SF-3050

GNSS Product
User Guide

find your way

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SF-3050 GNSS Product User Guide
P/N 96-310034-3001
Rev E
October 2011

Serial Number: _____

Date Delivered: _____

Purchased From: _____

Copyright

Trademarks

FCC Notice

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

1. This device may not cause harmful interference, and
2. 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.

User Notice

NavCom Technology, Inc. shall not be responsible for any inaccuracies, errors, or omissions in information contained herein, including, but not limited to, information obtained from third party sources, such as publications of other companies, the press, or competitive data organizations.

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Limited Warranty

NavCom warrants that its Products will be free from defects in material and workmanship at the time of delivery. The warranty period is one (1) year from the date of purchase of the Product(s). Under this warranty, Products found to be defective in material or in workmanship will be repaired or replaced at the discretion of NavCom at no cost to the Customer, provided that the Customer returns the defective Product to NavCom and pays all transportation charges, duties, and taxes associated with the return of the Product. Parts replaced during the warranty period do not extend the period of the basic warranty.

This provision does not extend to any NavCom Products which have been subjected to misuse, accident or improper installation, maintenance or application, nor does it extend to Products repaired or altered outside the NavCom production facility unless authorized in writing by NavCom.

This provision is expressly accepted by the customer in lieu of any or all other agreements, statements or representations, expressed or implied, in fact or in law, including the implied warranties of merchantability and fitness for a particular purpose and of all duties or liabilities of NavCom to the customer arising out of the use of the goods, and no agreement or understanding varying or extending the same will be binding upon NavCom unless in writing, signed by a duly-authorized officer of NavCom. No implied warranty of fitness and merchantability is made.

StarFire™ Licensing

The StarFire signal requires a subscription and software option that must be purchased in order to access the service. Licenses are non-transferable,

and are subject to the terms of the StarFire Signal License agreement. For further details on the StarFire Signal Network, its capabilities, terms and conditions visit *www.navcomtech.com* or send an email inquiry to *sales@navcomtech.com*

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, Galileo) 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 E (Oct 2011)	Appendix C, changed StarFire visibility from “76°N to 76°S latitude” “10 degree look angle” Chapter 3, revised the Note below Figure 55; added a Note regarding missing cable pins Added StarFire GNSS service specifications throughout manual Corrected 1PPS pulse characteristics in Chapter 3 Specifications: added pulse width to 1PPS
Rev D (Nov. 2010)	Updated graphics throughout , as necessary, to reflect new StarUtil 3000 GUI designs Added NTRIP standards to “Related Standards” section in front matter 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 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 44 (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) Setup" section; added Heading and Slew degrees to "Measurement Performance" table *Appendix B*: added antenna info for L1 *Appendix C*: 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 27 and Table 28 and a note regarding the reassignment of satellites ID # 609 and # 643 *Appendix E:* added this appendix (Networked Transport of RTCM Internet Protocol Setup) *Appendix F*: (formerly Appendix E) Glossary: Updated table references
Rev C (Nov. 2009)	Removed all references to Tall L-band antenna and combiner kit
Rev B (Nov. 2009)	Added the Software License Agreement section to Notices, and added Appendix E Software License Agreement Added information about MED Compass Safe Distance Added information on equipment that is required to pass the conducted MED type emission criteria Extensively updated Firmware, Software Options, and StarFire License sections in Chapter 1 Updated various screen captures of StarUtil 3000 in Chapter 1 Changed extensions to *.opt for Software Options File and *.lic for StarFire License File Added the part number for the Positronic plug on both data cables, with the pin type Changed reference to "supplied GNSS antenna" to "supplied Rover, Base, or Airborne antenna" Added the caveat that the SF-3050 is IP67compliant only when cables are connected

	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) Revised section on the proper shutdown of the SF-3050 via ignition pin 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

Galileo OS SIS ICD

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

GLONASS ICD, Version 5.0, 2002

Russian Space Agency, Information Analytical Centre 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.

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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.

Refer to Chapter 3, *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:

   a. 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.

   b. Connect the female Positronic connector end of the Power Adapter cable into the male connector, labeled POWER, at the rear of the SF-3050.

   c. Plug the AC power cord into an AC receptacle.

5. Press the front panel On/Off switch to turn on the SF-3050 (see Figure 46). 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.)

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

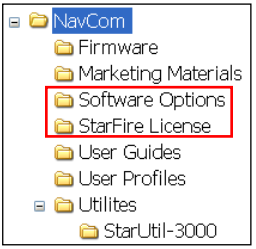


Figure 2: NavCom Sub-Folders on PC

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

10. Browse to Navcom\Utilities\StarUtil 3000 on the PC (see Figure 2).
11. 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.

12. Double-click “Starutil3000_v0,0,x.exe” to open the program.

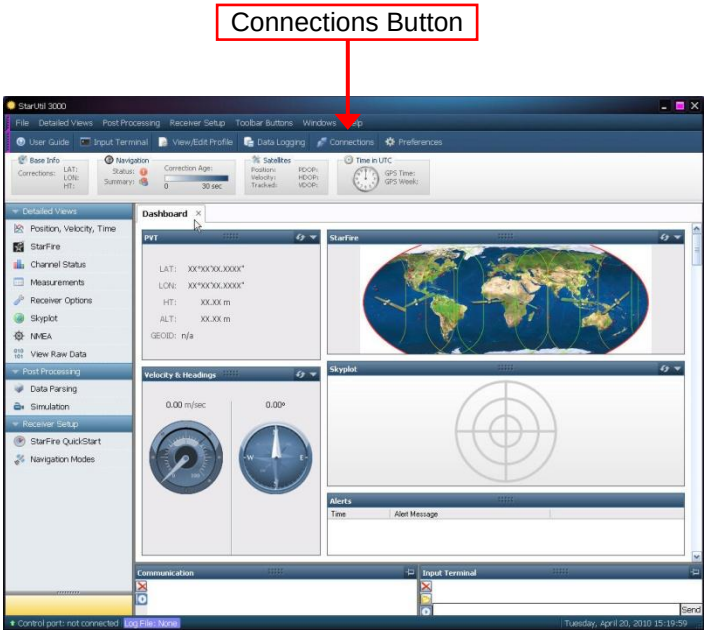
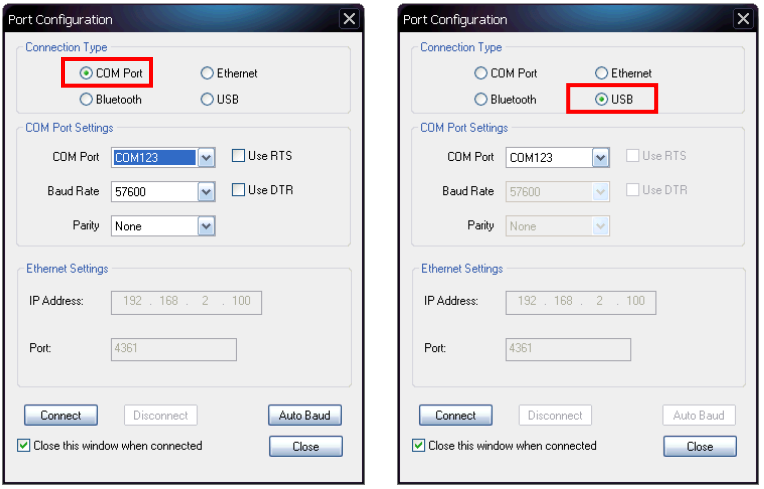


Figure 3: StarUtil 3000 – Main Window

13. 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:



COM Port Settings *USB Settings*

Figure 4: Port Configuration

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

    - *COM Port*:
        - *COM Port*: The appropriate PC COM Port

          Baud Rate: 57600 (keep the default)
        - *Parity*: None (keep the default)

    Or

    - *USB Port*:
        - *COM Port*: The appropriate virtual PC COM Port
        - *Mass Storage*: The appropriate flash drive

15. Click Auto Baud or (for USB) Connect to connect.
16. 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).

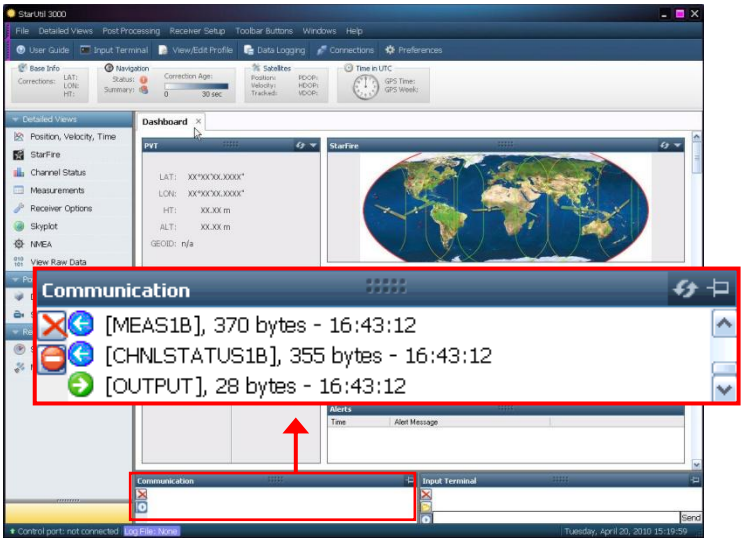


Figure 5: StarUtil 3000 Communication Window

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.

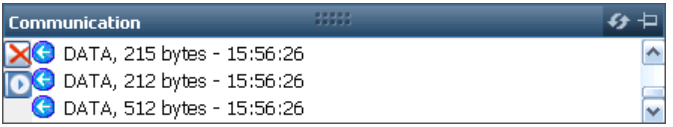


Figure 6: Connection at Incorrect Baud Rate

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).

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

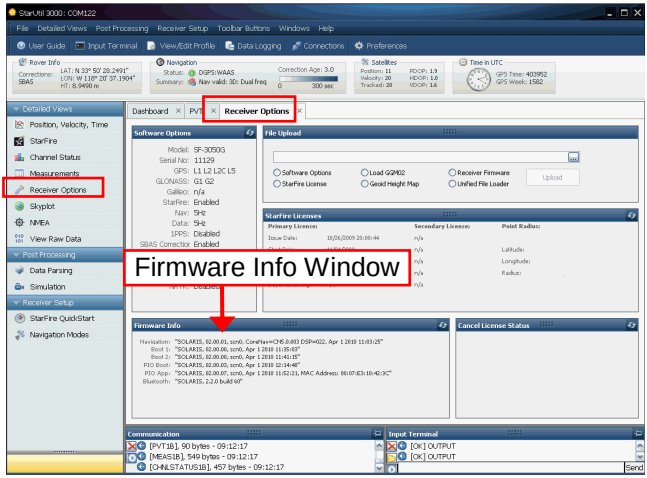


Figure 7: Access to Receiver Options Tab

18. 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.

