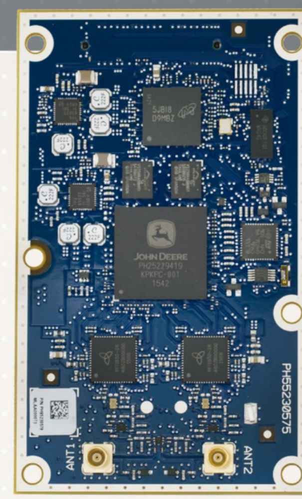
ONYX Technical Reference Manual



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Onyx Technical Reference Manual
96-312008-3001
Revision A
December 2018

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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 Onyx Technical Reference Manual Appendix B.

Revision History

Draft Rev A (Dec 2018)	Initial release; specifically relates to ICD, version 5.01, Firmware version 1.0.2
WEBUSERS	Updated command description
15.5W Satellite	Removed the satellite from Tables 175 and 214
Draft Rev A (Nov 2018)	Initial release; specifically relates to ICD, version 4.98, Firmware version 1.0.0
LOGFILEDRIVEFULLSEL	Command added
Draft Rev A (Sep 2018)	Initial release; specifically relates to ICD, version 4.90, Firmware version 0.1.7
Draft Rev A (Aug 2018)	Initial release; specifically relates to ICD, version 4.89, Firmware version 0.1.6
FSDIR	Removed Drive B; Added Drive C
FSDRIVE	Removed Drive B
FSFORMAT	Removed Drive B
FSLOAD	Removed Drive B
FSSPACE	Removed Drive B
FTPCONTROL	Removed Drive B
LOGFILEDRIVE	Removed Drive B
SFLICENSEB	Added COM3 and COM4 to the source table
MSGCANCELHISTORYB	Added COM3 and COM4 to the source table
ENABLEGEOFENCE	Updated description
Draft Rev A (Jul 2018)	Initial release; specifically relates to ICD, version 4.80, Firmware version 0.1.5
SFLICENSEB	Updated “Status” table
MSGCANCELHISTORYB	Updated “MSGCANCELHISTORYB Cancellation Source” table
SFSTATUS1B	Added field ‘External Hub ID’
ENABLEGEOFENCE	Added command
Draft Rev A (Jun 2018)	Initial release; specifically relates to ICD, version 4.70, Firmware version 0.1.4
REFSTNPOS	Replaced “Hieght over Mean Sea Level” with “Height over Ellipsoid”
SETPOSITION	Replaced “Hieght over Mean Sea Level” with “Height over Ellipsoid”
WEBCONTROL	Updated to indicate that changes made using [WEBCONTROL] have to made using a local port (serial or USB)
1PPS	Updated command width range.
NTRIPSTAT	Updated message format to be comma-delimited after “TOW”.
Appendix H	Added Appendix H - Web Server
Draft Rev A (May 2018)	Initial release; specifically relates to ICD, version 4.63, Firmware version 0.1.3
POINTRADIUSDATAB	Updated message structure
LOGFILENAME	Changed file logging naming convention
Draft Rev A (May 2018)	Initial release; specifically relates to ICD, version 4.58, Firmware version 0.1.2
ERASEEPH	Updated keyword and description
Draft Rev A (Apr 2018)	Initial release; specifically relates to ICD, version 4.56, Firmware version 0.1.1
STARFIREMODE	Added note with regard to single frequency operation (fallback scenario)
3RDPARTYRTKX	Added note with regard to StarFire signaling support

TXRXINFOA	Updated f73 – f76 to Reserved
Draft Rev A (Feb 2018)	Initial release; specifically relates to ICD, version 4.52, Firmware version 0.1.0
PRDGPSMODE	Added note with regard [3RDPARTYRTKX] setting
STARFIREMODE	Added note with regard [3RDPARTYRTKX] setting
NCTBB	Added note with regard [3RDPARTYRTKX] setting
NCTCB	Added note with regard [3RDPARTYRTKX] setting
NavCom Technology, Inc.	Updated appropriate references to *Deere & Company*
Bluetooth®	Added appropriate trademark references
ANTENNAOFFSET	Command removed
Draft Rev A (Jan 2018)	Initial release; specifically relates to ICD, version 4.49, Firmware version 0.0.0.26
BOOTLOADB	Updated GNSS Software Loading Sequence
PASSTHRU	Update examples and Warning
ANTPOWER	Updated command description and description
Draft Rev A (Nov 2017)	Initial release; specifically relates to ICD, version 4.39, Firmware version 0.0.0.25
LOGFILEDRIVE	Updated to include definition of device types.
SFSTATUS1B	Updated Hub Id information
WEBLOADB	Updated Webpages Limits
Draft Rev A (Oct 2017)	Initial release; specifically relates to ICD, version 4.30, Firmware version 0.0.0.24
Appendix F	Updated Appendix F - MBRTK
SELFSURVEYSTATUS1A	Rewrote the command to accommodate DDMMSS… format
OUTPUT	Removed web ports as valid port IDs from Table 73
WEBLOADB	Changes the valid count data type from U16 to U32
TRACKINGMODE	Updated definition for ALL keyword
QUICKSTARTPOSA	Added SF-Start-Status keyword and definition
EVENTLATCHVOLTSEL	Added command
DNSOVERRIDE	Added command
Draft Rev A (Sep 2017)	Initial release; specifically relates to ICD, version 4.19, Firmware version 0.0.0.23
BOOTLOADB	Updated Table 21: Software Type Enum
Draft Rev A (Aug 2017)	Initial release; specifically relates to ICD, version 4.16, Firmware version 0.0.0.22
ANTREMOTE	Added examples
BTSET	Added maximum length definition
SFSTATUS1B	Updated Hub ID’s and StarFire license status
TXRXINFO	Replaced Octagon with SF-3040
Draft Rev A (July 2017)	Initial release; specifically relates to ICD, version 4.09, Firmware version 0.0.0.21
ALM1B	Updated for Galileo, Beidou, QZSS
EPHEM1B	Updated for Galileo, Beidou, QZSS
MEAS1B	Added E5AltBOC to Table 141: Frequency Number and Table 142: Code Type
SFCORRSELECT	Added command
STARFIREALTSAT	Added ‘Auto’ keyword definition and examples

TRACKINGMODE	Significantly Updated argument table, notes and examples
TXRXINFOA	Updated port table
WIFICLIENT	Updated Note 1
Draft Rev A (June 2017)	Initial release; specifically relates to ICD, version 4.00, Firmware version 0.0.0.19
LEDTEST	Remove [LEDTEST] from manual
PVT1B	Add StarFire LP to line 9 Table: 188 Navigation Solution Mode
RTKTIMEOUT	Change “Integer” to “Float” in time field
RTKMODE	Update Base62 Keyword to BaseNCT62 in Table 81: RTK Modes Added note for USB2 port
SHUTDOWN	Added table showing interaction with other system elements
GEOIDALMODEL	Removed EGM2008
FIXBASELINE	Clarified parameter input requirements
TRACKINGMODE	Updated GLONASS notes
USBMODE	Updated description for Options
SELFSURVEY	Updated notes
WEBLOAD	Updated Table 92: WEBLOADB Message Function SubID Enum Definition
MEAS1B	Updated Table 137: PRN Slot Number
CHNLSTATUS1B	Updated to reflect only Version 3 implementation – primarily sections 2.4.3, 2.4.7.1, and 2.4.8.2; Removed Versions 1 and 2
OUTPUT	Table 73: Added note for USB2 port
Draft Rev A (March 2017)	Initial release; specifically relates to ICD, version 3.76, Firmware version 0.0.0.16

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. The user is in a situation that could cause bodily injury. Before starting work on any equipment, be aware of the hazards involved with electrical and RF circuitry and be familiar with standard practices for preventing accidents.

This symbol means Default. Unless otherwise set, these are the factory preset parameters.

Revisions to this User Guide can be obtained in a digital format from
http://www.navcomtech.com/Support/DownloadCenter.cfm?category=manuals

Related Documents

Onyx Integration Guide
P/N 96-310041-3001

Describes the operation and use of NavCom's Onyx GNSS/StarFire™ receivers

StarUtil 5000 User Guide
P/N 96-310029-3001

Describes the operation and use of NavCom's Windows based control program (included on CD)

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; included on CD

Technical Reference Manual
P/N 96-312008-3001

Describes the control and output data message formats utilized by the NavCom legacy Starlight receivers.

NavCom Release Notes

Describes software updates for NavCom products. Current and archived Release Notes are available on the NavCom web site:
http://www.navcomtech.com/Support/DownloadCenter.cfm?category=releasenotes.

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

Related Standards

ICD-GPS-200

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

RTCM-SC-104

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

CMR, CMR+

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

NMEA-0183

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

QZSS

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

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 2059

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

Fundamental Onyx Message Block Formats

Message Application

This document describes the formats and protocols that are applicable to all of the Onyx receiver's physical ports (RS-232, RS-422, USB, Ethernet) at the application layer.

Refer to these sections for basic format information:

- ✓ *Onyx ASCII Input Commands*
- ✓ *Onyx Output Messages*

Refer to these sections for detailed format information. (The commands and output streams are provided in alphabetical order according to their identifying mnemonics. Each command and output stream is provided in a table with definitions of each parameter.)

- ✓ *Onyx Input Commands Detailed Formats*
- ✓ **Error! Reference source not found.**

Software Ensemble

This manual specifically relates to the software ensemble version detailed in the most recent Revision History.

