmium and Hexavalent chromium, there must be less than 0.01% of the substance by weight at raw homogeneous materials level. For Lead, PBB, and PBDE, there must be no more than 0.1% of the material, when calculated by weight at raw homogeneous materials. Any RoHS compliant component must have 100 ppm or less of mercury and the mercury must not have been intentionally added to the component.

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*Table 30: Toxic or Hazardous Substances or Elements Disclosure by Part Number*

#### 92-310501-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
PCBA	X	O	O	O	O	O
USB Flash Drive	O	O	O	O	O	O
Antenna	X	O	O	O	O	O
Labels	O	O	O	O	O	O

#### 92-310503-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
PCBA	X	O	O	O	O	O
USB Flash Drive	O	O	O	O	O	O
Antenna	O	O	O	O	O	O
Labels	O	O	O	O	O	O



92-310411-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers (PBDE)
PCBA	X	O	O	O	O	O
Labels	O	O	O	O	O	O

92-210206-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers (PBDE)
PCBA	X	O	O	O	O	O
Radio	O	O	O	O	O	O
Spacer	O	O	O	O	O	O
Pad	O	O	O	O	O	O
Housing	O	O	O	O	O	O
Labels	O	O	O	O	O	O
Shim	O	O	O	O	O	O
Cable	O	O	O	O	O	O
Hardware	O	O	O	O	O	O

92-310459-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
Memory Card	O	O	O	O	O	O
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Shield	O	O	O	O	O	O
Housings	O	O	O	O	O	O
Labels	O	O	O	O	O	O
Tripod/ Poles	O	O	O	O	O	O
Measuring Instruments	O	O	O	O	O	O
Carrying Cases	O	O	O	O	O	O
PDA	O	O	O	O	O	O
Bumper	O	O	O	O	O	O
Antenna	X	O	O	O	O	O
Cables	X	O	O	O	O	O
Hardware	O	O	O	X	O	O
Gaskets	O	O	O	O	O	O
Battery	X	O	O	O	O	O
Battery Charger	O	O	O	O	O	O
USB Flash Drive	O	O	O	O	O	O

92-310520-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Shield	O	O	O	O	O	O
Housings	O	O	O	O	O	O
Labels	O	O	O	O	O	O
Bumper	O	O	O	O	O	O
Antenna	X	O	O	O	O	O
Cables	X	O	O	O	O	O
Hardware	O	O	O	X	O	O
Gaskets	O	O	O	O	O	O

92-310458-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
Memory Card	O	O	O	O	O	O
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Shield	O	O	O	O	O	O
Housings	O	O	O	O	O	O
Labels	O	O	O	O	O	O
Tripod/ Poles	O	O	O	O	O	O
Measuring Instruments	O	O	O	O	O	O
Carrying Cases	O	O	O	O	O	O
PDA	O	O	O	O	O	O
Bumper	O	O	O	O	O	O
Antenna	X	O	O	O	O	O
Cables	X	O	O	O	O	O
Hardware	O	O	O	X	O	O
Gaskets	O	O	O	O	O	O
Battery	X	O	O	O	O	O
Battery Charger	O	O	O	O	O	O
USB Flash Drive	O	O	O	O	O	O

92-310441-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
Memory Card	O	O	O	O	O	O
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Shield	O	O	O	O	O	O
Housings	O	O	O	O	O	O
Labels	O	O	O	O	O	O
Bumper	O	O	O	O	O	O
Antenna	X	O	O	O	O	O
Cables	X	O	O	O	O	O
Hardware	O	O	O	X	O	O
Gaskets	O	O	O	O	O	O
Battery	X	O	O	O	O	O
Battery Charger	O	O	O	O	O	O

92-310413-3002LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Clamp	O	O	O	O	O	O
Housing	O	O	O	O	O	O
Labels	O	O	O	O	O	O
End Plate	O	O	O	O	O	O
End Cover	O	O	O	O	O	O
Cable	O	O	O	O	O	O
Hardware	O	O	O	X	O	O
Gaskets	O	O	O	O	O	O
Brackets	O	O	O	O	O	O