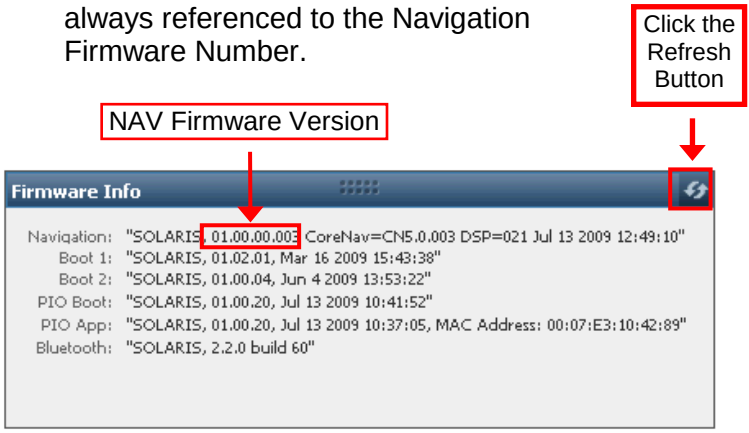


Figure 8: Example of Installed Firmware

19. 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.

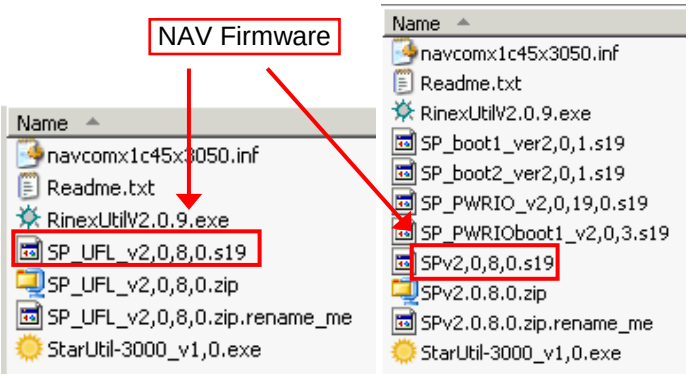


Figure 9: Firmware Folder

Open the Readme.txt file for additional information.

20. 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.

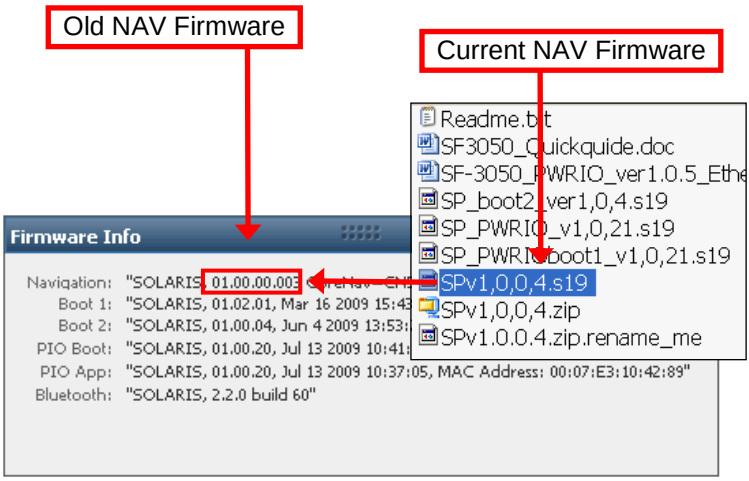


Figure 10: Comparing Current and Installed Firmware

21. 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

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

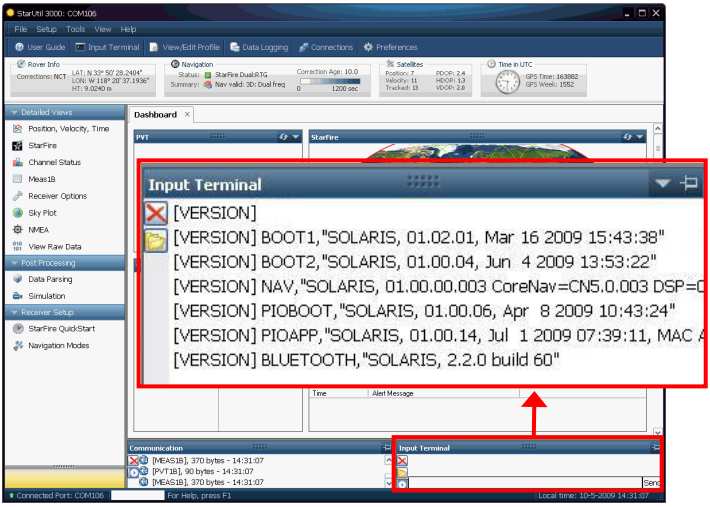


Figure 11: Input Terminal – Firmware Versions

Figure 12: Input Terminal

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

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

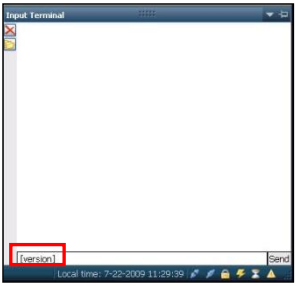


Figure 13: Version Command

25. Click the *Send* button on the *Input Terminal*. The receiver returns a list of the currently installed firmware.

26. 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.

27. 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.
- Go to the Upload Firmware section, below.

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

28. Click *Receiver Options* on the *Detailed Views* menu to open the *Receiver Options* tab (see Figure 14).

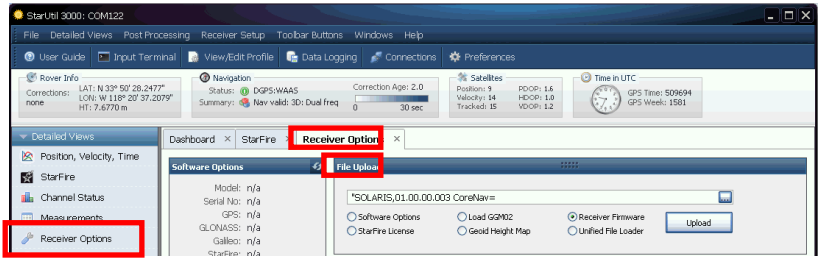


Figure 14: Receiver Options Tab

29. Select *Unified File Loader* on the *File Upload* window (see Figure 15).

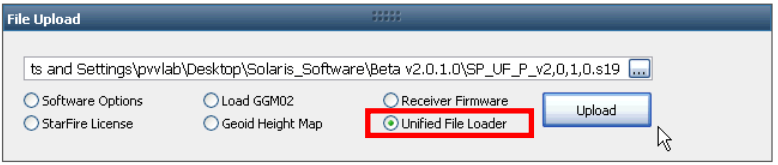


Figure 15: File Upload – Unified File Loader Option

30. Click ... .

31. Browse to the NavCom\Firmware folder on the PC (refer to Figure 16).

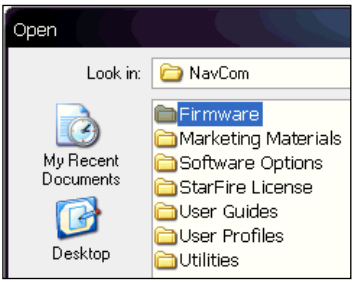


Figure 16: Firmware Folder

32. Select the appropriate *unified* file to upload and click Upload (see Figure 16).
33. The files to be uploaded are displayed on the *Ready to Downline Load File* dialog box with their corresponding check boxes selected (see Figure 17). Select and deselect files as necessary.

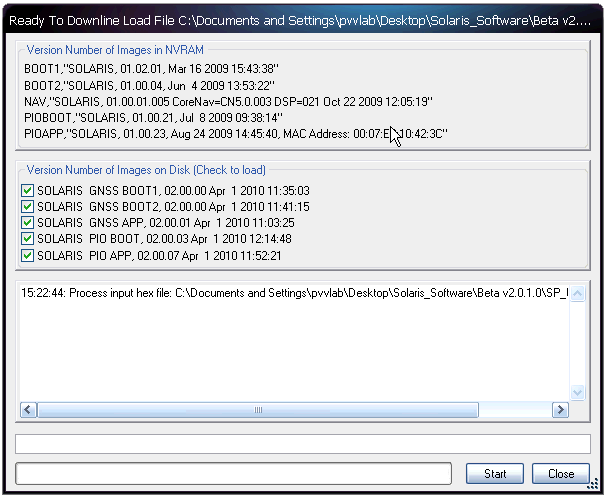


Figure 17: Ready to Downline Load File

34. Click Start.
35. Once the firmware files are uploaded, the *Finished with All Downline Loads* dialog box is displayed (see Figure 18).

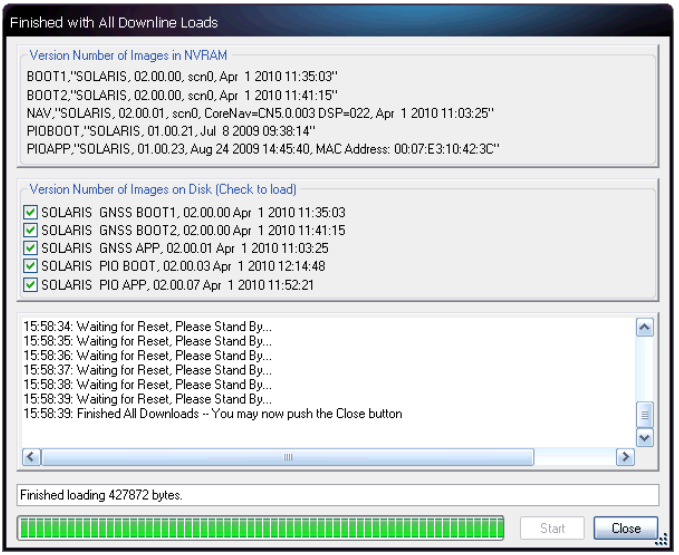


Figure 18: Finished with All Downline Loads

36. Click 

.