Message Query

Each message block may be queried by the command [**Error! Reference source not found.**] mnemonic, ONCE

For example, [OUTPUT] MSGVERSION, ONCE queries the receiver to provide a one-time output of the version number of the navigation firmware component.

Refer to section 1.95 **Error! Reference source not found.** in this manual for more information about the OUTPUT command.

Onyx ASCII Input Commands

ASCII input commands are used to set parameters which control the operation of the Onyx GNSS receiver. There are ASCII input commands to set navigation control parameters (DOP limits, elevation masks, etc.), to enable and disable various navigation modes, to configure the data ports, to turn on output streams, and to control numerous other receiver functions.

ASCII Message Organization

The basic format of Onyx ASCII input commands include a command mnemonic, framed by square brackets, followed by one or more arguments, which specify the new values of the control parameters. If there is more than one argument associated with a mnemonic, the argument values may be separated by commas or by one or more blanks. Input commands are terminated by a new line sequence (<CR><LF> = carriage return + line feed).

Table 1 and Table 2 show the basic format for Onyx input commands.

Table 1: Basic Command Format Using Blanks as Delimiters

Command:	[command mnemonic] arg1 arg2 … argN<CR><LF>

Table 2: Basic Command Format Using Commas as Delimiters

Command:	[command mnemonic] arg1,arg2,…,argN<CR><LF>

When command responses are enabled, the Onyx GNSS receiver issues a response to each ASCII input command. The response is output on the data port on which the command was received.

- ✓ If the command is successfully parsed and accepted, the response characters are [OK] followed by the command mnemonic.
- ✓ If the command does not parse successfully and is not accepted, the response characters are [??] followed by the command mnemonic, and, in some cases, an indication of which argument caused the command not to be accepted.

Refer to the section below, Examples of ASCII Input Commands and Responses.

When command responses are enabled, the receiver is in verbose mode.

ASCII Input Command Parsing Rules

These sections describe the detailed parsing rules for the ASCII input command fields.

Command Mnemonic Parsing

Command mnemonics identify which control parameter or group of control parameters are specified in the argument values. The entire command mnemonic must be enclosed in a beginning square bracket ([ ) and an ending square bracket ( ]). Within the brackets, the command mnemonic is not case sensitive, and any number of blanks may be used to improve legibility.

If an invalid command mnemonic is issued, the response characters will be [??] followed by the message “Unrecognized command mnemonic”.

Argument String Parsing

The argument string fields can be delimited by any number of blanks or by single commas. When null fields are needed (no argument value provided), commas must be used to indicate them. The argument string (and the entire command sentence) is terminated with a new line sequence (<CR><LF> = carriage return + line feed).

There are four types of arguments for Onyx ASCII input commands:

1. Integers: Decimal integers containing only the characters 0 to 9 and + or –
2. Float: Floating point numbers containing only the characters 0 to 9 and + or – and, optionally, the decimal point “.”
3. Keywords: ASCII strings that must match a predefined list of options for each command These are case insensitive, but cannot contain embedded blanks. An example of a keyword argument is the parity specification for a serial port, which is either NONE, ODD, or EVEN.

4. Strings: String arguments must be enclosed in quotes (“”). Within the quotes, all ASCII characters are permissible, including commas. String arguments are intended to support user defined names and messages that require the use of some punctuation or special characters.

When a valid command mnemonic is received and the argument string is absent, the receiver responds with a one-time output of the stored values for the command parameters.

Optional CRC Field (*CRC)

An optional CRC field can be appended to input commands. This supports interfaces with external controllers (e.g., laptops, PDAs with wireless connectivity) with application software that computes and appends the CRC field to provide additional integrity.

The CRC field is expressed as a sequence of four hex-ASCII digits, preceded by an asterisk (*CRC). The four hex-ASCII digits represent the binary value of a 16-bit CCITT cyclic redundancy check computed by the C-language function shown in Appendix A.

Parser Pseudocode

The C-language Onyx parser pseudocode is shown in Appendix A.

Examples of ASCII Input Commands and Responses

Table 3 shows examples of a basic single-argument command. The example uses the [NAVELEVMASK] command to set the elevation mask, in degrees, for the main, code-based navigation solution.

Table 3: Examples of Single Argument Command Inputs and Responses

Input	Response*	Description
[NAVELEVMASK] 7.5<CR><LF>	[OK] NAVELEVMASK<CR><LF>	Command accepted
[Nav Elev Mask] 9<CR><LF>	[OK] NAVELEVMASK<CR><LF>	Command accepted. (Note the free use of spaces and upper/lower case in the command mnemonic.)
[NAVELEVMASK] -7<CR><LF>	[??] NAVELEVMASK,argument #1 out of range<CR><LF>	Command not accepted. Problem with argument.
[NAVELEVMASK] <CR><LF>	[NAVELEVMASK] 9.00<CR><LF>	No arguments specified so receiver reports current value(s).

*Command responses must be enabled to receive responses (verbose mode).

<CR><LF> = carriage return + line feed

Table 4 shows examples of a command that accepts multiple arguments. If an argument is not specified, the value is assumed to be the current set value. The command in these examples is the [PORT] command, which is used to configure the RS-232 serial ports, and the RS-422 serial port if available, of the Onyx receiver.

[PORT] accepts up to five arguments:

1. The port identifier: An integer from 1 to 4. If this argument is not specified, the port is assumed to be the one receiving the command.
2. The baud rate (1200,2400,4800,9600,19200,38400,57600,115200)
3. The number of data bits per frame (7 or 8)
4. The number of stop bits per frame (1 or 2)
5. The parity option for each frame (NONE, ODD, EVEN)

Table 4: Examples of Multiple Argument Command Inputs and Responses

Input	Response*	Description
[PORT] 1,19200<CR><LF>	[OK] PORT<CR><LF>	Command accepted. Last 3 arguments left off.
[PORT] 1,19200,,,NONE<CR><LF>	[OK] PORT<CR><LF>	Command accepted. Arguments 3 and 4 not specified as indicated by commas.
[PORT] 1 4800 8 1 NONE<CR><LF>	[OK] PORT<CR><LF>	Command accepted. (Note use of spaces as argument delimiters.)
[PORT] 2,9600,9<CR><LF>	[??] PORT,argument #3 out of range<CR><LF>	Command not accepted. Problem with third argument.
[PORT]<CR><LF>	[PORT] 1,4800,8,1,NONE<CR><LF>	No arguments specified so receiver reports current value(s) for port receiving command.
[PORT] 2<CR><LF>	[PORT] 2,9600,9,1,NONE<CR><LF>	Only port argument specified so receiver reports current value(s) for specified port.

* Command responses must be enabled to receive responses (verbose mode).

<CR><LF> = carriage return + line feed

Onyx Output Messages

The Onyx GNSS receiver supports a number of different types of output messages (data output streams). Some of these are industry standard outputs such as NMEA-0183 sentences and various RTK/dGPS correction formats (RTCM, CMR, etc.). This section, however, describes the format of specialized Onyx output messages designed to provide access to commonly used internal receiver data (measurements, ephemeris, channel status, etc.), as well as efficient, low latency outputs of the navigation results.

Onyx output messages are ASCII or binary. Not all binary output messages have an ASCII equivalent and vice versa.

Both ASCII and binary Onyx output messages share these format elements in common:

- ✓ Both begin with a unique, identifying ASCII mnemonic enclosed in square brackets.
- ✓ The last letter of the mnemonic is the character 'A' for ASCII records or 'B' for binary records.
- ✓ Both are terminated with a CRC and a new line sequence (<CR><LF> = carriage return + line feed). The CRC has a format identical to the optional CRC used for ASCII input messages, i.e., four hex-ASCII characters preceded by an asterisk (*CRC).

Binary Output Message Organization

Onyx binary output messages use C-language structure definitions to describe the details of their formats. Table 5 lists the data type abbreviations used.

Table 5: Data Type Abbreviations

Data Type	# of bytes	C-Language Definition
U08	1	unsigned char
S08	1	signed char
Bool	1	unsigned char
U16	2	unsigned short
S16	2	signed short
U32	4	unsigned long
S32	4	signed long
R32	4	float
R64	8	double

Table 6 shows the general format of Onyx binary output messages.

Table 6: General Format of Onyx Binary Output Messages

[mnemonic] …… binary header …… binary message body …… *CRC<CR><LF>

[mnemonic]	binary header	binary message body	*CRC<CR><LF>
Unique record identifier. ASCII ending in 'B' enclosed in brackets	Standard binary header described in Table 7, or simplified binary header described in Table 9.	Binary message body unique for each record identifier.	CRC followed by carriage return + line feed

The majority of the Onyx binary messages use the standard binary message header. The simplified binary header is used only in some special cases; e.g., bootloading. The Onyx binary messages described in this manual use the standard binary header unless otherwise indicated.

The CRC includes all of the fields in the binary header (9 bytes) and the binary message body (variable number of bytes). The CRC is expressed as a sequence of four hex-ASCII digits, preceded by an asterisk. The four hex-ASCII digits represent the binary value of a 16-bit CCITT cyclic redundancy check computed by the C-language function shown in Appendix A.

Table 7: Standard Onyx Binary Header Format

Field	# Bits	Data Type	Description
Length	16	U16	Number of bytes in the binary header plus the data block, i.e. data block length plus 9 bytes for the length of the binary header
GPS Week	16	U16	GPS week number
GPS time	32	U32	GPS time (milliseconds into the week)
Time Confidence	4LSB	U08	Receiver time confidence (refer to Table 8)
Version	4MSB		Message version control

Table 8: Time Confidence Values

Code	Description
0	Time is unknown
1	Time has been set from the real time clock
2	Time has been set from the serial port
3	Time has been obtained from a satellite
4	Time has been obtained from a navigation solution
5	Time has been obtained from a stable navigation solution

Table 9: Simplified Onyx Binary Header Format

Field	# Bits	Data Type	Description
Length	16	U16	Number of bytes in the binary header plus the data block; i.e., data block length plus 2 bytes for the length of this header

Output Rate Description

Output commands also support an output rate parameter, as described in the following list.