92-310416-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
Antenna	O	O	O	O	O	O
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Clamp	O	O	O	O	O	O
Housing	O	O	O	O	O	O
Labels	O	O	O	O	O	O
End Plate	O	O	O	O	O	O
End Cover	O	O	O	O	O	O
Power Cord	O	O	O	O	O	O
Cables	O	O	O	O	O	O
Hardware	O	O	O	X	O	O
Gaskets	O	O	O	O	O	O
Brackets	O	O	O	O	O	O

92-310418-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Clamp	O	O	O	O	O	O
Housing	O	O	O	O	O	O
Labels	O	O	O	O	O	O
End Plate	O	O	O	O	O	O
End Cover	O	O	O	O	O	O
Cables	O	O	O	O	O	O
Hardware	O	O	O	O	O	O
Gaskets	O	O	O	O	O	O
USB Flash Drive	O	O	O	O	O	O
Brackets	O	O	O	O	O	O

92-310413-3003LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
PCBAs	X	O	O	O	O	O
Switch	O	O	O	O	O	O
Clamp	O	O	O	O	O	O
Housing	O	O	O	O	O	O
Labels	O	O	O	O	O	O
End Plate	O	O	O	O	O	O
End Cover	O	O	O	O	O	O
Cables	O	O	O	O	O	O
Hardware	O	O	O	O	O	O
Gaskets	O	O	O	O	O	O
Brackets	O	O	O	O	O	O

92-310415-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
Power Adapter	0	0	0	0	0	0
PCBAs	X	0	0	0	0	0
USB Flash Drive	0	0	0	0	0	0
Switch	0	0	0	0	0	0
Clamp	0	0	0	0	0	0
Housing	0	0	0	0	0	0
Labels	0	0	0	0	0	0
End Cover	0	0	0	0	0	0
Spacer	0	0	0	0	0	0
Cable	X	0	0	0	0	0
Hardware	0	0	0	X	0	0
Gaskets	0	0	0	0	0	0
Brackets	0	0	0	0	0	0

92-310413-3001LF

Part Name	Toxic or hazardous substances and elements					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated dephenyl ethers PBDE)
Clamp	0	0	0	0	0	0
PCBAs	X	0	0	0	0	0
Housing	0	0	0	0	0	0
Switch	0	0	0	0	0	0
Labels	0	0	0	0	0	0
End Cover	0	0	0	0	0	0
Spacer	0	0	0	0	0	0
Cable	X	0	0	0	0	0
Hardware	0	0	0	X	0	0
Gaskets	0	0	0	0	0	0
Bracket	0	0	0	0	0	0



“O” indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006 (Standard of the Electronics Industry of the People’s Republic of China).

“X” indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials for this part is above the limit requirement in SJ/T11363-2006 (Standard of the Electronics Industry of the People’s Republic of China).

## RoHS 认证

### 说明

RoHS ( 危险物质的使用限制 ) 法规限制或禁止在新的电气和电子设备中使用特定物质，这些物质包括铅、镉、多溴二苯醚 (PBB)、汞、六价铬和多溴代二苯醚 (PBDE) 阻燃剂。

对于镉和六价铬，在原材料均匀级别下按重量计算物质含量必须低于 0.01%。对于铅、PBB 和 PBDE，在均匀的原材料水平下，按材料重量计算时的不能超过 0.1%。任何符合 RoHS 的部件汞含量必须小于等于 100 ppm，并且不能将汞故意添加到部件中。

下列部件符合 RoHS 技术规格。 这些物质的测试结果显示它们是 RoHS 受控物质，并且符合 RoHS 法规的要求。

*表31：按部件号列出的有毒或危险物质或原件*

92-310501-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
USB 闪存驱动器	O	O	O	O	O	O
天线	X	O	O	O	O	O
标签	O	O	O	O	O	O

92-310503-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
USB 闪存驱动器	O	O	O	O	O	O
天线	O	O	O	O	O	O
标签	O	O	O	O	O	O

92-310411-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
标签	O	O	O	O	O	O

92-210206-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
收音机	O	O	O	O	O	O
隔片	O	O	O	O	O	O
衬垫	O	O	O	O	O	O
外壳	O	O	O	O	O	O
标签	O	O	O	O	O	O
垫片	O	O	O	O	O	O
线缆	O	O	O	O	O	O
固定件	O	O	O	O	O	O

