



SF-5050

GNSS Product User Guide



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Notices

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P/N 96-310045-3001
Rev A
January, 2019

Serial Number: _____

Date Delivered: _____

Purchased From: _____

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FCC Notice

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

This device may not cause harmful interference, and

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

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

User Notice

Deere & Company 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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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 Deere & Company GNSS Receiver Software License and Open Source Software Licenses. The complete terms and conditions of these software licenses may be found in the SF-5050 GNSS Products User Guide, Appendix E.

USG FAR

Technical Data Declaration (Jan 1997)

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

Global Navigation Satellite System

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

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

The U.S. State Department International Traffic in Arms Regulations (ITAR) regulations limit the performance of commercial GNSS products. As a result, access to satellite measurements and navigation results will be limited from display and recordable output when predetermined values of velocity and altitude are exceeded. These threshold values are far in excess of the normal and expected operational parameters of the SF-5050 GNSS Sensor.

Revision History

Rev A (January 2019)	Initial release
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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 <https://www.navcomtech.com/en/support/contactsupport/>

Related Documents

All of the documents below, except for the NavCom Release Notes, are included on the supplied SF-5050 Product Configuration USB Flash Drive (P/N PH98233233).

[SF-5050 Quick Start Guide](#)
P/N 96-310048-3001

Provides instructions to quickly set up the standard configuration of the SF-5050

[Onyx Technical Reference Manual](#)
P/N 96-310008-3001

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: <https://www.navcomtech.com/en/support/faqs/>.

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

Related Standards

ICD-GPS-200

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

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

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

GLONASS ICD, Version 5.0, 2002

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

Beidou

BeiDou Navigation Satellite System

Internet: <http://en.beidou.gov.cn/>

Tel: +86 10 62567566

Email: webeditor@beidou.gov.cn

Galileo ICD Issue 1, Revision 2, November 2015

Internet: <https://www.gsa.europa.eu/>

ICD: https://www.gsc-europa.eu/system/files/galileo_documents/Galileo_OS_SIS_ICD.pdf

European GNSS Agency

Janovského 438/2

170 00 Prague 7 – Holesovice

Czech Republic

Tel: +420 234 766 000

RTCM-SC-104

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

NTRIP

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

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

CMR, CMR+

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

RINEX

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

QZSS

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

NMEA-0183

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

Publicly Operated SBAS Signals

RTCA/DO-229D

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

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

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

WAAS (Wide Area Augmentation System)

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

EGNOS (European Geostationary Navigation Overlay Service)

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

MSAS (MTSAT Satellite-based Augmentation System)

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

GAGAN (GPS Aided Geo Augmented Navigation)

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

Chapter 1 Getting Started

This chapter provides instructions to enable the robust functionality of the SF-5050 Basic (GNSS Receiver, PN: PH90229910).

- ü Confirm that all ordered equipment is delivered. Refer to these tables for detailed lists:
 - Table 1: Supplied Equipment
 - Optional Cables
- ¥ If any items are missing or damaged, immediately contact NavCom Customer Support:
 Telephone: +1 (310) 381-2000 (Monday – Friday 8 AM to 5 PM; Pacific Time)
 Web: <https://www.navcomtech.com/en/support/contactsupport/>
- ¥ Consult your dealer to determine if the SF-5050 is already fully configured. If it is configured, the SF-5050 is ready to use. To get started, refer only to the sections below to connect equipment and operate the receiver.
- ¥ If the SF-5050 is not dealer-configured, the receiver is not operational until the steps in this chapter are performed.
- ¥ *MED Compass Safe Distance*: The SF-5050 receiver may not be installed closer than 0.3m to the ship’s compass.

Product Configuration Files

All the files needed to set up the ordered configuration of the SF-5050 are included on the SF-5050 Product Configuration USB Flash Drive (P/N PH98233233). The main product configuration files are:

- ü Firmware (*.s19): The most current firmware consisting of boot loader, navigation, and input/output application files.
- ü Software Options (*.opt): The options enable the functionality of the SF-5050. Software Options may be purchased in a bundle and/or individually.
- ü StarFire™ License (*.lic): The SF-5050 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-5050 G, S, and M Software Bundles, and may also be purchased individually. The StarFire™ License, which defines the subscription period, is a purchased item in addition to the StarFire™ Software Option.
- ü NavCom’s Windows-based control program (StarUtil-5000) or the webpages are used to upload the product configuration files.
- ü USB Driver (*navcomx1c45x5050x64.inf* for 64-bit machines or *navcomx1c45x5050.inf* for 32-bit machines)

- ü User Profiles (*.npt): The SF-5050 is already configured with a factory default User Profile which defines the operational characteristics and output messages/rates/port assignments. If desired, the user may define up to 20 additional profiles with a predefined setting.

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

Connect Equipment



Figure 1: SF-5050 Rear Panel

Refer to Figure 1 for the steps below.

1. Connect to the Ethernet (LAN) port to access the webpage interface. The webpage interface is the primary receiver performance monitoring utility.
 - RJ45 cable (P/N PH96235870): Connect the Positronic connector end to COM1 - LAN at the rear of the SF-5050. Connect the RJ45 end to the PC.
2. Mount the supplied GNSS antenna. Locate the antenna in an area with a 360° clear view of the sky.
 - ☞ Refer to *Chapter 4 Antenna* 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 GNSS 1, at the rear of the SF-5050.
 - ☞ Refer to Table 16 for longer cable lengths.
4. Plug the supplied AC power cord (P/N 73-200002-0001LF) into the supplied Universal AC/DC Power Adapter (P/N PH96237115). The adapter operates on either 120 or 240 VAC power. Refer to Table 16 for power on/off states.

- ⚠ The purchase of a separate appliance cable (not available from NavCom) may be necessary if the VAC plug configuration needed is not the standard 2-prong American connector.
5. Connect the female Positronic connector end of the Power Adapter cable into the male connector, labeled PWR - 1PPS, at the rear of the SF-5050.
 6. Plug the AC power cord into an AC receptacle.
 7. Press the front panel On/Off button to turn on the SF-5050. All front panel LEDs illuminate for a period of approximately 5 seconds during power-up as the receiver performs its built-in-test. The Power/GNSS Status LED changes from Red to Green.
- If the ignition pin is in use, the front panel switch acts as a reset button adding an additional 2-seconds to the startup time.

Establish Communications

Enable or Disable Receiver Use of Signals and Frequencies for Navigation

WebPages

The receiver is operated via a series of webpages which are accessed over the Ethernet or Wi-Fi® port, if Wi-Fi® equipped (Wi-Fi® requires authentication). The default Ethernet (wired) address is “AUTO” which means that there isn’t a default IP address. By default, the receiver is configured to obtain an IP address from a local DHCP server. The [ETHCONFIG] command can be used to determine the address assigned by the DHCP server or can be used to set a static IP address manually.

- ⚠ Negative & Positive Switch Spikes on the Ethernet port may cause invalid duplicate epoch data. Users should take care to ensure both the SF-5050 and connected equipment are operated on stable input power which may require additional conditioning if communications problems are experienced.
- ⚠ Shorting on the Ethernet port may cause data on the Ethernet port to halt. Users should take care to ensure connected equipment are operated with appropriate fail-safes to ensure appropriate equipment response for safety of life and property if communications problems are experienced. The appropriate response to this failure mode is to re-establish an Ethernet connection.
1. Update firmware on SF-5050 receiver.
 2. Determine the receiver’s IP address OR give it a static IP address by entering the [ETHCONFIG] command in the Input Terminal screen. Refer to the Onyx Technical Reference Manual for additional Ethernet configuration tools.
 - *Specify [ETHCONFIG]MANUAL to manually change the IP address.*

- *Using [ETHCONFIG]AUTO will automatically set the IP address.*
 - ⚠ The IP address consists of the first four sets of three numbers separated by periods. For further information on this command, see the Technical Reference Manual.
3. Save the profile by entering [PROFILE]SAVEAS “XXX” in the Input Terminal screen where the Xs indicate the name chosen for the profile.
 - ⚠ If the profile is not saved, the IP address will be lost the next time the receiver is shut off and rebooted.
 4. If the memory is not formatted, refer to the Onyx Technical Reference Manual [FSFORMAT] for additional information.
 - ⚠ The SF-5050 is capable of accepting a removable 32GB SD card for user data logging. Once this card is formatted, there is no need to reformat it. While the SF-5050 does have internal memory accessible by the end user, it is not intended for user data logging as the available space is very limited due to other receiver operations. User data logging should be sent to the removable SD card.
 - ⚠ SD card data logging is not guaranteed below -15°C. Operational characteristics vary by card model and manufacturer. If data logging at lower temperatures is required, a small amount of space (<2GB) is available on the internal memory chip. Alternatively, users can opt to test different card models to identify a card which will function for their needs.
 5. To load the Webpage files using StarUtil5000, select the File Upload screen under the Receiver Options tab.
 6. Click the Webpage Loader button and browse to the SF-5050WebpagesvX.X.X/NCT (where X.X.X is the version number) file on the USB stick.
 7. Select the NCT folder and click **OK**.
 8. Click the Load button to load the NCT directory.
 9. Enable the WebServer and choose webpage directory by entering the [WEBCONTROL]ENABLE,NCT command in the Input Terminal screen. This will ensure that the webpages in the NCT directory are enabled.

Chapter 2 Introduction

System Overview

GNSS Sensor System

The SF-5050 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-5050 Basic (PN: PH90229910): consisting of the 255 channel Oynx GNSS board with two RF ports, the Power Input/Output board, the display board, and the SD card board. The system top assembly includes a power supply and certain cables (accessories).

The SF-5050 software-enabled features, bundled or purchased individually, cover a wide variety of applications.

The SF-5050 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-5050 provides flexibility to be configured as a base station, a rover, or a heading receiver (requires additional hardware).

Superior interference suppression (both in-band & out-band), multipath mitigation, and measurement accuracy are only a few of the sensor’s technological advances when coupled with a NavCom antenna. The SF-5050 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.

Depending upon the bundle, this receiver provides, but is not limited to:

- ü NavCom’s StarFire™¹ Network: A worldwide Satellite Based Augmentation System (SBAS) for near-centimeter level position accuracy (post-convergence period). Refer to [Appendix C](#) for detailed information.

☹ ¹Dependent on the bundle: Subscription and Software Option Required

- ü 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-5050 delivers centimeter level position accuracy via external RTK² correction formats. The receiver is capable of NCT RTK/UltraRTK™, and RTCM 2.3 and 3.1 (code and phase; single base solution) DGPS operating methods. The operating software is also capable of supporting an internal or external radio modem.

☹ ²Dependent on the bundle: Separate Software Option Required

- ü Signal Reception: The SF-5050 GNSS engine includes a digital ASIC to handle high speed signal processing. The sensor provides proven unparalleled performance in spite of adverse signal tracking conditions by incorporating the use of GPS (L1, L2, L2C, L5), GLONASS (G1, G2), and SBAS (WAAS, EGNOS, MSAS, GAGAN and SNAS) signals (standard for most software bundles). The receiver tracks and provides raw measurement data for Beidou (B1 and B2) and Galileo (E1, E5a, and E5b) satellite signals.
- ¥ Beidou and Galileo signals are not used in the navigation engine. Other performance restrictions may exist with the use of these signals. No guarantee exists that these signal will be utilized now or in the future for PNT output.
- ü 255 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. 3 channels are dedicated to tracking StarFire™ signals.

The system includes antenna, and interconnection accessories outlined in Table 1.

CE Compliance and the Radio Equipment Directive (RED)

The SF-5050 is only compliant with the European Union CE Radio Equipment Directive when using a qualified antenna that has been agency tested with the SF-5050. Users should not assume that commercially available third party antennas maintain system CE compliance without first testing to applicable standards. NavCom is not responsible for system testing of third party antennae. CE qualified antennae tested by NavCom are identified by model number in this manual.

Black Box Data Logging

Background data logging is enabled in this product by default (if Software Option 97-310041-3405: Black Box Recorder is not ordered at time of purchase) to provide end users with the ability to collect vital errors needed by engineering to troubleshoot in the event of software misbehavior. Once an error occurs, the end user can chose to offload and forward the file to the manufacturer for further troubleshooting. The manufacturer does not have direct access to this log file. This feature can be turned off by end users via software command regardless of the software option setting via the [LOGFILEBGENABLE] command on a per-session basis. By default, log files are automatically deleted at startup or during continuous operation after 48-hours, unless the user defines a different period between 6 hours and 96 hours with the [LOGFILEBGSETTIMELIMIT] command. Files are captured in a maximum of 15-minute intervals. To permanently disable this feature, order Software Option 97-310041-3405: Black Box Recorder, which will be provided free of charge. The state of this option setting can be verified by entering the [INPUTSWOPTION] command from the Input Terminal screen. For DataLog, 0=Disabled; 1=Enabled.

Customer data which is forwarded to the manufacturer shall be used for the sole purpose of software troubleshooting. Data is destroyed after its useful purpose has been served, not to exceed six (6) years. Customer data shall not be disclosed to third parties without the customers' written permission.

No personal user information is captured in the collected receiver data. However, the data may contain position, date, and time information, vital satellite tracking and navigation messages, and other operational parameters. The list of stored messages is defined by engineering. The collected data is viewable by customers, to the extent that the Technical Reference Manual supports those messages. The collected data likely contains message structures known only to Deere & Company.

Accuracy

SBAS

When WAAS, EGNOS, MSAS, GAGAN (RTCA/DO-229D compliant) and SNAS 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 *Onyx Technical Reference Manual* (TRACKINGMODE command) and the *StarUtil-5000 User Guide* for details on disabling WAAS, EGNOS, and MSAS.

StarFire™

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

- ⚠ ¹Convergence is the time needed to resolve ambiguities to final accuracy level. This period varies dependent on DOP and algorithms in use.

RTK

The system provides immediate < 1 cm position accuracy when UltraRTK¹ correction signals are used:

- L1, L2, L2C, L5, G1,G2 baseline:
< 40 km, ±1 cm + 0.5 ppm)
- Also applies to Moving Base RTK

- ⚠ ¹Dependent 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-5050 GNSS receiver can output proprietary raw data at programmable rates from $\leq 1\text{Hz}$ to predetermined rates up to 25Hz^1 and Position Velocity Time (PVT) data at programmable rates from $\leq 1\text{Hz}$ to predetermined rates up to 25Hz^1 through the data ports² 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 various ports is limited by the baud rate, the byte size, and number of messages output.

⚠ ¹ Dependent on software bundle options. Rates beyond 25Hz are possible, but require further product and business development.

⚠ ² Port dependent, refer to Communications Ports for details.

NCT Binary Proprietary Data

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

- ü Satellite Ephemeris (EPHEM1B)
- ü Satellite Almanac (ALM1B)
- ü Raw Pseudorange Measurements (MEAS1B)
- ü Position, Height, Velocity, Time, and statistics (PVT1B)
- ü Heading, bearing and distance to moving base (MBRTK1B)
- ü Signal to Noise (CHNLSTATUS1B)
- ü Channel Status (CHNLSTATUS1B)
- ü Correction Data (mirror data ECHODGPS; RTKSTATUS1B)
- ü Event/Marker (EVENTLATCHA)
- ü 1PPS
- ü 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 *Onyx 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-5050 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 (i.e. \$GP, \$GL). Proprietary data strings are denoted with a \$PNCT header unique to NavCom data formats. The *Onyx Technical Reference Manual* provides

additional controls for heading types and message lengths for some NMEA messages. NMEA data complies with v.4.1 of the standard in SF-5050.

n Standard

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

n Proprietary (header \$PNCT)

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

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

n 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-5050. Later purchased software upgrades are also provided in a Software Options File for upload.

G-Bundle (PN: 97-310041-3303)

The SF-5050G is a multi-constellation, 5Hz update rate, StarFire™-enabled¹ software option for users that require high-availability, worldwide, decimeter accuracy.

Upgrade paths for higher data rates and other options make the SF-5050G ideal for many Offshore Survey and Positioning applications:

- ü Nautical Station Keeping
- ü Dynamic Positioning
- ü Dredging and Offshore Construction
- ü Deep Water Survey

¥ ¹StarFire™ Option is standard. StarFire™ subscription is sold separately.

S-Bundle (PN: 97-310041-3304)

Adding RTK¹ Base and Rover to the feature-rich software “G-Bundle”, the “S-Bundle” is a powerful engine for use in Land Survey applications where precision is vital. When coupled with an external UHF radio (not sold through NavCom) allows the receiver to fit nicely into a backpack Land Survey system with an external RF cable to the pole-mounted antennae. 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-5050 sensor meets the needs of a large number of applications including, but not limited to:

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

¥ ¹Dependent on software bundle

M-Bundle (PN: 97-310041-3305)

With 25Hz data rate output, 1PPS, Event Marker, and StarFire™² enable features standard, the M-Bundle is an option 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).

¥ ²StarFire™ subscription is sold separately.

The SF-5050M is ideal for vehicle mounting to suit a wide variety of machine guidance and control applications:

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

Ethernet Connection

An Ethernet connection may be set up for the SF-5050 receiver. Refer to the *Onyx Technical Reference Manual* [ETHCONFIG] and [ETHVCOM] commands for detailed instructions on configuring and establishing an Ethernet connection.

Antenna

The SF-5050 GNSS sensor must be ordered with a Rover antenna. Each antenna is described below.

Rover

The Rover integrated GNSS antenna (PN: 82-001020-3001LF) tracks GPS (L1, L2, L2C, L5), GLONASS (G1, G2), Beidou (B1, B2), Galileo (E1, E5a, E5b), 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. NavCom supplied antennae are listed in the [Antenna Calibration Values](#) available from the International GNSS Service (IGS) calibration table hyperlinked to this text, as NAV-ANT3001R.



- ⚠ The ANT3001R, when used with the SF-5050, does not meet the Directive 2014/53/EU of the European Parliament and of the Council on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC with regard to adjacent band signal rejection requirements. The SF-5050 may not be imported into a European Union Member State with the ANT3001R antenna. An alternative antenna, which has been tested to meet CE RED will be made available at a future date and identified in this user guide.

Beidou, Galileo, GPS L2C/L5/L1C signals are not used in the navigation engine. No guarantee exists that these signal will be utilized now or in the future for PNT output.

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).

Controller

The SF-5050 GNSS sensor is designed for use with an external controller solution connected via one of the receiver’s many communications ports.

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.

Included Items



Figure 2: SF-5050 Supplied Equipment

Table 1: Supplied Equipment

1	SF-5050 GNSS Sensor; PH90229910 (Basic; GNSS receiver)
2	GNSS Antenna Cable, 12 ft (P/N 94-310261-3012LF)
3	Positronic 9-Pin Female Universal AC/DC Power Adapter 110-220VAC, 12VDC, 1.50A. (P/N PH96237115)
4	Harns Power Cord 2-Prong North America (73-200002-0001LF)
5	Positronic Ethernet/Serial Y Cable, 6ft (P/N PH96235870)
6	SF-5050 Product Configuration USB Flash Drive (not shown). Contains: Software Options file, Firmware file, User Profiles, User Guides, Brochures, Software Utilities, Technical Papers, and if purchased, a StarFire™ License file (PH98233233) <i>Important:</i> Refer to Chapter 1 for steps to enable the functionality of the SF-5050 via the USB flash drive.



Figure 3: Rover Antenna

Table 2: SF-5050 Antennae

1	NAV-ANT3001R Rover GNSS Antenna (P/N 82-001020-3001LF) *Does not meet system-level EU RED (2014/53/EU) requirements
---	--

Unique Features

The SF-5050 GNSS sensor has many unique features:

n Performance Upgrade Path

The SF-5050 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-5050 software-enabled features, bundled or purchased individually, cover a wide variety of applications.

n StarFire™

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

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

n StarFire™ Rapid Recovery

StarFire™ also incorporates the Rapid Recovery feature to quickly regain StarFire™ converged-level accuracy after brief satellite blockage.

n StarFire™ Over IP

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

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

n 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.

n Web Server

The Web Server feature allows the user to access positioning information and control the receiver via a standard web browser and is the primary user interface for live streaming data. Each receiver can be configured with a unique IP address that can be accessed from any computer using Firefox, Chrome, Safari or Internet Explorer. Easily accessible web pages can be used to view satellite data and configure a variety of functions.

n 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-5050 is capable of outputting or accepting legacy 0x5B (RTK) or new NCT62 (UltraRTK) binary formats. Refer to the TRM for more details (see *Related Documents* in the fore-matter).

n Positioning Flexibility

The SF-5050 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-5050 automatically configures to use the most suitable correction source available and changes as the survey dictates (this feature can be overridden).

n RTK Extend™

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

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

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

n Multi-Format RTK

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

n 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 *Onyx Technical Reference Manual* and the *StarUtil-5000 User Guide* for detailed instructions on the use of the [DATUM] command.

n Heading

The SF-5050 heading system consists of two SF-5050 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.

n Coordinated Machines

An SF-5050 configured as a moving base is located on a reference platform. An SF-5050 configured as a rover is located on one or more additional platforms. All of the SF-5050 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.

n Data Sampling

GPS (L1, L2, L2C, L5), GLONASS (G1, G2), and SBAS (WAAS, EGNOS, MSAS, GAGAN and SNAS) raw measurement data is up to 5Hz in the standard configuration for the SF-5050G and SF-5050S. An optional upgrade allows 10, and 25Hz raw measurement data via high speed ports.

For the SF-5050 M-bundle, the raw measurement data is up to 25Hz in the standard configuration.

The PVT (Position, Velocity, & Time) data is output at up to 5Hz in the standard configuration for the SF-5050G and SF-5050S. An optional upgrade allows 10, and 25Hz position updates for highly dynamic applications.

For the SF-5050 M-bundle, the PVT data is output at up to 25Hz in the standard configuration.

n Internal Memory

See the *Onyx Technical Reference Manual* and the *StarUtil-5000 User Guide* for detailed instructions on utilizing the SF-5050 internal memory flash drive. However, the removable SD Card capability provides better ease of use and far more recording capacity. The SD Card capability is the recommended medium for recording on-board data.

n Continuously Operating Reference Station (CORS) Support

When optioned as an RTK Base Station, the SF-5050 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:

- ü Com 1: NavCom proprietary corrections (x62, etc.); transmit via 900 or 400MHz radios
- ü Com 2: RTCM 3.1; transmit via 900 or 400MHz radios
- ü USB: Command and Control; thumb drive data logging not supported
- ü Ethernet Port 1: Command and Control (StarUtil Interface)
- ü Ethernet Port 2: RTCM v3.1 (can include Ntrip)
- ü Ethernet Port 3: x62

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

n 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 *Onyx Technical Reference Manual* for detailed instructions.

n GNSS Performance

The SF-5050 utilizes NavCom's Onyx GNSS engine, which incorporates several patented innovations. Onyx'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.

n Rugged Design

Units have been tested to conform to MIL-STD-810G 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-5050 is also designed to comply with the relevant type approval procedures for marine equipment of the Marine Equipment Directive (MED) 96/98/EC.