- OnTime, which tells the receiver to output the message each time it enters a new interval. This interval is defined in units of seconds, with a range from 0.01 to 9999.9 seconds. The receiver truncates this value to the nearest 0.01 seconds. The default interval is 1 second if not specified.
- OnChange, which means something more like “On Trigger”. For this keyword, the receiver will schedule a message for output when something is ready to be displayed, but this may or may not mean the data has really changed since the last time it was displayed. It means more like, “display the current contents of the specified data elements”.
- OnEvent, which is supported by the message, but does not appear at this time to do anything.
- Once, which means to output the message right now, and exactly one time.
- Off, which means to stop sending the message

Input Parameter Formats	
I	Integer
H	Hex number
F	Floating point number
K	Keyword, case insensitive
S	String – input must be delimited by double quote marks, Cannot be NULL
Z	String – input must be delimited by double quote marks, Can be NULL

Command Types	
One Time	One time command, not stored in NVRAM
User	Stored in NVRAM with the PROFILE command
System	Stored in NVRAM as soon as entered
Factory	Stored in NVRAM, cannot be changed once entered

Message Updates & Software Revisions

From time to time it may be necessary for NavCom to change the format of an existing message. This is normally accomplished by appending to the existing message (which will be defined in a later version of this manual). Programmers should design software to be forward compatible by recognizing that messages may be extended and the content of the extension may be unknown to the user. In this circumstance, the message length will increase. Do not reject the data record if the message length and checksum are valid for any given record. Allow the program to ignore "undefined data" to ensure forward compatibility.

Factory Default Profile

Table 10: Factory Default Output Proprietary Messages and Responses

Output on Ports COM1 and USB1		
Message	**Rate**	**Description**
ALM1B	On Change	Almanac
CHNLSTATUS1B	On Time, 1Hz	ASIC & StarFire™ Channel Status
EPHEM1B	On Change	Ephemeris
MEAS1B	On Time, 1Hz	Raw 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 (command mnemonic)	On Change	Ack ("Acknowledged"). Ack indicates a successful operation.
?? (command mnemonic)	On Change	Nak ("Not Acknowledged"). NAK indicates a failure in executing a command.
PANICA	On Change	Factory Use

The messages are fully defined in sections 1 *Onyx Input Commands Detailed Formats*

Several different navigation solutions may be computed at a 1 Hz rate. Refer to *Section 2.60*, PVT1B, for detailed information. The navigation rate sets the measurement rate. The maximum PVT output rate is 100Hz. The maximum raw data output rate is 100Hz.

These settings indicate:

- 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.
- 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, 0.1 (10 Hz).

In the supplied utility, StarUtil 5000, the Navigation Rate setting sets the output of the NCT Binary message PVT1B and the NMEA messages GGA, RMC and VTG, provided that those messages are set to On Change.

The NCT Binary message MEAS1B does not follow the navigation rate. To match a higher navigation rate, the user must schedule the output of MEAS1B. The rate must be a purchased navigation and raw data rate.

Profile Functionality

The Onyx receiver provides for storage of up to 20 user profiles in its non-volatile memory. The command mnemonic, [PROFILE], plus the command action keyword, SAVEAS, and a user-defined "name", saves the current configuration settings of the receiver as a user profile with the specified name. Each user profile is stored in the receiver with a name. A controller solution, such as StarUtil 5000, is used to activate a user-defined profile by its name.

⚠ Before turning off the receiver, to make the current profile available for future use, the user must save the current profile as a user profile if it is not saved already. Refer to PROFILE (ASCII) for detailed information.

A new profile sent to the receiver replaces the currently used profile, but it does not necessarily replace all 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.

NMEA Messages Overview

This product provides support for selected sentences defined in the National Marine Electronics Association (NMEA) document 0183 "Standard for Interfacing Marine Electronic Devices", Version 3.01, January 1, 2002. These messages are all prefixed with the string value "NMEA", and can be viewed as a common set of sentences describing navigation data.

These NMEA sentences describe mechanics for GPS, GLONASS and WAAS satellites. To differentiate them, NMEA defines the following naming convention for satellite ids:

- ✓ GPS satellites are identified by their PRN numbers, which range from 1 to 32.
- ✓ The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.
- ✓ The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by "64 + satellite slot number". The slot numbers are 1 through 24 for the full GLONASS constellation, giving a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

The NMEA sentences describe the satellite population using the following naming convention:

- ✓ $GAxxx, describes data generated from Galileo satellites only
- ✓ $GPxxx, describes data generated from GPS satellites only
- ✓ $GLxxx, describes data generated from GLONASS satellites only
- ✓ $GNxxx, describes data generated from mixed GPS, GLONASS, and Galileo satellites

The following are some common definitions that appear in NMEA sentences in particular, and in GPS frequently. Each represents a value that is accurate, but does not necessarily conform to any given mathematical range limits.

- ✓ Dilution of precision is a figure of merit describing the navigation efficiency provided by the satellite geometry. This value manifests in one, two or three dimensions, and is always "the lower the better", with 1 being the ideal (best) value, and usually anything over about 20 is bad.
- ✓ Geoidal height and mean sea level form virtual boundaries that define the surface of the Earth. These values grow in tables accrued by continuous surveying.
- ✓ DGPS correction age is the number of seconds since the last differential correction packet arrived from a reference station. A few seconds is okay, but many seconds indicate the fix is degrading over time, and becoming less and less accurate.
- ✓ A standard deviation is used to measure the error in any calculation, for example latitude or longitude. If the measurement is good, the standard deviation will be small. If not, it will be large.
- ✓ The signal to noise ratio is a number that represents how "loud" the information is when compared to the ambient noise. This number is specific to the measurement.
- ✓ Speed over ground is the actual speed the GNSS unit is moving over the ground. This may differ from airspeed or nautical speed due to such things as head winds or sea conditions.
- ✓ Delta values for Solid Earth tides are governed by the Earth, the Moon, and other factors that also affect ocean tides. There is no specific range.

Refer to the fore-matter for the address of the headquarters of the National Marine Electronics Association (NMEA). The NMEA messages listed in this manual begin with Section 8, $GPxxx, describes data generated from GPS satellites only, $GLxxx, describes data generated from GLONASS satellites only, $GNxxx, describes data generated from mixed GPS and GLONASS or GALILEO satellites

Table 11: Supported Standard NMEA Messages

NMEA Message	Description
ALM	GPS Almanac Data
GBS	GNSS Satellite Fault Detection
GGA	Global Positioning System Fix Data
GLL	Geographic Position – Latitude/Longitude
GRS	GNSS Range Residuals
GSA	GNSS DOP and Active Status Satellites
GST	GNSS Pseudorange Error Statistics
GSV	GNSS Satellites in View
HDT	Heading, Degrees True
MLA	GLONASS Almanac Data
RMC	Recommended Minimum Specific GNSS Data
ROT	Rate of Turn
VTG	Course over Ground and Ground Speed
ZDA	Time and Data

Table 12: Supported Non-Standard NMEA Messages

NMEA Message	Description
PNCTGGA	Global Positioning System Fix Data, with additional station ID information
PNCMDE	Marginally Detectable Error
PNCTGST	Scaled Pseudorange Noise Statistics
PNCTSET	Solid Earth Tide Correction
RRE	Range Residual Error

GPS Week Number

The GPS Week Number count began at midnight on the evening of 05 January 1980 / morning of 06 January 1980. Since that time, the count has been incremented by 1 each week, and broadcast as part of the GPS message. The GPS Week Number field in the data stream is modulo 1024. This meant that at the completion of week 1023, the GPS week number rolled over to 0 on midnight GPS Time of the evening of 21 August 1999 / morning of 22 August 1999.

GPS Time

The GPS time (seconds into the week) always starts on Sunday morning at 00:00 GMT. Each 24 hour period contains 86,400 seconds. A full week contains 604,800 seconds. Please see the table below for a breakdown of hourly / daily increments.

GT	Sun	Mon	Tue	Wed	Thu	Fri	Sat
0:00:00	0	86400	172800	259200	345600	432000	518400
1:00:00	3600	90000	176400	262800	349200	435600	522000
2:00:00	7200	93600	180000	266400	352800	439200	525600
3:00:00	10800	97200	183600	270000	356400	442800	529200
4:00:00	14400	100800	187200	273600	360000	446400	532800
5:00:00	18000	104400	190800	277200	363600	450000	536400
6:00:00	21600	108000	194400	280800	367200	453600	540000
7:00:00	25200	111600	198000	284400	370800	457200	543600
8:00:00	28800	115200	201600	288000	374400	460800	547200
9:00:00	32400	118800	205200	291600	378000	464400	550800
10:00:00	36000	122400	208800	295200	381600	468000	554400
11:00:00	39600	126000	212400	298800	385200	471600	558000
12:00:00	43200	129600	216000	302400	388800	475200	561600
13:00:00	46800	133200	219600	306000	392400	478800	565200
14:00:00	50400	136800	223200	309600	396000	482400	568800
15:00:00	54000	140400	226800	313200	399600	486000	572400
16:00:00	57600	144000	230400	316800	403200	489600	576000
17:00:00	61200	147600	234000	320400	406800	493200	579600
18:00:00	64800	151200	237600	324000	410400	496800	583200
19:00:00	68400	154800	241200	327600	414000	500400	586800
20:00:00	72000	158400	244800	331200	417600	504000	590400
21:00:00	75600	162000	248400	334800	421200	507600	594000
22:00:00	79200	165600	252000	338400	424800	511200	597600
23:00:00	82800	169200	255600	342000	428400	514800	601200
23:59:59	86399	172799	259199	345599	431999	518399	604799

System Control & Response Commands

This section details formats for

- ✓ Onyx Input Commands (in alphabetical order according to their identifying mnemonics)
- ✓ Onyx Output Messages (in alphabetical order according to their identifying mnemonics)
- ✓ Legacy and current Proprietary RTK Correction Messages
- ✓ Other Correction Output and Input Message Types

Reserved place holders are used throughout this manual to maintain alignment integrity with the master internal Interface Control Document maintained by NavCom Engineering.