92-310459-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
存储卡	O	O	O	O	O	O
PCBA	X	O	O	O	O	O
开关	O	O	O	O	O	O
屏蔽板	O	O	O	O	O	O
外壳	O	O	O	O	O	O
标签	O	O	O	O	O	O
三脚架/ 柱杆	O	O	O	O	O	O
测量仪表	O	O	O	O	O	O
便携包	O	O	O	O	O	O
PDA	O	O	O	O	O	O
减震台	O	O	O	O	O	O
天线	X	O	O	O	O	O
线缆	X	O	O	O	O	O
固定件	O	O	O	X	O	O
衬垫	O	O	O	O	O	O
电池	X	O	O	O	O	O
电池充电器	O	O	O	O	O	O
USB 闪存驱动器	O	O	O	O	O	O



92-310520-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	○	○	○	○	○
开关	○	○	○	○	○	○
屏蔽板	○	○	○	○	○	○
外壳	○	○	○	○	○	○
标签	○	○	○	○	○	○
减震台	○	○	○	○	○	○
天线	X	○	○	○	○	○
线缆	X	○	○	○	○	○
固定件	○	○	○	X	○	○
衬垫	○	○	○	○	○	○

92-310458-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
存储卡	○	○	○	○	○	○
PCBA	X	○	○	○	○	○
开关	○	○	○	○	○	○
屏蔽板	○	○	○	○	○	○
外壳	○	○	○	○	○	○
标签	○	○	○	○	○	○
三脚架/ 柱杆	○	○	○	○	○	○
测量仪表	○	○	○	○	○	○
便携包	○	○	○	○	○	○
PDA	○	○	○	○	○	○
减震台	○	○	○	○	○	○
天线	X	○	○	○	○	○
线缆	X	○	○	○	○	○
固定件	○	○	○	X	○	○
衬垫	○	○	○	○	○	○
电池	X	○	○	○	○	○
电池充电器	○	○	○	○	○	○
USB 闪存驱动器	○	○	○	○	○	○

92-310441-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
存储卡	○	○	○	○	○	○
PCBA	X	○	○	○	○	○
开关	○	○	○	○	○	○
屏蔽板	○	○	○	○	○	○
外壳	○	○	○	○	○	○
标签	○	○	○	○	○	○
减震台	○	○	○	○	○	○
天线	X	○	○	○	○	○
线缆	X	○	○	○	○	○
固定件	○	○	○	X	○	○
衬垫	○	○	○	○	○	○
电池	X	○	○	○	○	○
电池充电器						

92-310413-3002LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	○	○	○	○	○
开关	○	○	○	○	○	○
线箍	○	○	○	○	○	○
外壳	○	○	○	○	○	○
标签	○	○	○	○	○	○
端板	○	○	○	○	○	○
端盖	○	○	○	○	○	○
线缆	○	○	○	○	○	○
固定件	○	○	○	X	○	○
衬垫	○	○	○	○	○	○
支架	○	○	○	○	○	○

92-310416-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
天线	○	○	○	○	○	○
PCBA	X	○	○	○	○	○
开关	○	○	○	○	○	○
线箍	○	○	○	○	○	○
外壳	○	○	○	○	○	○
标签	○	○	○	○	○	○
端板	○	○	○	○	○	○
端盖	○	○	○	○	○	○
电源线	○	○	○	○	○	○
线缆	○	○	○	○	○	○
固定件	○	○	○	X	○	○
衬垫	○	○	○	○	○	○
支架	○	○	○	○	○	○

92-310418-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	○	○	○	○	○
开关	○	○	○	○	○	○
线箍	○	○	○	○	○	○
外壳	○	○	○	○	○	○
标签	○	○	○	○	○	○
端板	○	○	○	○	○	○
端盖	○	○	○	○	○	○
线缆	○	○	○	○	○	○
固定件	○	○	○	○	○	○
衬垫	○	○	○	○	○	○
USB 闪存驱动器	○	○	○	○	○	○
支架	○	○	○	○	○	○

92-310413-3003LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
PCBA	X	0	0	0	0	0
开关	0	0	0	0	0	0
线箍	0	0	0	0	0	0
外壳	0	0	0	0	0	0
标签	0	0	0	0	0	0
端板	0	0	0	0	0	0
端盖	0	0	0	0	0	0
线缆	0	0	0	0	0	0
固定件	0	0	0	0	0	0
衬垫	0	0	0	0	0	0
支架	0	0	0	0	0	0