The rugged design of the SF-5050 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.

Chapter 3 Web Server

This chapter details the use of the Web Server, the internet-based interface between the SF-5050 and the user. This interface can be used instead of the StarUtil software if desired.

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

Accessing the WebServer

Each SF-5050 receiver comes with a unique IP address. See Chapter 1 setup Web Server. Typing the IP address into the Address box on the browser page will open a security screen.

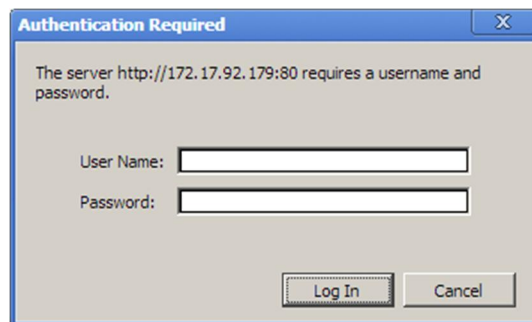


Figure 4: Windows Security Screen

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

- User Name: admin
- Password: admin

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

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

Welcome Page

Firmware	Version	Date
Main Board Boot1	1.0.2	Dec 4 2018 23:38:57
Main Board Boot2	1.0.2	Dec 4 2018 23:39:54
Main Board Application	1.0.2	Dec 4 2018 23:48:59
Power IO Board Boot1	1.0.2	Dec 5 2018 00:00:23
Power IO Board Boot2	1.0.2	Dec 5 2018 00:01:03
Power IO Board Application	1.0.2	Dec 5 2018 00:13:52
Bluetooth	4.0.0 build 317	-
WiFi	2.4.0,1.5.4	-
Radio	NOT AVAILABLE!	-

Figure 5: Welcome Page

The Welcome Page shows the following information:

- ü Serial Number of the SF-5050 receiver
- ü Firmware with version and date installed

Receiver Location Bar

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

Figure 6: Location Bar

☹ This bar appears across the top of every WebPage.

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

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

Main Menu

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

NAVCOM A John Deere Company	Lat: N 33° 50' 28.2491" Lon: W 118° 20' 37.0384"	Navmode: StarFire Dual-GNSS CorrAge: 4 seconds	Tracked: 19 PDOP: 1.5	Position: 15 Velocity: 16	Week: 1976 Time: 109534	[Logout]
---------------------------------------	---	---	--------------------------	------------------------------	----------------------------	----------

<p>Welcome Page</p> <ul style="list-style-type: none"> - Messages - PVT Data - Channel Status - Measurements - StarFire Status - StarFire Almanac - NMEA View - Skyplot - Configuration - Schedule Messages - NTRIP Config - StarFire QuickStart - Navigation Modes - RTK Mode - Self Survey - Antenna - Ethernet - Bluetooth - Utility - View / Load Profile - Firmware Update - Data Logging - Almanac Loader - Options and License - Change Password - Manage Web Accounts - Manage Ftp Accounts - Input Terminal - Help 	<p>Welcome to the SF-5050 SN: 000944</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Firmware</th> <th>Version</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>Main Board Boot1</td> <td>0.0.25</td> <td>Nov 16 2017 16:09:46</td> </tr> <tr> <td>Main Board Boot2</td> <td>0.0.25</td> <td>Nov 16 2017 16:10:39</td> </tr> <tr> <td>Main Board Application</td> <td>0.0.23</td> <td>Sep 14 2017 01:10:10</td> </tr> <tr> <td>Power IO Board Boot1</td> <td>0.0.25</td> <td>Nov 16 2017 16:28:28</td> </tr> <tr> <td>Power IO Board Boot2</td> <td>0.0.25</td> <td>Nov 16 2017 16:30:06</td> </tr> <tr> <td>Power IO Board Application</td> <td>0.0.23</td> <td>Sep 14 2017 01:33:24</td> </tr> <tr> <td colspan="3"> </td> </tr> <tr> <td>Bluetooth</td> <td>5.0 build 1022</td> <td>-</td> </tr> <tr> <td>WiFi</td> <td>2.6.2.1.7.7</td> <td>-</td> </tr> <tr> <td>Radio</td> <td>NOT AVAILABLE!</td> <td>-</td> </tr> </tbody> </table>	Firmware	Version	Date	Main Board Boot1	0.0.25	Nov 16 2017 16:09:46	Main Board Boot2	0.0.25	Nov 16 2017 16:10:39	Main Board Application	0.0.23	Sep 14 2017 01:10:10	Power IO Board Boot1	0.0.25	Nov 16 2017 16:28:28	Power IO Board Boot2	0.0.25	Nov 16 2017 16:30:06	Power IO Board Application	0.0.23	Sep 14 2017 01:33:24				Bluetooth	5.0 build 1022	-	WiFi	2.6.2.1.7.7	-	Radio	NOT AVAILABLE!	-
Firmware	Version	Date																																
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Power IO Board Application	0.0.23	Sep 14 2017 01:33:24																																
Bluetooth	5.0 build 1022	-																																
WiFi	2.6.2.1.7.7	-																																
Radio	NOT AVAILABLE!	-																																

Figure 7: Welcome Page with Expanded Menu Bar

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

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

Messages

n PVT Data

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

Position			Velocity		Error Estimate		
Lat:	N 33° 50' 28.2491"		East:	0.0000 m/s	Position FOM: 5 cm		
Lon:	W 118° 20' 37.1250"		North:	-0.0010 m/s	Time FOM: 5		
Ht:	8.741 m		Up:	-0.0020 m/s	NORTH:	0.04 m	PDOP: 1.2
Alt:	43.655 m		Ground Speed:	0.0010 m/s	EAST:	0.03 m	HDOP: 0.7
Datum:	ITRF 2008 / GEOID99		Ground Track:	180.00°	UP:	0.08 m	VDOP: 1.0
Navigation Status							
Summary Nav Status:	Nav valid / No Doppler / GeoFence not used / Rapid Recovery Inactive						
Nav Mode:	StarFire Dual:GNSS : 3D : Dual freq						
Constellation:	GPS / GLONASS						
StarFire Engine Mode:	Not Defined						
StarFire Source:	n/a						
Correction Age:	4 sec						
Age Limit:	n/a sec						
Antenna Offset							
Phase Center(H1):	0						
Slant Range:	109						
Radius Antenna Body:	0						
Solid Earth Tide							
North:	-29 mm						
East:	-46 mm						
Up:	126 mm						

Figure 8: PVT Screen

The PVT screen shows the following information:

- ü *Position*: Displays altitude, Longitude, Height, Altitude and Datum. Datum displays the selected reference model.
- ü *Velocity*: The speed over ground and direction of travel (true, not magnetic).
- ü *Navigation Status*: Displays Summary Nav Status, Nav Mode, Constellation (either GPS or GPS/GLONASS), StarFire™ Engine Mode, StarFire™ Source, Correction Age and Age Limit
 - *Summary Nav Status*: Various indications of nav status, including Nav valid, Nav invalid, No Doppler, Doppler Used, etc.
 - *Nav Mode*: Various indications of nav mode, for example, StarFire™ Dual:GNSS; 3D: Dual freq; Non differential: 3D: Dual freq, etc.

- *Constellation*: GPS or GPS/GLONASS
- *Correction Age*: The age of the current aided navigation correction in seconds. This value changes depending on the correction source and the correction interval. A few seconds is okay, but many seconds indicate the fix is degrading over time, and becoming less and less accurate.
- *Age Limit*: The maximum amount of time in seconds the received correction will be used in case of an outage or drop in the reception of corrections. The maximum age limit is 100 seconds. The default is 300 seconds for SBAS (WAAS, EGNOS, MSAS, GAGAN) and RTCM type 1 or 9. The default is 1200 seconds for GNSS (StarFire™).

ü *Error Estimate*

- *Position FOM*: The position Figure Of Merit is the estimated uncertainty in the navigation solution. FOM is the same as the One sigma error estimate. Refer to the Onyx Technical Reference Manual (see Related Documents in the forematter).
- *Time FOM*: 10x TDOP
- *DOP*: Dilution of Precision. A class of measures of the magnitude of error in GPS position fixes due to the orientation of the GPS satellites with respect to the GPS receiver. There are several DOPs to measure different components of the error: GDOP (Position and Time), PDOP (Dimensional Position), HDOP (Horizontal Position), VDOP (Vertical Position), and TDOP (Time).

ü *Antenna Offset*: If applicable.

ü *Solid Earth Tide*: Displays earth's deformation vector in three dimensions, north, east and vertical.

n *Channel Status*

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

CHNLSTATUS1B - GPS Constellation																										
GPS			L1-C/A						L1-P(Y)						L2-P(Y)						L2C					
PRN	AZ	EL	CH	ST	C/N0	CR	AL	TM	CH	ST	C/N0	CR	AL	TM	CH	ST	C/N0	CR	AL	TM	CH	ST	C/N0	CR	AL	TM
1	234	41	1	LOCK	50.75	1	N	3	220	COHY	46.5	0.98	N	3	221	COHY	48.25	0.99	N	3	104	LOCK	52.25	1	N	3
3	320	55	32	LOCK	52.5	1	N	3	240	COHY	49	0.95	N	3	241	COHY	50.25	0.99	N	3	94	LOCK	53.5	1	N	3
9	273	4	12	LOCK	40.75	0.99	N	3	232	COHY	36	0.97	N	3	233	COHY	40.5	0.98	N	3	96	LOCK	44	1	N	3
11	222	15	6	LOCK	40.5	0.96	N	3	236	COHY	37	0.89	N	3	237	COHY	40.5	0.96	N	3	-	-	-	-	-	-
14	63	27	15	LOCK	47.5	0.96	N	3	212	COHY	43.5	0.98	N	3	213	COHY	44.75	0.99	N	3	-	-	-	-	-	-
16	149	18	28	LOCK	48.25	0.99	N	3	234	COHY	44	0.98	N	3	235	COHY	44.25	0.98	N	3	-	-	-	-	-	-
18	202	26	38	LOCK	47	0.99	N	3	210	COHY	43	0.97	N	3	211	COHY	45.25	1	N	3	-	-	-	-	-	-
22	316	79	26	LOCK	54	0.98	N	3	208	COHY	50.5	0.95	N	3	209	COHY	51.75	1	N	3	-	-	-	-	-	-
23	286	30	20	LOCK	47.75	0.97	N	3	204	COHY	43	0.96	N	3	205	COHY	46	0.99	N	3	-	-	-	-	-	-
26	121	33	35	LOCK	49.75	0.97	N	3	226	COHY	45.5	0.99	N	3	227	COHY	48.5	0.99	N	3	108	LOCK	53.25	1	N	3
31	45	48	0	LOCK	54	1	N	3	238	COHY	48.25	1	N	3	239	COHY	49.5	1	N	3	86	LOCK	51.5	1	N	3
32	76	10	27	LOCK	46.75	0.98	N	3	242	COHY	43	0.98	N	3	243	COHY	44.25	0.98	N	3	88	LOCK	47.75	1	N	3

CHNLSTATUS1B - GLONASS Constellation														
GLONASS			G1-C/A						G2-C/A					
PRN	AZ	EL	CH(G1C)	ST	C/N0	CR	AL	TM	CH(G2C)	ST	C/N0	CR	AL	TM
1	102	18	21	LOCK	47.5	0.98	N	4	93	LOCK	45.5	0.99	N	4
2	34	56	14	LOCK	58.5	0.99	N	4	101	LOCK	53	1	N	4
3	323	29	5	LOCK	52.5	0.97	N	4	107	LOCK	53	1	N	4
11	30	18	36	LOCK	50.25	0.96	N	4	85	LOCK	49.5	1	N	4
12	58	59	25	LOCK	55.5	1	N	4	91	CSTS	13.25	0.4	N	41
13	179	43	37	LOCK	50.5	1	N	4	103	LOCK	46.25	0.99	N	4
17	233	6	34	LOCK	51.75	1	N	4	97	LOCK	46.5	1	N	4
18	280	15	39	LOCK	52.25	0.96	N	4	95	LOCK	50.5	0.99	N	4
19	327	7	31	LOCK	45.5	1	N	4	99	LOCK	42.25	0.99	N	4

CHNLSTATUS1B - SBAS Constellation									
SBAS		L1							
PRN	AZ	EL	CH(L1CA)	ST	C/N0	CR	AL	TM	
131	177	50	50	LOCK	53.25	1	N	3	
135	205	47	51	LOCK	53	1	N	3	
138	160	48	52	LOCK	52	0.98	N	3	

Figure 9: Channel Status Screen

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

- ü PRN: The satellite number assigned to each channel.
- ü GPS: The valid range is 1-32. (The receiver allocates the range of 1-37, with 33-37 reserved for expansion.)
- ü GLONASS: The valid range is 1-24.
- ü SBAS: The valid range is 120-138.
- ü AZ: Azimuth. The horizontal angle of the satellite relative to the receiver position in reference to North ranging from 0 (360) to 359 degrees.+
- ü EL: Elevation. The vertical angle of the satellite off the horizon ranging from 0 degrees to a zenith of 90 degrees.
- ü CH (Code Type): The channel number of the receiver, within a range of 0 – 53. The code types tracked by the channel are:
 - GPS: L1CA, L1P1, L2, L2C, and L5 based on the [TRACKINGMODE] command settings
 - GLONASS: G1C, G2C, G1P, and G2P based on the [TRACKINGMODE] command settings

- SBAS: L1CA (These code types are displayed, but don't apply: L1P1, L2, L2C, and L5.)
- ü ST: Status. The channel tracking status of each channel. The status code LOCK means the channel is locked up for measurement type and satellite, measurements are ready.
- ü C/No: Signal-to-Noise. The signal-to-noise value varies depending on satellite elevation and any obstructions between the satellites and the receiver. The typical performance range for C/N0 for all displayed L1/G1 (GPS/GLONASS) channels is 46dB to 52dB, although higher and lower values can be noted. The C/N0 for C/A and G1 is the same. G2 is similar to P2 C/No (6 [dB-Hz] less than G1). L1P is 3dB lower than CA, and L2 is 6dB lower than CA. A value > 50 is typical of a satellite with 50° elevation or higher and a clear view of the sky.
- ü CR: Costas Ratio: the estimate of maximum error in phase measurement. The Costas Ratio value has a range of 100 to -100.
- ü AL: Almanac. Y = almanac is available for the position solution. N = no almanac
- ü TM: The search timeout; i.e. the number of seconds before the search for the satellite is stopped.

n Measurements

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

MEAS1B - GPS Constellation																
GPS	L1CA				L1PY				L2CA				L2PY			
PRN	Range(m)	Phase(m)	C/No (dB)	Doppler (cs)	Range(m)	Phase(m)	C/No (dB)	Doppler (cs)	Range(m)	Phase(m)	C/No (dB)	Doppler (cs)	Range(m)	Phase(m)	C/No (dB)	Doppler (cs)
5	25170229.670	0.588	43.000	-3453.662	0.100	-	39.000	-	0.520	-8.658	40.000	-2691.104	1.730	-9.944	39.000	-2691.145
10	22988021.340	7.564	48.000	2779.704	0.480	-	44.000	-	2.250	11.060	46.000	2165.962	2.720	11.483	44.000	2165.982
13	23177713.400	11.494	48.000	-819.391	0.110	-	43.000	-	-	-	-	-	0.270	10.995	43.000	-638.466
15	21350644.950	7.209	55.000	835.314	0.270	-	49.000	-	-0.370	8.988	51.000	650.915	-0.100	11.861	50.000	650.894
16	23451550.210	7.019	47.000	754.938	-0.230	-	43.000	-	-	-	-	-	-0.910	4.831	42.000	588.284
20	20978571.300	6.550	51.000	1732.244	-0.220	-	48.000	-	-	-	-	-	-0.560	11.184	48.000	1349.800
21	21633892.840	4.541	52.000	762.269	-0.370	-	50.000	-	-	-	-	-	-1.520	8.822	49.000	593.976
25	25690681.690	-10.623	37.000	-3253.760	1.270	-	37.000	-	7.520	-13.734	41.000	-2535.439	4.930	-11.352	36.000	-2535.398
26	22988545.670	0.934	47.000	-807.646	-45.670	-	43.000	-	3.680	7.181	47.000	-629.335	3.480	6.386	44.000	-629.335
29	20900074.660	1.383	55.000	-1951.063	0.410	-	49.000	-	0.860	-28.604	52.000	-1520.309	0.500	0.643	50.000	-1520.309

MEAS1B - GLONASS Constellation								
GLONASS	G1C				G2C			
PRN	G1C(m)	L1C-G1C(m)	C/No (dB)	Doppler (cs)	G1C(m)	L2-G1C(m)	C/No (dB)	Doppler (cs)
3	20585549.590	1.516	54.000	-2789.971	1.140	7.399	52.000	-2169.977
4	19290971.310	4.280	56.000	1411.671	0.190	10.070	54.000	1097.966
5	22494318.030	3.670	49.000	4135.166	5.450	9.588	49.000	3216.220
9	24240412.220	-0.661	41.000	-2656.489	5.480	-0.961	38.000	-2066.158
10	24171810.300	1.762	44.000	-830.715	6.010	12.189	37.000	-646.112
17	23860407.380	-10.636	50.000	-3088.767	3.730	-12.667	48.000	-2402.375
18	20350272.600	-11.547	57.000	-1167.462	2.680	-5.687	51.000	-908.026
19	20148078.530	7.987	50.000	1916.851	0.320	10.647	50.000	1490.884
20	24061176.870	7.219	41.000	3392.235	2.270	-2.457	40.000	2638.405

Figure 10: Measurements Screen

GPS Constellation

- ü PRN: The satellite number assigned to each channel.

- ü Range (m): The number of meters (range measurement) to the satellite.
- ü Phase (m): Phase shift in meters.
- ü C/No (dB): Carrier to Noise measurement
- ü Doppler (cs): The shift in cycles.

GLONASS Constellation

- ü PRN: The satellite number assigned to each channel. The valid range for GLONASS is 1-24.
- ü G1C (m): The civilian G1 code range measurement.
- ü L1-G1C (m): The L1 frequency minus the G1C measurement.
- ü P1-G1C (m): The P1 pseudorange minus the G1C measurement.
- ü C/No (dB): Carrier to Noise measurement
- ü Doppler (cs): The shift in cycles.

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

n StarFire™ Status

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

SFSTATUS1B Message						
	StarFire Channel Block 1		StarFire Channel Block 2		StarFire Channel Block 3	
Signal Strength:	16.89		7.69		12.17	
Good Packet Percentage:	100.00 %		100.00 %		100.00 %	
Idle Packet Percentage:	9.03 %		8.31 %		9.03 %	
Re-synchronization Counts:	1		347		5	
Signal Status:	TRCK		TRCK		TRCK	
StarFire License Status:	Active		Active		Active	
Frequency Offset:	226 Hz		-549 Hz		193 Hz	
AGC Voltage:	31.29 V		31.29 V		31.29 V	
Satellite ID:	402		678		446	
Downlink Beam Indicator:	98W Laurentides		178E Santa Paula, CA		54W Southbury	
Hub ID:	SF GPS	SF GNSS	SF GPS	SF GNSS	SF GPS	SF GNSS
	6	7	5	6	5	7
Hub ID Valid?:	Valid		Valid		Valid	

External Hub ID
255

Figure 11: StarFire™ Status Screen

- ü Signal Strength: This field represents the signal to noise ratio for the StarFire™ channel in dB/Hz. The LSB represents 0.25 dB/Hz.
- ü Good Packet Percentage: This field displays percentage of good packets in received StarFire™ data. It is updated every 20 seconds.
- ü Idle Packet Percentage: This field displays percentage of idle packets in received StarFire™ data. It is updated every 20 seconds.

- ü Re-synchronization Counts: This field represents the StarFire™ parser packet framing re-synchronization count.
- ü Signal Status: Indicates if the signal is being tracked.
 - TRCK (green background) indicates that the signal is locked in.
 - IDLE indicates that the signal is not being tracked.
 - SGDP indicates that the signal is being detected.
 - SGDF (red background) indicates that the signal has failed.
 - ACQ indicates that the signal is being acquired.
 - PLIN indicates the signal is being pulled in.
- ü StarFire™ License Status: Active indicates StarFire™ option is licensed and enabled.
- ü Frequency Offset: This field displays the difference between the expected baseband frequency and the tracked baseband frequency, in Hz.
- ü AGC Voltage: Automatic Gain Control. Indicates the strength of the signal. The higher the voltage, the weaker the strength. The AGC range is -15 to +42.3 [dB]. The desired range is from +10 to +30 dB, with 20 dB being the nominal operating point.
- ü Satellite ID: This field represents the current StarFire™ satellite ID, in the range 320 to 680.

n StarFire™ Almanac

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

STARFIREALM1B				
Set Num	3			
Number of Records	6			

STARFIREALM1B Records				
Record ID	Satellite ID	Health	NetID	Longitude
0	402	1	0	W98
1	446	1	1	W54
2	525	1	0	E25
3	564	1	1	E64
4	643	1	0	E143.5
5	678	1	1	E178

Figure 12: StarFire™ Almanac screen

- ü Record ID: Satellite record identifier number. Describes the ordering of the records in a set. Records with the same record ID imply no particular order. Almanac updates are delivered every half hour.
- ü Health: Indicates health and status of satellite:
 - 0 = Unhealthy
 - 1 = Healthy
- ü NetID: Network identification number.
 - 0 = Net 1

- 1 = Net 2

ü Longitude: Indicates the position of the satellite in degrees of longitude above the equator.

n NMEA View

The SF-5050 does not output NMEA messages by default. They must be scheduled by the user.

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

This page is intended to allow the user to view message content for verification of the message format. Turn on no more than three messages at any given time to avoid missing display data.