37. 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

38. Locate the *File Upload* window on the *Receiver Options* tab (see Figure 19).

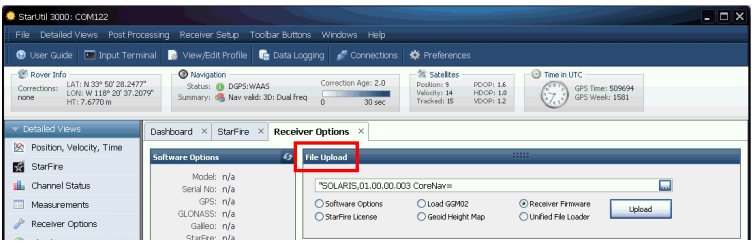


Figure 19: File Upload Window

39. Select *Receiver Firmware* on the *File Upload* window (see Figure 20).

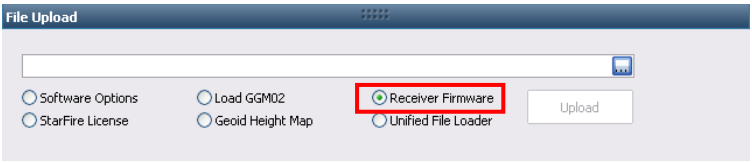


Figure 20: Receiver Firmware Option

40. Click Upload and the *Load Receiver Firmware* dialog box opens (see Figure 21).

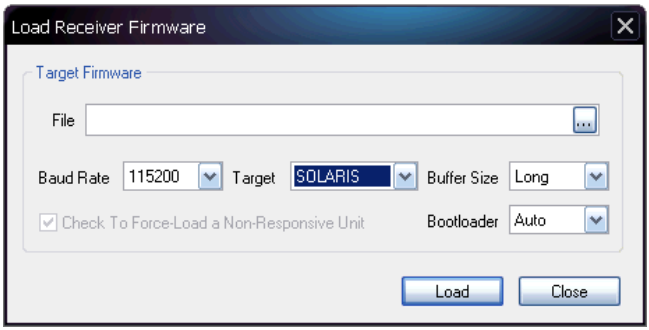


Figure 21: Load Receiver Firmware

41. Click ....

42. Browse to NavCom\Firmware on the PC (see Figure 22).

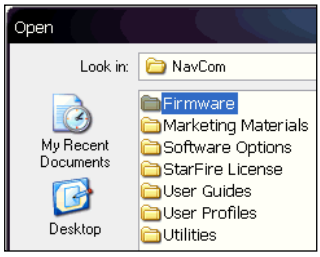


Figure 22: Firmware Folder

43. 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

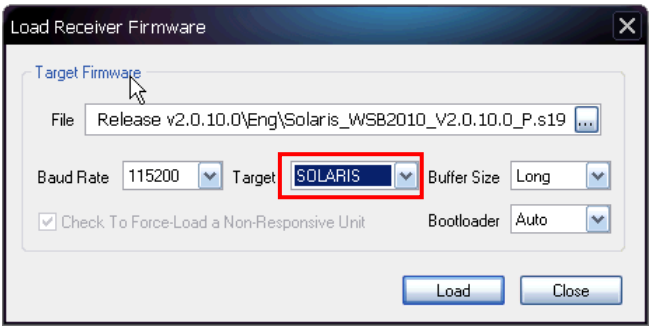


Figure 23: Settings for GNSS Firmware

44. 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 23):
    SP_boot1_[version number].s19
    SP_boot2_[version number].s19
    SPv[version number].s19

    Or
  - Select SOLARIS PIO to upload PWRIO

firmware (see Figure 24):
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).

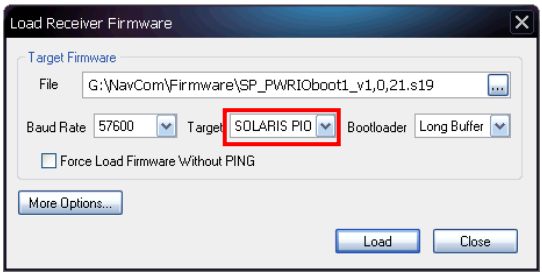


Figure 24: Settings for PWRIO Firmware

45. Click Load. An upload progress window opens (see Figure 25).

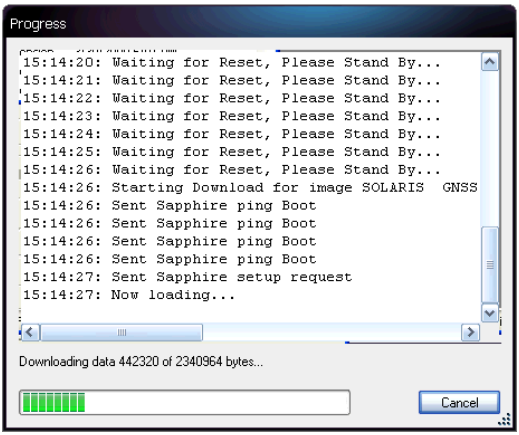


Figure 25: Progress Dialog Box

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

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.

49. Select *Software Options* on the *File Upload* window (see Figure 26).

Figure 26: Software Options

50. Click ... .
51. Browse to NavCom\Software Options on the PC. The Software Options file extension is *.opt.

52. Select the Software Options file. The path to the file appears in the upload field (see Figure 27).

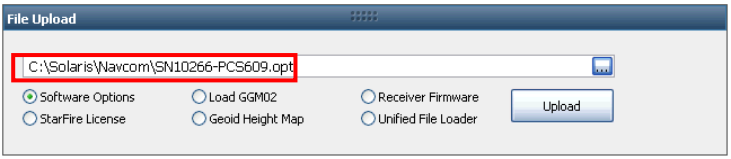


Figure 27: Software Options Upload

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

The *Input Terminal* window also displays the outcome of the upload (see Figure 28). 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 28: Successful Software Options Upload

54. Click (refresh) on the *Software Options* window and check to ensure that all uploaded software options are displayed (see Figure 29).

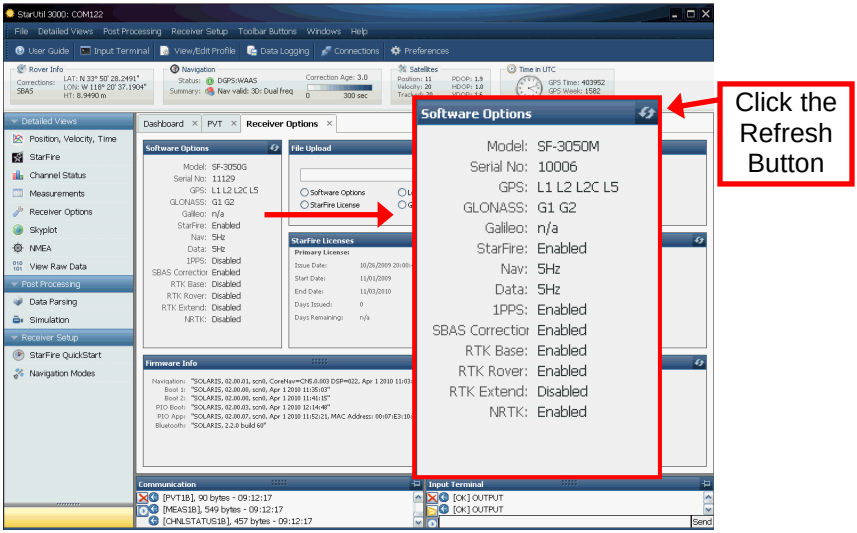


Figure 29: Software Options Window

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

55. 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.

56. Type the command [INPUTSWOPTION] on the *Input Terminal* window.

57. Click *Send*.
58. Highlight and copy the entire output.
59. 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 59 through 64 to upload software options via the *Input Terminal*.

60. Open the software option file in any text editing program (e.g., Notepad).
61. Locate the option code at the bottom of the file (e.g., 74C91E91 789FA173 8E70296A 3259B2E6).
62. Highlight and copy the option code.
63. Enter the command [INPUTSWOPTION] on the *Input Terminal* window and then paste the option code: 74C91E91 789FA173 8E70296A 3259B2E6.
64. Click *Send* on the *Input Terminal* window. If the software options loaded successfully, the *Input Terminal* window displays a confirmation message (see Figure 28).
65. To view all currently loaded software options, click  (refresh) on the *Software Options* window (see Figure 29).

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.

66. 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).

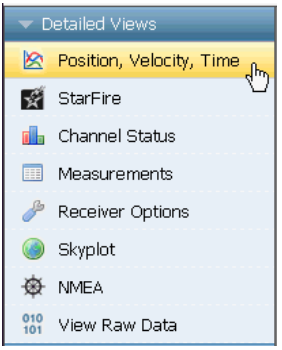


Figure 30: Position, Velocity, Time Menu Item

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

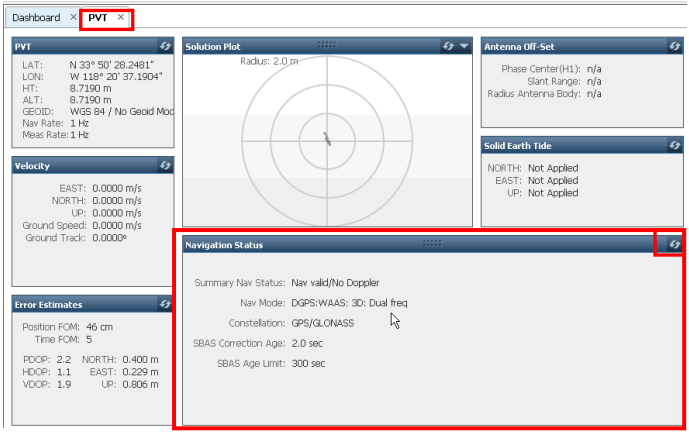


Figure 31: PVT Tab/Navigation Status Window

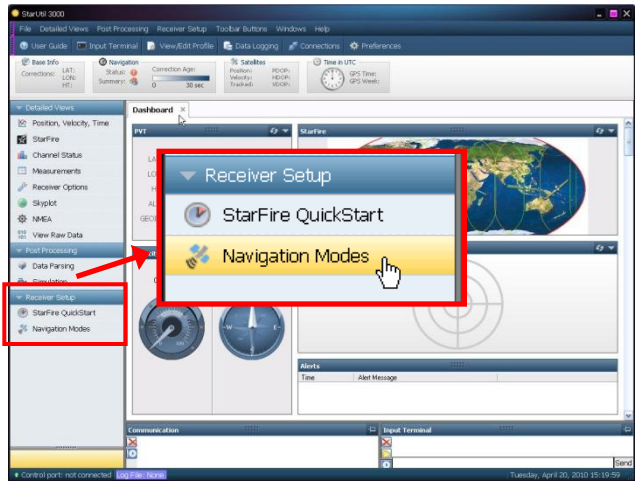


Figure 32: Navigation Modes Menu Item

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

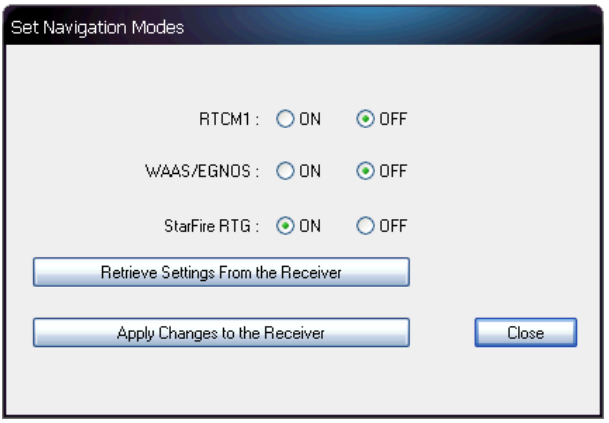


Figure 33: Set Navigation Modes/StarFire RTG ON

Refer to Figure 33 for the steps below:

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

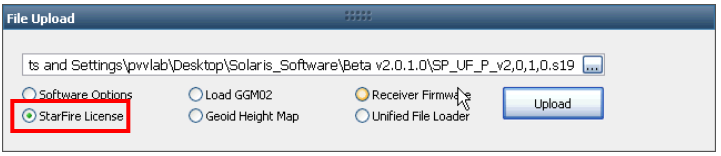


Figure 34: StarFire License

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

74. Select the StarFire License file. The path to the file appears in the upload field (see Figure 34).
75. 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

76. 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).

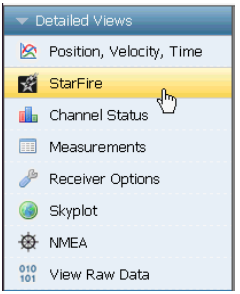


Figure 36: StarFire Menu Item

Confirm StarFire Navigation

77. 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.