92-310415-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
电源适配器	0	0	0	0	0	0
PCBA	X	0	0	0	0	0
USB 闪存驱动器	0	0	0	0	0	0
开关	0	0	0	0	0	0
线箍	0	0	0	0	0	0
外壳	0	0	0	0	0	0
标签	0	0	0	0	0	0
端盖	0	0	0	0	0	0
隔片	0	0	0	0	0	0
线缆	X	0	0	0	0	0
固定件	0	0	0	X	0	0
衬垫	0	0	0	0	0	0
支架	0	0	0	0	0	0

92-310413-3001LF

部件号	有毒或危险物质和元件					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴二苯醚 (PBB)	多溴代二苯醚 (PBDE)
线箍	0	0	0	0	0	0
PCBA	X	0	0	0	0	0
外壳	0	0	0	0	0	0
开关	0	0	0	0	0	0
标签	0	0	0	0	0	0
端盖	0	0	0	0	0	0
隔片	0	0	0	0	0	0
线缆	X	0	0	0	0	0
固定件	0	0	0	X	0	0
衬垫	0	0	0	0	0	0
支架	0	0	0	0	0	0



“0”表示本部件中所有均匀物质中的有毒物质或危险物质含量均低于 SJ/T11363-2006 ( 中华人民共和国电子工业标准 ) 的限制要求。

“X”表示本部件中至少有一项均匀物质中的有毒物质或危险物质含量均超过了 SJ/T11363-2006 ( 中华人民共和国电子工业标准 ) 的限制要求。

## Glossary

**.yym files** see meteorological files (where yy = two- digit year data was collected).

**.yyn files** see navigation files (where yy = two digit year data was collected).

**.yyo files** see observation files (where yy = two digit year data was collected).

**almanac files** an almanac file contains orbit information, clock corrections, and atmospheric delay parameters for all satellites tracked. It is transmitted to a receiver from a satellite and is used by mission planning software.

**alt** see *altitude*.

**altitude** vertical distance above the *ellipsoid* or *geoid*. It is always stored as height above *ellipsoid* in the GPS receiver but can be displayed as height above *ellipsoid* (HAE) or height above *mean sea level* (MSL).

**Antenna Phase Center (APC)** The point in an antenna where the *GPS* signal from the satellites is received. The height above ground of the APC must be measured accurately to ensure accurate *GPS* readings. The APC height can be calculated by adding the height to an easily measured point, such as the base of the antenna mount, to the known distance between this point and the APC.

**APC** see *antenna phase center* or *phase center*.

**Autonomous positioning (GPS/GLONASS)** a mode of operation in which a GNSS receiver computes *position* fixes in real time from satellite data alone, without reference to data supplied by a *reference station* or orbital clock corrections. Autonomous positioning is typically the least precise positioning procedure a GNSS receiver can perform, yielding *position* fixes that are precise to 100 meters with Selective Availability on, and 30 meters with S/A off.

**azimuth** the *azimuth* of a line is its direction as given by the angle between the *meridian* and the line measured in a clockwise direction from the north branch of the meridian.

**base station** see *reference station*.

**baud rate (bits per second)** the number of bits sent or received each second. For example, a *baud rate* of 9600 means there is a data flow of 9600 bits each second. One character roughly equals 10 bits.

**bits per second** see *baud rate*.

**bps** see *baud rate*.

**BSW (British Standard Whitworth)** a type of coarse screw thread. A 5/8" diameter *BSW* is the standard mount for survey instruments.

**C/A code** see *Coarse Acquisition code*.

**CAN BUS** a balanced (differential) 2-wire interface that uses an asynchronous transmission scheme. Often used for communications in vehicular applications.

**channel** a channel of a GPS receiver consists of the circuitry necessary to receive the signal for a single GPS satellite.

**civilian code** see *Coarse Acquisition code*.

**Coarse Acquisition code (C/A or Civilian code)**

the pseudo-random code generated by GPS satellites. It is intended for civilian use and the accuracy of readings using this code can be degraded if *selective availability (S/A)* is introduced by the US Department of Defense.

**COM#** shortened form of the word Communications. Indicates a data communications port to/from the GPS sensor to a controller or data collection device.

**Compact Measurement Record (CMR)** a standard format for DGPS corrections used to transmit corrections from a *reference station* to *rover* sensors. See *Related Standards in Notices*.