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

NMEA Sentences		
Sentence ID	Enable	Sentence Contents
DTM	<input type="checkbox"/>	-
GBS	<input type="checkbox"/>	-
GFA	<input type="checkbox"/>	-
GGA	<input checked="" type="checkbox"/>	GNGGA,153454.00,3350.4708,N,11820.6174,W,2,19,0.6,44.9,M,-36.0,M,4.0,0.0975*5F
GLL	<input type="checkbox"/>	-
GNS	<input type="checkbox"/>	-
GRS	<input type="checkbox"/>	-
GSA	<input type="checkbox"/>	-
GST	<input checked="" type="checkbox"/>	GNGST,153455.00,0.2579,0.0331,0.0320,353.2302,0.0330,0.0320,0.0670*75
GSV	<input type="checkbox"/>	-
HDT	<input type="checkbox"/>	-
RMC	<input type="checkbox"/>	-
ROT	<input type="checkbox"/>	-
RRE	<input type="checkbox"/>	-
VTG	<input checked="" type="checkbox"/>	GNVTG,343.0,T,M,0.00,N,0.01,K,P*07
ZDA	<input type="checkbox"/>	-
PNCTDTM	<input type="checkbox"/>	-
PNCTGGA	<input type="checkbox"/>	-
PNCTGST	<input type="checkbox"/>	-
PNCTMDE	<input type="checkbox"/>	-
PNCTSET	<input type="checkbox"/>	-

Note: This NMEA page updates each message sequentially.

Figure 13: NMEA View Screen

≠ The DTM message automatically displays at the same rate as the GGA.

≠ Refer to the *Onyx Technical Reference Manual (TRM)* for detailed information on the output formats of NMEA messages and NavCom proprietary NMEA type messages (see *Related Documents* in the fore-matter). In addition, refer to the section, *NMEA Messages Overview*, in the TRM.

≠ The NMEA View Screen page does not contain MLA or ALM due to the way they are output.

n Skyplot

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

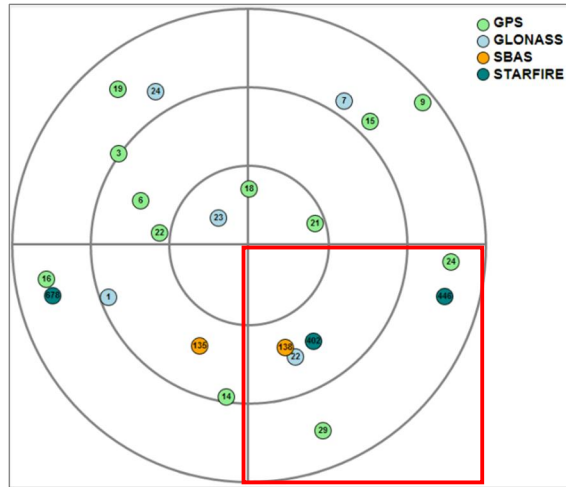


Figure 14: Skyplot Screen

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

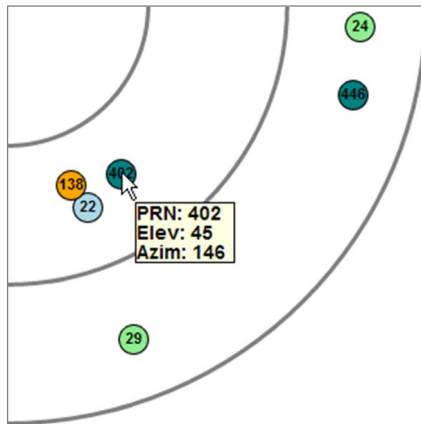


Figure 15: Skyplot Rollover Info

Configuration

n Schedule Messages

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

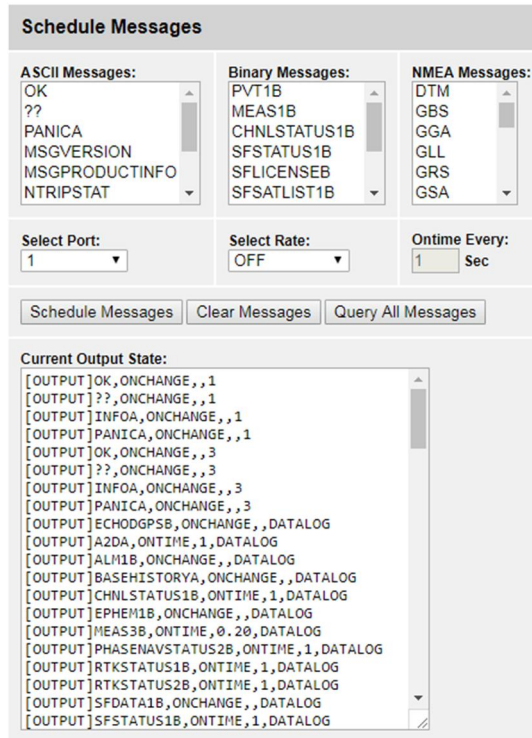


Figure 16: Schedule Messages Screen

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

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

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

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

n NTRIP Config

NTRIP CONFIG		
Caster Preset:	StarFire Settings	CURRENT CONFIGURATION
Caster:	string (128 characters max)	
Port:	2101	2101
Mount Point:	string (70 characters max)	
Username:	string (128 characters max)	
Password:	string (128 characters max)	
Send NMEA GGA:	Off	OFF
Auto Connect As:	Off	OFF
Corrections Port:	Eth	ETH
Authentication:	Basic	BASIC
	Send Ntrip Config	Refresh Current

NTRIP CLIENT			
Connect	Disconnect	Reconnect	IDLE

NTRIP SERVER			
Connect	Disconnect	Reconnect	IDLE

Figure 17: NTRIP Config Screen

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

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

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

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

NTRIP CONFIG		
Caster Preset:	Starfire Settings	CURRENT CONFIGURATION
Caster:	NTRIP.StarfireNetwork.co	
Port:	2101	0
Mount Point:	SFGNSS.15	
Username:		
Password:		
Send NMEA GGA:	Off	OFF
Auto Connect As:	Cient	OFF
Corrections Port:	Eth	ETH
Authentication:	Digest	BASIC
	Send Ntrip Config	Refresh Current
NTRIP CLIENT		
	Connect	Disconnect IDLE
NTRIP SERVER		
	Connect	Disconnect IDLE

Figure 18: NTRIP Config Screen with StarFire™ Settings enabled

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

n StarFire™ QuickStart

Provides entry field for the user to set the position of the antenna and bypass StarFire™ convergence. Any user entered bias will cause the receiver double the normal convergence time to correct.

The user has the choice of entering the antenna position in the current ITRF or WGS-84 supported reference frame, degrees/decimal degrees/degrees minutes seconds, and either meters or feet.

The receiver must be in StarFire™ operational mode prior to initiating QuickStart.

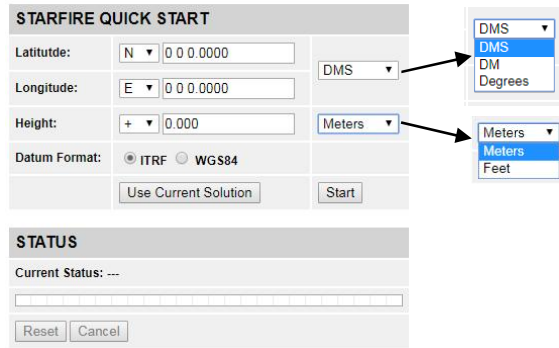


Figure 19: StarFire™ QuickStart Screen

n Navigation Modes

Provides access to navigation mode settings for the following modes:

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

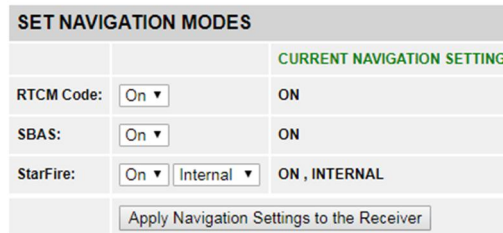


Figure 20: Navigation Modes Screen

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

n RTK Mode

Configures the RTK mode as follows:

RTKMODE CONFIG		CURRENT CONFIGURATION
Mode:	Rover	ROVER
Type:	RTCM	RTCM
ID:	0	0
Port:	none specified	
Dynamics:	none specified	
Scheduling Type:	none specified	
RTK-X Mode:	On	X_ON
<input type="button" value="Set RTKMODE"/> <input type="button" value="Refresh Current"/>		

REF STATION POSITION CONFIG		CURRENT CONFIGURATION
LATITUDE		
Degrees:	0	Minutes: 0
		Seconds: 0.000000
		0° 0' 0.000000"
LONGITUDE		
Degrees:	0	Minutes: 0
		Seconds: 0.000000
		0° 0' 0.000000"
HEIGHT	0.000000	
		0.000000 meters
<input type="button" value="Set REFSTNPOS"/>		<input type="button" value="Refresh Current"/>

Figure 21: RTK Mode Screen

ü Mode: Configures the mode as Rover or Base

RTKMODE CONFIG		CURRENT CONFIGURATION
Mode:	Rover	ROVER
Type:	Rover	RTCM
ID:		0
Port:		
Dynamics:		
Scheduling Type:		
RTK-X Mode:		X_ON
		<input type="button" value="Refresh Current"/>

Figure 22: RTK Mode Select

- ü Type: For a rover, this is a required field. It is used to validate the Site ID based on the correction type. For a base, this field must be empty.
- ü ID: Set ID range for rover site ID and base station. Receiver will use default value if this field is empty.
- ü Port: Enter port number if base. This field must be empty for rover mode.
- ü Dynamics: This is an optional field. The default is static or none specified. When setting the base station to output moving base DGPS/RTK corrections or setting the moving base RTK rover, set this field to Dynamic.

RTKMODE CONFIG		CURRENT CONFIGURATION
Mode:	Rover	ROVER
Type:	RTCM	RTCM
ID:	0	0
Port:	none specified	
Dynamics:	none specified	
Scheduling Type:	Dynamic	
RTK-X Mode:	On	X_ON
<input type="button" value="Set RTKMODE"/> <input type="button" value="Refresh Current"/>		

Figure 23: RTK Mode Dynamics

- ü Scheduling Type: This is an optional field specifying if messages are automatically scheduled. The default setting is AUTO.
- ü RTK-X: This is an optional field specifying whether or not the user would like the receiver to transition into RTK-X mode. If the user does not specify this keyword, nothing changes and the receiver will stay in the current mode. ON indicates RTK-X is enabled. This is the default mode. OFF indicates RTK is disabled.

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

n Self Survey

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

The receiver waits for a period of time (nominally 1440 minutes or 24 hours) to allow the StarFire™ readings to “settle.” This means there will be no valid survey results until this time has passed. However, if the user specifies less than this value as the time limit, the survey will continue until complete.

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

Self Survey Control		Self Survey Control	
Duration (min):	1440	Duration (min):	1440
<input type="button" value="Start"/> <input type="button" value="Stop/Apply"/> <input type="button" value="Cancel/Discard"/>		<input type="button" value="Start"/> <input type="button" value="Stop/Apply"/> <input type="button" value="Cancel/Discard"/>	
Self Survey Status		Self Survey Status	
Time:	319493.0000 sec	Time:	319537.0000 sec
Lat:	0.0000°	Lat:	33.8412°
Lon:	0.0000°	Lon:	-118.3436°
Ht:	0.0000 m	Ht:	8.8703 m
Current State:	OFF	Current State:	RUNNING
Sampled Positions:	0	Sampled Positions:	7
Duration to Survey:	0 sec	Duration to Survey:	86400 sec
Remaining Time:	0 sec	Remaining Time:	86393 sec

Figure 24: Self Survey Screen

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

n Antenna

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

ANTENNA HEIGHT ADJUSTMENT		
		CURRENT ANTENNA HEIGHT SETTING
Enable/Disable Antenna Height Adjustment:	Disable ▼	OFF
- Antenna Phase Center Adjustment:	-128 to 127	none
- Slant Range of Antenna Body:	-32768 to 32767	none
- Radius of Antenna Body:	-32768 to 32767	none
Configure Antenna Height		

ANTENNA REMOTE	
(Detect remote base station's antenna type from correction messages)	
Mode	AUTO ▼
Select Antenna	Other ▼
Other(Please Specify)	
OK	

ANTENNA INFO	
Antenna Type	NAVANT5001R ▼
Other(Please Specify)	
Serial Number	
Setup ID	0
OK	

NAVANT5001R ▼
NAVAN2004T
NAVAN2008T
NAVANT5001R
NAVSF3040
NAV_ANT3001BR
NAV_ANT3001R
None
Other

Figure 25: Antenna Height Adjustment Screen

- ü Height Adjustment: Indicates whether or not the antenna offset is applied.
- ü Phase Center Adjustment: The offset in millimeters from the physical center of the antenna (the element) to the Mechanical Reference Plane (MRP). The MRP is at the bottom of the BSW antenna mount. The range limits are -128 to 127mm.
- ü Slant Range of Antenna Body: For a pole, the vertical measurement in millimeters from the Mechanical Reference Plane (MRP) to the control point. For a tripod, the measurement in millimeters from the edge of the antenna to the control point. The range limits are -32768 to 32767mm.
- ü Radius of Antenna Body: The measurement in millimeters from the physical center of the antenna to the edge of the antenna. For a pole, enter 0. For a tripod, the range limits are -32768 to 32767mm.
- ü Under Antenna Info, be sure to select the antenna in use. Otherwise, the output position from the receiver will be incorrectly biased by an incorrect antenna phase center setting.

n Ethernet

Allows the user set to the receiver up for DHCP (Auto) or manually set parameters and displays the current settings.

ETHERNET CONFIG		
		CURRENT CONFIGURATION
Mode:	AUTO ▾	AUTO
IP Address:	172.17.92.62	172.17.92.62
Network Mask:	255.255.255.0	255.255.255.0
Gateway Address:	172.17.92.254	172.17.92.254
DNS1:	164.121.15.220	164.121.15.220
DNS2:	204.54.162.18	204.54.162.18
	<input type="button" value="Send Ethernet Config"/>	<input type="button" value="Refresh Current"/>

Warning: Changing the network settings could cause you to disconnect from the receiver

Utility

n View/Load Profile

The SF-5050 receiver provides for storage of up to 20 user profiles in its non-volatile memory. Each user profile is stored with a name and contains a complete set of user-controlled configuration parameters. A profile can be selected from a profile list or retrieved from a computer file using the Choose File button. Once selected, a profile can be, saved, used or deleted.

User Profile

PROFILE in use: NONE

[Save Current Profile to File](#)

Receiver Profiles

List of Profile(s): ▾

Load from File

File Name: No file chosen

Figure 26: View/Load Profile Screen

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

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

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

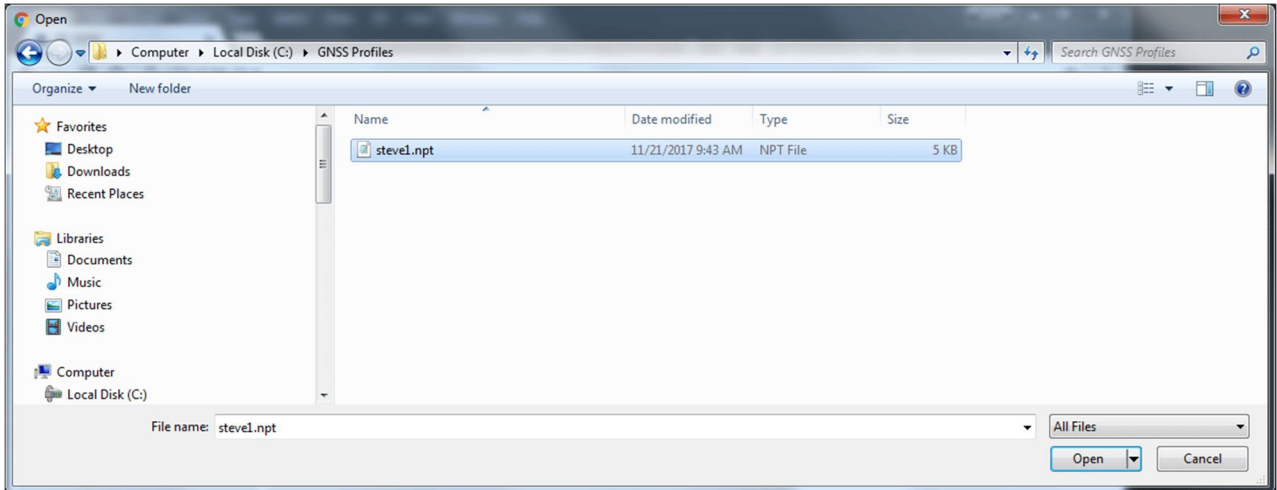


Figure 27: View/Load Profile Screen

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

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

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

n Firmware Update

This function allows firmware to be updated by uploading the most recent version from an external file.

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

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

Firmware Update

Choose File No file chosen

Firmware File			
Product	Version	Date	
Start Firmware Update			

Firmware Update Status	
Progress	
Bytes Loaded	
Status	

Figure 28: Firmware Update Screen

n Data Logging

This feature allows data to be logged onto one of two internal memory drives, either an internal memory drive (Drive A; space is limited to <2GB), or an internal SD card (Drive C).

Configure Internal Logging

Select Drive: Drive C ▼

Action: Stop ▼

Delay (HH:MM): 00 : 00

Duration (HH:MM): 00 : 00

Apply Refresh

Log File Name

Logfile Name: userdata

Apply

LogFile Time

File Duration(HH:MM): 15

Rollover Minutes: 2880

Apply

Stop ▼

Start

Stop

Pause

Resume

Figure 29: Data Logging Screen

- ü Drive C consists of the internal memory card of the SF-5050. It is formatted and segmented by using the [FSFORMAT] command (see [Upload WebPages](#) section in Chapter 1).

n Almanac Loader

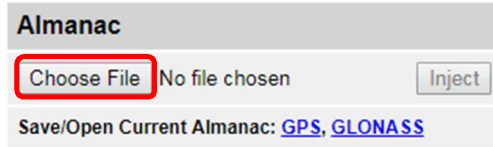


Figure 30: Almanac Loader Screen

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

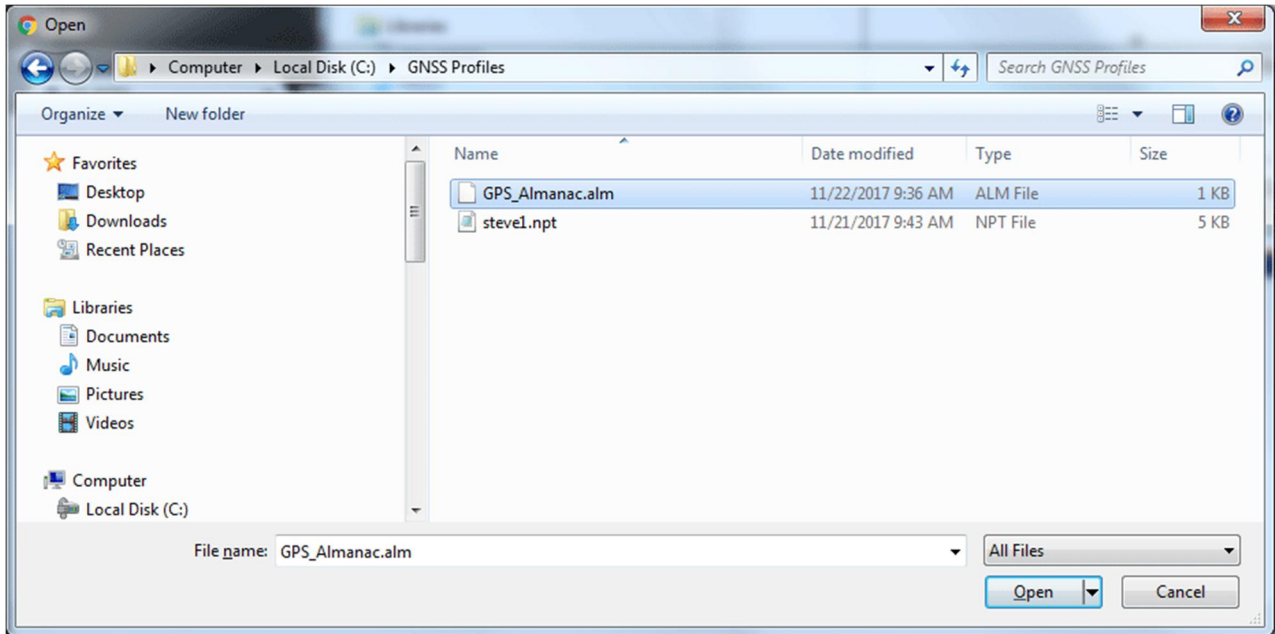


Figure 31: Almanac File Selection

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

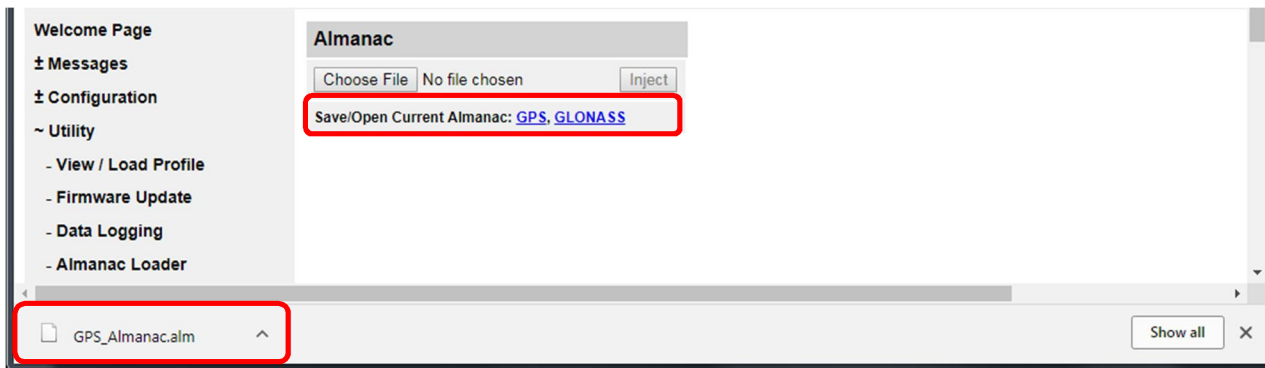


Figure 32: Almanac File Download

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

n Options and License

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

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

Receiver Options and License

Software Options		StarFire License	Primary License	Secondary License
Model:	SF-5050	Status:	Active	n/a
Serial No:	000082	Time Period:	Calendar	n/a
GPS:	L1 L2 L2C L5	Precision Type:	Precise	n/a
GLONASS:	G1 G2	Net Authorization:	All	n/a
GALILEO:	E1 E5a E5b	Issue Date:	3/9/2018 19:42:31	n/a
BEIDOU:	B1 B2 B3	Start Date:	3/9/2018	n/a
StarFire:	Yes	End Date:	3/9/2021	n/a
Nav:	10Hz	Regional Selection:	Land Only	n/a
Data:	10Hz	Run Time Info		
1PPS/Event Latch:	Yes	Days Issued:	0	n/a
SBAS Corrections:	Yes	Days Remaining:	n/a	n/a
RTK Base:	Yes	StarFire License	Point Radius	
RTK Moving Base:	Yes	Latitude:	n/a	
RTK Rover:	Yes	Longitude:	n/a	
RTK Extend:	Yes	Radius:	n/a	
Reserved:	No			
Reserved:	No			
Network RTK:	No			
L-Band Only:	No			
L-Band ENC:	No			
StarFire Over IP:	Yes			
Black Box Disable:	No			

File Upload

Key
 File

StarFire License Software Options

Upload

Figure 33: Options and License Screen

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

n **Change Password**

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

Figure 34: Change Password Screen

⚠ User names and passwords are both case sensitive.

n **Manage Web Accounts**

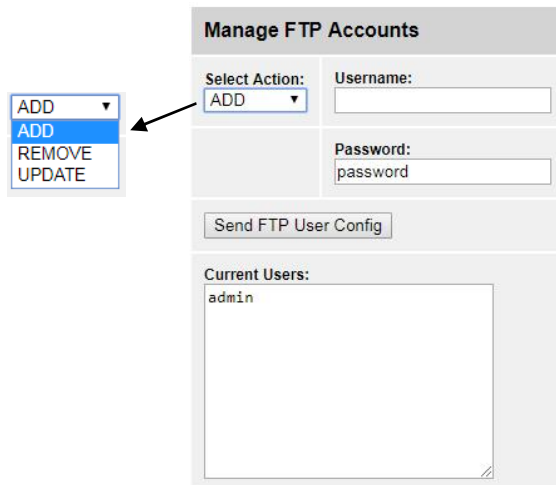
Allows user to add, remove or update users, change access levels and change usernames and passwords as needed.