1 Onyx Input Commands Detailed Formats

This section provides Onyx Input Commands in alphabetical order according to their identifying mnemonics. Each command is provided in a table with definitions of each command parameter.

1.1 1PPS (ASCII)

☒SF-5050 ☒Onyx

This command is used to set up and control the output of the programmable PPS signal. 1PPS is available TBD.

Command:		[1PPS] polarity, width, interval, delayMS, delayNS
Parameter		**Definition**
polarity	K	Keyword that defines the polarity of the PPS pulse (NEGATIVE, POSITIVE)
width	I	Sets the width of the PPS pulse (integer, nano-seconds) (13-1600000)
interval	I	Sets the interval in between pulses (integer, milli-seconds) (1-32768)
delay_MS	I	Sets the delay of the PPS pulse from GPS time (integer, milli-seconds) (0-32768)
delayNS	I	Sets an additional delay of the PPS pulse from GPS time (integer, nano-seconds) (0-999999)

Default: polarity = POSITIVE, width = 1000000 ns, interval = 1000 ms, delayMS = 0, delayNS = 0

Polarity, width, interval, delayMS, delayNS are all optional arguments.

Examples:

[1PPS] NEGATIVE,1500000,2000,50,30
Configures PPS to output a signal with a negative pulse that is 1.5ms wide, every 2 seconds, and delayed from GPS time by 50ms and 30ns

1.2 2DNAVMODE (ASCII)

☒SF-5050 ☒Onyx

This command is used to enable or disable GPS navigation with height constrained (2D navigation) and set the height constraint when the receiver computes a 2D navigation solution.

Command:	[2DNAVMODE] mode, height	
Parameter		**Definition**
mode	K	2D navigation mode, keyword (NEVER, ALWAYS, AUTO)
height	F	Value used to constrain the height relative to mean sea level (float, meters) (-100 m. to 30980 m.). This argument is optional; if no height is entered, the GNSS receiver uses its previous height for the 2D solution. The height value out of valid range (-100 m to 30980m) is rejected as an invalid argument.

Default: *NEVER*

Upper height limit imposed due to export limitations

⚠ Use 2D navigation mode only when the height can be constrained accurately. Otherwise, large errors may occur in the position solution.

Examples:

[2DNAVMODE] AUTO
Command the receiver to automatically switch between 2D and 3D modes as needed.

[2DNAVMODE] ALWAYS, 10.5
Command the receiver to switch to 2D mode and set 2D height to 10.5 meters.

[2DNAVMODE] ALWAYS
Command the receiver to switch to 2D mode and use its previous height constraint for 2D solution.

1.3 3RDPARTYRTKGLONASS

☒SF-5050 ☒Onyx

This command turns on or off GLONASS RTK corrections usage in RTK.

This feature does not support RTCM 2.3 or RTCM 20/21.

Command:	[3RDPARYRTKGLONASS] {AUTO, ON, OFF}, {Receiver Type}, {Bias*}
Parameter	**Definition**
ON,OFF	Keyword: AUTO_ON_OFF = (AUTO, ON, OFF)
Receiver Type	NAV, NOV, TRI, JVD, TOP, LEI, UNKNOWN, MANUAL
Bias*	Float: Bias* = Bias value when Receiver Type is MANUAL

Default: *OFF*

The abbreviations given in the Receiver Type Parameter list refer to the following third party receivers:

NAV: Navcom

NOV: Novatel

TRI: Trimble

JVD: Javad

TOP: Topcon Positioning Systems

LEI: Leica

Examples:

[3RDPARTYRTKGLONASS] OFF
Receiver will not use GLONASS RTK corrections in RTK.

[3RDPARTYRTKGLONASS] ON, NAV
Receiver will use Glonass RTK corrections from a Navcom receiver.

[3RDPARTYRTKGLONASS] ON, NOV
Receiver will use Glonass RTK corrections from a Novatel receiver.

[3RDPARTYRTKGLONASS] ON, MANUAL,-0.0256
Receiver will use Glonass RTK corrections with the specified bias value.

[3RDPARTYRTKGLONASS] ON, UNKNOWN
Receiver will not fix Glonass Satellite Ambiguity but it will be used in L1PNAV as float.

1.4 3RDPARTYRTKX

This command enables an enhanced version of StarFire-GNSS which will calculate an improved bias vector for the RTK-X corrections coming from a 3rd party (non NavCom) base. These corrections are not required for RTK-X corrections from a NavCom base.

Enabling this feature will turn off the Starfire Backup Engine (SF GPS) and will use that engine to calculate the bias vector for the RTK-X solution. Apply only if using SF GNSS and not SF GPS. If use of SF GPS is desired, this feature must be turned OFF and NCT RTK corrections applied. Switching this command from ON to OFF will enable the SF GPS engine, but it will also cause it to re-converge and pull-in again.

Command:	[3RDPARTYRTKX] {ON, OFF}
Parameter	**Definition**
ON,OFF	Keyword: {ON,OFF} ON: Enables the enhanced StarFire corrections. OFF: Disables the enhanced StarFire corrections.

Default: *ON*

This command is linked to the RTK-X Option of the [RTKMODE] command. The user will not be able to enable this command if the RTK-X Option is set to OFF. Changing the RTK-X option to ON or OFF will change this command to ON or OFF respectively. To disable this command after enabling the RTK-X option, it must be explicitly turned OFF and the profile saved.

The user must also ensure that [STARFIREMODE] is set to BOTH and [3RDPARTYRTKGLONASS] is enabled for this command to function.

Examples:

[3RDPARTYRTKX]ON
Will turn on the enhanced SF corrections. The bias vector for the 3rd party RTK base will be corrected.

[3RDPARTYRTKX]OFF
Will turn off the enhanced SF corrections. The bias vector for the 3rd party RTK base will not be corrected. The unenhanced StarFire corrections must re-converge and pull-in again.

1.5 ALM1B

☒SF-5050 ☒Onyx

This command allows the user to enter almanac data for GPS, GALILEO, SBAS or GLONASS. From a cleared memory without an almanac present, it takes about 13 minutes after satellite lock to obtain and display complete almanac information. Wth an almanac present, it takes only a matter of seconds.

Command:	[ALM1B[{Binary message}

The format of the binary message is defined in Table 13.

Table 13: ALM1B Binary message data

Data Item	Data Type
Satellite type (-1=NONE, 0=GPS, 1=GALILEO, 2=SBAS, 3=GLONASS, 4=BEIDOU, 5=QZSS)	U08
Almanac data	

For detailed information on the almanac data format, see the GPSALM1B, GLALM1B and GNALM1B commands.

The ALM1B command does not produce a status message if entered without an argument. To output the current almanacs, schedule the ALM1B message.

1.6 ANTALIGN (ASCII)

☒SF-5050 ☒Onyx

This command specifies the alignment of the two antennas in a fixed-antenna MBRTK system.

Command:		[ANTALIGN] mode, <user_angle>
Parameter		**Definition**
mode	K	Keyword: LAT, LON, or USER LAT: Antennas are aligned side-by-side with respect to the center-line of the vehicle. LON: Antennas are aligned along the center-line USER: Antennas are aligned at some user-specified angle. *Default*: *LON*
user_angle	F	The user-specified angle between the rover antenna and the base antenna with respect to the center-line of the vehicle in degrees, float, range = 0-360. *Default*: *0*

Default: *LON*

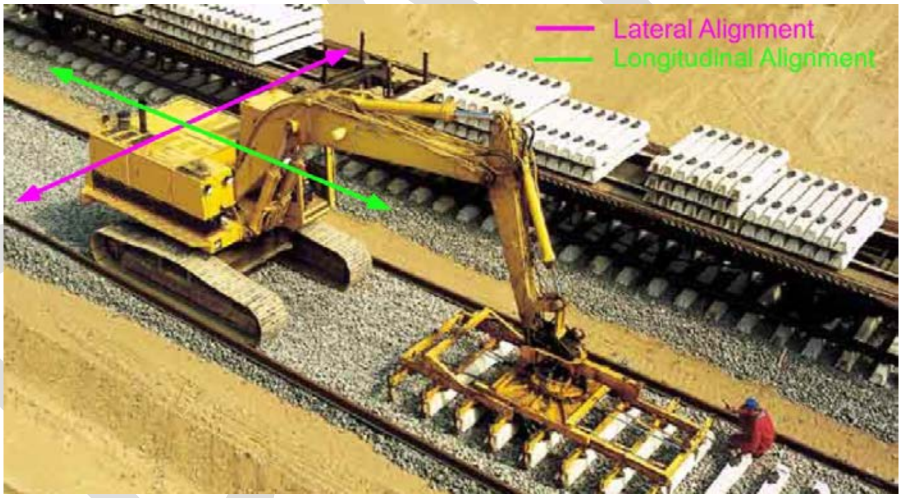


Figure 1: Antennae Alignment – Lateral and Longitudinal

Examples:

[ANTALIGN] LAT
Two fixed antennas are laterally installed.