**controller** a device consisting of hardware and software used to communicate and manipulate the I/O functions of the GPS sensor.

**convergence period** (StarFire) is the time necessary for the received StarFire signal corrections to be applied and the position filtered to optimal performance. The convergence period is typically 30 to 45 minutes to achieve <decimeter accuracy. This period may be overcome using the Quick Start method.

**data files** files that contain Proprietary, GPS, NMEA, RTCM, or any type of data logged from a GPS receiver.

**datum** A reference datum is a known and constant surface that can be used to describe the location of unknown points. Geodetic datums define the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth.

**DB9P** a type of electrical connector containing 9 contacts. The P indicates a plug pin (male).

**DB9S** a type of electrical connector containing 9 contacts. The S indicates a slot pin (female).

**DCE** Data Communications Equipment. Defined pin assignments based on the IEEE RS-232 signaling standard. See Figure 82:

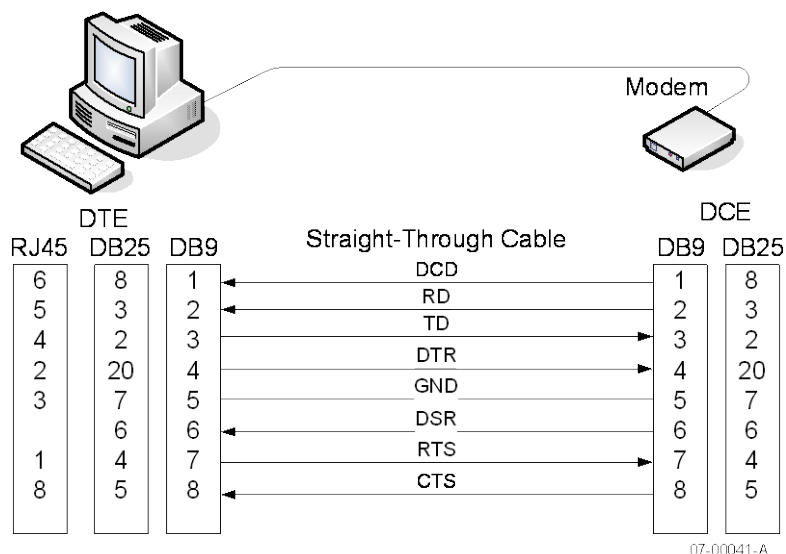


Figure 120: DTE to DCE RS-232 Pin Assignments

**DGPS** see *Differential GPS*.

**Differential GPS (DGPS)** a positioning procedure that uses two receivers, a rover at an unknown location and a reference station at a known, fixed location. The reference station computes corrections based on the actual and observed ranges to the satellites being tracked. The coordinates of the unknown location can be computed with sub-meter level precision by applying these corrections to the satellite data received by the rover.

**Dilution of Precision (DOP)** a class of measures of the magnitude of error in GPS *position* fixes due to the orientation of the GPS satellites with respect to the GPS receiver. There are several DOPs to measure different components of the error. Note: this is a unitless value. see also PDOP.

**DOP** see *Dilution of Precision*.

**DTE** Data Terminal Equipment. See *DCE*.

**dual-frequency** a type of GPS receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays. The SF-3050 is a multi-frequency GNSS receiver.

**dynamic mode** when a GPS receiver operates in dynamic mode, it assumes that it is in motion and certain algorithms for GPS position fixing are enabled in order to calculate a tighter position fix.

**ECEF (Earth Centered Earth Fixed)** a Cartesian coordinate system used for GPS, sometimes known as a "conventional terrestrial" system.

**EGNOS (European Geostationary Navigation Overlay Service)** a European satellite system used to augment the two military satellite navigation systems now operating, the US GPS and Russian GLONASS systems.

**elevation** distance above or below Local Vertical Datum.

**elevation mask** the lowest elevation, in degrees, at which a receiver can track a satellite. Measured from the horizon to zenith, 0° to 90°.

**ellipsoid** a mathematical figure approximating the Earth's surface, generated by rotating an ellipse on its minor axis. GPS positions are computed relative to the WGS-84 ellipsoid. An ellipsoid has a smooth surface, which does not match the earth's geoidal surface closely, so GPS altitude measurements can contain a large vertical error component. Conventionally surveyed positions usually reference a geoid, which has an undulating surface and approximates the earth's surface more closely to minimize altitude errors.