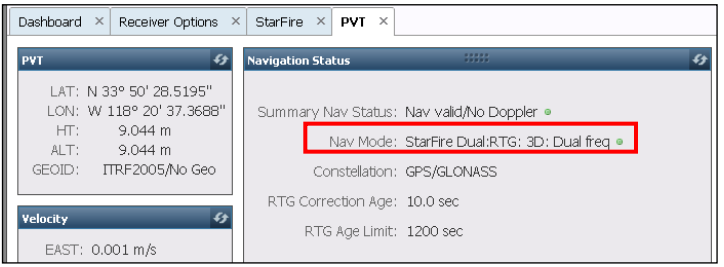


Figure 37: Nav Mode: StarFire

The Nav Mode: *StarFire Dual:RTG: 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. RTG is another term for StarFire (refer to the Glossary at the end of this guide).

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.

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

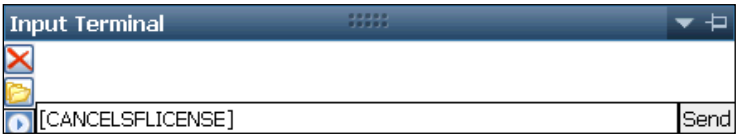


Figure 38: Input Terminal – Cancel StarFire License

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.

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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[1] Network: A worldwide Satellite Based Augmentation System (SBAS) for decimeter level position accuracy (post-convergence period). Refer to Appendix C for detailed information.

[1]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[2] 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.

[2] 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), Galileo (E1, E5a), 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[1]	**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

[1] 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

Signals	SF-3050 Bundles			
	A[1]	***G***	***S***	***M***
GPS				
L1	Std	Std	Std	Std
L2	Opt	Std	Std	Std
L2C	Opt	Std	Std	Std
L5	Opt	Std	Std	Std

Table continued on next page…

Signals	SF-3050 Bundles			
	A[1]	***G***	***S***	***M***
GPS				
G1	Std	Std	Std	Std
G2	Opt	Std	Std	Std
Galileo (Hardware Ready)[2]				
E1	--	Std	Std	Std
E5a	--	Std	Std	Std
Correction Source				
SBAS	Std	Std	Std	Std
StarFire[3]	Std	Std	Std	Std

[1] Bundle A is not available in software prior to v. 2.0.22.0.

[2] Not available for version 1.0 software. Not supported in the current firmware (v.2.0.22.0).

[3] 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[2]	SF-3050 Bundles			
	A[1]	**G**	**S**	**M**
RTK Base	Opt	Opt	Std	Opt
RTK Moving Base	Opt	Opt	Opt	Opt
RTK Rover	Opt	Opt	Std	Opt
RTK Extend™	Opt	Opt	Opt	Opt
Network RTK[2]	Opt	Opt	Std	Opt

[1] Bundle A is not available in software prior to v. 2.0.22.0.

[2] Dependent on bundle options

Table 4: Performance Upgrade Path – 1PPS/Event

	SF-3050 Bundles			
	A[1]	**G**	**S**	**M**
1PPS/Event	Opt	Opt	Opt	Std

[1] Bundle A is not available in software prior to v. 2.0.22.0.

Accuracy

L1-RTK

L1-RTK supports 1 cm accuracy and is valid for up to a 5 km baseline.

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) [1] when StarFire correction signals are used.

RTK

The system provides immediate < 1 cm position accuracy when UltraRTK[1] correction signals are used:

- L1, G1 baseline: < 5 km 1 cm + 1 ppm RMS
- L1, L2, L2G, L5, G1,G2 baseline: < 40 km, ±1 cm + 0.5 ppm)

[1] 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[1] and Position Velocity Time (PVT) data at programmable rates from ≤1Hz to predetermined rates up to 100Hz[1] through the data ports[2] 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.

[1] Dependent on software bundle options

[2] Refer to Chapter 3, 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.

- ■ Standard
- ✓ ALM – GPS Almanac Data
- ✓ GBS – GPS Satellite Fault Detection
- ✓ GGA – GPS Fix Data
- ✓ GLL – Geographic Position – Lat /Lon

- ✓ 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.)
- ✓ 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)

- ✓ 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-3050A

The SF-3050A[1] is a multi-constellation, StarFire-enabled[2] single-frequency GNSS receiver system for users that require precise global positioning superior to WAAS-based L1 receivers without being limited to a specific geographical region. Upgrade paths for higher data rates and other options make the SF-3050A ideal for many Survey and Positioning applications:

- ✓ Construction Machine Control
- ✓ Assisted Crane Guidance
- ✓ Offshore Dynamic Positioning
- ✓ GIS Data Collection

[1]Not supported in version 1.0

SF-3050G

The SF-3050G is a multi-constellation, StarFire-enabled[2] 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

[2]StarFire Software Option is standard. StarFire subscription is required.

SF-3050S

Adding Base, Rover, and Network RTK[2] 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/Bluetooth Communications Setup* 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), Galileo (E1, E5A), 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 NOAA GNSS Antenna Calibration tables, as NCT-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), Galileo (E1, E5A), 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. This antenna is listed in the NOAA GNSS Antenna Calibration tables, as NCT-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), Galileo (E1, E5A), 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).

L1/G1

The standard integrated antenna (PN: 82-001017-0001LF) tracks GPS L1, GLONASS G1, WAAS/EGNOS/MSAS/GAGAN, and StarFire signals. This antenna is not listed on the NOAA GPS Antennae Calibration Table Web site. Our compact GPS antenna has excellent tracking performance and a stable phase center for GPS L1. 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 ft.

Controller

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

[1]For initial configuration

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.

Included Items

Figure 39: 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} *Important:* 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 40: Rover, Base, and Airborne Antennae

Table 6: SF-3050 Antennae

1	Rover GNSS Antenna (P/N 82-001020-3001LF)
2	L1/G1 Antenna (P/N: 82-001017-0001LF)
3	Airborne GNSS Antenna (P/N 82-001022-3001LF)
4	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[1] correction service is fully integrated within each unit (no additional equipment required). A single set of corrections can be used globally enabling a user to achieve 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-05 datum.

- 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.

[1]Dependent on Bundle Options: Subscription and Software Option Required.

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[1] 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.

[1]Separate Software Option Required

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.

Data Sampling

GPS (L1, L2, L2C, L5), GLONASS (G1, G2), Galileo (E1, E5a), 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.

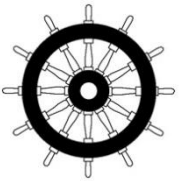
GNSS Performance

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[1] to comply with the relevant type approval procedures for marine equipment of the Marine Equipment Directive (MED) 96/98/EC. The "wheel mark" displayed to the right signifies that the SF-3050 complies with the MED requirements.



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.

[1]Requires use of NavCom's supplied AC/DC converter.

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Chapter 3..... 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 44 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 41.
- ✓ 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 43.
  - Later Production Units:

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

Figure 41: 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 42: AC Power Cord

Figure 43: Unterminated Power Cable without Filter

P/N 94-310262-3010LF is supplied with early SF-3050 production units (see Figure 43). 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

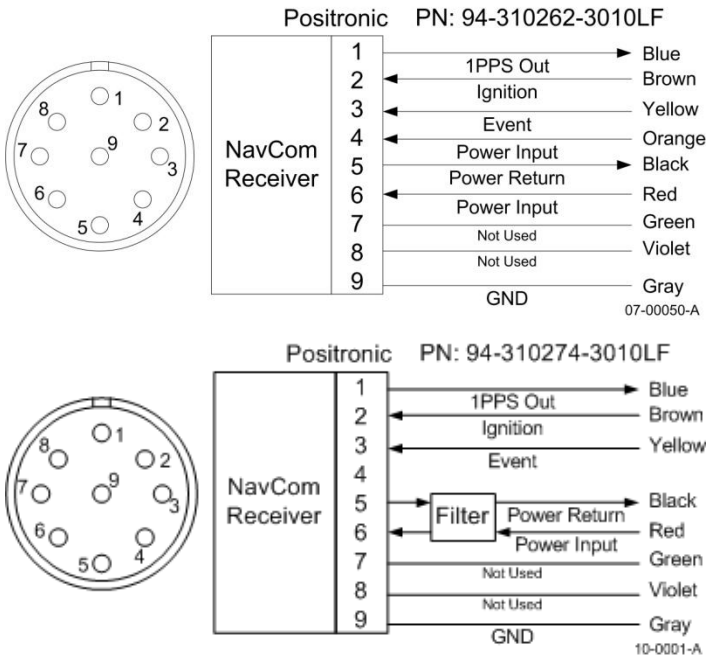


Figure 44: Power Cable Pin Assignment

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 ≥ 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 46). 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 45.

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.

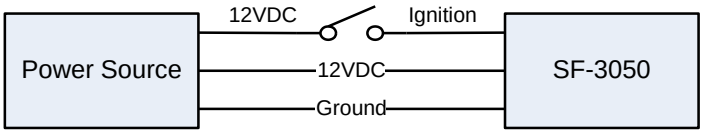


Figure 45: Proper External Power Source Setup

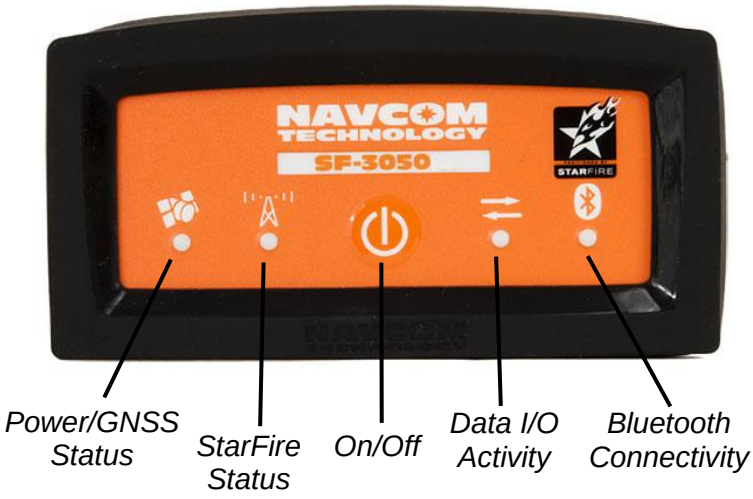


Figure 46: SF-3050 Front View

Figure 47: 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 47 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 49 and Figure 50.
- ✓ Positronic 9-Pin Male to USB 2.0 Device Plug (P/N 94-310266-3006LF): constructed as described in Figure 51.