[ANTALIGN] LON
Two fixed antennas are longitudinally installed.

[ANTALIGN] USER, 45
Longitudinally installed with additional rotation of 45 degrees

1.7 ANTENNAHEIGHT (ASCII)

☒SF-5050 ☒Onyx

This command is used to enable or disable the antenna height adjustment.

Command:		[ANTENNAHEIGHT] mode, phase_center_adj, slant_range, radius (repeat for each antenna)
Parameter		**Definition**
mode	K	Keyword (ON, OFF) to enable/disable the antenna height adjustment.
phase_center_adj	I	SF-5050 and Onyx do not use any Antenna Phase Center corrections other than the internl Antenna database, thus it becomes “reserved” and its value is always set to 0. If a third party antenna is used and it is listed in the internal database this value is also set to 0. Refer to ANTLIST. If a third party antenna is used, the user may set this value between -128 and +127 millimeters, as appropriate
slant_range	I	Slant range of antenna body: -32768 - +32767 (Integer, millimeters)
radius	I	Radius of antenna body: -32768 - +32767 (Integer, millimeters)

Default: OFF

If the mode is set to ON for any antenna, the phase center adjustment, slant range, and radius must be specified for that antenna.

Information may be entered for all antennas even if they are not currently attached (see NUMANTENNAS).

Examples:

[ANTENNAHEIGHT]ON,5,5000,3000
Enable antenna phase center adjustment for antenna #1

[ANTENNAHEIGHT],,,,ON,5,5000,3000
Enable antenna phase center adjustment for antenna #2, leaving the settings for antenna#1 unchanged.

[ANTENNAHEIGHT]
[ANTENNAHEIGHT]ON,5,5000,3000,OFF,0,0,0
Display current ANTENNAHEIGHT settings for both antennas.

1.8 ANTENNAINFO (ASCII)

☒SF-5050 ☒Onyx

This command allows the user to store and retrieve information about the antennas. This information includes the type, the serial number and the setup id. This command is formatted as shown in the following list.

Command:		[ANTENNAINFO] "name", "serial_number", setup id (repeated for each antenna)
Parameter		**Definition**
type	Z	Antenna type – Name of antenna specified in antenna database or entered by the user. "NONE" tells the receiver to use 0 PCO and PCV values.
serial number	Z	Serial number, ASCII string, 0-32 characters, default = empty
setup_id	I	Setup id, integer, 0-255, default = 0

Default: *"NAVANT5001R   NONE", "", 0, "NONE", "", 0*

Examples:

Store and query the name, serial number and setup ID for antennas 1 and 2:

[ANTENNAINFO] "NAVANT5001R NONE", "123abc", 1
Sets antenna 1 to type NAVANT5001R NONE, serial number 123abc, setup ID 1

[ANTENNAINFO] "NAVANT5001R   NONE"
Sets antenna 0 to type NAVANT5001R Antenna. Exactly 20 chars inside of "" as required.

1.9 ANTLIST

☒SF-5050 ☒Onyx

Lists the names of all the antennae in the PCO/PCV database.

Command:		[ANTLIST] listoption {<BLANK>, FIRST200, LAST200} (optional parameter)
Parameter		**Definition**
listoption	K	FIRST200, LAST200 (optional parameter) <BLANK> - List Antennas 1-200 FIRST200 – List Antennas 1-200 LAST200 – List Antennas 201-399

Default: NA

Examples:

[ANTLIST]
List Antennas 1-200

[ANTLIST] LAST200
List Antennas 201-399

1.10 ANTPOWER

☒SF-5050 ☒Onyx

This command controls the power to the GNSS 1 and GNSS 2 antenna LNA's.

Command:		[ANTPOWER] on_off<GNSS 1>, on_off<GNSS 2>
Parameter		**Definition**
OFF	K	Antenna LNA power off
ON	K	Antenna LNA power on

Power setting for both antennas must be specified

Default: [ANTPOWER] ON, OFF

This command is also available in manufacturing test.

Examples:

[ANTPOWER] OFF, ON
Turn the GNSS 1 antenna LNA power off and the GNSS 2 antenna LNA power on

1.11 ANTREMOTE

☒SF-5050 ☒Onyx

This command tells the receiver configured as a rover whether to try to automatically detect the remote base station's antenna type from the corrections messages. The user may manually specify the antenna type as well.

Command:		[ANTREMOTE] mode, type
Parameter		**Definition**
mode	K	AUTO or MANUAL If manual the user must specify the remote base station's antenna type
type	S	Antenna type – This is a quoted string specifying the antenna name in the antenna database. See the ANTLIST for valid names.

Default: [ANTREMOTE] AUTO, "NONE"

Examples:

[ANTREMOTE] AUTO
Determine the remote base station's antenna type from the corrections messages

[ANTREMOTE] MANUAL, "JDCSF6000 NONE"
The remote base station is set to manual mode and has an SF6000 antenna

[ANTREMOTE] AUTO, "JDCSF6000 NONE"
The remote base station is set to auto mode and won't change the current remote antenna type until the corrections messages such as 1007/1008/1033/NCT62_1033 is received. The antenna type after "AUTO" is NOT necessary, and does NOT take effect.

1.12 ANTSWAP

☒SF-5050 ☒Onyx

This command swaps which antenna is connected to which RF ASIC

Command:		[ANTSWAP] on_off {, reset }
Parameter		**Definition**
OFF	K	Antenna jack J3 is connected to RF ASIC 0, J4 to RF ASIC 1
ON	K	Antenna jack J4 is connected to RF ASIC 0, J3 to RF ASIC 1
RESET	K	RESET – Reset receiver after changing antenna connection (default)

Default: *[ANTSWAP] OFF*

Only RF ASIC 0 can be used for L-Band (tracking StarFire). Please be sure that the antenna connected to RF ASIC 0 is capable of L-Band.

This command is also available in manufacturing test

Changing the ANTSWAP setting causes the receiver to reset itself.

Examples:

[ANTSWAP] ON
Connect antenna jack J4 to RF ASIC 0 and J3 to RF ASIC 1 and reset the receiver.

[ANTSWAP]ON, RESET
Connect antenna jack J4 to RF ASIC 0 and J3 to RF ASIC 1 but do not reset the receiver

1.13 ARLENGTHCONSTR (ASCII)

☒SF-5050 ☒Onyx

This command is used to specify whether to use baseline length as ambiguity constraint and pseudo measurement. In order to make the setting valid, receiver must be in MBRTK rover mode and the fixed baseline must be set.

Command:		[ARLENGTHCONSTR] ON_OFF
Parameter		**Definition**
ON_OFF	K	Indicates whether the mode is on or off.

Default: *OFF*

Examples:

[ARLENGTHCONSTR] ON
Use length as constraint

[ARLENGTHCONSTR] OFF
Do not use length as constraint

[ARLENGTHCONSTR]
Displays length constraint status

1.14 AUTOSCHEDULEDTM

☒SF-5050 ☒Onyx

This command controls the automatic scheduling of NMEADTM and NMEAPNCTDTM messages.

If this command is enabled, then:

1. NMEADTM will be scheduled automatically ONCHANGE or ONTIME whenever the user schedules NMEAGGA, NMEAGLL, NMEARMC, or NMEAGNS.
    a. The NMEADTM will always change to match the fastest output rate scheduled on a specific port.
    b. If either of the messages listed is scheduled ONCHANGE, then NMEADTM will be scheduled ONCHANGE.
    c. If none of the above is scheduled ONCHANGE, but ONTIME instead, then NMEADTM will be scheduled ONTIME with an interval matching the fastest scheduled interval of the above messages.
2. NMEAPNCTDTM will be scheduled automatically ONCHANGE whenever the user schedules NMEAPNCTGGA.
    a. The NMEAPNCTDTM will always change to match the message listed above.
3. The user will have to deschedule the DTM messages manually even if all the other related messages have been descheduled. The DTM messages will only change if any of the messages listed change to ONCHANGE or ONTIME state.

Command:		[AUTOSCHEDULEDTM] on_off
Parameter		**Definition**
ON	K	Enables the autoscheduling on all ports
OFF	K	Disables the autoscheduling on all ports

Default: ON

Examples:

[AUTOSCHEDULEDTM] ON
Turns on automatic scheduling

1.15 BOOTLOADA (ASCII)

☒SF-5050 ☒Onyx

This command is used to initiate a GNSS board software download using GNSS Bootloader1 or Bootloader2.

Command:		[BOOTLOADA] command, target, action
Parameter		**Definition**
command	K	The only valid command is PING
target	K	For [BOOTLOADA] command sent from PC to receiver, this is which bootloader to transfer control to (BOOT1, BOOT2) For [BOOTLOADA] reply sent from receiver to PC, this is the target software type that generates the reply. (NAV_PROG)
action	K	What action the bootloader is to take (see Table 14 and Table 15).

Bootloader1 can only perform Bootloader1 actions and Bootloader2 can only perform Bootloader2 actions.

The Power I/O board uses a Virtual COM port interface for the USB and Ethernet ports, so all bootloading is done using the LOADSERIALBOOTx actions.