**epoch** literally a period of time. This period of time is defined by the length of the said period.

**G1 carrier frequency** the primary L-Band carrier used by GLONASS satellites to transmit satellite data. The frequency is 1603.00MHz.

**G2 carrier frequency** the secondary L-Band carrier used by GLONASS satellites to transmit satellite data. The frequency is 1247.00MHz.



**GAGAN (GPS Aided Geo Augmented Navigation)** an Indian satellite system that provides a set of corrections for the GPS satellites, which are valid for the Indian region. They incorporate satellite orbit and clock corrections.

**geoid** the gravity-equipotential surface that best approximates mean sea level over the entire surface of the earth. The surface of a geoid is too irregular to use for GPS readings, which are measured relative to an ellipsoid. Conventionally surveyed positions reference a geoid. More accurate GPS readings can be obtained by calculating the distance between the geoid and ellipsoid at each position and subtracting this from the GPS altitude measurement.

**GIS (Geographical Information Systems)** a computer system capable of assembling, storing, manipulating, updating, analyzing and displaying geographically referenced information, i.e. data identified according to their locations. GIS technology can be used for scientific investigations, resource management, and development planning. GIS software is used to display, edit, query and analyze all the graphical objects and their associated information.

**Global Positioning System (GPS)** geometrically, there can only be one point in space, which is the correct distance from each of four known points. *GPS* measures the distance from a point to at least four satellites from a constellation of 24 NAVSTAR satellites orbiting the earth at a very high *altitude*. These distances are used to calculate the point's position.

**GLONASS (Global Orbiting Navigation Satellite System)** the Russian Federation's GNSS system, managed by the Russian Space Forces (Russian: VKS). GLONASS uses the same concepts for positioning as GPS.

**GMT** see *Greenwich Mean Time*.

**GNSS** Global Navigation Satellite System.

**GPS** see *Global Positioning System*.

**GPS time** a measure of time. GPS time is based on UTC, but does not add periodic 'leap seconds' to correct for changes in the earth's period of rotation. As of September 2002 *GPS* time is 13 seconds ahead of UTC.

**Greenwich Mean Time (GMT)** the local time of the 0° meridian passing through Greenwich, England.

**HAE** see *altitude*, and *ellipsoid*.

**IODC** Issue of Data, Clock - The IODC indicates the issue number of the data set and thereby provides the user with a convenient means of detecting any change in the correction parameters. The transmitted IODC will be different from any value transmitted by the satellite during the preceding seven days.

**JPL** Jet Propulsion Laboratory.

**Kbps** kilobits per second.

**L-Band** the group of radio frequencies extending from approximately 400MHz to approximately 1600MHz. The GPS carrier frequencies L1 (1575.4MHz) and L2 (1227.6 MHz) are in the L-Band range.

**L1 carrier frequency** the primary L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1575.42MHz. It is modulated by C/A code, P-code, or Y-code, and a 50 bit/second navigation message. The bandwidth of this signal is 1.023MHz.

**L2 carrier frequency** the secondary L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6MHz. It is modulated by P-code, or Y-code, and a 50 bit/second navigation message. The bandwidth of this signal is 10.23MHz.

**L2C carrier frequency** a L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6MHz. It is identical to L2 carrier frequency except that it is also modulated by C/A code, which provides a narrower band and is easier to track.

**L5 carrier frequency** a L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1176.45MHz. Like L2, L5 better characterizes the ionosphere and the atmosphere.

**lat** see latitude.

**latitude (lat)** the north/south component of the coordinate of a point on the surface on the earth; expressed in angular measurement from the plane of the equator to a line from the center of the earth to the point of interest. Often abbreviated as Lat.

**LED** acronym for Light Emitting Diode.

**LEMO** a type of data or power connector.

**LES Land Earth Station** the point on the earth's surface where data is up linked to a satellite.

**logging interval** the frequency at which positions generated by the receiver are logged to data files.

**lon** see *longitude*.

**longitude (long)** the east/west component of the coordinate of a point on the surface of the earth; expressed as an angular measurement from the plane that passes through the earth's axis of rotation and the 0° meridian and the plane that passes through the axis of rotation and the point of interest. Often abbreviated as Long.