Figure 35: Manage Web Accounts Screen

- ⊞ There are three levels of access:
 - USER: Able to view all webpages with the exception of Input Terminal and Manage Accounts
 - TECH: Same as USER but is able to view Input Terminal
 - ADMIN: Able to view all pages and modify user accounts
- ⊞ There can be at least 1 and at most 9 accounts consisting of:

- 1 ADMIN
 - 0-8 USER or TECH
 - ü The default ADMIN account programmed into the receiver is stored in the NVRAM but not stored in the profile.
 - ü All accounts (with the exception of the admin account) must only be modified by using the web pages. They cannot be modified by using StarUtil-5000. Only the admin account can have its password updated by StarUtil-5000.
 - ü Using the [NVCLEAR] command in the Input Terminal Screen will wipe out all user accounts except for the admin and will return the admin to the default password.
 - ü The Manage Accounts screen is only available to Level Access TECH and ADMIN.
- n [Manage FTP Accounts](#)

Allows user to add, remove or update users and change usernames and passwords as needed.



n [Input Terminal](#)

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

With a user profile loaded and in use, the receiver configuration may be changed with individual commands via the Input Terminal. Commands entered via the Input Terminal are not saved to NVRAM through a receiver power cycle. To maintain the new settings entered through the Input Terminal, the current settings must be retrieved and saved as a new user profile, or overwrite an existing profile before cycling receiver power.



Figure 36: Input Terminal Screen

n Help

The Help function provides links to resources that can be useful in using the SF-5050 Webpages.

Navcom SF-5050 Webpages

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Version: 1.0.2

Help and Support Links

[NAVCOM Headquarters](#)

[NAVCOM Support](#)

Figure 37: Help Screen

Chapter 4 Interfacing

This chapter details the SF-5050 GNSS sensor connectors, LED display, appropriate sources of electrical power, and how to interface the communication ports.

- ☞ To maintain IP67 capability, the round Positronic connectors must be fitted with o-rings which are properly seated on the female connector and all data connectors must be fully seated in the mating connector. In addition, the SD card cover must be fully seated with the turn handle aligned in the notched 9 o'clock closed indicator position.

Electrical Power

A rear panel 9-pin Positronic male connector provides electrical power to the SF-5050. Pin assignments are given in Table 3; see Figure 36 for pin location on the connector.

Table 3: External Power Cable Pin-Out

Pin	Signal
1	1PPS Out
2	Ignition (refer to Table 16)
3	Event
4	Power Input 9 to 32VDC, 6W typical
5	Power Return
6	Power Input 9 to 32VDC, 6W typical
7	Com 3 Tx (Not Used on the supplied harness)
8	Com 3 Rx (Not Used on the supplied harness)
9	Signal GND

- ☞ Power may be applied to Pins 6 and 4, which are diode isolated. Pin 6 is primarily used.

The SF-5050 is supplied with:

- ü Universal AC/DC, 12V, 1.5A power adapter (utilizes the ignition pin) (P/N PH96237115). See Figure 33.



Figure 38: Universal Power Adapter

- ☞ Where MED type approved installations are required, the SF-5050 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 PH96235771); supplied only with later SF-5050 production units.
- Approved DC to DC power converter. The converter isolates the SF-5050 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 39: AC Power Cord



Figure 40: Unterminated Power Cable

P/N PH96235771 is an optional SF-5050 power cable (see Figure 35). It is a 10ft (3m) unterminated power cable with a filter used to connect directly to a DC source.

The 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 4: DC Power Cable Pin Assignments

Color	Signal	Pin No
Blue	1PPS Out	1
Brown	Ignition (refer to Table 16)	2
Yellow	Event	3
Orange	Power Input (unfiltered; Not Used in this harness)	4
Black	Power Return	5
Red	Power Input	6
Green	COM 3 Tx	7
Violet	COM 3 Rx	8
Gray	GND	9

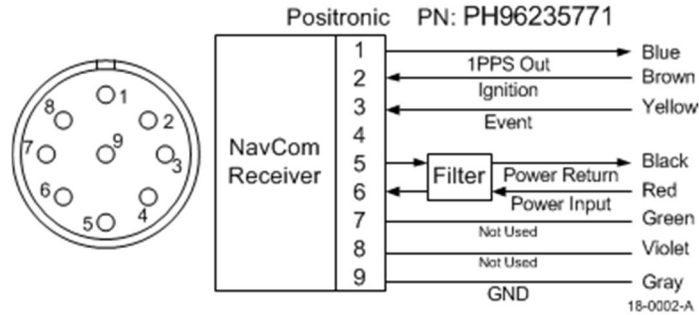


Figure 41: Power Cable Pin Assignment

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 ³ 9 to 32 VDC (refer to Table 16)
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 36VDC will activate the over voltage protection circuit, which can be reset by removing and reapplying power. The power supply must be well conditioned with surge protection. Vehicular electrical systems which create voltage spikes in excess of 36VDC 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-5050

To turn off the SF-5050 properly:

- ü Press the On/Off switch on the front panel. There may be a delay of approximately 2 seconds before the unit turns off. If the ignition pin is in use, refer to Table 16.

Or

- ü Switch off power to the ignition pin.

⚠ The SF-5050 will not shut down properly unless the external power source is correctly connected to the SF-5050 as displayed in Figure 42.

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-5050.

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.

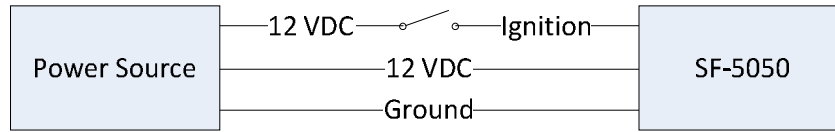


Figure 42: Proper External Power Source Setup

Communication Ports

The SF-5050 provides one 9-pin female Positronic connector communication port labeled COM1 - LAN and one DB26 connector as shown in Figure 1 located at the rear of the sensor.

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 Table 5.

COM2 and COM 4 conform to the EIA RS-232/RS-422 standard with data rates from 9.6 to 115.2kbps max. USB1 and USB2 are USB 2.0 compliant with 480Mbps maximum data rate.

The SF-5050 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

There is one supplied interface data cable:

- ü Positronic 9-Pin Male to DB9S (RS-232/Ethernet) (P/N PH96235870): constructed as described in Figures 42 and Figure 43.

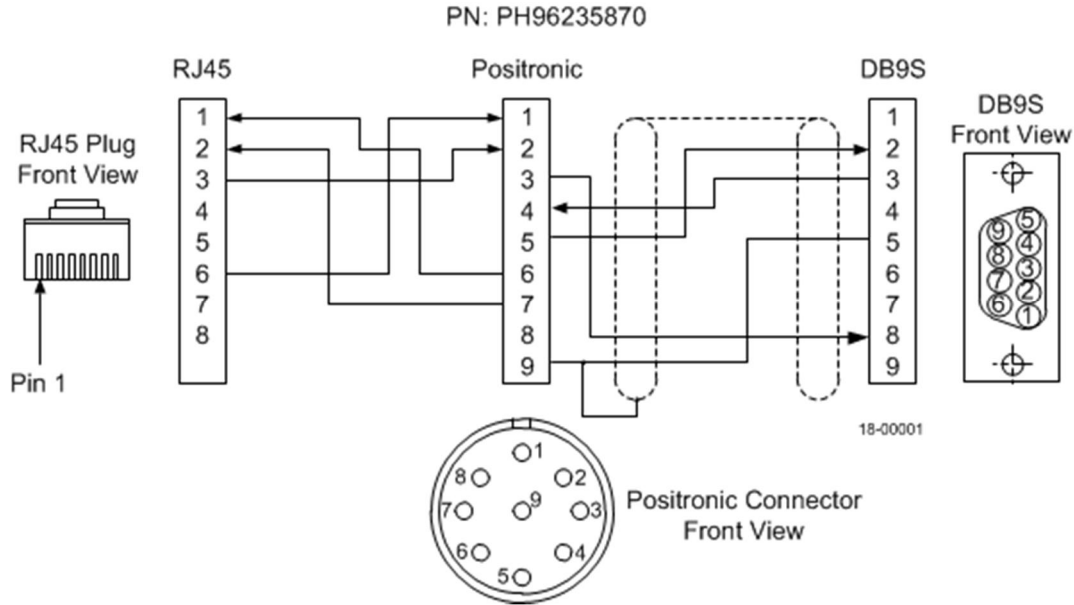


Figure 43: COM1/Ethernet Data Cable Wiring Diagram

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



Figure 44: COM1/Ethernet Data Cable

The optional interface data cables support USB 2.0 Device and Host, and RS-232 and RS-422. USB host does not support a thumb drive

Table 5: COM1/Ethernet Cable Pin Assignment
(P/N PH96235870)

Positronic Pins	Signal Nomenclature [DCE w/respect to DB9]	DB9S Pins	RJ45 Pins
1	RX-	-	6
2	RX+	-	3
3	1PPS Out (SF-5050 not supported)	8	-
4	RXD RS-232 COM1	3	-
5	TXD RS-232 COM1	2	-
6	Not connected	7	-
7	TX+	-	1
8	TX-	-	2
9	GND	5/9	-

Optional Cables

USB1 Cable

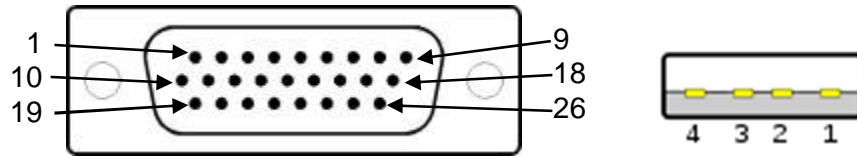


Figure 45: USB1 Cable Pin Assignment

PH96229303

Table 6: USB Cable Pin Assignment
(P/N PH96229303)

HDD26 Pins	Signal Nomenclature	USB Pins
5	USB1 D-	2
6	USB1 D+	3
15	Ground / Shield	4
23	USB1 POWER	1

USB 2 and COM 4 Cable

⚠ The USB2 function is not fully functional at product launch. Both USB1 and USB2 are fully functional for outputting data. The high speed port (USB2) is intended to provide added functionality to make the receiver look like a remote hard drive. That function is disabled. The full speed USB interface (the slower of the two) supports only the device comport mode. Additional driver support is planned in a future release.

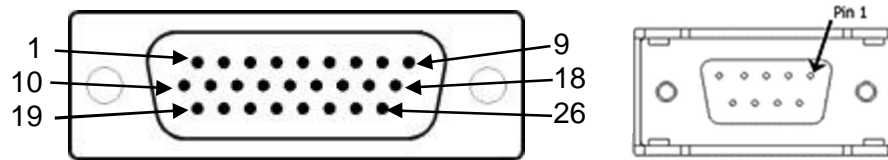


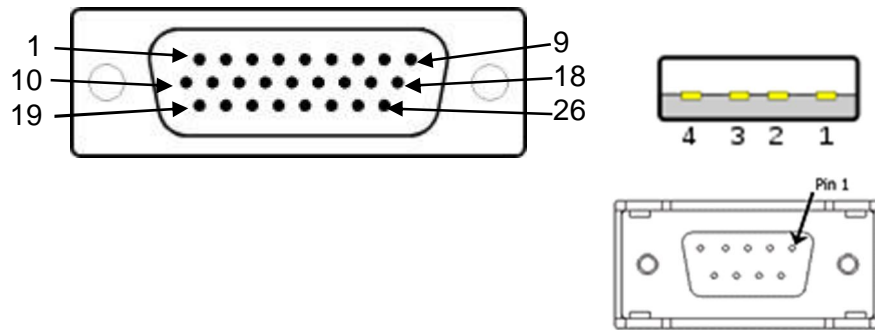
Figure 46: USB 2 and COM 4 Cable Pin Assignment

(PH96229300)

*Table 7: USB 2 and COM 4 Cable Pin Assignment
(P/N PH96229300)*

HDD26 Pins	Signal Nomenclature	USB Pins	DB9S Pins
1	COM4 422 TXD+	-	7
2	COM4 RS-232/RS-422 TXD- (refer to [SERIALMODE] command)	-	2
4	USB2 POWER	1	-
13	Ground / Shield	4	-
10	COM4 422 RXD+	-	8
11	Isolated Ground RS-232	-	5
19	COM4 RS-232/RS-422 RXD- (refer to [SERIALMODE] command)	-	3
21	USB2 D-	2	-
22	USB2 D+	3	-

USB1, COM2, and COM4 Cable



*Figure 47: USB 1, COM 2 COM 4 Cable Pin Assignment
(P/N PH96229301)*

*Table 8: USB 1, COM 2 COM 4 Cable Pin Assignment
(P/N PH96229301)*

HDD26 Pins	Signal Nomenclature	USB Pins	DB9S Pins	DB9S Pins
1	COM4 TXD+	-	-	7
2	COM4 TXD-	-	-	2
5	USB1 D-	2	-	-
6	USB1 D+	3	-	-
8	COM2 TXD+	-	7	-
9	COM2 TXD-	-	2	-
10	COM4 RXD+	-	-	8
11	Isolated Ground	-	-	5
15	Ground / Shield	4	-	-
17	COM2 RXD+	-	8	-
18	Isolated Ground	-	5	-
19	COM4 RXD-	-	-	3
23	USB1 POWER	1	-	-
26	COM2 RXD-	-	3	-

Accessories

Phenolic Washer Kit – PN: PH90232615



Figure 48: Phenolic Washer Kit

This kit includes hardware for all three mounting bracket types (supports one bracket). This hardware enables the receiver chassis to be electrically isolated from the mounting surface. Some applications, such as marine, require that the chassis be isolated from the vehicle body or vessel hull to prevent galvanic corrosion.

Top/Bottom, GNSS Receiver Painted Bracket - PH60229636

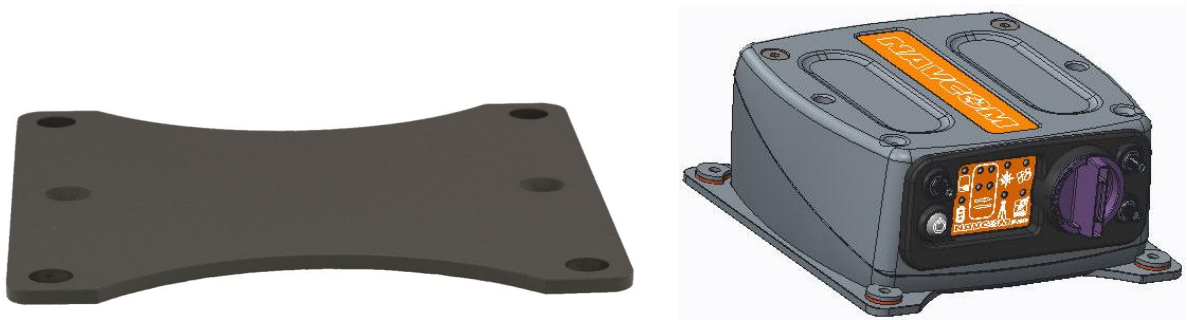


Figure 49: Top/Bottom, GNSS Receiver Painted Bracket

This bracket provides the same footprint as the SF-3050 mounting brackets; the product which preceded the SF-5050. The corner positions mount the receiver to the desired surface. The two center holes align with the receiver and are countersunk on the surface away from the receiver to accept the two metric M6 x 1.0 X16mm, flat head machine screws included with the receiver.

Side GNSS Receiver Painted Bracket - PH60229635



Figure 50: Side GNSS Receiver Painted Bracket

This bracket allows the SF-5050 to be mounted 90° from its normal horizontal orientation. The short flange mounts the receiver to the desired surface. The two center holes align with the receiver and are countersunk on the surface away from the receiver to accept the two metric M6 x 1.0 X16mm, flat head machine screws included with the receiver. The bracket can be attached on either the receiver's top or bottom and set to hang or base mount.

Front GNSS Receiver Painted Bracket - PH60229634

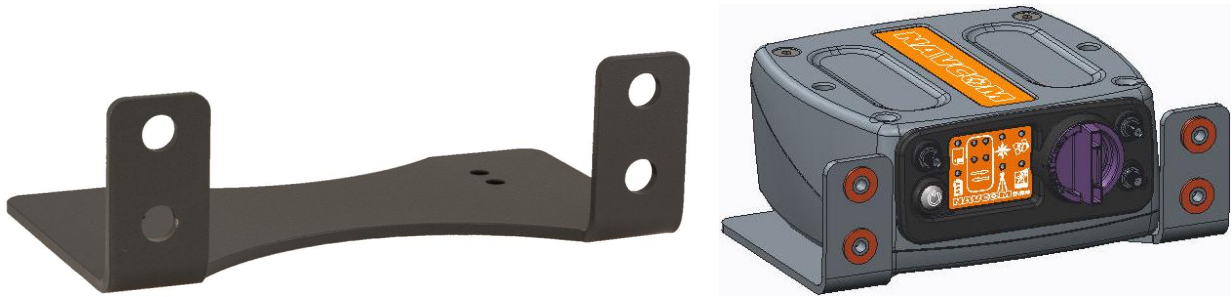


Figure 51 Front GNSS Receiver Painted Bracket

This bracket allows the SF-5050 to be panel mounted in a 19 or 24 inch rack. The short flange mounts the receiver to the desired surface. The two center holes align with the receiver and are countersunk on the surface away from the receiver to accept the two metric M6 x 1.0 X16mm, flat head machine screws included with the receiver. The bracket can be attached on either the receiver's top or bottom.

Logging to Removable SD Card

- ⚠ Refer to the *Onyx Technical Reference Manual* for details on the commands used in this section (see *Related Documents* in the fore-matter).
- ⚠ 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 SD card must be dismounted and moved to a PC.
- ⚠ SD card data logging is not guaranteed below -15°C.

The SF-5050 SD cards up to 32GB in size with a Fat 32 file structure. The receiver has been tested using Panasonic RP-SDPC04DA1 and variants up to 32GB.

Data Logging

The SDCARD must be formatted prior to first use. Refer to the FSFORMAT command.

- ⚠ This process will overwrite any previously stored data. However, [FSFORMAT] must be used prior to the first instance of data logging and should be repeated on a periodic basis for best performance.

[FSFORMAT]C:

Will format drive C: and return current FAT information for drive C:. for example:

[FSFORMAT]C:

Will format drive C as FAT_32

While doing formatting, the following message will be output:

[FSFORMAT] formatting drive C:...

While formatting is done, the following messages will be output:

```
[FSFORMAT]Format      Total      Free      Bad
[FSFORMAT]-----
[FSFORMAT]FAT_32  7853154304      7853133824      0
```

SD Card Detection

The following [SDCARD] messages are output for the stated two cases:

Case 1: When SD CARD is inserted on receiver.

Case 2: If receiver is RESET/power cycled, when SD CARD is already present.

```
[SDCARD]INSERTED
[SDCARD]INITIALIZING...
[SDCARD]INITIALIZED
[SDCARD]MOUNTING...
[SDCARD]MOUNTED
[SDCARD]UNLOCKED
[SDCARD]PRESENT
```

The following [SDCARD] messages are output for the stated two cases:

Case 1: When SD CARD is removed from receiver.

Case 2: If receiver is RESET/power cycled after removing SD CARD.

```
[SDCARD] REMOVED
```

With the SD card write-protected (Locked), the following [SDCARD] message is output if mounted successfully:

```
[SDCARD]INSERTED
[SDCARD]INITIALIZING...
[SDCARD]INITIALIZED
[SDCARD]MOUNTING...
[SDCARD]MOUNTED
[SDCARD]LOCKED
[SDCARD]PRESENT
```

With the SD card unlocked, the following [SDCARD] message is output if mounted successfully:

```
[SDCARD]INSERTED
[SDCARD]INITIALIZING...
[SDCARD]INITIALIZED
[SDCARD]MOUNTING...
```


[SDCARD]MOUNTED
[SDCARD]UNLOCKED
[SDCARD]PRESENT

When SD card mounting fails or is unusable (corrupted), the following [SDCARD] message is output:

[SDCARD]INSERTED
[SDCARD]INITIALIZING...
[SDCARD]INITIALIZED
[SDCARD]MOUNTING...
[SDCARD] MOUNTING FAILED
[SDCARD] UNUSABLE

Scheduling Messages & Logging Data

To log data to internal memory, the messages to be logged are first scheduled on a special port, *SDCARD*. The [OUTPUT] command is used to schedule the messages.