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

RS-232/RS-422/1PPS
(P/N 94-310260-3006LF)

USB 2.0 Device
(P/N 94-310266-3006LF)

Figure 48: 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)

Positronic Pins	Signal Nomenclature [DCE w/respect to DB9]	DB9S Pins
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)

Positronic Pins	Signal Nomenclature [DCE w/respect to DB9]	DB9S Pins
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

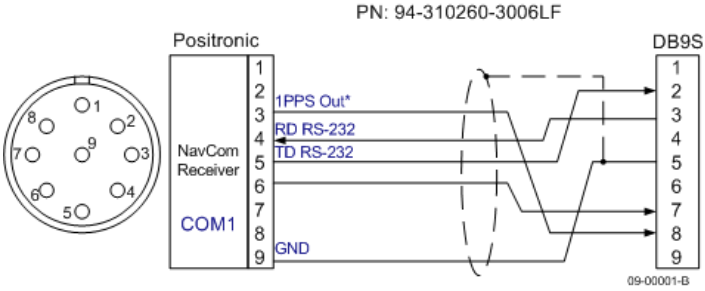


Figure 49: COM1 Serial Cable Pin Assignment

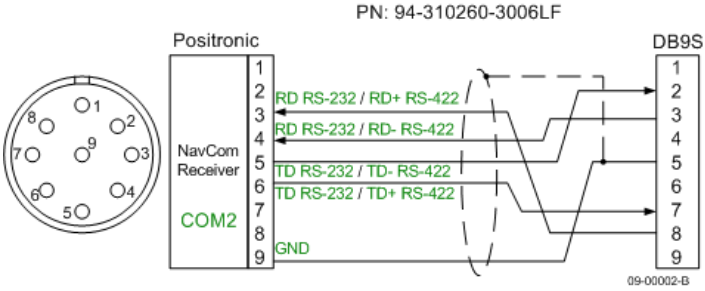


Figure 50: COM2 Serial Cable Pin Assignment

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

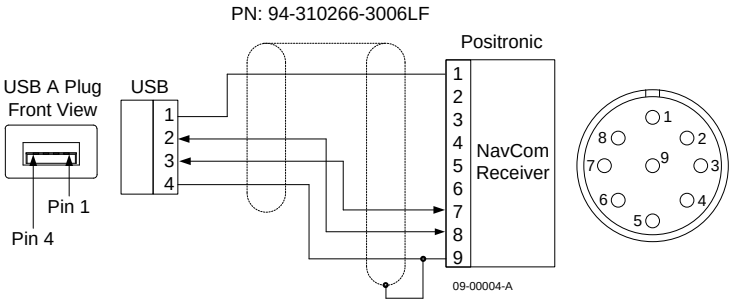


Figure 51: USB Device Cable Pin Assignment

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[1]) into the proper port on the PC.

[1]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 52).

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 53).

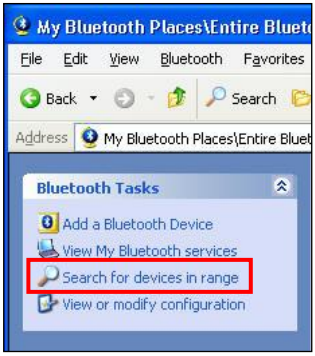


Figure 52: Search for devices in range

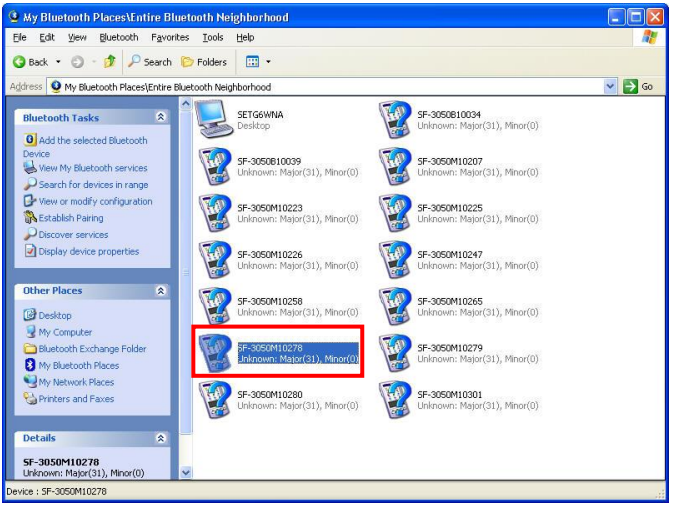


Figure 53: Bluetooth Devices in Range

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 53). A Bluetooth serial port icon for the selected receiver is displayed (see Figure 54).

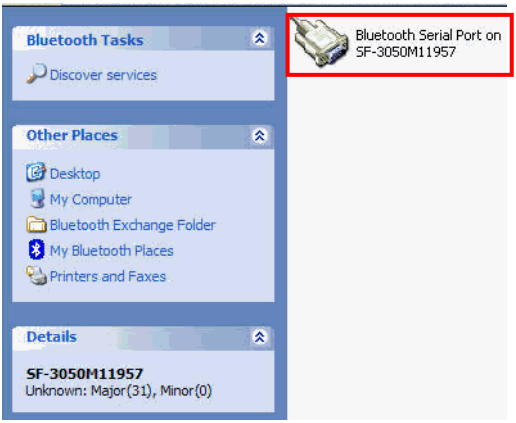


Figure 54: Bluetooth Serial Port Icon

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 55).

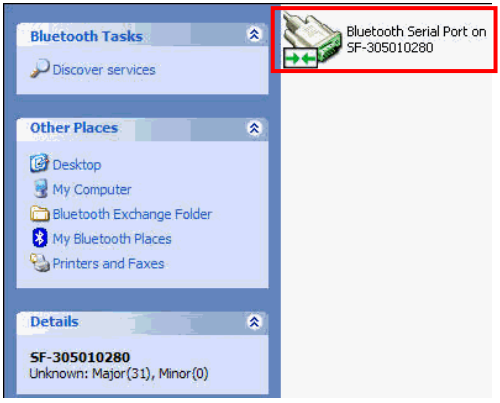


Figure 55: Bluetooth Serial Port Connection

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 55 to display the *Bluetooth Serial Port* dialog box (see Figure 56), which confirms the configured COM port.
9. Click OK.

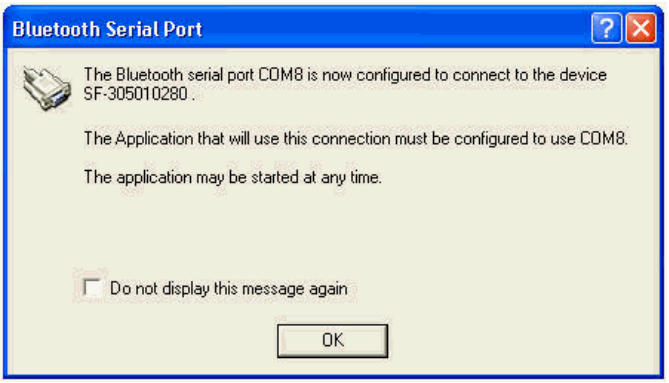


Figure 56: Bluetooth Serial Port

10. To verify the assigned COM port, right-click the Bluetooth serial port icon (refer to Figure 55) and select *Properties* on the pop-up menu (the *Bluetooth Properties* dialog box opens).

The *Bluetooth Properties* dialog box (refer to Figure 57) displays the Bluetooth virtual COM port assigned to the Bluetooth dongle. (Notate the COM port number for use in step 15, below.)

Figure 57: 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 58).

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.

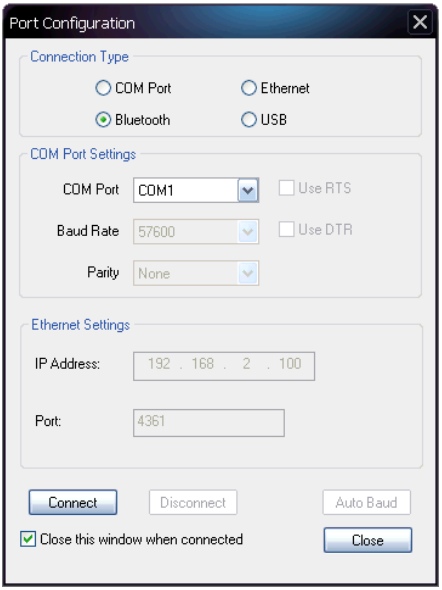


Figure 58: Port Configuration – Bluetooth

Refer to Figure 58 for the steps below:

14. Select *Bluetooth* as the *Connection Type*.
15. Under *COM Port Settings*, select the appropriate COM Port (refer to Figure 56, above).
16. Click Connect 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
	***Bluetooth***	**Off**	Bluetooth off
		Blue Blinking	Bluetooth on, no connection
		Blue	Bluetooth connected

- Type [PING] in the *Input Terminal* and click the *Send* button. If properly connected, the response is [PING]BT(see Figure 59).

Figure 59: 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 60: 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