Example: [BOOTLOADA] PING, BOOT2, LOADSERIALBOOT2

Bootload through a serial port using BOOT2

Table 14: BOOTLOADA Bootloader1 Actions

Bootloader1 Action	**Description**
BOOT1	Remain in bootloader1. Do not try to start the navigation program automatically.
BOOT2	Start bootloader2.
NAV	Start the navigation program.
MTEST	Start the manufacturing test program.
LOADSERIALBOOT1	Bootload through the serial port using bootloader1. For SF-5050, bootloader1 only supports loading through COM1.

Table 15: BOOTLOADA Bootloader2 Actions

Bootloader2 Action	**Description**
LOADSERIALBOOT2	Bootload through the serial port using bootloader2. For the SF-5050, bootloader2 supports loading through COM1, COM2, USB and Ethernet. Loading through COM2, USB and Ethernet requires that Power I/O board software is up and running.
Reserved	--

**For information on loading firmware without using StarUtil 5000, See Appendix G*

1.16 BOOTLOADB

☒SF-5050 ☒Onyx

GNSS Bootloader1 and Bootloader2 monitor the serial ports for the download of binary software messages. [BOOTLOADB] is the message ID for the software that is being downloaded. It uses the simplified binary header format described below.

Field	# Bits	Type	Description
Length	16	U16	Number of bytes in the binary header plus the data block i.e. data block length plus 2 bytes for the length of this header

1.16.1 Bootload Input File Format

The input file to the bootload process is the ".s19" file. This file format is generated by the software build process post-linker tool. It is the standard Motorola s-record file with special s0 record for the SF-5050.

The input file for the GNSS board bootload process could be one of the following: GNSS bootloader1, bootloader2 and NAV program (main application).

The input file for the PowerIO board bootload process could be one of the following: PIO bootloader and application program.

1.16.1.1 SF-5050 S0 Record Format

For the SF-5050, the s19 file includes multiple lines of s0 records, which contain useful information about the details of the software image, including the version, product type, product string, build data, time, etc. The information can be used with the bootloading tool to tell which program it is loading. Some older versions of the s19 file build do not implement this format of the s0 record.

The first s0 record contains the string "NCT SWINFO VER 001". This line defines the version of the software info structure that follows. The "001" is the current version.

The second, third, and forth lines of the s0 record contain the software_info structure defined below.

Table 16: Software Info Structure Definition

Field	Data Type	Value and Description
CRC32 pointer	U32	Address of the CRC32 of the whole software image
Major version	U08	Software major version
Minor version	U08	Software minor version
Build number	U08	Software build number
Software type	U08	Software type enum defined in Table 21
Data	U08[12]	ANSI C standard software build date string. Example: Mar 13 2009

Table continued on next page…

Field	Data Type	Value and Description
Time	U08[9]	ANSI C standard software build time string; example: 17:17:11
Reserved1	U08[3]	Reserved field
Product type	U08	
Spin number	U08	Software spin number
Reserved2	U08	Reserved field
Swinfo_ver	U08	Software Info structure (this structure) version
Product string	U08[28]	Descriptive text string for the product. See Table 21 for the list.

The data portion of those s0 records contains a maximum of 44 hex characters (representing 22 bytes of data). The total size of the software_info structure is 64 bytes, so the second and third s0 record contain 22 bytes of data, and the forth s0 record contains 20 bytes of data.

Example s0 records for bootloader1 ".s19" file:

```
S01600004E4354205357494E464F20564552203030310050
S0190000FFF12AA0010201004A756C203234203230303900313724
S01900003A32313A33380000000000003000001534F4C415249532063
S0170000474E535320424F4F5431000000000000000000000028
```

Decoding of the first s0 record:

```
S0 16 0000 4E4354205357494E464F2056455220303031 00 50
 length |  N C T   S W I N F O   V E R   0 0 1   | checksum
      address                                 terminating null character
```

1.16.2 BOOTLOADB Message Body General Format

The BOOTLOADB message general format is defined in the following table:

Table 17: BOOTLOADB Binary Message

Data Item (8 Bytes + data)	Data Type	Section
Function Type SubID (enum)	U08	1.25.2.1
Pass or Fail (1 = pass, 0 = fail)	U08	1.25.2.2
Valid count	U16	1.25.2.3
Address	U32	1.25.2.4
Data	U08[]	1.25.2.5

1.16.2.1 Function Type

Function Type provides a Function/SubID of the command. The following function type subIDs are defined as enum: (Enums ending with "Cmd" are commands sent from a PC tool to the receiver. Enums ending with "Rep" are replies sent from the receiver to a PC tool).

Table 18: BOOTLOADB Message Function SubID Enum Definition

Value	Enum Name
1	NB_PingCmd
2	NB_PingRep,
3	NB_BaudCmd,
4	NB_BaudRep,
5	NB_SetupCmd,
6	NB_SetupRep,
7	NB_LoadDataCmd,
8	NB_LoadDataRep,
9	NB_ChkCrcCmd,
10	NB_ChkCrcRep,
11	NB_ProgCmd,
12	NB_ProgRep,
13	NB_EraseCmd,
14	NB_EraseRep,
15	NB_WriteFCmd,
16	NB_WriteFRep,
17	NB_ResetCmd,
18	NB_ResetRep,
19	NB_Working,
20	NB_EnumLast

1.16.2.2 Pass or Fail

For a reply message, this field indicates if the previous command passed or failed. For a command message, this field is either not used or has another meaning.

1.16.2.3 Valid Count

This field indicates how many bytes in the data field are valid.

1.16.2.4 Address

When downloading data, this field indicates the destination address of the data. In a response message, if the pass/fail field is fail, this field indicates the error code. BootloadB and BootloadPIOB message error codes are defined in Table 19. This field has other meanings under different circumstances.

Table 19: BOOTLOADB and BootloadPIOB Message Error Codes

Value	Enum	Description
0	Err_PingTarget	For the BootloadB command, this means Ping Target Error. This could be caused by an invalid value in the ping_target (address) field in the NB_PingCmd command, or by trying to ping bootloader2 when bootloader1 is running. For the BootloadPIOB command, this enum is not used.
1	Err_InvalidBaud	Invalid baud rate in NB_BaudCmd command
2	Err_SetupRange	Address range error in NB_SetupCmd command
3	Err_LoadData	Error in NB_LoadDataCmd command
4	Err_MaxAddr	Maximum address error. This could be caused by the maximum address of the data received being inconsistent with the value specified in NB_SetupCmd command.
5	Err_BadCrc	Software image CRC error detected in replying to NB_ChkCrcCmd command
6	Err_EraseFlash	Erase flash error
7	Err_WriteFlash	Write to flash error
8	Err_Reset	Receiver reset error
100	Err_SubID	Unknown subID received in [BOOTLOADB] or [BOOTLOADPIOB] command

1.16.2.5 Data

In the NB_LoadDataCmd message, this field contains the data. It has other meanings in other SubID messages. The maximum size of this field is 2048 bytes. If loading through the Ethernet port using UDP, the maximum size should be less than about 1400 bytes.

1.16.3 BootloadB SubID Message Format

1.16.3.1 SubID NB_PingCmd Message Format

The SubID NB_PingCmd is sent from a PC to the receiver. It is used by the PC to ping the receiver bootloader software and to start the bootloading process. Its format is defined in Table 20.

Table 20: SubID NB_PingCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_PingCmd*.
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0. There is no data following the address field
Address	U32	*Ping_Target*: *Ping_Target* is the receiver software type that the PC program is trying to ping. The software type enum is defined in Table 21. For this command, the valid value is ST_Bootblock1 or ST_Bootblock2. For the SF-5050, Bootloader1 can be used to load any GNSS board software from COM1 except itself. Bootloader2 can be used to load any GNSS board software from both COM1 and COM2. Use bootloader2 to load software whenever possible.

Table 21: Software Type Enum

Value	Enum	Description	Product String (in Software Info Structure)
0	ST_BOOTBLOCK1	GNSS board Bootloader1 software	“GNSS BOOT1”
1	ST_BOOTBLOCK2	GNSS board Bootloader2 software	“GNSS BOOT2”
2	ST_NAVPROG	GNSS board Navigation software	“NAV”
3	Reserved	Reserved	Reserved
4	ST_PIOBOOT1	PIO board bootloader1	“PIOBOOT1”
5	ST_PIOBOOT2	PIO board bootloader2	“PIOBOOT2”
6	ST_PIOAPP	PIO board application	“PIOAPP”

1.16.3.2 SubID NB_PingRep Message Format

SubID NB_PingRep is sent from receiver to PC. It is the reply message for NB_PingCmd. Its format is defined in Table 22.

Table 22: SubID NB_PingRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_PingRep*.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field
Address	U32	If pass, this field contains the enum of the software type that generates this response. If fail, this field contains error code *Err_PingTarget*.

1.16.3.3 SubID NB_BaudCmd Message Format

SubID NB_BaudCmd is sent from the PC to a receiver. It is used by the PC to specify an alternative Baud rate for bootloading. This message is not required if the Baud rate doesn’t need to be changed.

For the SF-5050, if GNSS software bootloading port is USB or Ethernet, this command has no effect and should not be sent. Also, due to hardware architecture design, if GNSS software bootloading port is COM2, this command is not sent.

Table 23: SubID NB_BaudCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_BaudCmd*
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0. There is no data following the address field
Address	U32	The Baud rate the PC commands the receiver to change to. The supported Baud rates are: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

1.16.3.4 SubID NB_BaudRep Message Format

SubID NB_ BaudRep is sent from receiver to PC. It is the reply message for NB_BaudCmd.