1. Specify the the recording device
[LOGFILE] C:
2. Schedule the messages
[OUTPUT](message), (timing), (interval), USERLOG

For example, to output PVT1B at 10 Hz: [OUTPUT]PVT1B, ontime, 0.1, USERLOG

Repeat this step to schedule all necessary messages.

3. Initiate data logging
[LOGFILE] START

⚠ To avoid file system corruption on the SD card, always stop file logging before removing the drive.

Direct Ethernet Connection via Static IP Address

⚠ The SF-5050 supports both UDP and TCP connections. This section provides only the basic configuration for a direct Ethernet connection between the SF-5050 and a PC. Refer to Chapter 2 of the *StarUtil-5000 User Guide* for detailed instructions on configuring and establishing Ethernet communications.

Ethernet cables are supplied with the SF-5050.

- ü Y-Cable, Positronic 9-Pin Male to Ethernet RJ45 Plug & DB9S (RS-232) (P/N PH96235870)

Setup

This setup uses the factory default IP address of the SF-5050:

192.168.0.2, 255.255.255.0, 0.0.0.0

↑ ↑ ↑
 IP Address Network Mask Gateway

The PC IP address is set manually in Windows.

1. Connect the Positronic 9-Pin connector of the Ethernet cable (P/N PH96235870) to COM1 - LAN of the SF-5050. 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 55.

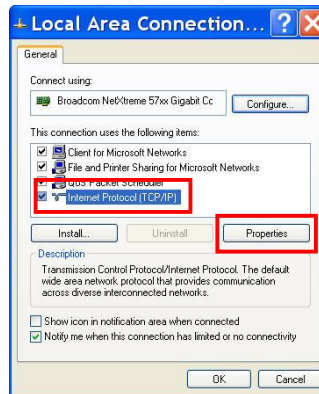


Figure 52: Local Area Connection Window

5. Click the *Properties* button. The *Internet Protocol* window opens.
6. Select the option, *Use the following IP address* (see Figure 56).

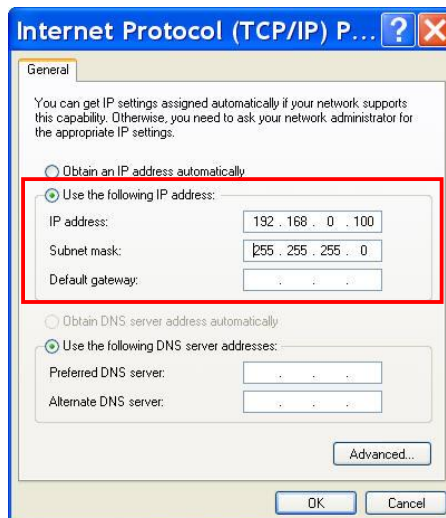


Figure 53: Internet Protocol Window

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-5050 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-5050 to PC

1. Open StarUtil-5000 on the PC.
2. Click the *Connections* button to establish communications between the PC and the SF-5050. The *Port Configuration* dialog box opens.

Refer to *Figure 57* 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-5050. The default virtual COM port is 4361.



Figure 54: Ethernet Port Configuration

4. Click the *Connect* button.
5. Verify that the SF-5050 is connected to the PC. Messages scrolling in the *Communication* window indicate that the connection is established.
 - ⚠ If an Ethernet connection is not established, use StarUtil-5000 to verify the IP address of the SF-5050. A serial connection must be used to determine the receiver’s IP address.

Event

The SF-5050 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-5050M 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 3).

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-5050 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:

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

Indicator Panel



Figure 55: SF-5050 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, and data I/O and logging 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-5050*, for details on powering off the unit.


n GNSS LEDs

Table 9: GNSS LED Indication

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


n StarFire™ Link LEDs

Table 10: StarFire™ Link LED Indication

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


n Navigation Mode LEDs

Table 11: Navigation Mode LED Indication

Icon	Indicator	Status	Description
	Positioning	Green Steady	RTK
		Green Blinking	RTK Extend
		Red Steady	StarFire™
		Yellow Steady	Code Differential, SBAS (WAAS/EGNOS/MSAS/GAGAN)
		Yellow Blinking	Autonomous

n Base RTK Mode LEDs

Table 12: Base RTK Mode LED Indication

Icon	Indicator	Status	Description
	Base RTK Mode	Off	Not in Base mode
		Red Steady	Correction data is transmitting
		Red Blinking	Correction data is not transmitting

n Data I/O Active LEDs


Table 13: Data I/O Active LED Indication

Icon	Indicator	LED	Status	Description
	Data	Data Upper-Left	Off	Data I/O inactive
			Red Blinking	Data I/O active
		Upper-Right (not in use)	Off	off
			Blue Blinking	on, no connected
			Blue Steady	on, connected
		Lower-Right (not in use)	Off	off
			Green Blinking	data active
		Lower-Left (not in use)	Off	off
			Green Blinking	
			Red Blinking	

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

n SD Card Data Logging LED

Table 14: SD Card LED Indication

Icon	Indicator	Status	Description
	SD Card	Off	No Card
		Green Steady	Card inserted, not logging
		Green Blinking	Logging data
		Yellow, steady	10% remaining capacity or less, No Data Activity
		Yellow, blinking	10% remaining capacity or less, Data Activity
		Red, blinking	Card unreadable or full

Chapter 5 Installation

This chapter provides guidance on hardware installation for optimum performance.

Antenna

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 56: Rover Antenna

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

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

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

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

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

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

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

Do not place the antenna too close to other active antennas. The wavelength of the lowest and highest signals tracked are: 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 LNAs 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 54° West, 97.65° West, 025° East, 64° East, 143° 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-5050 GNSS sensor on a flat surface. Shock isolators suitable for 2kg (4.24 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-5050 receiver may not be installed closer than 0.3m to the ship's compass.

The SF-5050 can be installed in a backpack for mobile surveying applications.

- ⚠ There are no user serviceable parts inside the SF-5050 GNSS sensor. Removing the screws that secure the front end and rear end plates will void the equipment warranty.

Communication Port Connectivity

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

Establish communications via data cable:

- ü Connect the Positronic 9-Pin connector of the supplied DB9S cable (P/N PH96235870) to COM1 - LAN (RS-232) of the SF-5050. Connect the DB9S end to the control device.

- ⚠ 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 *Accessories*). The receiver is configured as a DCE device.

GNSS Antenna Connector

The connector used on the SF-5050 is a TNC female, labeled *GNSS 1* on the rear panel of the sensor as shown in Figure 1.

- ⚠ Each 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-5050 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 15: Acceptable Cable Lengths

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

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

- ⚠ The antenna cable can degrade signal quality if incorrectly installed, or the cable loss exceeds NavCom specifications. Take care not to kink, stretch, distort, or damage the antenna cable. Do not place the cable adjacent to cables carrying electrical power or radio frequencies. In these instances,

attempt to cross cables at 90° angles in an effort to reduce cross-coupling of RF signals.

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

Basics of RTK Surveying

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

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

Proper setup of a reference station minimizes GNSS errors in the rover. The reference GNSS sensor is set up at a known surveyed location, established by surveying the antenna coordinates. This is accomplished by performing a 24-hour self survey (at minimum) or other well established surveying methods. 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. Record the precise antenna coordinates for use if the antenna must be replaced by a same model and placement or if the receiver must be reset to factory defaults and base coordinates reentered. As a last resort, the base station coordinates can be re-surveyed using the methods above; however, any bias introduced via new base coordinates will directly impact prior and new rover position results.

The SF-5050, 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 RTK. The signal can be received in less than ideal environments, though some data loss may occur. Details of supported RTK formats and specific message combinations are detailed in the Onyx Technical Reference Manual. VRS blended solution and MAC RTK networks are not supported.

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 60 and Figure 61 illustrate proper and improper RTK reference station installation.



Figure 57: RTK Setup – Good Line of Sight



Figure 58: RTK Setup – Poor Line of Sight

☹ Refer to Chapter 8, RTK Setup, in the *StarUtil-5000 User Guide* for detailed instructions.

Input Power

Input power control is flexible with the SF-5050 to meet a variety of operational environments. This includes the use of an input ignition pin, front panel switch, or front panel power switch in combination with the [POWERMODE] command. See the table below.

Table 16: Power On/Off Truth Table

IGN Signal	External Supply Voltage	IGN Voltage	POWERMODE Setting	SF-5050 State	Power Button Action	SF-5050 Action
Disconnected	0 VDC		Off	Off	Actuated	Unit remains off
Disconnected	> +9 VDC		Off	Off	Actuated	Unit starts operation
Disconnected	> +9 VDC		Off	Operating	Actuated	Unit ceases operation
Disconnected	0 VDC		On	Off	Actuated	Unit remains off
Disconnected	> +9 VDC		On	Off	Unactuated	Unit starts operation
Disconnected	> +9 VDC		On	Operating	Actuated	Unit reboots
Disconnected	0 VDC		On	Operating	Unactuated	Unit ceases operation
Disconnected	0 VDC		Switch	Off	Actuated	Unit remains off
Disconnected	> +9 VDC		Switch	Off	Unactuated	Unit remains off *
Disconnected	> +9 VDC		Switch	Off	Unactuated	Unit starts operation *
Disconnected	> +9 VDC		Switch	Off	Actuated	Unit starts operation
Disconnected	> +9 VDC		Switch	Operating	Actuated	Unit ceases operation
Connected	0 VDC	0 VDC	Off	Off	Unactuated	Unit remains off
Connected	> +9 VDC	> +9 VDC	Off	Off	Unactuated	Unit starts operation
Connected	> +9 VDC	> +9 VDC	Off	Operating	Actuated	Unit reboots
Connected	> +9 VDC	0 VDC	Off	Operating	Unactuated	Unit ceases operation
Connected	0 VDC	0 VDC	On	Off	Actuated	Unit remains off
Connected	> +9 VDC	> +9 VDC	On	Off	Unactuated	Unit starts operation
Connected	> +9 VDC	> +9 VDC	On	Operating	Actuated	Unit reboots
Connected	> +9 VDC	0 VDC	On	Operating	Unactuated	Unit ceases operation
Connected	0 VDC	0 VDC	Switch	Off	Actuated	Unit remains off
Connected	> +9 VDC	> +9 VDC	Switch	Off	Unactuated	Unit starts operation
Connected	> +9 VDC	> +9 VDC	Switch	Operating	Actuated	Unit reboots
Connected	> +9 VDC	0 VDC	Switch	Operating	Unactuated	Unit ceases operation

* depends on the state prior to the last power down

Chapter 6 Configuration

The SF-5050 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-5050:

- ü User Program (primary intent) – Users may develop unique operating programs to control the SF-5050 (potentially in conjunction with other devices or utilities). To facilitate this effort, NavCom provides the Onyx Technical Reference Manual (TRM). Information on this tool is available from the NavCom web site and customer service. Users should consider this as the primary method of accessing the full capability of the SF-5050.
- ü Web pages – The receiver is equipped with a variety of web-based pages to monitor receiver operation at a basic level. Customer can create their own set of web pages to display a wide variety of data, or simply re-skin the NavCom web pages with their logo.
- ü 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.
- ü StarUtil-5000 – This program is a NavCom-developed utility designed to configure and many of the SF-5050 functions. The utility’s primary purpose is to perform desktop operations. It is not intended to be used during normal live receiver operation. It is used to upload new software and licenses to the internal processor, load new firmware, and parse some commonly recorded data formats. 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-5050 Product USB Flash Drive.

There is no default control port on the receiver. When a port is connected to control software, such as StarUtil-5000, that port becomes the control port by virtue of sending input proprietary commands.

n COM1 – LAN

- ü Configuration – Control or Data Port
- ü 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 19 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-5000 or a third party software/utility.

Ethernet provides up to 8-simultaneous sessions. Wi-Fi® and Ethernet share the same 8-virtual ports.

n **COM2 – COM4 - USB1 – USB2**

- ü Configuration – Control or Data Port
- ü Rate – RS-232/RS-422: 9.6 to 115.2kbps
- USB 2.0: 480Mbps

These ports are normally used to output data to other devices or machines that can make immediate use of the precise positioning data available from the SF-5050. The data port outputs NCT Binary Messages and NMEA Messages, and when applying external dGNSS corrections, also serves as the dGNSS correction input port.

n **COM3**

Com3 is not pinned out, but does exist on the rear panel on the PWR/1PPS connector. Contact NavCom Customer Support for details, if needed. Com3 follows the same conventions as Com1.

Factory Default Output Messages

n **NCT Messages**

Table 17: 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 *Onyx Technical Reference Manual* (see *Related Documents* in the fore-matter).

- ü 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.
- ü CHNLSTATUS1B Channel Status:
Receiver channel status information containing: Onyx 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.
- ü 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.
- ü 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.
- ü MSGPRODUCTINFO Product Information:
Product type, digital serial number, and system revision number (incremented at every hardware change).
- ü MSGVERSION Firmware Version:
Version number, date and time stamp for the requested firmware component.
- ü PVT1B (Position, Velocity, and Time):
Provides: GPS Week number, GNSS satellites used, latitude, longitude, navigation

mode, and DOP information.

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

n NMEA Messages

The SF-5050 provides support both for selected standard NMEA messages and for nonstandard proprietary NMEA-type messages. These messages must be scheduled by the user.

n Base and Rover Navigation Setup

NavCom's StarUtil-5000 provides Base and Rover setup capabilities. Refer to the *StarUtil-5000 User Guide* for details. The guide is included on the supplied SF-5050 Product Configuration USB Flash Drive and is also available on the NavCom web site.

User Profiles

The SF-5050 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-5050 provides for storage of up to 20 user profiles. A file with commonly used user profiles is included on the supplied USB flash drive.

- ü The SF-5050 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.
- ü StarUtil-5000, or another controller solution, is used to upload a user profile by its name.
- ü The SF-5050 may be initially configured with the factory default user profile or a profile customized for the user by an authorized dealer.
- ü Predefined, commonly used profiles are included on the supplied SF-5050 Product Configuration USB Flash Drive or available by email.
- ü 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 *Onyx 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-5000 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-5000 User Guide* for detailed instructions.

Third-Party Controller Configuration Settings

Refer to the third-party controller solution manual/user guide if your SF-5050 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:

- ü Valid Purchase Order
- ü Signed License Agreement
- ü Appropriate Credit Terms with Deere & Company 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.

- ü The scheduled broadcast must occur at least 3 business days after a valid P.O. is received by NavCom Sales.
- ü Specify broadcast date and time in GMT on the P.O.
- ü 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:

- ü StarUtil-5000
- ü Onyx Message SFLICENSEB (described in the Onyx Technical Reference Manual) (Refer to *Related Documents* in the fore-matter.)

Verify this StarFire™ license data:

- ü 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
- ü 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-5000. 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-5050 provides three user controls to set the StarFire™ tracking and use: automatic, [SFCORRSELECT], and [SFNETPRIORITY].

In order to make best use of the multiple StarFire™ signals which are likely present, ‘automatic’ (default) utilizes a scoring algorithm which considers satellite elevation, correction content, correction latency, signal strength and other parameters to assign the best available correction resource. The algorithm provides a filter to allow some variability to prevent hysteresis between different signal sources.

[SFCORRSELECT] allows the user to set the receiver to track the signal with the second highest score as the primary correction source. This is useful where a second SF-5050 receiver is set as the redundant device in system. The algorithm provides a filter to allow some variability to prevent hysteresis between different signal sources. In a fallback scenario, there is no guarantee that the receiver will select the highest elevation satellite as the secondary source when more than two signal sources are available.

This command provides two controls: *default* or *secondary*. The secondary mode forces the receiver to utilize the next available, second highest-scored StarFire™ correction stream to navigate in StarFire™ mode in real-time check. Doing so allows the receiver to act as an on-line redundant device to the primary receiver system.

If there are no other available StarFire™ correction streams available other than the current one, it will remain on the current StarFire correction stream.

Additional information and examples of use are provided in the Onyx Technical Reference Guide.

[SFNETPRIORITY] allows the user to prioritize tracking by the StarFire™ network assignment and highest available satellite between on that network. If multiple receivers are used on one platform, the user may force one to use Net1 and the other to use Net2. This is least desirable method, as it follows the legacy implementation and does not consider the scoring algorithm utilized in the default ‘automatic’ or [SFCORRSELECT] methods.

Additional information and examples of use are provided in the Onyx Technical Reference Guide.

RapidRecovery

The Rapid Recovery feature provides a way to more quickly recover from the loss of StarFire™ corrected positioning after loss and recovery of navigation. The receiver starts using these corrections when the link to the navigation satellites has been lost, or has degraded to a specified quality value called Figure of Merit (FOM) which represents the best-guess accuracy of the horizontal position. Convergence time in StarFire™ mode is virtually eliminated under certain conditions following a very brief navigational outage.

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

RapidRecovery with QuickStart

StarFire™ QuickStart enables Rapid Recovery when an accurately known ITRF08 position is used to initialize StarFire™ navigation. This is typically a position previously surveyed and converted to ITRF08 prior to initialization.

- ü This feature is available for StarFire™ GNSS only.
- ü The receiver must have a StarFire™ Dual Frequency solution prior to initiating QuickStart
- ü RapidRecovery is available only on the GPS portion of the StarFire™ correction, which constitutes the larger weighted component of the correction
- ü RapidRecovery is not available for the first 5 minutes after a successful quick start is completed
- ü When a lower FOM_limit value is input, the receiver is more constrained in completing a Rapid Recovery process
- ü In order for RapidRecovery to function, the outages must not exceed 2 minutes.
- ü Requires one minute to complete
- ü Option to manually enter coordinates to initiate feature

Failed Search

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

This functionality only applies to:

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

Chapter 7 Safety Instructions

The SF-5050 GNSS sensor is designed for precise navigation and positioning using the Global Positioning System, GLONASS. Users must be familiar with the use of portable GNSS equipment, the limitations thereof and these safety instructions prior to use of this equipment.

Transport

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

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

Maintenance

Internal components of this device are not field serviceable. Opening and servicing the internal components of the SF-5050 voids the product warranty and also releases NavCom and its agents from claims of liability due to product damage or personal injury.

The NavCom equipment may be cleaned using a new lint free cloth moistened with Isopropyl or Ethel 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

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.

- ⚡ Negative & Positive Switch Spikes on the Ethernet port may cause invalid duplicate epoch data. Users should take care to ensure both the SF-5050 and connected equipment are operated on stable input power which may require additional conditioning if communications problems are experienced.

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 Deere & Company 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-5050 GNSS sensor. Accessing the inside of the equipment will void the equipment warranty.

Take care to ensure the SF-5050 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.

- ⚠ Shorting on the Ethernet port may cause data on the Ethernet port to halt. Users should take care to ensure connected equipment are operated with appropriate fail-safes to ensure appropriate equipment response for safety of life and property if communications problems are experienced. The appropriate response to this failure mode is to re-establish an Ethernet connection.

A.....GNSS Module Specifications

The technical specifications of this unit are detailed below. Deere & Company 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

- ü Full constellation coverage with up to 252 signals tracked simultaneously, plus three StarFire™ channels
- ü SBAS (WAAS, EGNOS, MSAS, GAGAN, SNAS) tracking
- ü Built in StarFire™ receiver and demodulator
- ü L1C/A, L2P, L2C, L5, G1C/A, G2P, G2C/A, CMDA, C1, C2 C5b, C6, E1, E5A, E5B, E6 code and full wavelength carrier phase tracking
- ü High sensitivity/low signal level tracking
- ü Fast acquisition/re-acquisition
- ü Superior interference suppression (both in-band & out-of-band)
- ü Patented multipath rejection
- ü Minimal data latency
- ü 8GB of internal memory (up to 2GB available to the user)
- ü Network RTK, RTCM 2.3 and 3.0 (code & carrier), NTRIP, and CMR/CMR+.
- ü Output NMEA 0183, NavCom Binary, NavCom ASCII formats
- ü Configurable as RTK base or rover
- ü Moving Base Code
- ü MBRTK
- ü RTK Extend
- ü Heading
- ü Programmable output rates
- ü Event Marker input
- ü 1PPS Output
- ü Communications Ports: RS-232, RS-422, USB 2.0 (Device & Host), and Ethernet
- ü StarFire™ over IP corrections via the Internet

Performance

SF-5050 performance is dependent on location, satellite geometry, atmospheric conditions, and GNSS correction.

Tracking Characteristics

The SF-5050 engine has 255 signal channels with the required flexibility to track all civilian GNSS and SBAS signals. The SF-5050 engine is also capable of tracking the code and carrier from all GNSS signals.

- 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 *Onyx Technical Reference Manual* for details (see *Related Documents* in the fore-matter).

Signals Tracked

Navigation & Public Correction Signals	
Services include: GPS L1, and SBAS (WAAS, EGNOS, MSAS, GAGAN,); all at the same frequency:	1575.42MHz, ±16MHz
Services include: GPS (L2, L2C ^{1,2}); all at the same frequency:	1227.60MHz, ±16MHz
Services include: GPS L5 ^{1,2} , Galileo ^{1,2} E5A, E5B, Beidou ^{1,2} B2 all at the same frequency	GPS: 1176.45MHz, ±16MHz Galileo: 1176.45MHz, ±12.5 MHz
G1 services include: GLONASS	1602.00MHz, ±3.9375MHz
G2 services include: GLONASS	1246.00MHz, ±3.0625MHz
StarFire™ Signals	
L-Band Differential Correction:	1525 to 1560MHz

¹Hardware ready

²Beidou, Galileo, GPS L2C/L5/L1C signals are not used in the navigation engine. Other performance restrictions may exist with the use of these signals. No guarantee exists that these signal will be utilized now or in the future for PNT output.