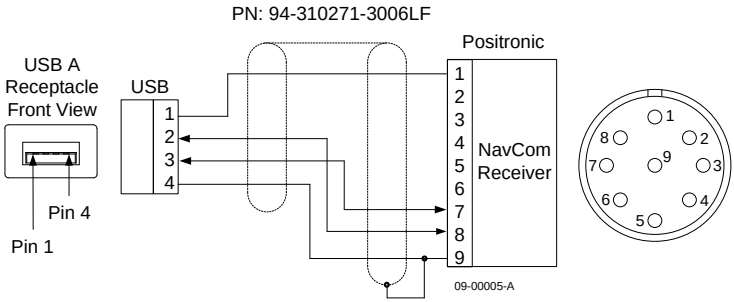


Figure 61: Optional USB Host Cable Pin Assignment

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

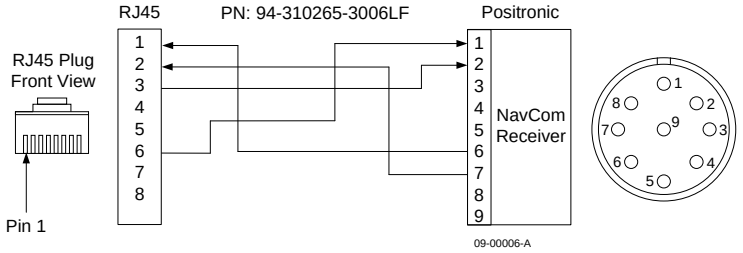


Figure 62: Optional Ethernet Cable Pin Assignment

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

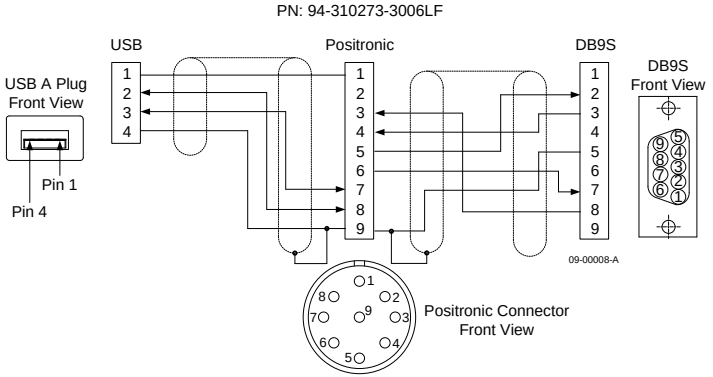


Figure 63: Optional USB Device/RS-232/RS-422 Y-Cable Pin Assignment

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

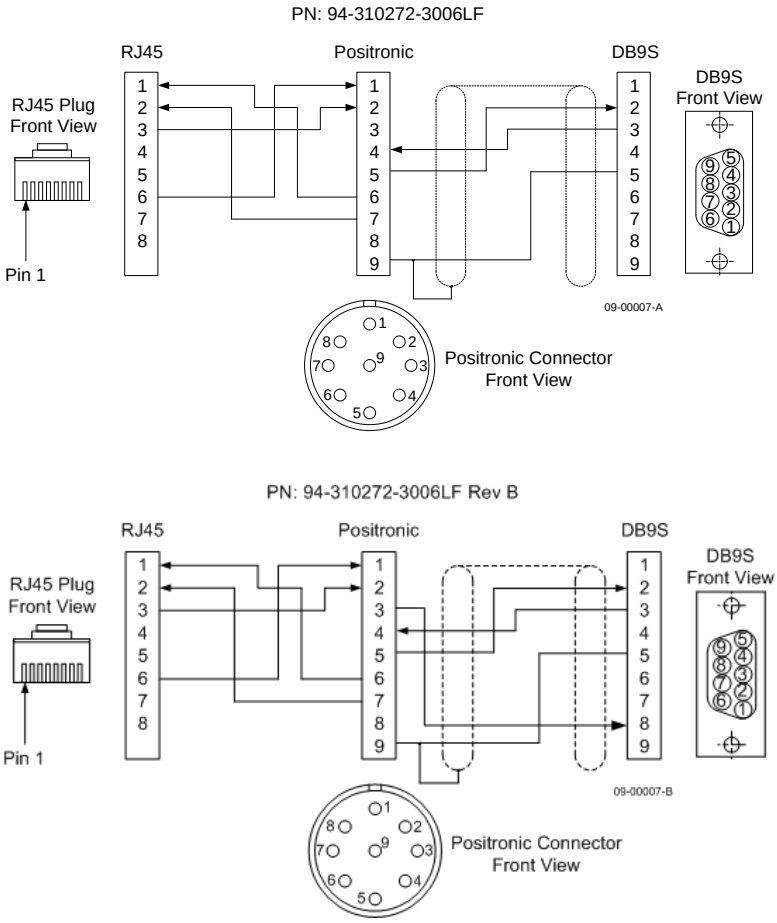


Figure 64: Optional Ethernet/RS-232/1PPS Y-Cable Pin Assignment

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 65).

Figure 65: 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:
   a. 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

   b. Click the *Send* button.
3. 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.

4. Type the command '[LOGFILE]start'.
5. 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]forcestart, 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.

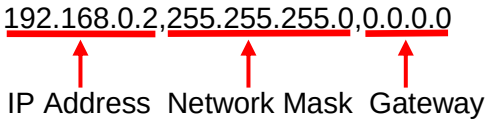
Ethernet cables are not supplied with the SF-3050. These cables are available via a NavCom authorized representative, or by contacting the NavCom Sales Department:

- ✓ 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:



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 66.

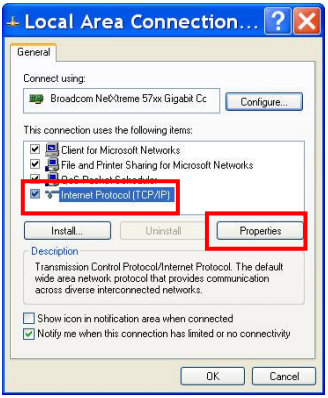


Figure 66: Local Area Connection Window

5. Click the *Properties* button. The *Internet Protocol* window opens.
6. Select the option, *Use the following IP address* (see Figure 67).

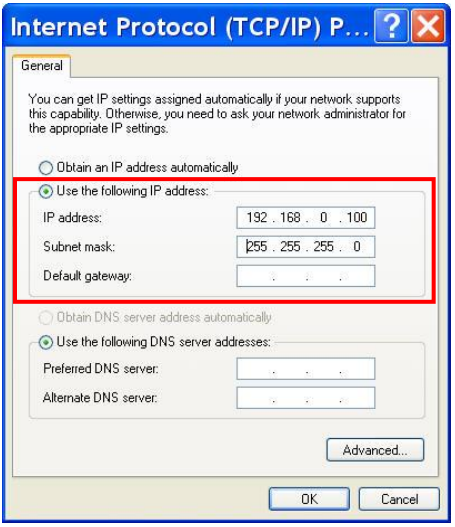


Figure 67: Internet Protocol Window

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 68 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 68: 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 69: 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
	Power/GNSS	**Off**	Power off
		Red	Power on but not tracking
		Green Blinking	Acquiring or tracking GNSS satellites (no position fix yet)
		Green	Using GNSS satellites (position fix)

- StarFire Link LEDs

Table 19: StarFire Link LED Indication

Icon	Indicator	Status	Description
	***StarFire Link***	**Red**	No StarFire signal
		Red Blinking	No StarFire License (or expired)
		Green Blinking	Acquiring StarFire signal
		Green	Tracking StarFire signal

- Data I/O Active LEDs

Table 20: Data I/O Active LED Indication

Icon	Indicator	Status	Description
	***Data***	**Off**	Data I/O inactive
		Green Blinking	Data I/O active
		Green	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 4.....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.

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 70: Rover, Base, Airborne GNSS Antennae (see Table 6 for P/Ns)

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 7º if possible. Obstructions below 15º elevation generally are not a problem, though this is dependent on satellite availability for the local region.
- ✓ Avoid placing the antenna where more than 90º azimuth of the sky is obstructed. When more than 90º of azimuth is shaded, it is often still possible for the reciever to navigate; however, poor satellite geometry (due to satellite shading) will provide poor positioning results. Even 10º 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.

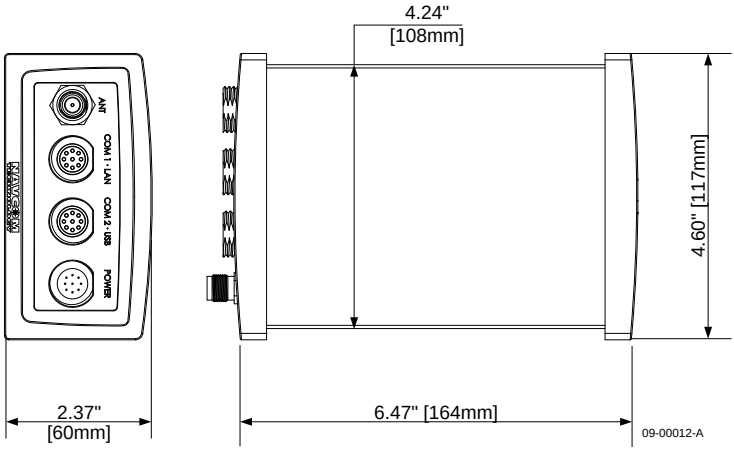


Figure 71: SF-3050 Base Plate Dimensions Without Mounting Brackets

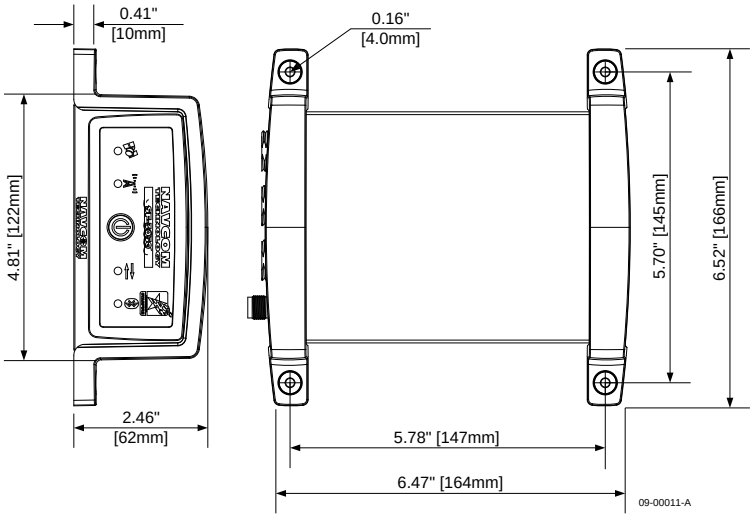


Figure 72: SF-3050 Base Plate Dimensions with Mounting Brackets

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 73 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 73: 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 47.

The GNSS antenna connector provides +5V ± 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 90º 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[1], 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 74

[1]Network RTK is not supported in software version 1.0.

and Figure 75 illustrate proper and improper RTK reference station installation.

Figure 74: RTK Setup – Good Line of Sight

Figure 75: 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 5 ..... 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.
- ✓ 3rd 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 ≤ 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 does not output NMEA messages by default. NMEA 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[1] 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[2] to set Net1 as the priority net, which commands the receiver to select the Net2 StarFire satellite with the highest elevation angle.

[1] 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.

[2] 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.

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 Table 23 and Table 24).

Table 23: 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 24: 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

Chapter 6.....Safety Instructions

The SF-3050 GNSS sensor is designed for precise navigation and positioning using the Global Positioning System, GLONASS, and is designed for Galileo when the constellation becomes commercially available. 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/Galileo/ GLONASS) code and full wavelength carrier phase tracking
- ✓ Software upgradeable for Galileo signal reception (E1, E5A)[1]
- ✓ High sensitivity/low signal level tracking
- ✓ Fast acquisition/re-acquisition

[1] The SF-3050 is hardware-ready for Galileo. Software capability will follow in a later release.

- ✓ Superior interference suppression (both in-band & out-of-band)
- ✓ Patented multipath rejection
- ✓ Minimal data latency
- ✓ 2 GB of internal memory[2]
- ✓ 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

Performance

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

[2] Not supported in version 1.0 software

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, Galileo E1, 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, Galileo E5A; all at the same frequency:	GPS: 1176.45MHz, ±16MHz Galileo: 1176.45MHz, ±12.5 MHz
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, L5, E1, and E5A) 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 @ 290º Kelvin; 1Hz RBW

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

Dynamics

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

[1]Restricted by USA export laws

Measurement Performance

Measurement Precision (RMS)	
Raw C/A code: Raw Carrier Phase Noise:	7.50cm L1: 0.7mm L2: 0.9mm
RTK Positioning – Multi-Frequency <40kms (RMS)	
Position (H): Position (V):	± 1cm +0.5ppm ± 2cm +1ppm

RTK Positioning – Single-Frequency < 5kms (RMS)	
Position (H): Position (V):	± 1cm +0.5ppm ± 2cm +1ppm
RTK Extend (see note below)	
Position (H): Position (V):	± 3cm +1ppm ± 6cm +2ppm
RTK Float	
Position (H): Position (V):	± 20cm +3ppm ± 40cm +3ppm
RTG (single)	
Position (H): Position (V):	± 50cm ± 100cm
StarFire (multi)	
Position (H): Position (V):	± 5cm GNSS, ± 10cm GPS ± 10cm GNSS, ± 15cm GPS
Code Differential GPS <200kms (RMS)	
Position (H): Position (V):	± 45cm +3ppm ± 90cm +3ppm
Heading – Multi-Frequency	.1 degrees Requires 10Hz update rate
Slew – Single-Frequency	.75 degrees
Velocity (for all DGPS described above)	
Velocity:	0.01m/s
Enhanced SBAS (WAAS/EGNOS/MSAS/GAGAN) Position Accuracy (RMS)	
Position (H): Position (V):	± 30cm ± 60cm

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. Equipment operated on a single-frequency (i.e., L1/G1) is more susceptible to atmospheric and solar storm activity than multi-frequency operated equipment.