Table 24: SubID NB_BaudRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ BaudRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field
Address	U32	If pass, this field is 0. If fail, this field contains error code *Err_InvalidBaud*.

The receiver sends out this reply at the original baud rate, and then changes the port baud rate to the value specified in the *NB_BaudCmd* command.

The PC changes its baud rate after it receives this reply from the receiver. Wait 10 to 100 ms before sending the next command from the PC to allow both the receiver and the PC to finish changing the baud rate.

1.16.3.5 SubID NB_SetupCmd Message Format

SubID NB_SetupCmd is sent from the PC to the receiver. It is used by the PC to specify the minimum and maximum address of the data to be loaded.

Table 25: SubID NB_SetupCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_SetupCmd.
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	4. This is the data size following the address field (in bytes)
Address	U32	Minimum address of the software image data to be loaded
Data	U32	Maximum address of the software image data to be loaded

1.16.3.6 SubID NB_SetupRep Message Format

SubID NB_SetupRep is sent from receiver to PC. It is the reply message for NB_ SetupCmd. Its format is defined in Table 27.

Table 26: SubID NB_SetupRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_ SetupRep.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field
Address	U32	If pass, this field is 0. If fail, this field contains error code *Err_SetupRange*.

1.16.3.7 SubID NB_LoadDataCmd Message Format

SubID NB_LoadDataCmd is used for sending software image data from PC to receiver.

Table 27: SubID NB_LoadDataCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_LoadDataCmd.
Pass or Fail	U08	For SF-5050 GNSS bootloader1, this field is not used. Value should be 0. For SF-5050 GNSS bootloader2, this field is the data frame number between 1 and 255 (inclusive). For each sub-sequent data messages, this number shall increment by 1. When it reaches 255, next message shall have value 1 again. The SF-5050 bootloader2 uses a sliding window so that each data message does not need to be acknowledged before sending the next. However, the window should be kept reasonably small with high speed ports like Ethernet and Bluetooth®. The recommended window size is 3. If the SF-5050 bootloader2 receives a data message out of order, it won't ack or nak, which should cause a timeout for PC to resend the old data frame. Current version of SF-5050 bootloader1 doesn't implement this mechanism. (This field is not used in SF-5050 bootloader1)
Valid count	U16	Number of data in the data field (in bytes)
Address	U32	Destination address of the first data byte in data field
Data	U08[]	Array of software image data

1.16.3.8 SubID NB_LoadDataRep Message Format

SubID NB_LoadDataRep is sent from receiver to PC. It is the reply message for NB_LoadDataCmd.

Table 28: SubID NB_ LoadDataRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_LoadDataRep.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	This is the length for the data field (in bytes). 0 for SF-5050 bootloader1. 1 for SF-5050 bootloader2.
Address	U32	If pass, this field is the address in the received command. If fail, this field contains error code Err_LoadData.
Data	U08	This field only exists for SF-5050 bootloader2. It contains the data frame number of the received command that generates this reply.

1.16.3.9 SubID NB_ChkCrcCmd Message Format

SubID NB_ ChkCrcCmd is sent from PC to receiver. It is used to tell the receiver that the data loading process is complete. After receiving this command, the receiver starts comparing the maximum address of the received data with the value in the NB_SetupCmd message, and computing the CRC of all the received data. Its format is defined in Table 29.

Table 29: SubID NB_ChkCrcCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ChkCrcCmd*.
Pass or Fail	U08	This field is not used for this command. Value should be 0.
Valid count	U16	0
Address	U32	0

1.16.3.10 SubID NB_ChkCrcRep Message Format

SubID NB_ChkCrcRep is sent from receiver to PC. It is the reply message for NB_ChkCrcCmd.

Table 30: SubID NB_ChkCrcRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_ChkCrcRep.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	This is the length for the data field (in bytes). 4 if fail due to CRC error 0 otherwise
Address	U32	If pass, the value is 0. If fail due to maximum address not equal to the value in NB_SetupCmd, the value is error code Err_MaxAddr. If fail due to CRC error, the value is error code Err_BadCrc.
Data	U32	This field only exists if fail due to CRC error. Its value is the computed CRC32 of the data image.

1.16.3.11 SubID NB_ProgCmd Message Format

SubID NB_ ProgCmd is sent from PC to receiver. It is used to tell the receiver to start programming the new data into Flash. After receiving this command, the receiver starts erasing the Flash and writing the new data into Flash.

Table 31: SubID NB_ProgCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ProgCmd*.
Pass or Fail	U08	This field is not used for this command. Value should be 0.
Valid count	U16	0
Address	U32	0

1.16.3.12 SubID NB_EraseRep Message Format

SubID NB_EraseRep is sent from receiver to PC. It is one of the reply messages for NB_ProgCmd. The receiver sends out this message after it erases Flash, which typically takes 1 to 3 seconds.

Table 32: SubID NB_EraseRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_EraseRep.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	If pass, value is 0. If fail, value is error code Err_EraseFlash.

1.16.3.13 SubID NB_WriteFRep Message Format

SubID NB_WriteFRep is sent from receiver to PC. It is one of the reply messages for NB_ProgCmd. The receiver sends out this message after it writes new data to Flash, which can take up to 20 seconds, depending on program size.

Table 33: SubID NB_WriteFRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_WriteFRep.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	If pass, value is 0. If fail, value is error code Err_WriteFlash.

1.16.3.14 SubID NB_Working Message Format

SubID NB_Working is sent from receiver to PC. It is one of the reply messages for NB_ProgCmd. The receiver sends out this message at approximately 1 Hz rate when the receiver is erasing Flash or writing data to Flash. It is used to keep the PC from timing out because erasing and writing data to flash might take up to 20 seconds.

Table 34: SubID NB_Working Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_Working.
Pass or Fail	U08	1
Valid count	U16	0
Address	U32	0

1.16.3.15 SubID NB_ResetCmd Message Format

SubID NB_ResetCmd is sent from PC to receiver. It is used to tell the GNSS board software to do a software reset after bootloading. After reset, the GNSS board runs navigation software if it exists; otherwise, it stays in bootloader1.

Table 35: SubID NB_ResetCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_ResetCmd.
Pass or Fail	U08	0
Valid count	U16	0
Address	U32	0

1.16.3.16 SubID NB_ResetRep Message Format

SubID NB_ResetRep is sent from receiver to PC. It is the reply message for NB_ResetCmd. Its format is defined in Table 36.

Table 36: SubID NB_ResetRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_ResetRep.
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	0

1.16.4 GNSS Software Loading Sequence

PC	Receiver Navigation Software
1. Send "[BOOTLOADA] PING, BOOT1, LOADSERIALBOOT1" Or "[BOOTLOADA] PING, BOOT2, LOADSERIALBOOT2"	2. If GNSS board navigation software is running, it decodes the command and replies with "[BOOTLOADA]PING, NAV_PROG". Then it runs bootloader1 or bootloader2. Bootloader1 and bootloader2 always run at the default baud rate 57600. If GNSS board bootloader1 or bootloader2 is already running, the reply is NAK.
PC	**Receiver Bootloader1 or Bootloader2**
3. If received [BOOTLOADA] reply, go to step 4. If received NAK, continue to send the [BOOTLOADA] command 2 more times, then go to step 4. 4. Change PC baud rate to 57600 and send out "[BOOTLOADB]NB_PingCmd" command. The ping_target field should be consistent with the one in [BOOTLOADA] command. "[BOOTLOADB]NB_PingCmd" may need to be sent out multiple times before a reply can be received due to the receiver transitioning between navigation software and bootloader1 or bootloader2. Sending this command at 5 Hz rate until a reply is received is recommended. Normally when bootloader1 starts, there is a 0.5 seconds window in which it listens to the bootload command. Sending this command at 5 Hz rate will improve the chance of bootloader1 catching the command within the window and help receiver recovery in some cases.	5. Bootloader1 or bootloader2 runs, receives the command and replies with [BOOTLOADB]NB_PingRep".
PC	**Receiver Bootloader1 or Bootloader2**
6. If the PC wants to change the baud rate, send "[BOOTLOADB]NB_BaudCmd"; otherwise, go to step 11. This command is not sent under certain circumstances. Refer to section 1.16.3.3 for more details.	7. Send "[BOOTLOADB]NB_BaudRep" and start to change receiver baud rate.

PC	Receiver Navigation Software
8. After receiving "[BOOTLOADB]NB_BaudRep", change PC baud rate. 9. Send "[BOOTLOADB]NB_PingCmd" again at new baud rate. This message may need to be sent multiple times before a reply is received, due to lack of synchronization between PC and receiver because of the changing baud rate. Sending this command at 1 Hz rate until a reply is received is recommended.	10. Reply with "[BOOTLOADB]NB_PingRep"
11. Send "[BOOTLOADB]NB_SetupCmd"	12. Reply with "[BOOTLOADB]NB_SetupRep"
13. Send "[BOOTLOADB]NB_LoadDataCmd"	14. Reply with "[BOOTLOADB]NB_LoadDataRep"
15. Repeat step 13 and 14 until all the software image data are sent	
16. Send "[BOOTLOADB]NB_ChkCrcCmd"	17. Reply with "[BOOTLOADB]NB_ChkCrcRep"
18. Send "[BOOTLOADB]NB_ProgCmd"	19. Start to erase Flash and send out "[BOOTLOADB]NB_Working" at 1 Hz rate 20. Reply with "[BOOTLOADB]NB_EraseRep" when finished erasing the Flash 21. Start to write new data to Flash and send "[BOOTLOADB]NB_Working" at 1 Hz rate 22. Reply with "[BOOTLOADB]NB_WriteFRep" when finished writing new data to the Flash
23. Send "[BOOTLOADB]NB_ResetCmd"	24. Reply with "[BOOTLOADB]NB_ResetRep" and do GNSS software reset.