Receiver Noise Figure

20.0dB ±2dB @ 290° Kelvin; 1Hz RBW

Time-to-First-Fix

Cold Start:	< 65 seconds	Old ephemeris >2hrs old, time error >10mS or position unknown
Warm Start:	< 55 seconds	Position <60Km from last known position, time error <0.5mS and current ephemeris
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)

¹Restricted by USA export laws

Measurement Performance

RTK Positioning – Multi-Frequency <40kms	
Position (H):	± 1.5 cm, +1ppm, 2 σ ; ± 1 cm, +0.5ppm, 1 σ
Position (V):	± 3.0 cm, +2ppm, 2 σ ; ± 2 cm, +1ppm, 1 σ
RTK WL Positioning – Multi-Frequency <40kms (RMS) (see note below)	
Position (H):	± 5 cm +2ppm
Position (V):	± 10 cm +2ppm
RTK Extend (see note below)	
Position (H):	± 4.5 cm, +1ppm, 2 σ ; ± 3 cm +1ppm, 1 σ
Position (V):	± 10 cm, +2ppm, 2 σ ; ± 6 cm +2ppm, 1 σ
RTK Float	
Position (H):	± 30 cm, +3ppm, 2 σ
Position (V):	± 60 cm, +3ppm, 2 σ
StarFire™ (multi)	
Position (H):	± 7 cm, 2 σ ; ± 5 cm, 1 σ GNSS; ± 10 cm, 1 σ GPS
Position (V):	± 14 cm, 2 σ , ± 10 cm, 1 σ GNSS, ± 15 cm, 1 σ GPS
Rapid Recovery (StarFire™ GNSS only)	
Position (H):	± 7 cm, 2 σ
Position (V):	± 14 cm, 2 σ
Outage Duration:	< 55sec
Recovery Period:	Up to 4min
StarFire™ -LP	
Position (H):	100cm, 2 σ
Position (V):	200cm, 2 σ
Code Differential GPS <200kms (RMS)	
Position (H):	± 45 cm +3ppm
Position (V):	± 90 cm +3ppm
Enhanced SBAS (WAAS/EGNOS/MSAS/GAGAN) Position Accuracy	
Position (H):	± 80 cm, 2 σ ; ± 30 cm, RMS
Position (V):	± 150 cm, 2 σ ; ± 60 cm, RMS
Heading	
Multi-Frequency	0.1 degrees Requires 10Hz update rate
Velocity (for all DGPS described above)	
Velocity:	0.01m/s

⚠ The specifications herein are based on the following: PDOP <4, 2-sigma (95%; unless otherwise noted), 24-hour averaged set of data. Further, performance is dependent upon, but not limited to location, satellite geometry, atmospheric conditions (i.e., solar storm activity), local interference, DoD signal degradation (i.e., Selective Availability or similar techniques), satellite messaging or timing errors, and augmentation correction messages.

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

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

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

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

- 2 to 15 minutes for an NCT base station
- 2 to 10 minutes for a non-NCT base station

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

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

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

Refer to the *StarUtil-5000 User Guide*, Chapter 5, for more information on RTK Extend.

Pull-in Times

StarFire™ LP	10 minutes, typical
StarFire™ GPS	45 minutes, typical
StarFire™ GNSS	45 minutes, typical to 1σ 90 minutes, typical to 2σ

User-Programmable Output Rates

Rate	SF-5050 Bundles		
	G	S	M
Position, Velocity, and Time			
1, 5*Hz	Std	Std	Std
10Hz	Opt	Opt	Std
25*Hz	Opt	Opt	Std
Raw Data			
1, 5*Hz	Std	Std	Std
10Hz	Opt	Opt	Std
25*Hz	Opt	Opt	Std

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

Data Latency and Memory

PVT:	< 10 ms
Raw Data:	< 10 ms
Internal Memory	8GB (up to 2GB available to user)

1PPS

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

Connector Assignments

GNSS1 (primary): GNSS2: When two antenna applications are active	TNC (female), GNSS/StarFire™ RF Input, RF Ground TNC (female), GNSS RF Input, RF Ground GNSS2 is for future capabilities
COM 1 – LAN: (connector: FR11MP922LM0/AA pin: MC422N/AA)	Positronic (female) RS-232, from 9.6 to 115.2 kbps Ethernet, 10 to 100 Mbps; up to 8-sessions (shared with Wi-Fi®)
COM 2/4 – USB1/2: (DB26S)	Positronic (female) RS-232/RS-422, from 9.6 to 115.2 kbps, USB 2.0, 12 Mbps max data rate
PWR 1PPS: (connector: FR11FP922LM0/AA; pin: FC422N6/AA).	Positronic (male) 9 to 32 VDC, 8 W typical; Ignition; 1PPS / Event Marker; COM3
SD Card	SDHC up to 32GB, front panel access

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

Input/Output Data Messages

Control Commands (Input Only):	NavCom proprietary commands (refer to TRM)
Differential Correction (I/O):	RTCM 2.3 and 3.0, RTCM types 1, 3, 9, 31, and 34 SBAS (WAAS/EGNOS/ MSAS/ GAGAN), and StarFire™
RTK Correction Data (I/O):	RTCM types 3, 18-22, and 1001-1012, 1019-1020, 1033; NCT types 0x62 (hex)
NMEA-0183 Messages (Output Only):	ALM, DTM, GBS, GFA, GGA, GLL, GNS, GRS, GSA, GST, GSV, HDT, MLA, RMC, RRE, ROT, TTM, VTG, ZDA, PNCT

⚠ 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, SNAS)
Private subscription service:	StarFire™

StarFire™ Rapid Recovery

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

Physical and Environmental

Size (L x W x H) (Not including mounting bracket):	176.3 x 168 x 72 mm
Weight (including SD card; Not including mounting bracket):	4.24 lbs (1.93kg)
Power Consumption: Input Voltage: Output Voltage: Output Current:	8 Watts 9 to 32VDC; 110/220 VAC, 18W, 1.5A autoranging +5V ± 0.5V power for each GNSS / L-band antenna via the antenna connector 100mA per antenna port 100mA USB port
Temperature (ambient) Operating: Storage:	-40° C to +70° C** (-40° to +158° F) -40° C to +85° C (-40° to +185° F)
Humidity:	95% Non-Condensing
Vibration:	MIL-STD-810G Method 514.6
Shock:	MIL-STD-810G Method 516.6
Ingress Protection:	IP67*
Outdoor Equipment	This device is not considered <i>Outdoor Equipment</i> and not tested to IEC 60950-22

Regulatory Certifications	FCC Part 15 CE (includes RED, RoHS & EMC; requires use of a GNSS antenna which has been tested with the SF-5050 to appropriate standards) WEEE REACH (EC1907/2006) AS/NZS CISPR 22 (2006)
Marine Electronics Directive Compliant	Software: IEC 61108-1, IEC 61162-1:2011 with backward compatibility to IEC 61162-1:2008 and NMEA-0183 v4.1 Hardware IEC 60945:2002 (including Corr.1:2008)
Minimum Compass Safe Distance	0.3m

* Compliant only when cables are connected and properly seated and the SD card cover is fully seated with the turn handle aligned in the 12 o'clock locked indicator position.

** SD card data logging is not guaranteed below -15°C. Operational characteristics vary by card model and manufacturer. If data logging at lower temperatures is required, a small amount of space (<2GB) is available on the internal memory chip. Alternatively, users can opt to test different card models to identify a card which will function for their needs.