**Mean Sea Level (MSL)** a vertical surface that represents sea level.

**meridian** one of the lines joining the north and south poles at right angles to the equator, designated by degrees of longitude, from 0° at Greenwich to 180°.

**meteorological (.YYm) files** one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. A meteorological file contains atmospheric information.

**MSAS (MTSAT Satellite-based Augmentation System)** a Japanese satellite system that provides a set of corrections for the GPS satellites, which are valid for the Japanese region. They incorporate satellite orbit and clock corrections.

**MSL** see *Mean Sea Level*.

**Multi-Frequency-GNSS Receiver** a type of receiver that is capable of using multiple signals, for example, GPS (L1, L2, L2C, L5), GLONASS (G1, G2), StarFire L-band, SBAS (WAAS, EGNOS, MSAS, GAGAN), and QZSS signals. The use of multiple signals

provides compensation for ionospheric effects. In addition, reception of multiple signals provides redundancy that results in a more stable navigation solution during adverse conditions.

**multipath error** a positioning error resulting from interference between radio waves that has traveled between the transmitter and the receiver by two paths of different electrical lengths.

**navigation (.YYn) files** one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. A navigation file contains satellite position and time information.

**OEM (Original Equipment Manufacturer)** is typically a company that uses a component made by a second company in its own product, or sells the product of the second company under its own brand. The specific meaning of the term varies in different contexts.

**observation (.YYo) files** one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. An observation file contains raw GPS position information.

**P/N** Part Number.

**P-code** the extremely long pseudo-random code generated by a *GPS* satellite. It is intended for use only by the U.S. military, so it can be encrypted to Y-code deny unauthorized users access.

**parity** a method of detecting communication errors by adding an extra parity bit to a group of bits. The parity bit can be a 0 or 1 value so that every byte will add up to an odd or even number (depending on whether odd or even parity is chosen).

**PDA** Personal Digital Assistant.

**PDOP** see *Position Dilution of Precision*.

**PDOP mask** the highest PDOP value at which a receiver computes positions.

**phase center** the point in an antenna where the *GPS* signal from the satellites is received. The height above ground of the phase center must be measured accurately to ensure accurate *GPS* readings. The phase center height can be calculated by adding the height to an easily measured point, such as the base of the antenna mount, to the known distance between this point and the phase center.

**Position** the latitude, longitude, and *altitude* of a point. An estimate of error is often associated with a position.

**Position Dilution of Precision (PDOP)** a measure of the magnitude of Dilution of Position (DOP) errors in the x, y, and z coordinates.

**Positronic** a type of data or power connector.

**Post-processing** a method of differential data correction, which compares data logged from a known reference point to data logged by a roving receiver over the same period of time. Variations in the position reported by the reference station can be used to correct the positions logged by the roving receiver. Post-processing is performed after you have

collected the data and returned to the office, rather than in real time as you log the data, so it can use complex, calculations to achieve greater accuracy.

**Precise code** see *P-code*.

**PRN (Uppercase)** typically indicates a *GPS* satellite number sequence from 1 – 32.

**prn (Lower Case)** see Pseudorandom Noise.

**Protected code** see *P-code*.

**Proprietary commands** those messages sent to and received from GPS equipment produced by NavCom Technology, Inc. own copyrighted binary language.

**pseudo-random noise (*prn*)** a sequence of data that appears to be randomly distributed but can be exactly reproduced. Each GPS satellite transmits a unique PRN in its signals. GPS receivers use PRNs to identify and lock onto satellites and to compute their pseudoranges.

**Pseudorange** the apparent distance from the reference station's antenna to a satellite, calculated by multiplying the time the signal takes to reach the antenna by the speed of light (radio waves travel at the speed of light). The actual distance, or range, is not exactly the same because various factors cause errors in the measurement.

**PVT** GNSS information depicting Position, Velocity, Time in the NCT proprietary message format.

**Quick Start (StarFire)** a startup mode that allows instant <decimeter accuracy with received StarFire signals, allowing the convergence period to be waived. The Quick Start (user input) position should have an accuracy of better <decimeter to achieve maximum results. Any error in the user input position will bias the StarFire position error accordingly, until convergence can correct the bias. In this scenario, convergence may take longer than the typical startup convergence period.