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 10 minutes for a non-NCT base station

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

RTG (StarFire) Single:	Immediate
RTG (StarFire) Dual:	45 minutes, typical

User-Programmable Output Rates

Rate	SF-3050 Bundles			
	A	**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

*5 Hz is the default PVT and Raw Data Rate for software bundles A, 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[1]	2 GB

[1]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 3, 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, MLA, GBS, GGA, GLL, GRS, GSA, GST, GSV, HDT, RMC, RRE, ROT, VTG, ZDA

See *Related Standards* at the front of this manual for information on the various data formats.

Satellite-Based Augmentation System Signals

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

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:	 -40ºC to +70ºC (-40º to +158º F) -40ºC to +85ºC (-40º to +185º 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
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

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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 Galileo E1: 1575.42MHz, ±16MHz Galileo E5A: 1176.45MHz, ±12.5 MHz
Phase Centre (see Figure 76)	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
Immersion	MIL-STD-810F, Method 512.4

*Does not apply to the Base antenna

Table continued on next page…

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.

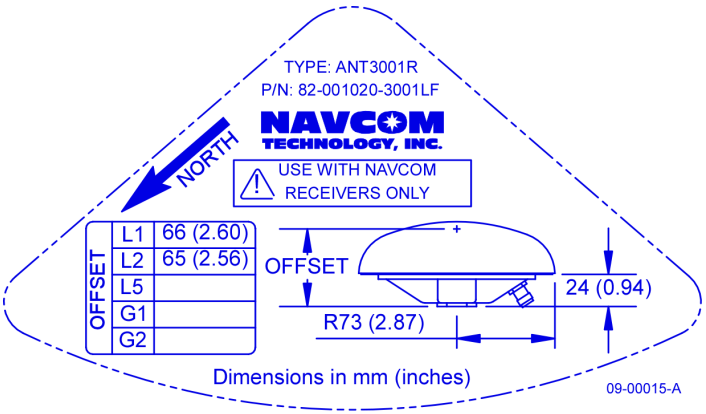


Figure 76: Rover GNSS Antenna Offset

Figure 76 is a drawing of the label on the Rover GNSS antenna (P/N 82-001020-3001LF). The phase centre provided is based on NGS test results. NGS does not currently provide GLONASS calibrated values.

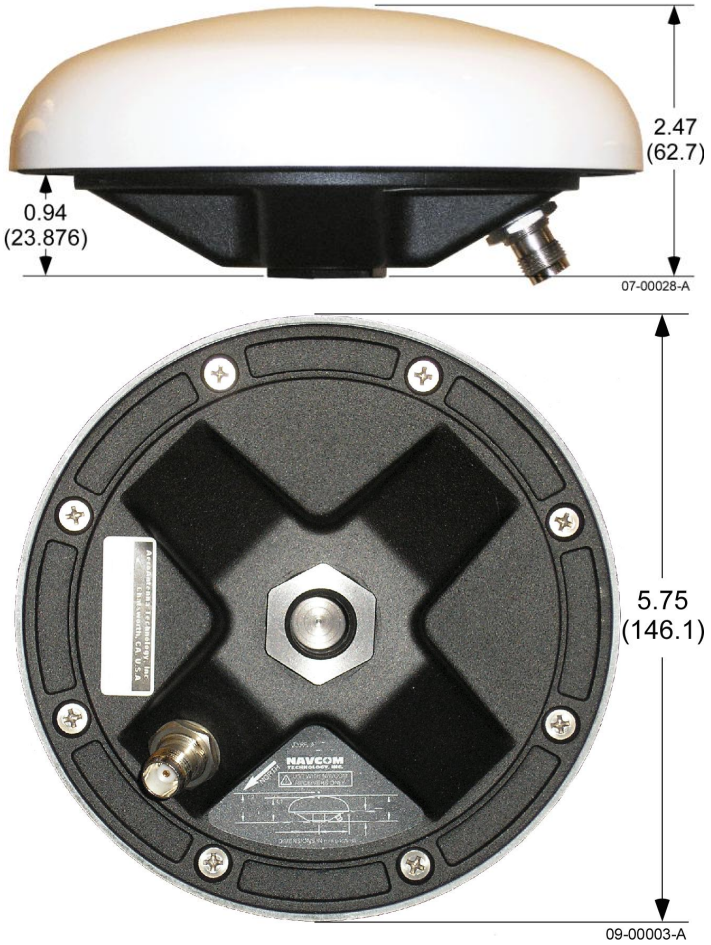


Figure 77: Rover (P/N 82-001020-3001) Antenna Dimensions

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

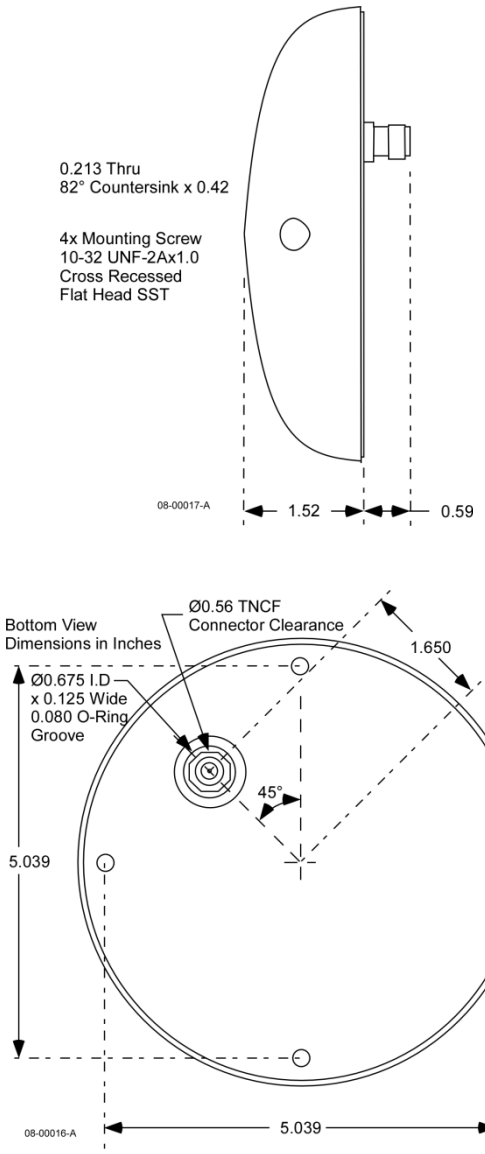


Figure 78: Airborne (P/N 82-001022-3001LF) Antenna Dimensions

Rover/Airborne Antennae Radiation Pattern

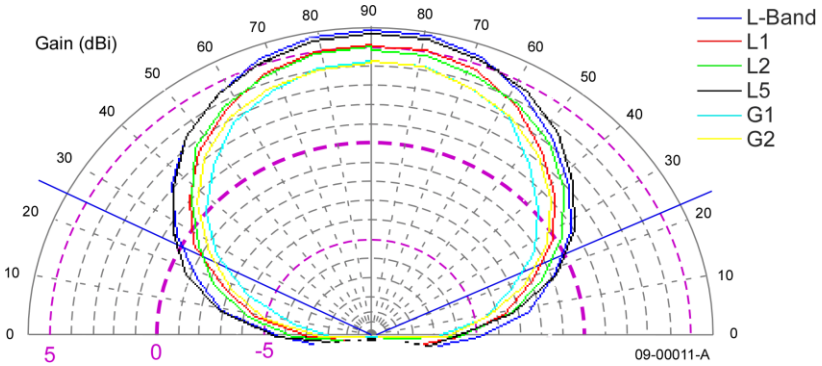


Figure 79: Rover/Airborne GNSS Antenna Radiation Pattern

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

- There is a 10dB variation between 0º and 90º elevation (factor 10x); therefore, lower elevation satellites are always more difficult to track.
- There is a 5dB variation between ~35º and 0º elevation (factor >3x)

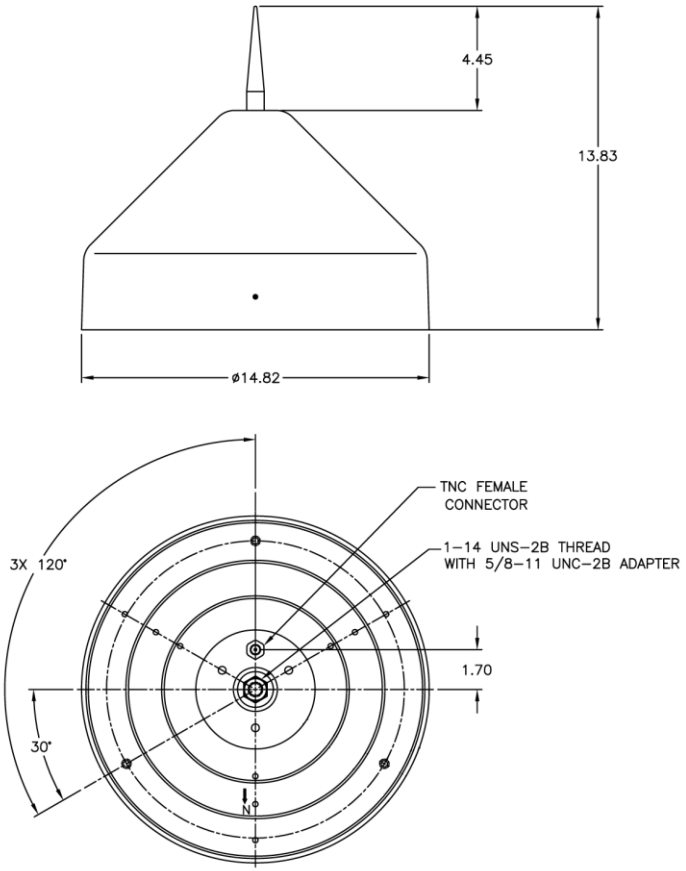


Figure 80: Base (P/N 82-001021-3001LF) Antenna Dimensions

Base Antenna Radiation Pattern

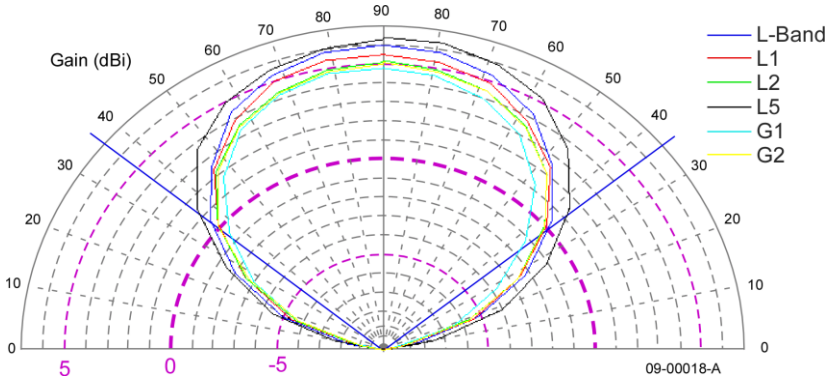


Figure 81: Base GNSS Antenna Radiation Pattern

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

- There is an 11dB variation between 15º and 90º elevation (factor >10x); therefore, lower elevation satellites are always more difficult to track.
- There is a 9dB variation between ~35º and 0º elevation (factor >8x)