LED Display Functions

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

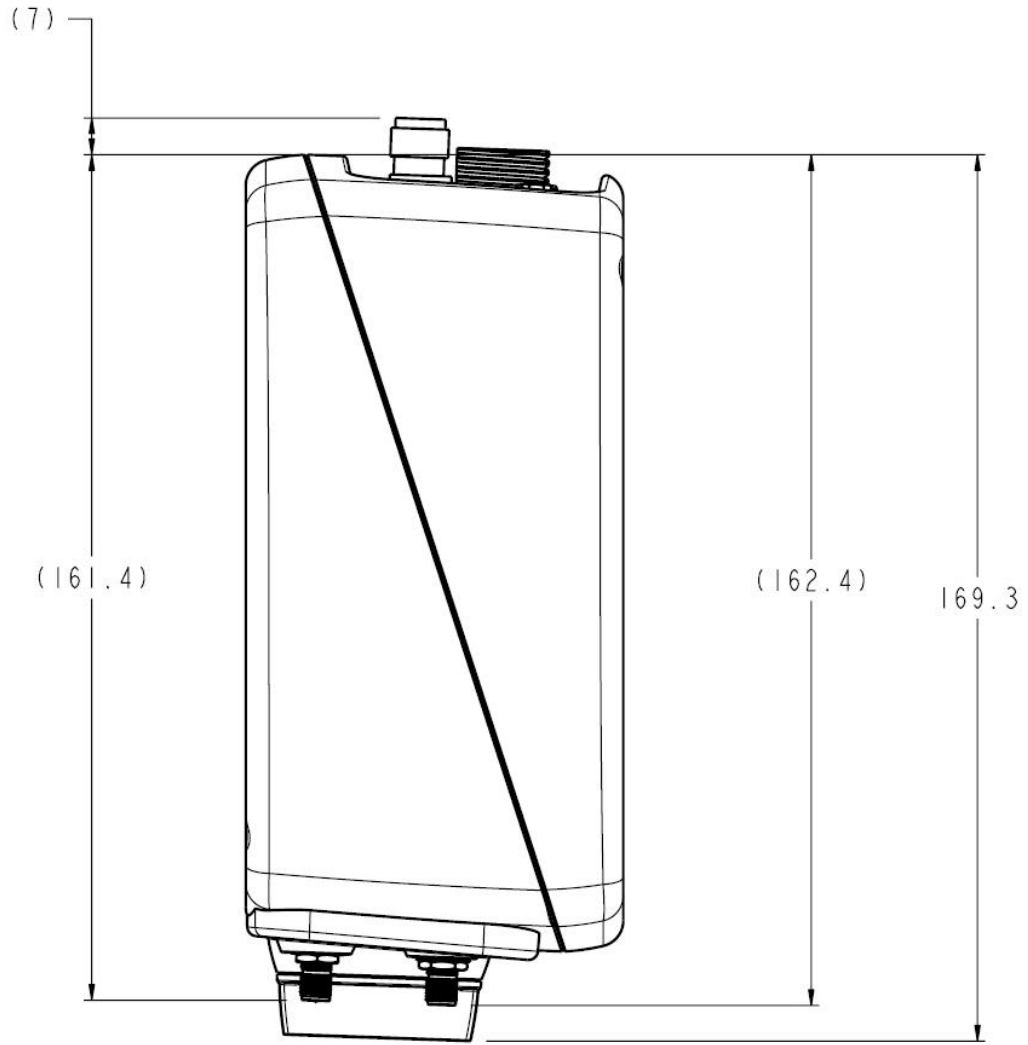


Figure 59: Receiver Front to Rear Dimensions

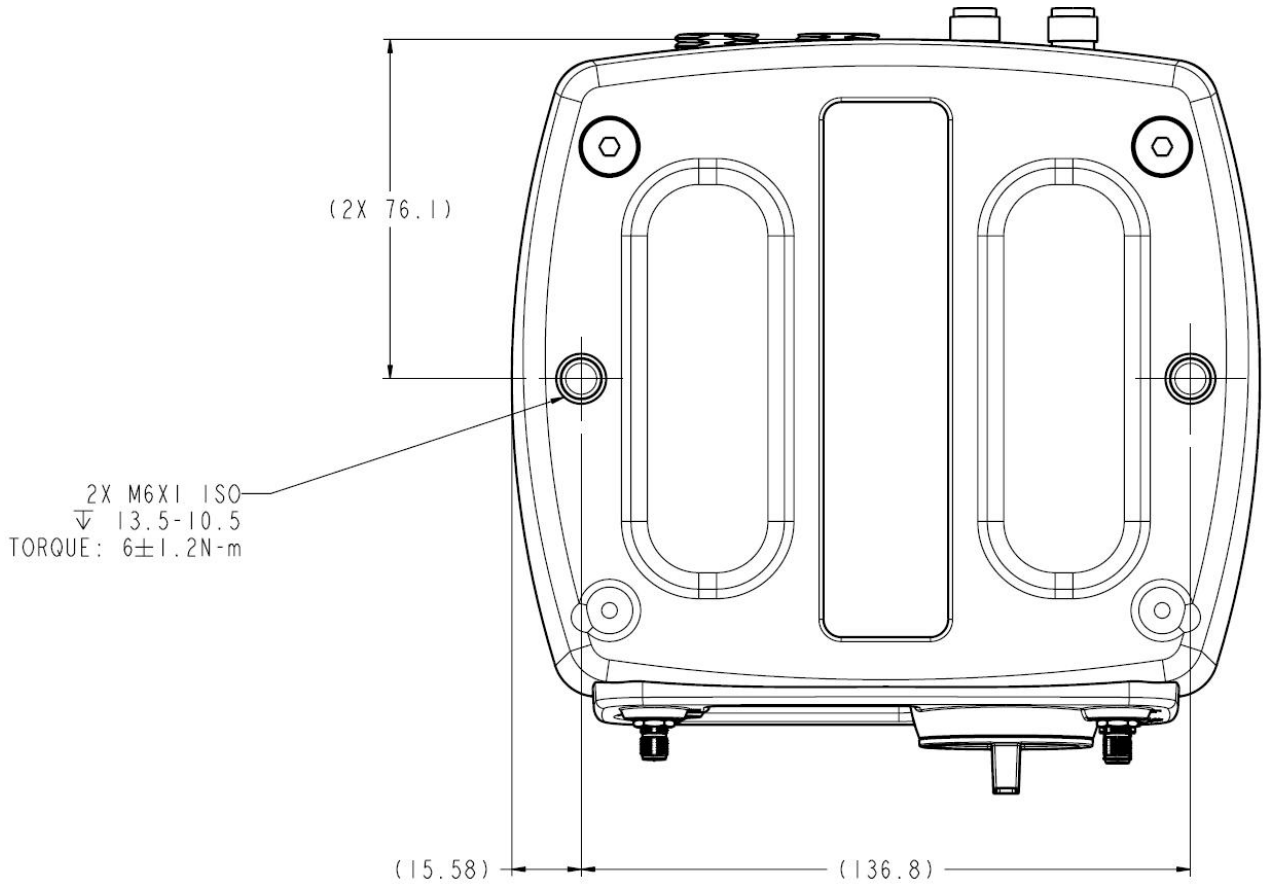


Figure 60: Receiver Mounting Hole Dimensions

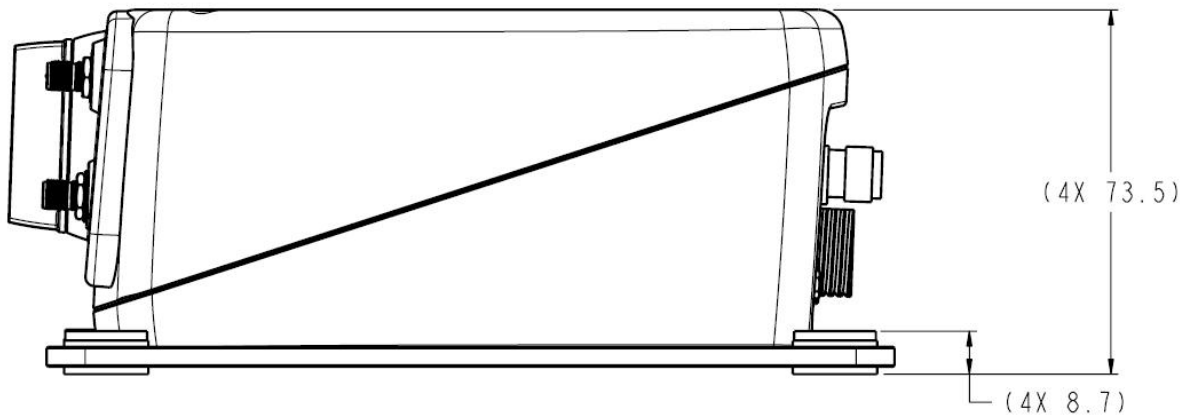


Figure 61: Receiver Height Dimensions

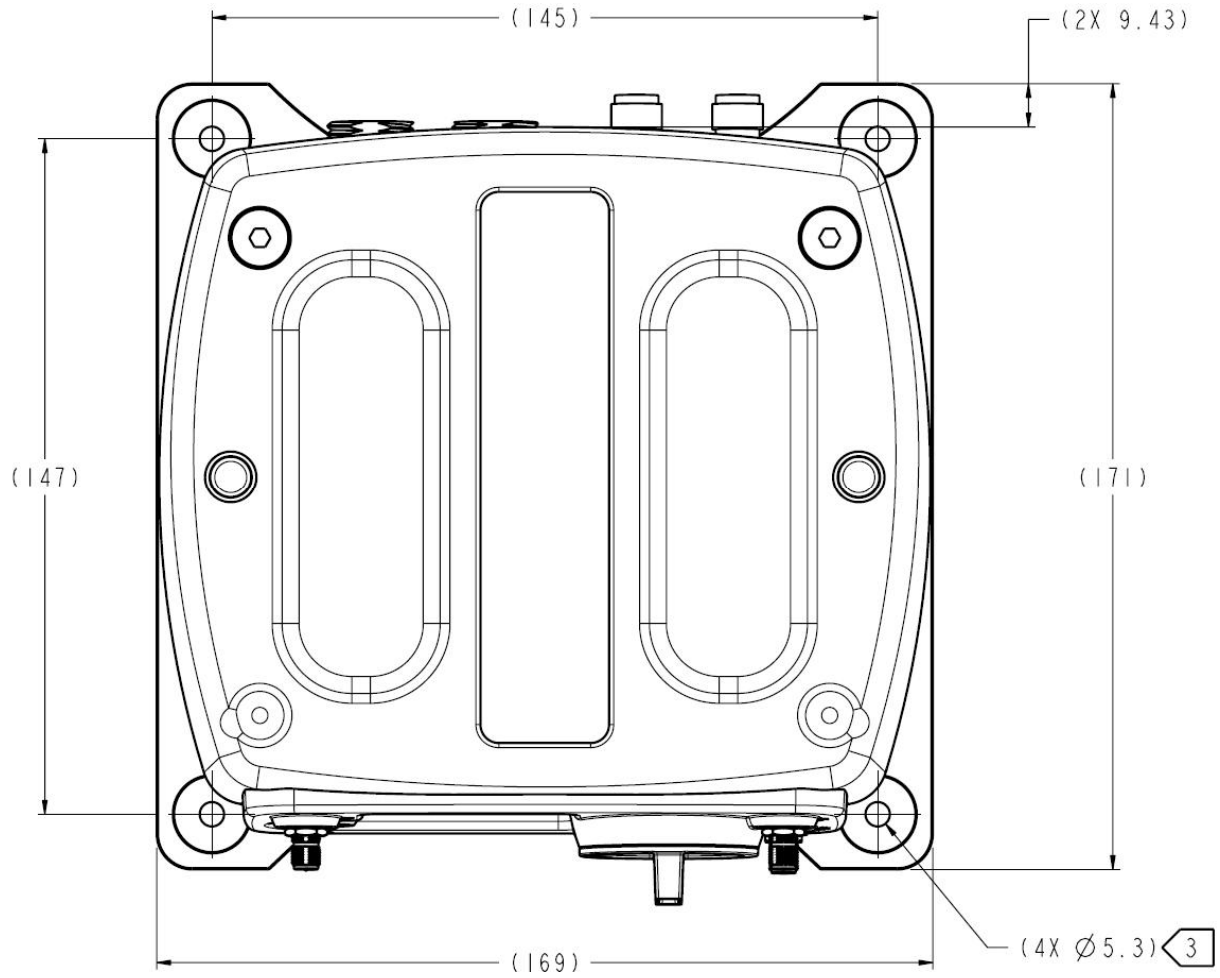


Figure 62: Top/Bottom Bracket Dimensions

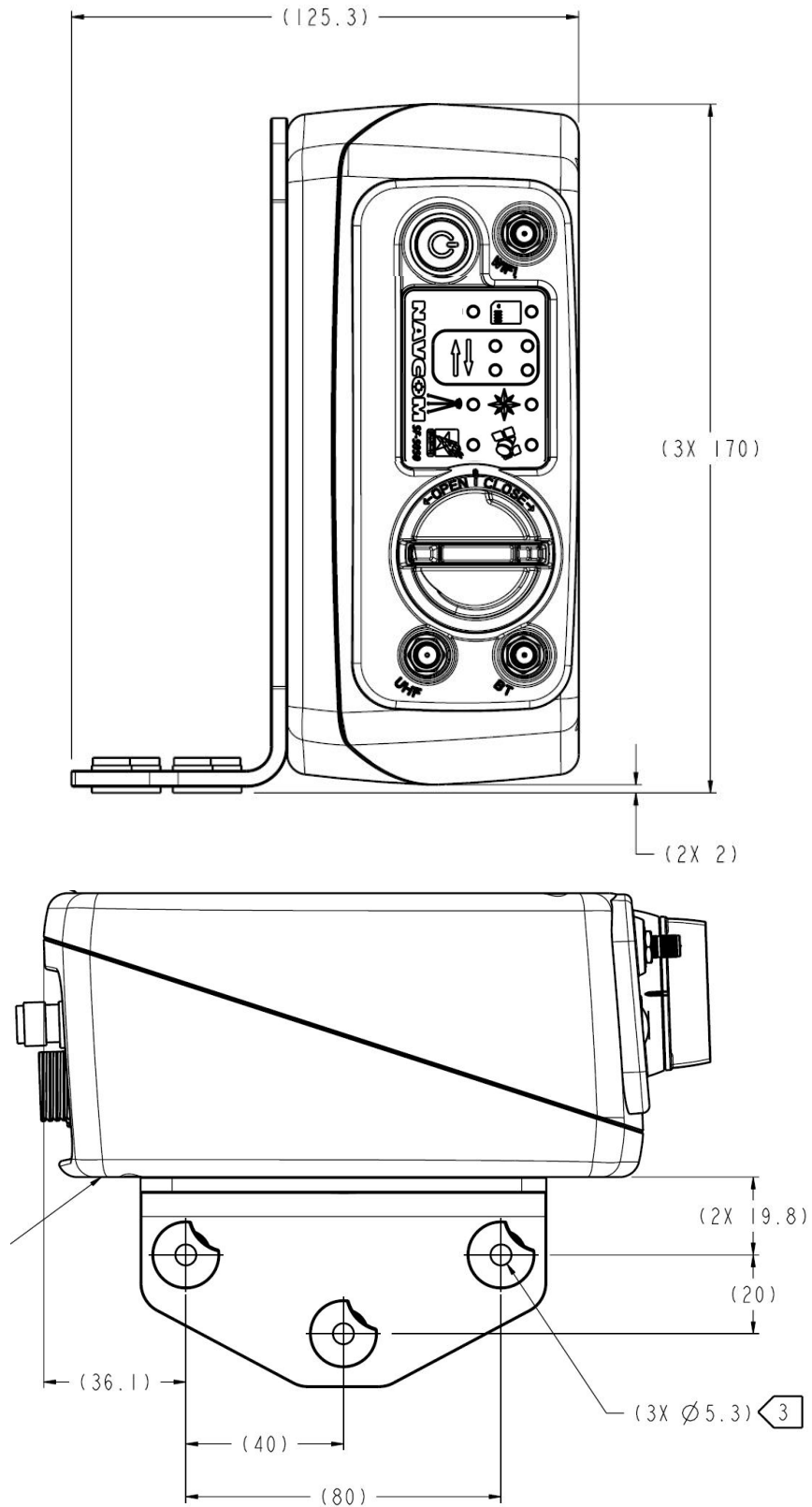


Figure 63: Side Bracket Dimensions

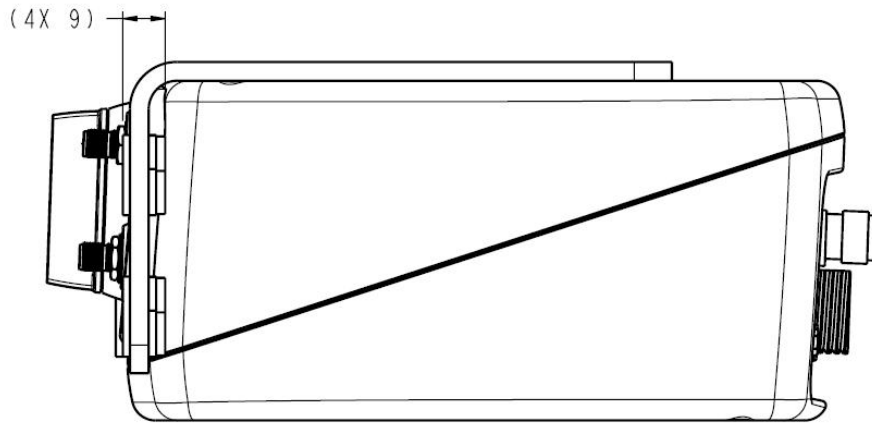
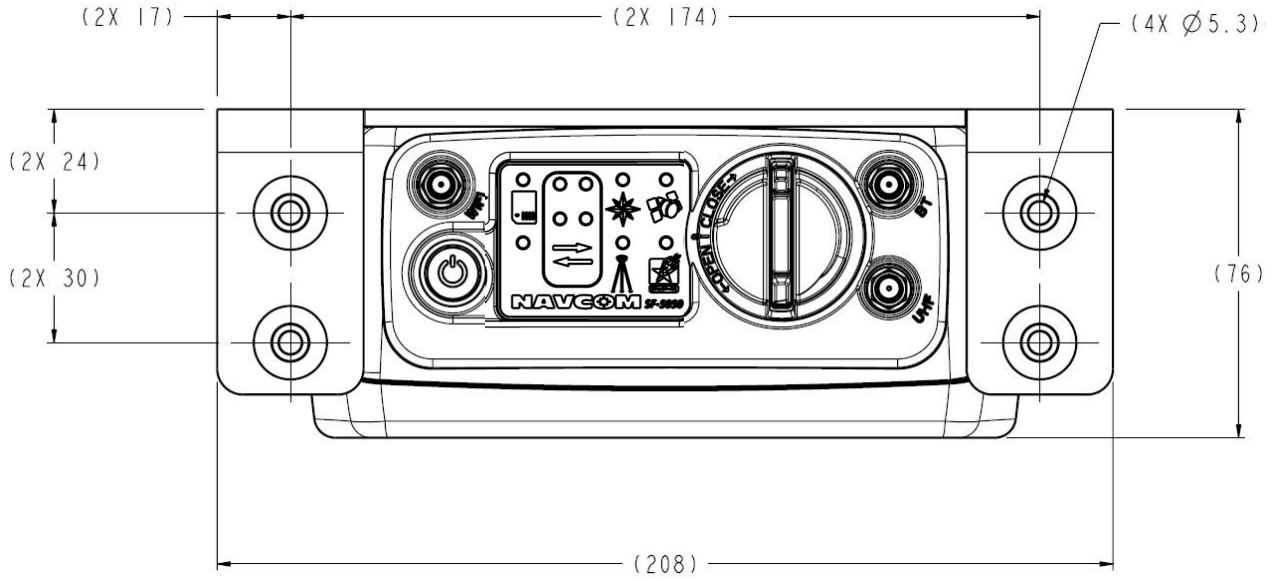


Figure 64: Front Panel Bracket Dimensions

B..... Antenna Specifications

Table 18: Rover GNSS Antenna

Part Numbers	Rover: 82-001020-3001LF
Model	ANT3001R
Frequency (Frequency is dependent on software bundle options.)	GPS L1: 1575.42MHz, ±16MHz GPS L2: 1227.60MHz, ±16MHz GPS L2C: 1227.60MHz, ±16MHz GPS L5: 1176.45MHz, ±16MHz StarFire™ L-Band: 1525 -1585 MHz GLONASS G1: 1603.00MHz, ±6.5MHz GLONASS G2: 1247.00MHz, ±5MHz
Phase Center (see Error! Reference source not found.)	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
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.

⚠ The ANT3001R, when used with the SF-5050, does not meet the European CE Radio Equipment Directive with regard to adjacent band signal rejection requirements.

⚠

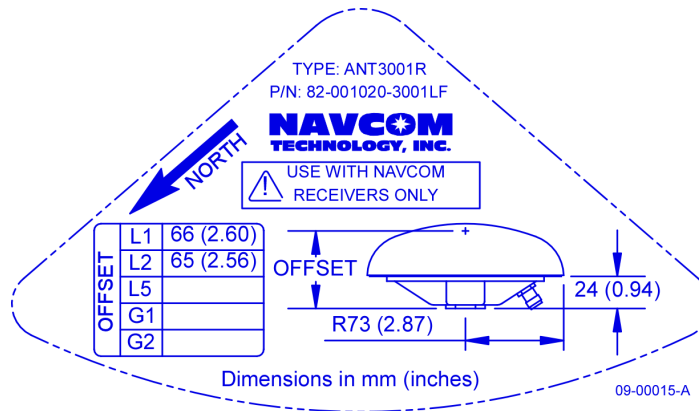


Figure 65: ANT3001R Rover GNSS Antenna Offset

⚠ Figure 65 is a drawing of the label on the Rover GNSS antenna (P/N 82-001020-3001LF). The phase center provided is based on [NGS test results](#). NGS does not currently provide GLONASS calibrated values.



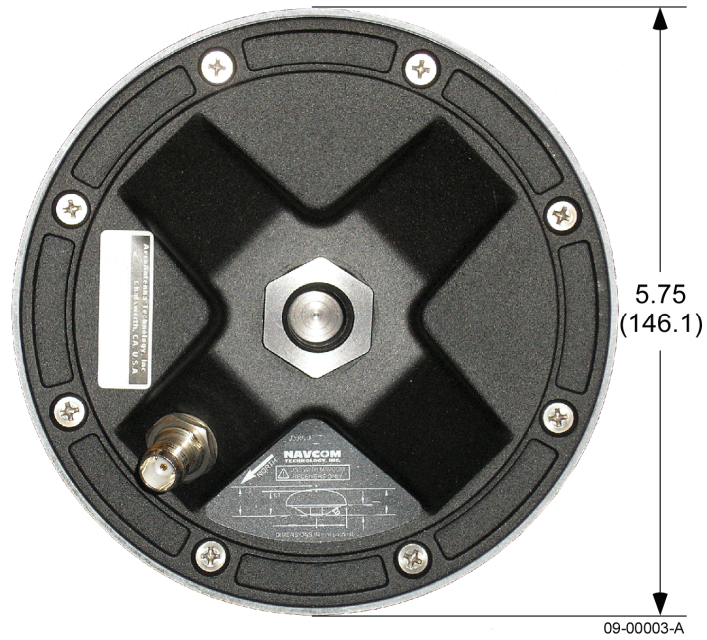
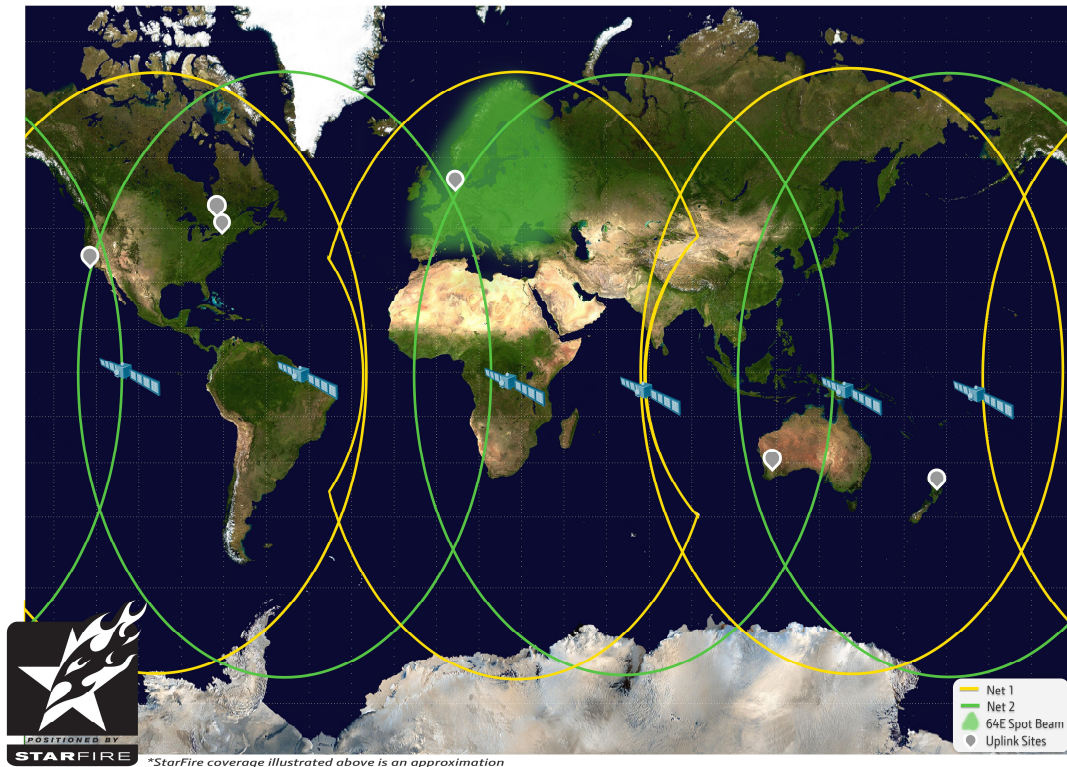


Figure 66: Rover (P/N 82-001020-3001) Antenna Dimensions

CStarFire™



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 El Segundo, California and Moline, Illinois, where they are processed to generate the differential corrections.

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

The key to the accuracy and convenience of the StarFire™ system is the source of SBAS corrections. GPS satellites transmit navigation data on several L-Band frequencies. The StarFire™ reference stations are all equipped with geodetic-quality, multi-frequency receivers. These reference receivers decode GPS signals and send precise, high quality, multi-frequency pseudorange and carrier phase measurements back to the processing centers together with the data messages, which all GPS satellites broadcast.

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

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

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

The StarFire™ network ground reference frame is currently tied to ITRF-2014 and was transitioned on March 1, 2017. Earlier transitions include transition from the ITRF-2005 to the ITRF-2008 system on January 21, 2014. For information on this transition, please consult NavCom's website.

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 El Segundo, 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 19: StarFire™ Satellites

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

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

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-5050 receiver requires a StarFire™ Software Option¹. 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-5050 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-5050 receiver only, subsequent renewals of the license can be transmitted to the receiver via satellite.

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

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.

¹ Dependent on Bundle Options: Standard or Optional

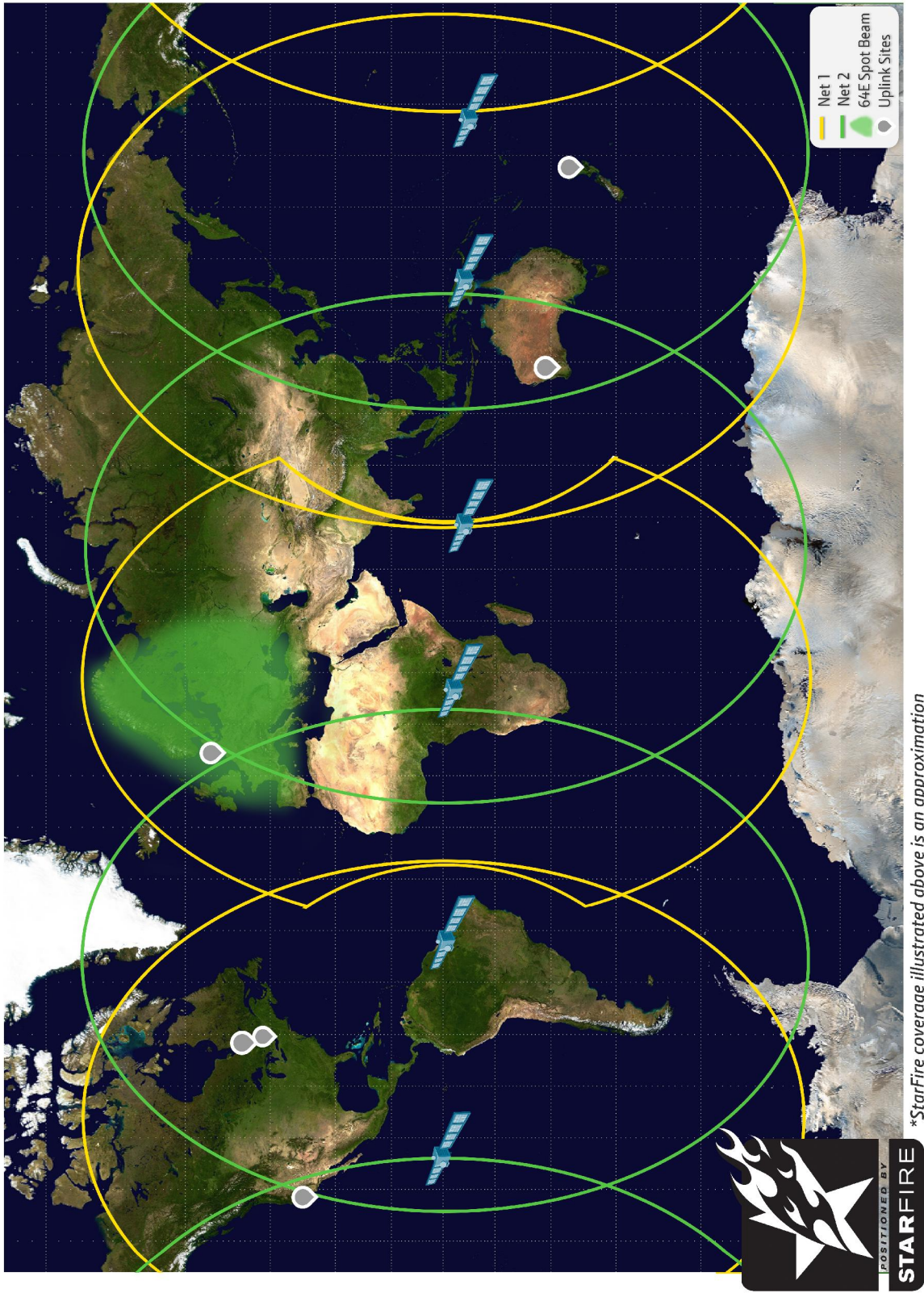


Figure 67: StarFire™ Network

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

D Event Input Configuration

Figure 73 details the wiring of the optional Event cable assembly, part number PH96235771.

Refer to Chapter 3/Event for detailed electrical specifications.

Table 26 details the wiring configuration required for Event pulse sensing.

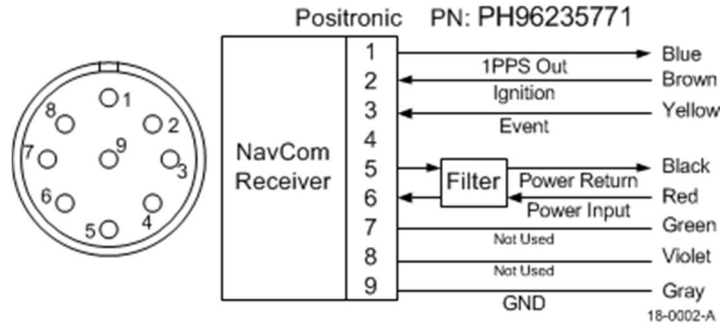


Figure 68: Event Cable Wiring Diagram

Table 20: 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 *Onyx Technical Reference Manual* (see *Related Documents* in the fore-matter).

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

Configure the SF-5050 for Wireless Connection

Perform these steps:

1. Connect the SF-5050 to the computer either on the USB port or the COM1 port.
2. Start StarUtil-5000 or another application that provides an *Input Terminal*.
3. Configure the SF-5050 as a rover:

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

4. Schedule the following messages for the desired port (USB1 in this example):

```
[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-5050 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 *Onyx 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-5050 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 *Onyx 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-5050 for Ethernet.

F European Declaration of Conformance

English



JOHN DEERE

Deere & Company

Moline, Illinois USA

EU Declaration of Conformity

The undersigned hereby declares that:

Product Name: NavCom SF-5050, C-Nav 5000
 Model(s): PH90229910, SF-5050 Basic, PH90229916, C-Nav 5000 Basic
 Antenna Model(s): AT1675-582JD-R and PFP18281

fulfills all relevant provisions and essential requirements of the following directives:

DIRECTIVE	NUMBER	CERTIFICATION METHOD
Radio Equipment Directive (RED)	2014/53/EU	Annex II of the Directive
Restriction of Hazardous Substances	2011/65/EU	Article 7 of the Directive

The product is in conformity with the following standards and/or other normative documents:

- EN 301 489-1 v2.2.0
- EN 301 489-20 v2.1.0
- EN 303 413 v1.1.1
- ETSI EN 300 440 V2.1.1
- EN 55032:2015/AC:2016
- EN 55024:2010/A1:2015 / CISPR 24
- EN 60950-1 + A12

Name and address of the person in the European Community authorized to compile the technical construction file:

Brigitte Birk
 John Deere GmbH & Co. KG
 Mannheim Regional Center
 John Deere Strasse 70
 D-68163 Mannheim, Germany

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Place of Declaration:
 Torrance, California, USA

Signed:

Name: Rick Grefsrud

Date of declaration:
 12 December 2018

Title: Manager - ISG Torrance

French



JOHN DEERE

Deere & Company
Moline, Illinois USA

Déclaration de conformité UE

Le soussigné déclare par la présente que:

Nom du produit: NavCom SF-5050, C-Nav 5000
 Modèle(s): PH90229910, SF-5050 Basic, PH90229916, C-Nav 5000 Basic
 Modèle(s) d'antenne: AT1675-582JD-R et PFP18281

satisfait à toutes les prescriptions et exigences essentielles des directives suivantes:

DIRECTIVE	DU PRODUIT	MÉTHODE DE CERTIFICATION
Directive relative aux appareils radio (RED)	2014/53/UE	Annexe II de la directive
Limitation de l'utilisation de certaines substances dangereuses	2011/65/UE	Article 7 de la directive

Le produit est conforme aux normes et/ou autres documents normatifs suivants:

EN 301 489-1 v2.2.0
 EN 301 489-20 v2.1.0
 EN 303 413 v1.1.1
 ETSI EN 300 440 V2.1.1
 EN 55032:2015/AC:2018
 EN 55024:2010/A1:2015 / CISPR 24
 EN 60950-1 + A12

Nom et adresse de la personne de la Communauté européenne autorisée à établir le dossier technique de construction:

Brigitte Birk
 John Deere GmbH & Co. KG
 Mannheim Regional Center
 John Deere Strasse 70
 D-68163 Mannheim, Germany

Cette déclaration de conformité est émise sous l'unique responsabilité du fabricant.

Lieu de délivrance de la déclaration:
 Torrance, California, USA

Signature:

Nom: Rick Grefsrud

Date de délivrance de la déclaration:
 12 décembre 2018

Titre: Manager - ISG Torrance

German



JOHN DEERE

Deere & Company
Moline, Illinois USA

EU-Konformitätserklärung

Der Unterzeichnete erklärt hiermit, dass:

Produktname: NavCom SF-5050, C-Nav 5000
 Modell(e): PH90229910, SF-5050 Basic, PH90229916, C-Nav 5000 Basic
 Antennenmodell(e): AT1675-582JD-R und PFP18281

alle einschlägigen Bestimmungen und wesentlichen Anforderungen folgender Richtlinien erfüllt:

RICHTLINIE	NUMMER	ZERTIFIZIERUNGSMETHODE
Funkgeräterichtlinie	2014/53/EU	Anhang II der Richtlinie
Beschränkung der Verwendung gefährlicher Stoffe	2011/65/EU	Artikel 7 der Richtlinie

Das Produkt erfüllt die Anforderungen der folgenden Normen und/oder anderen normativen Dokumente:

EN 301 489-1 v2.2.0
 EN 301 489-20 v2.1.0
 EN 303 413 v1.1.1
 ETSI EN 300 440 V2.1.1
 EN 55032:2015/AC:2016
 EN 55024:2010/A1:2015 / CISPR 24
 EN 60950-1 + A12

Name und Adresse der Person in der Europäischen Gemeinschaft, die für die Zusammenstellung der technischen Konstruktionsdokumentation autorisiert ist:

Brigitte Birk
 John Deere GmbH & Co. KG
 Mannheim Regional Center
 John Deere Strasse 70
 D-68163 Mannheim, Deutschland

Diese Konformitätserklärung wird unter der alleinigen Verantwortung des Herstellers ausgestellt.

Ausstellungsort:
 Torrance, Kalifornien, USA

Unterschrift:

Name: Rick Grefsrud

Ausstellungsdatum:
 12. Dezember 2018

Titel: Manager - ISG Torrance

Spanish



JOHN DEERE

Deere & Company

Moline, Illinois USA

Declaración de conformidad de la UE

Por la presente, el abajo firmante declara que:

Nombre del producto: NavCom SF-5050, C-Nav 5000
 Modelo(s): PH90229910, SF-5050 Basic, PH90229916, C-Nav 5000 Basic
 Modelo(s) de antena: AT1675-582JD-R y PFP18281

cumple con todas las disposiciones relevantes y los requisitos esenciales de las siguientes directivas:

DIRECTIVA	NÚMERO	MÉTODO DE CERTIFICACIÓN
Directiva para equipos de radio (RED)	2014/53/UE	Anexo II de la directiva
Restricción de sustancias peligrosas	2011/65/UE	Artículo 7 de la Directiva

Este producto cumple con las normas siguientes y/o documentos normativos adicionales:

EN 301 489-1 v2.2.0
 EN 301 489-20 v2.1.0
 EN 303 413 v1.1.1
 ETSI EN 300 440 V2.1.1
 EN 55032:2015/AC:2018
 EN 55024:2010/A1:2015 / CISPR 24
 EN 60950-1 + A12

Nombre y dirección de la persona en la Unión Europea autorizada para cumplimentar el documento técnico de construcción:

Brigitte Birk
 John Deere GmbH & Co. KG
 Mannheim Regional Center
 John Deere Strasse 70
 D-68163 Mannheim, Alemania

Esta declaración de conformidad se emite bajo la responsabilidad absoluta del fabricante.

Lugar de la declaración:
 Torrance, California,
 EE.UU.

Firmado:

Nombre: Rick Grefsrud

Fecha de declaración:
 12 de diciembre de 2018

Título: Manager - ISG Torrance

G Software License Agreement

Software License Agreement for Deere & Company 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 Deere & Company GNSS StarFire™ Receiver (THE "Receiver"). AN ADDITIONAL END-USER LICENSE AGREEMENT ("EULA") IS REQUIRED FOR USE OF THE STARFIRE™ GPS CORRECTIONS SERVICE.

BY ACTIVATING OR OTHERWISE USING THE Receiver, YOU ARE ACCEPTING AND AGREEING TO THE TERMS OF THIS LICENSE AGREEMENT WITH RESPECT TO THE SOFTWARE (THE "Software") THAT HAS BEEN PRE-INSTALLED ON YOUR Receiver or provided by Deere & Company. YOU AGREE THAT THIS SOFTWARE LICENSE AGREEMENT, INCLUDING THE WARRANTY DISCLAIMERS, LIMITATIONS OF LIABILITY AND TERMINATION PROVISIONS BELOW, IS BINDING UPON YOU, AND UPON ANY COMPANY ON WHOSE BEHALF YOU USE THE Software, AS WELL AS THE EMPLOYEES OF ANY SUCH COMPANY (COLLECTIVELY REFERRED TO AS "YOU" IN THIS SOFTWARE LICENSE AGREEMENT). IF YOU DO NOT AGREE TO THE TERMS OF THIS AGREEMENT, OR IF YOU ARE NOT AUTHORIZED TO ACCEPT THESE TERMS ON BEHALF OF YOUR COMPANY OR ITS EMPLOYEES, PLEASE DISCONTINUE ACTIVATION OR USE OF THE Receiver. THIS LICENSE AGREEMENT REPRESENTS THE ENTIRE AGREEMENT CONCERNING THE Software BETWEEN YOU AND THE Licensor AND IT REPLACES ANY PRIOR PROPOSAL, REPRESENTATION, OR UNDERSTANDING BETWEEN YOU AND THE Licensor.

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6. *DISCLAIMER OF WARRANTIES.* YOU HEREBY AGREE THAT THE LIMITED WARRANTY PROVIDED ABOVE (THE "*Limited Warranty*") CONSTITUTES YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY PROBLEM WHATSOEVER WITH THE Software. EXCEPT AS PROVIDED IN THE LIMITED WARRANTY, THE Software IS LICENSED "AS IS," AND LICENSOR, ITS AFFILIATES AND THIRD PARTY SUPPLIERS EXPRESSLY DISCLAIM AND YOU EXPRESSLY WAIVE, RELEASE AND RENOUNCE ALL WARRANTIES ARISING BY LAW OR OTHERWISE WITH RESPECT TO THE Software, INCLUDING, BUT NOT LIMITED TO: ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE; ANY IMPLIED WARRANTY ARISING FROM COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE; ANY WARRANTY OF TITLE OR NON-INFRINGEMENT; AND, ANY OTHER WARRANTY ARISING UNDER ANY THEORY OF LAW, INCLUDING TORT, NEGLIGENCE, STRICT LIABILITY, CONTRACT OR OTHER LEGAL OR EQUITABLE THEORY. NO REPRESENTATION OR OTHER AFFIRMATION OF FACT INCLUDING, BUT NOT LIMITED TO, STATEMENTS REGARDING SUITABILITY FOR USE, SHALL BE DEEMED TO BE A WARRANTY BY LICENSOR OR ANY OF ITS AFFILIATES OR THIRD PARTY SUPPLIERS. LICENSOR DOES NOT WARRANT THAT THE Software IS ERROR-FREE OR WILL OPERATE WITHOUT INTERRUPTION.

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11. *Indemnification.* You agree to defend, indemnify and hold Licensor, its affiliates and third party supplier, and their officers, directors, employees, agents and representatives (each an "*Indemnified Party*"), harmless from and against all claims, demands proceedings, injuries, liabilities, losses, or costs and expenses (including reasonable legal fees) brought by any third party against any such persons arising from

or in connection with your use of the Software, regardless of whether such losses are caused, wholly or partially, by any negligence, breach of contract or other fault of an Indemnified Party.

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13. *Costs of Litigation.* If any claim or action is brought by either party to this License Agreement against the other party regarding the subject matter hereof, the prevailing party shall be entitled to recover, in addition to any other relief granted, reasonable attorney fees and expenses of litigation.

14. *Severability and Waiver.* Should any term of this License Agreement be declared void or unenforceable by any court of competent jurisdiction, such declaration shall have no effect on the remaining terms hereof. The failure of either party to enforce any rights granted hereunder or to take action against the other party in the event of any breach hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights of subsequent actions in the event of future breaches.

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16. *Assignment by Licensor.* Licensor may assign this Agreement without your prior consent to any company or entity affiliated with Licensor, or by an assignment associated with a corporate restructuring, merger or acquisition.

17. *Governing Law and Forum.* This Agreement will be governed by and construed in accordance with the substantive laws in force in the County of Los Angeles in the State of California. This Agreement will not be governed by the conflict of law rules of any jurisdiction or the United Nations Convention on Contracts for the International Sale of Goods, the application of which is expressly excluded.

18. Specific Exceptions.

18.1 *Limited Warranty for Users Residing in European Economic Area Countries and Switzerland.* If you obtained the Software in any European Economic Area countries and Switzerland, and you usually reside in such country, then Section 6 does not apply, instead, Licensor warrants that the Software provides the functionalities set forth in the Operators Manuals (the "*agreed upon functionalities*") for the Warranty Period. As used in this Section, "Warranty Period" means one (1) year. Non-substantial variation from the agreed upon functionalities shall not be considered and does not establish any warranty rights. THIS LIMITED WARRANTY DOES NOT APPLY TO Software PROVIDED TO

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(b) The aforesaid limitation of liability shall not apply to any mandatory statutory liability, in particular, to liability under the German Product Liability Act, liability for assuming a specific guarantee or liability for culpably caused personal injuries.

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No open source software is utilized in this product.

Glossary

.yym files see meteorological files (where yy = two-digit year data was collected).

.yyn files see navigation files (where yy = two-digit year data was collected).

.yyo files see observation files (where yy = two-digit year data was collected).

almanac files an almanac file contains orbit information, clock corrections, and atmospheric delay parameters for all satellites tracked. It is transmitted to a receiver from a satellite and is used by mission planning software.

alt see *altitude*.

altitude vertical distance above the *ellipsoid* or *geoid*. It is always stored as height above *ellipsoid* in the GPS receiver but can be displayed as height above *ellipsoid* (HAE) or height above *mean sea level* (MSL).

Antenna Phase Center (APC) The point in an antenna where the *GPS* signal from the satellites is received. The height above ground of the APC must be measured accurately to ensure accurate *GPS* readings. The APC height can be calculated by adding the height to an easily measured point, such as the base of the antenna mount, to the known distance between this point and the APC.

APC see *antenna phase center or phase center*.

Autonomous positioning (GPS/GLONASS) a mode of operation in which a GNSS receiver computes *position* fixes in real time from satellite data alone, without reference to data supplied by a *reference station* or orbital clock corrections. Autonomous positioning is typically the least precise positioning procedure a GNSS receiver can perform, yielding *position* fixes that are precise to 100 meters with Selective Availability on, and 30 meters with S/A off.

azimuth the *azimuth* of a line is its direction as given by the angle between the *meridian* and the line measured in a clockwise direction from the north branch of the meridian.

base station see *reference station*.

baud rate (bits per second) the number of bits sent or received each second. For example, a *baud rate* of 9600 means there is a data flow of 9600 bits each second. One character roughly equals 10 bits.

bits per second see *baud rate*.

bps see *baud rate*.

BSW (British Standard Whitworth) a type of coarse screw thread. A 5/8" diameter *BSW* is the standard mount for survey instruments.

C/A code see *Coarse Acquisition code*.

CAN BUS a balanced (differential) 2-wire interface that uses an asynchronous transmission scheme. Often used for communications in vehicular applications.

channel a channel of a GPS receiver consists of the circuitry necessary to receive the signal for a single GPS satellite.

civilian code see *Coarse Acquisition code*.

Coarse Acquisition code (C/A or Civilian code)

the pseudo-random code generated by GPS satellites. It is intended for civilian use and the accuracy of readings using this code can be degraded if *selective availability (S/A)* is introduced by the US Department of Defense.

COM# shortened form of the word Communications. Indicates a data communications port to/from the GPS sensor to a controller or data collection device.

Compact Measurement Record (CMR) a standard format for DGPS corrections used to transmit corrections from a *reference station* to *rover* sensors. See *Related Standards in Notices*.

controller a device consisting of hardware and software used to communicate and manipulate the I/O functions of the GPS sensor.

convergence period (StarFire™) is the time necessary for the received StarFire™ signal corrections to be applied and the position filtered to optimal performance. The convergence period is typically 30 to 45 minutes to achieve <decimeter accuracy. This period may be overcome using the Quick Start method.

data files files that contain Proprietary, GPS, NMEA, RTCM, or any type of data logged from a GPS receiver.

datum A reference datum is a known and constant surface that can be used to describe the location of unknown points. Geodetic datums define the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth.

DB9P a type of electrical connector containing 9 contacts. The P indicates a plug pin (male).

DB9S a type of electrical connector containing 9 contacts. The S indicates a slot pin (female).

DCE Data Communications Equipment. Defined pin assignments based on the IEEE RS-232 signaling standard. See Figure 82:

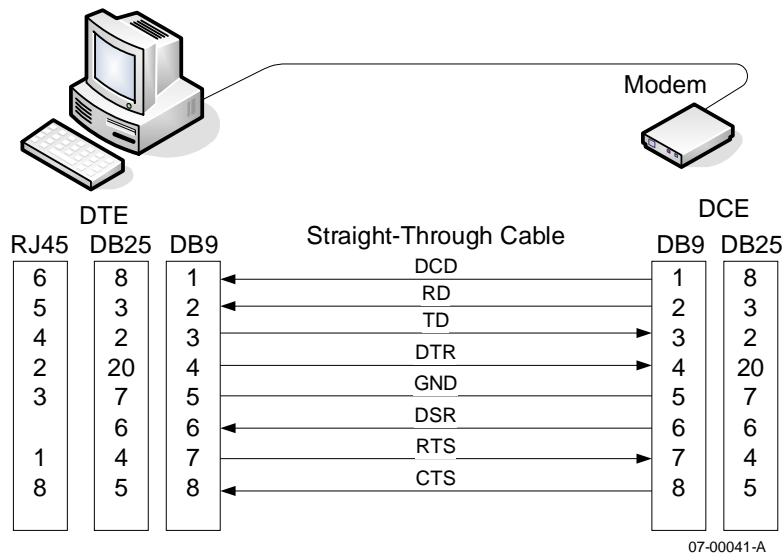


Figure 69: DTE to DCE RS-232 Pin Assignments

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-5050 is a multi-frequency GNSS receiver.

dynamic mode when a GPS receiver operates in dynamic mode, it assumes that it is in motion and certain algorithms for GPS position fixing are enabled in order to calculate a tighter position fix.

ECEF (Earth Centered Earth Fixed) a Cartesian coordinate system used for GPS, sometimes known as a "conventional terrestrial" system.

EGNOS (European Geostationary Navigation Overlay Service) a European satellite system used to augment the two military satellite navigation systems now operating, the US GPS and Russian GLONASS systems.

elevation distance above or below Local Vertical Datum.

elevation mask the lowest elevation, in degrees, at which a receiver can track a satellite. Measured from the horizon to zenith, 0° to 90°.

ellipsoid a mathematical figure approximating the Earth's surface, generated by rotating an ellipse on its minor axis. GPS positions are computed relative to the WGS-84 ellipsoid. An ellipsoid has a smooth surface, which does not match the earth's geoidal surface closely, so GPS altitude measurements can contain a large vertical error component. Conventionally surveyed positions usually reference a geoid, which has an undulating surface and approximates the earth's surface more closely to minimize altitude errors.

epoch literally a period of time. This period of time is defined by the length of the said period.

G1 carrier frequency the primary L-Band carrier used by GLONASS satellites to transmit satellite data. The frequency is 1603.00MHz.

G2 carrier frequency the secondary L-Band carrier used by GLONASS satellites to transmit satellite data. The frequency is 1247.00MHz.

GAGAN (GPS Aided Geo Augmented Navigation) an Indian satellite system that provides a set of corrections for the GPS satellites, which are valid for the Indian region. They incorporate satellite orbit and clock corrections.

geoid the gravity-equipotential surface that best approximates mean sea level over the entire surface of the earth. The surface of a geoid is too irregular to use for GPS readings, which are measured relative to an ellipsoid. Conventionally surveyed positions reference a geoid. More accurate GPS readings can be obtained by calculating the distance between the geoid and ellipsoid at each position and subtracting this from the GPS altitude measurement.

GIS (Geographical Information Systems) a computer system capable of assembling, storing, manipulating, updating, analyzing and displaying geographically referenced information, i.e. data identified according to their locations. GIS technology can be used for scientific investigations, resource management, and development planning. GIS software is used to display, edit, query and analyze all the graphical objects and their associated information.

Global Positioning System (GPS) geometrically, there can only be one point in space, which is the correct distance from each of four known points. *GPS* measures the distance from a point to at least four satellites from a constellation of 24 NAVSTAR satellites orbiting the earth at a very high *altitude*. These distances are used to calculate the point's position.

GLONASS (Global Orbiting Navigation Satellite System) the Russian Federation's GNSS system, managed by the Russian Space Forces (Russian: VKS). GLONASS uses the same concepts for positioning as GPS.

GMT see *Greenwich Mean Time*.

GNSS Global Navigation Satellite System.

GPS see *Global Positioning System*.

GPS time a measure of time. GPS time is based on UTC, but does not add periodic 'leap seconds' to correct for changes in the earth's period of rotation. As of September 2002 *GPS* time is 13 seconds ahead of UTC.

Greenwich Mean Time (GMT) the local time of the 0° meridian passing through Greenwich, England.

HAE see *altitude*, and *ellipsoid*.

IODC Issue of Data, Clock - The IODC indicates the issue number of the data set and thereby provides the user with a convenient means of detecting any change in the correction parameters. The transmitted IODC will be different from any value transmitted by the satellite during the preceding seven days.

JPL Jet Propulsion Laboratory.

Kbps kilobits per second.

L-Band the group of radio frequencies extending from approximately 400MHz to approximately 1600MHz. The GPS carrier frequencies L1 (1575.4MHz) and L2 (1227.6 MHz) are in the L-Band range.

L1 carrier frequency the primary L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1575.42MHz. It is modulated by C/A code, P-code, or Y-code, and a 50 bit/second navigation message. The bandwidth of this signal is 1.023MHz.

L2 carrier frequency the secondary L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6MHz. It is modulated by P-code, or Y-code, and a 50 bit/second navigation message. The bandwidth of this signal is 10.23MHz.

L2C carrier frequency a L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6MHz. It is identical to L2 carrier frequency except that it is also modulated by C/A code, which provides a narrower band and is easier to track.

L5 carrier frequency a L-Band carrier used by GPS satellites to transmit satellite data. The frequency is 1176.45MHz. Like L2, L5 better characterizes the ionosphere and the atmosphere.

lat see latitude.

latitude (lat) the north/south component of the coordinate of a point on the surface on the earth; expressed in angular measurement from the plane of the equator to a line from the center of the earth to the point of interest. Often abbreviated as Lat.

LED acronym for Light Emitting Diode.

LEMO a type of data or power connector.

LES Land Earth Station the point on the earth's surface where data is up linked to a satellite.

logging interval the frequency at which positions generated by the receiver are logged to data files.

lon see *longitude*.

longitude (long) the east/west component of the coordinate of a point on the surface of the earth; expressed as an angular measurement from the plane that passes through the earth's axis of rotation and the 0° meridian and the plane that passes through the axis of rotation and the point of interest. Often abbreviated as Long.

Mean Sea Level (MSL) a vertical surface that represents sea level.

meridian one of the lines joining the north and south poles at right angles to the equator, designated by degrees of longitude, from 0° at Greenwich to 180°.

meteorological (.YYm) files one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. A meteorological file contains atmospheric information.

MSAS (MTSAT Satellite-based Augmentation System) a Japanese satellite system that provides a set of corrections for the GPS satellites, which are valid for the Japanese region. They incorporate satellite orbit and clock corrections.

MSL see *Mean Sea Level*.

Multi-Frequency-GNSS Receiver a type of receiver that is capable of using multiple signals, for example, GPS (L1, L2, L2C, L5), GLONASS (G1, G2), StarFire™ L-band, SBAS (WAAS, EGNOS, MSAS, GAGAN), and QZSS signals. The use of multiple signals

provides compensation for ionospheric effects. In addition, reception of multiple signals provides redundancy that results in a more stable navigation solution during adverse conditions.

multipath error a positioning error resulting from interference between radio waves that has traveled between the transmitter and the receiver by two paths of different electrical lengths.

navigation (.YYn) files one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. A navigation file contains satellite position and time information.

OEM (Original Equipment Manufacturer) is typically a company that uses a component made by a second company in its own product, or sells the product of the second company under its own brand. The specific meaning of the term varies in different contexts.

observation (.YYo) files one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. An observation file contains raw GPS position information.

P/N Part Number.

P-code the extremely long pseudo-random code generated by a *GPS* satellite. It is intended for use only by the U.S. military, so it can be encrypted to Y-code deny unauthorized users access.

parity a method of detecting communication errors by adding an extra parity bit to a group of bits. The parity bit can be a 0 or 1 value so that every byte will add up to an odd or even number (depending on whether odd or even parity is chosen).

PDA Personal Digital Assistant.

PDOP see *Position Dilution of Precision*.

PDOP mask the highest PDOP value at which a receiver computes positions.

phase center the point in an antenna where the GPS signal from the satellites is received. The height above ground of the phase center must be measured accurately to ensure accurate GPS readings. The phase center height can be calculated by adding the height to an easily measured point, such as the base of the antenna mount, to the known distance between this point and the phase center.

PNT Positioning Navigation and Timing

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 Deere & Company 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 Deere & Company proprietary processing technique in which carrier phase measurements, free of Ionospheric and Troposphere effects are used for navigation.

Real-Time Kinematic (RTK) a GNSS system that yields very accurate 3D *position* fixes immediately in real-time. The base station transmits its GNSS position to roving receivers as the receiver generates them, and the roving receivers use the *base station* readings to differentially correct their own positions. Accuracies of a few centimeters in all three dimensions are possible. RTK requires multi-frequency GNSS receivers and high speed radio modems.

reference station a reference station collects GNSS data for a fixed, known location. Some of the errors in the GNSS positions for this location can be applied to positions recorded at the same time by roving receivers which are relatively close to the reference station. A reference station is used to improve the quality and accuracy of GNSS data collected by roving receivers.

RHCP Right Hand Circular Polarization used to discriminate satellite signals. GNSS signals are RHCP.

RINEX (Receiver Independent Exchange) is a file set of standard definitions and formats designed to be receiver or software manufacturer independent and to promote the free exchange of GNSS data. The *RINEX* file format consists of separate files, the three most commonly used are:

- the observation (.YYo) file,

- the navigation (.YYn) file,

- meteorological (.YYm) files; where YY indicates the last two digits of the year the data was collected.

rover any mobile GNSS receiver and field computer collecting data in the field. A roving receiver's position can be differentially corrected relative to a stationary reference GNSS receiver or by using GNSS orbit and clock corrections from a SBAS such as StarFire™.

roving receiver see *rover*.

RTCM (Radio Technical Commission for Maritime Services) a standard format for Differential GNSS corrections used to transmit corrections from a base station to rovers. RTCM allows both real-time kinematic (RTK) data collection and post-processed differential data collection. RTCM SC-104 (RTCM Special Committee 104) is the most commonly used version of RTCM message.

RTK see *Real-time kinematic*.

S/A see *Selective Availability*.

SBAS (Satellite Based Augmentation System) this is a more general term, which encompasses WAAS, StarFire™ and EGNOS type corrections.

Selective Availability (S/A) is the deliberate degradation of the GPS signal by encrypting the P-code and dithering the satellite clock. When the US Department of Defense uses S/A, the signal contains errors, which can cause positions to be inaccurate by as much as 100 meters.

Signal-to-Noise Ratio (SNR) is a measure of a satellite's signal strength.

SNR see *signal-to-noise Ratio*.

SNAS is a satellite system being developed by the People's Republic of China called the Satellite Navigation Augmentation System (SNAS). These stations will compliment the 11 ones already installed in around Beijing.

StarFire™ a set of real-time global orbit and clock corrections for GPS satellites. StarFire™ equipped receivers are capable of real-time decimeter positioning

(see Appendix C).

Spread Spectrum Radio (SSR) a radio that uses wide band, noise like (pseudo-noise) signals that are hard to detect, intercept, jam, or demodulate making any data transmitted secure. Because spread spectrum signals are so wide, they can be transmitted at much lower spectral power density (Watts per Hertz), than narrow band signals.

SV (Space Vehicle) a *GPS* satellite.

Universal Time Coordinated (UTC) a time standard maintained by the US Naval Observatory, based on local solar mean time at the Greenwich meridian. GPS time is based on UTC.

USB Universal Serial Bus.

UTC see *Universal Time Coordinated*.

WAAS (Wide Area Augmentation System) a US satellite system that provides a set of corrections for the GPS satellites, which are valid for the North American region. They incorporate satellite orbit and clock corrections.

WADGPS (Wide Area Differential GPS) a set of corrections for the GPS satellites, which are valid for a wide geographic area.

WGS-84 (World Geodetic System 1984) the current standard datum for global positioning and surveying. The WGS-84 is based on the GRS-80 ellipsoid.

Y-code the name given to encrypted P-code when the U.S. Department of Defense uses selective availability.