**QZSS** Quasi Zenith Satellite System.

**Radio Technical Commission for Maritime Services** see *RTCM*.

**range** the distance between a satellite and a GPS receiver's antenna. The *range* is approximately equal to the pseudorange. However, errors can be introduced by atmospheric conditions which slow down the radio waves, clock errors, irregularities in the satellite's orbit, and other factors. A GPS receiver's location can be determined if you know the ranges from the receiver to at least four GPS satellites. Geometrically, there can only be one point in space, which is the correct distance from each of four known points.

**RCP** a NavCom Technology, Inc. proprietary processing technique in which carrier phase measurements, free of Ionospheric and Troposphere effects are used for navigation.

**Real-Time Kinematic (*RTK*)** a GNSS system that yields very accurate 3D *position* fixes immediately in real-time. The base station transmits its GNSS position to roving receivers as the receiver generates them, and the roving receivers use the *base station* readings to differentially correct their own positions. Accuracies of a few centimeters in all three dimensions are possible. RTK requires multi-frequency GNSS receivers and high speed radio modems.

**reference station** a reference station collects GNSS data for a fixed, known location. Some of the errors in the GNSS positions for this location can be applied to positions recorded at the same time by roving receivers which are relatively close to the reference station. A reference station is used to improve the quality and accuracy of GNSS data collected by roving receivers.

**RHCP Right Hand Circular Polarization** used to discriminate satellite signals. GNSS signals are RHCP.

**RINEX (Receiver Independent Exchange)** is a file set of standard definitions and formats designed to be receiver or software manufacturer independent and to promote the free exchange of GNSS data. The *RINEX* file format consists of separate files, the three most commonly used are:

- the observation (.YYo) file,

- the navigation (.YYn) file,

- meteorological (.YYm) files; where YY indicates the last two digits of the year the data was collected.

**rover** any mobile GNSS receiver and field computer collecting data in the field. A roving receiver's position can be differentially corrected relative to a stationary reference GNSS receiver or by using GNSS orbit and clock corrections from a SBAS such as StarFire.

**roving receiver** see *rover*.

**RTCM** (Radio Technical Commission for Maritime Services) a standard format for Differential GNSS corrections used to transmit corrections from a base station to rovers. RTCM allows both real-time kinematic (RTK) data collection and post-processed differential data collection. RTCM SC-104 (RTCM Special Committee 104) is the most commonly used version of RTCM message.

**RTK** see *Real-time kinematic*.

**S/A** see *Selective Availability*.

**SBAS (Satellite Based Augmentation System)** this is a more general term, which encompasses WAAS, StarFire and EGNOS type corrections.

**Selective Availability (S/A)** is the deliberate degradation of the GPS signal by encrypting the P-code and dithering the satellite clock. When the US Department of Defense uses S/A, the signal contains errors, which can cause positions to be inaccurate by as much as 100 meters.

**Signal-to-Noise Ratio (SNR)** is a measure of a satellite's signal strength.

**SNR** see *signal-to-noise Ratio*.

**StarFire** a set of real-time global orbit and clock corrections for GPS satellites. StarFire equipped receivers are capable of real-time decimeter positioning

(see Appendix C).

**Spread Spectrum Radio (SSR)** a radio that uses wide band, noise like (pseudo-noise) signals that are hard to detect, intercept, jam, or demodulate making any data transmitted

secure. Because spread spectrum signals are so wide, they can be transmitted at much lower spectral power density (Watts per Hertz), than narrow band signals.

**SV (Space Vehicle)** a *GPS* satellite.

**Universal Time Coordinated (UTC)** a time standard maintained by the US Naval Observatory, based on local solar mean time at the Greenwich meridian. GPS time is based on UTC.

**USB** Universal Serial Bus.

**UTC** see *Universal Time Coordinated*.

**WAAS (Wide Area Augmentation System)** a US satellite system that provides a set of corrections for the GPS satellites, which are valid for the North American region. They incorporate satellite orbit and clock corrections.

**WADGPS (Wide Area Differential GPS)** a set of corrections for the GPS satellites, which are valid for a wide geographic area.

**WGS-84 (World Geodetic System 1984)** the current standard datum for global positioning and surveying. The WGS-84 is based on the GRS-80 ellipsoid.

**Y-code** the name given to encrypted P-code when the U.S. Department of Defense uses selective availability.