Table 26: 82-001017-0001LF Single-Frequency Antenna

Frequency	1525-1660 MHz GPS L1, GLONASS G1 plus StarFire
Polarization	Right Hand Circular (RHCP)
Pre–Amplifier	35dB gain (+/-1.2dB)
Noise Figure	<2.1dB
Filter Rejection	9dB @ 1690MHz 21dB @ 1626MHz 38dB @ 1660MHz
Impedance	50 Ohms
VSWR / RL	≤ 2.0:1 / 9.54dB min.
Band Rejection	20dB @ 250MHz
RF Power Handling	+30dBm (1 W)
Input Voltage	2.5 – 24 VDC
Power Consumption	0.2W 39mA ±10mA @ 5VDC
Cable Connector	TNC Female
Operating Temp	-55°C to +85°C
Altitude	70,000ft; 21,336m
Finish	Skydrol resistant polyurethane Enamel with nickel plated base
Material	6061-T6 Aluminum alloy base composite radome, impact, abrasion, UV, solvent, Skydrol resistant, and fire retardant
Weight	397g (14oz)
Vibration	>30g's

Designed to	FAA TSO-C144, DO-160D, D0-228, MIL-C-5541, MIL-E-5400, MIL-I-45208A, MIL-STD-810, AND SAE J1455

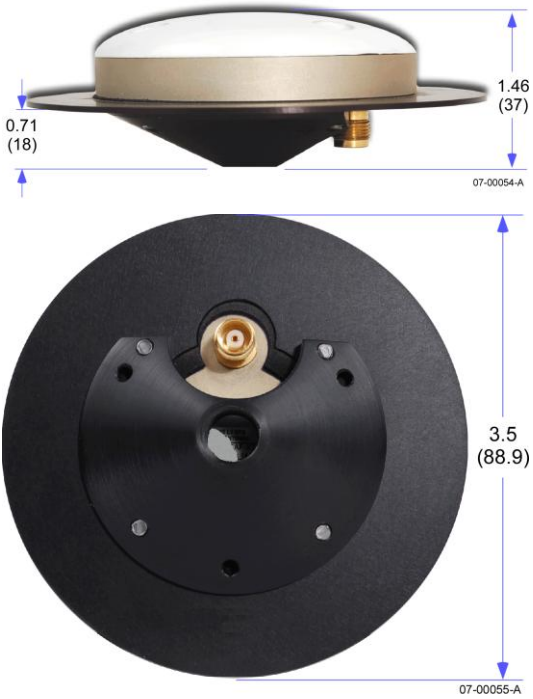


Figure 82: PN: 82-001017-0001LF Antenna Dimensions

To achieve the greatest level of accuracy, the absolute phase center values must be incorporated into the processing. Phase center information on this antenna is found in Table 26 above.

Radiation Pattern

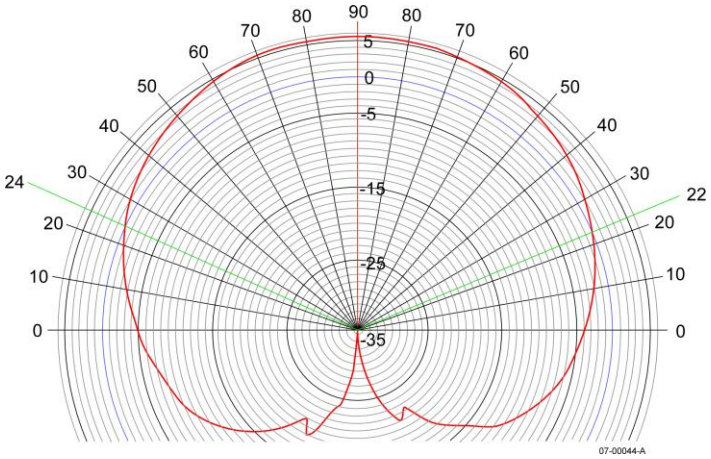


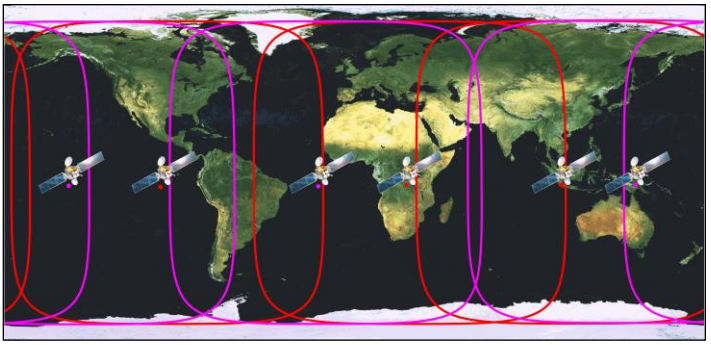
Figure 83: 82-001017-0001LF Radiation Pattern

Optimal antenna performance is realized at elevations greater than 30º.

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

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

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[1]. 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.

---

[1] A single-frequency operation mode is available for the SF-3050A. See the *Sapphire Technical Reference Manual* and the *StarUtil 3000 User Guide* for details on using this feature. Single-frequency is a receiver mode that uses only the L1 GPS signal. There is no compensation for ionospheric effects.

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.

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.

StarFire Satellites

Table 27: 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 28: 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.

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[1]. 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

[1] Dependent on Bundle Options: Standard or Optional

representative or the NavCom website at: *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.

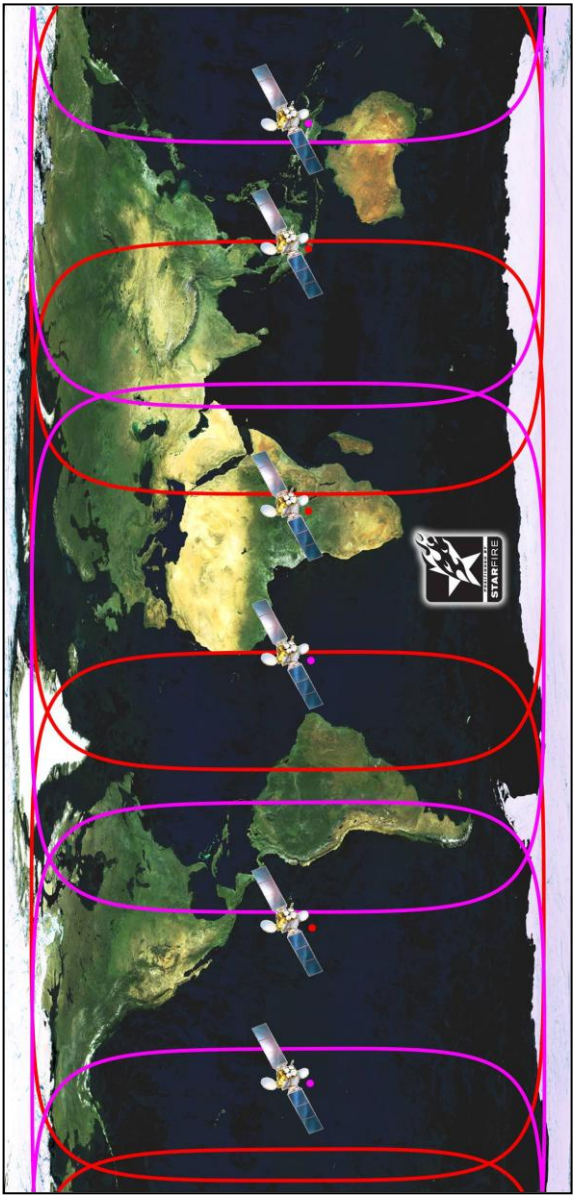


Figure 84: StarFire Network

D.....Event Input Configuration

Figure 85 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 29 details the wiring configuration required for Event pulse sensing.

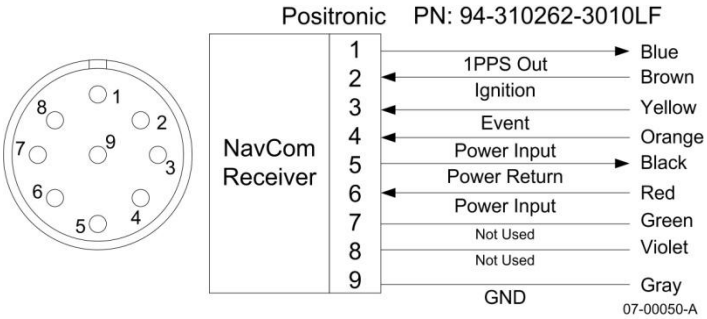


Figure 85: Event Cable Wiring Diagram

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

IMPORTANT – READ CAREFULLY: THIS SOFTWARE LICENSE AGREEMENT IS A LEGAL CONTRACT BETWEEN YOU AND THE LICENSOR ("Licensor") IDENTIFIED BELOW AND GOVERNS YOUR USE OF THE NavCom Technology GNSS StarFire™ Receiver (THE "Receiver"). AN ADDITIONAL END-USER LICENSE AGREEMENT ("EULA") IS REQUIRED FOR USE OF THE STARFIRE™ GPS CORRECTIONS SERVICE.

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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/Galileo*) 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:

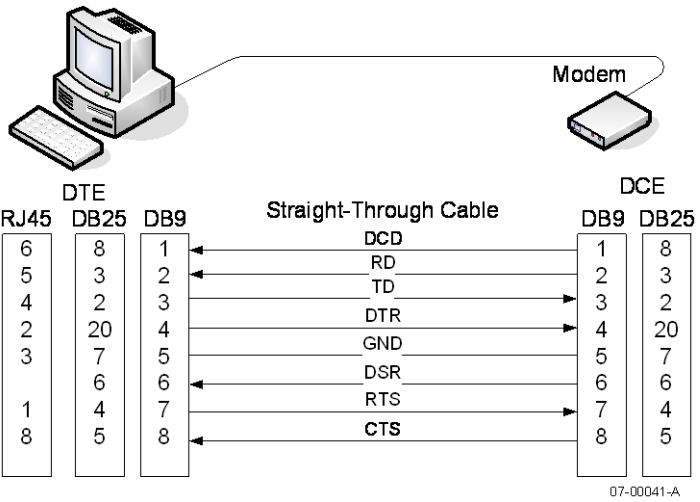

Figure 86: DTE to DCE RS-232 Pin Assignments

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.

E1 carrier frequency a L-Band carrier to be used by Galileo satellites to transmit satellite data. The frequency is 1575.42MHz.

E5A carrier frequency a L-Band carrier to be used by Galileo satellites to transmit satellite data. The frequency is 1176.45MHz.

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, 0º to 90º.

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.

Galileo a GNSS system currently being built by the European Union (EU) and the European Space Agency (ESA). Galileo uses the same concepts for positioning as GPS.

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), Galileo (E1, E5a), 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*.

RTG Real Time GIPSY, a processing technique developed by NASA's *Jet Propulsion Laboratory* to provide a single set of real time global corrections for the GPS satellites.

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.

single-frequency is a type of receiver that only uses the L1 GPS signal; there is no compensation for ionospheric effects.

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.

WAD*GPS* (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.

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