1.17 BOOTLOADPIOB

☒SF-5050 ☐Onyx

This command is used for downloading new SF-5050 Power I/O cold bootloader and application software images. The binary software downloading message has message ID [BOOTLOADPIOB].

It uses the simplified binary header format described in Table 9

The input file format of the PIO bootload process is the same as described in 1.25.1

Because of architectural differences between the PIO cold bootloader and warm bootloader, the commands and responses used near the end of the bootloading sequence are slightly different for the two bootloaders.

1.17.1 Message General Format

The input file to the bootload process is the ".s19" file. This file format is generated by the software build process post-linker tool. It is the standard Motorola s-record file with special s0 record for Solstice.

The input file for the GNSS board bootload process could be one of the following: GNSS bootloader1, bootloader2 and NAV program (main application).

The input file for the PowerIO board bootload process could be one of the following: PIO bootloader1, bootloader 2 and application program.

Table 37: BOOTLOADPIOB Binary Message

Data Item (8 Bytes + data)	Data Type	Section
Function Type SubID (enum)	U08	1.26.1.1
Pass or Fail (1 = pass, 0 = fail)	U08	1.26.1.2
Valid count	U16	1.26.1.3
Address	U32	1.26.1.4
Data	U08[]	1.26.1.5

1.17.1.1 Function Type

Function Type provides a Function/SubID of the command. The following function type subIDs are defined as enum: (Enums ending with "Cmd" are commands sent from a PC tool to the receiver. Enums ending with "Rep" are replies sent from the receiver to a PC tool).

Table 38: BOOTLOADB Message Function SubID Enum Definition

Value	Enum Name
1	NB_PingCmd
2	NB_PingRep,
3	NB_BaudCmd,
4	NB_BaudRep,
5	NB_SetupCmd,
6	NB_SetupRep,
7	NB_LoadDataCmd,
8	NB_LoadDataRep,
9	NB_ChkCrcCmd,
10	NB_ChkCrcRep,
11	NB_ProgCmd,
12	NB_ProgRep,
13	NB_EraseCmd,
14	NB_EraseRep,
15	NB_WriteFCmd,
16	NB_WriteFRep,
17	NB_ResetCmd,
18	NB_ResetRep,
19	NB_Working,
20	NB_EnumLast

1.17.1.2 Pass or Fail

For reply messages, this field indicates if the previous command passed or failed.

For command messages, this field is either not used, or another meaning (defined below).

1.17.1.3 Valid Count

This field indicates how many bytes in the data field are valid.

1.17.1.4 Address

When downloading data, this field indicates the destination address of the data.

In reponse messages, if the pass/fail field is fail, this field indicates the error code. Error codes are defined in Table 19.

This field has other meanings under different circumstances (defined below).

1.17.1.5 Data

In NB_LoadDataCmd message, this field contains the data. It has other meanings in other subID messages. The maximum size of this field is 2048 bytes. If loading through the Ethernet port using UDP, the maximum size should be less than 1400 bytes.

1.17.2 BOOTLOADPIOB SubID Message Format

1.17.2.1 SubID NB_PingCmd Message Format

SubID NB_PingCmd is sent from PC to receiver. It is used for PC to ping receiver bootloader software and to start the bootloading process.

Table 39: SubID NB_PingCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_PingCmd*.
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0. There is no data following the address field
Address	U32	0. The PIO does not require a "Target Type" in this message as does the GNSS firmware.

1.17.2.2 SubID NB_PingRep Message Format

SubID NB_PingRep is sent from receiver to PC. It is the reply message for NB_PingCmd. Its primary function in the PIO firmware load process is to verify the PIO is ready to begin the download process.

Table 40: SubID NB_PingRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_PingRep.
Pass or Fail	U08	1. Always set to "PASS" by PIO firmware.
Valid count	U16	0. There is no data following the address field
Address	U32	Same as the address field in the NB_PingCmd msg.

1.17.2.3 SubID NB_BaudCmd Message Format

SubID NB_BaudCmd is sent from PC to receiver. It is used for PC to specify an alternative baudrate for bootloading. This message is not required if baudrate doesn't need to be changed.

If PIO software bootloading port is USB or Ethernet, this command has no effect and should not be sent. Also, due to hardware architecture design, if PIO software bootloading port is COM1, this command shall not be sent.

Table 41: SubID NB_BaudCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_BaudCmd*.
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0. There is no data following the address field
Address	U32	Baudrate PC wants receiver to change to. The supported baudrates are: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

1.17.2.4 SubID NB_BaudRep Message Format

SubID NB_ BaudRep is sent from receiver to PC. It is the reply message for NB_BaudCmd. Its format is defined in Table 42.

Table 42: SubID NB_BaudRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ BaudRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field
Address	U32	If pass, this field is 0. If fail, this field contains error code *Err_InvalidBaud*.

The receiver will send out this reply at the original baudrate, then change the port baudrate to the value specified in the *NB_BaudCmd* command.

The PC shall change its baudrate after it receives this reply from receiver. It is recommended that PC wait for 10 to100ms before it sends the next command to allow both the receiver and PC to finish changing baudrate.

1.17.2.5 SubID NB_SetupCmd Message Format

SubID NB_SetupCmd is sent from PC to receiver. It is used for PC to specify the minimum and maximum address of the data to be loaded.

Table 43: SubID NB_SetupCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_SetupCmd*.
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	4. This is the data size following the address field (in bytes)
Address	U32	Minimum address of the software image data to be loaded
Data	U32	Maximum address of the software image data to be loaded

1.17.2.6 SubID NB_SetupRep Message Format

SubID NB_SetupRep is sent from receiver to PC. It is the reply message for NB_ SetupCmd.

Table 44: SubID NB_SetupRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ BaudRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field
Address	U32	If pass, this field is 0. If fail, this field contains error code *Err_SetupRange*.

1.17.2.7 SubID NB_LoadDataCmd Message Format

SubID NB_LoadDataCmd is used for sending software image data from PC to receiver.

Table 45: SubID NB_LoadDataCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_LoadDataCmd*.
Pass or Fail	U08	This field is the data frame number between 1 and 255 (inclusive). For each sub-sequent data messages, this number shall increment by 1. When it reaches 255, next message shall have value 1 again. The SF-5050 uses a sliding window so that each data message does not need to be acknowleged before sending the next. However, the window should be kept reasonably small with high speed ports like Ethernet and Bluetooth®. The recommended window size is 3. If SF-5050 receives a data message out of order, it won't ack or nak, which should cause a timeout on the PC to resend the 1st data frame in the current window.
Valid count	U16	Number of data bytes in the data field.
Address	U32	Destination address of the first data byte in data field
Data	U08[]	Software image data

1.17.2.8 SubID NB_LoadDataRep Message Format

SubID NB_LoadDataRep is sent from receiver to PC. It is the reply message for NB_LoadDataCmd.

Table 46: SubID NB_LoadDataRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_LoadDataRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	This is the length for the data field (in bytes). 0 for Onyx and Solstice bootloader1. 1 for Solstice bootloader2.
Address	U32	If pass, this field is address in the received command. If fail, this field contains error code *Err_LoadData*.
Data	U08	This field contains data frame number of the received command that generates this reply.

1.17.2.9 SubID NB_ ChkCrcCmd Message Format

The command SubID NB_ ChkCrcCmd is sent from PC to receiver. It is used to tell receiver that the data loading process has completed. After receiving this command, the receiver will start comparing the maximum address of the received data with the value in NB_SetupCmd message, and computing CRC of all the received data.

Table 47: SubID NB_ChkCrcCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ChkCrcCmd*.
Pass or Fail	U08	This field is not used for this command. Value should be 0.
Valid count	U16	0
Address	U32	0

1.17.2.10 SubID NB_ChkCrcRep Message Format

The command SubID NB_ ChkCrcRep is sent from receiver to PC. It is the reply message for NB_ChkCrcCmd.

Table 488: SubID NB_ChkCrcRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ChkCrcRep*.
Pass or Fail	U08	1=Pass, 0= Fail.
Valid count	U16	This is the length for the data field (in bytes). If fails, due to CRC error then 4 Otherwise its 0
Address	U32	If pass, value is 0. If fail due to maximum address not equal to the value in NB_SetupCmd, value is error code *Err_MaxAddr*. If fail due to CRC error, value is error code *Err_BadCrc.*
Data	U32	This field only exists if failed due to CRC error. Its value is the computed CRC32 of the data image.

1.17.2.11 SubID NB_ProgCmd Message Format

SubID NB_ ProgCmd is sent from PC to receiver. It is used to tell receiver to start programming the new data into flash. After receiving this command, the receiver will start erasing the Flash and writing the new data into flash.

The cold bootloader will send the NB_EraseRep, NB_WorkingRep and NB_WriteRep messages (described below) while programming, then wait for additional commands. The warm bootloader will respond with an NB_WriteFRep response, then automatically reboot after programming is complete.

Table 49: SubID NB_ProgCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ProgCmd*.
Pass or Fail	U08	This field is not used for this command. Value should be 0.
Valid count	U16	0
Address	U32	0

1.17.2.13 SubID NB_EraseRep Message Format

SubID NB_EraseRep is sent from receiver to PC. It is one of the reply messages for NB_ProgCmd. Receiver sends out this message after it erases Flash, which typically takes 1 to 3 seconds. This reply is sent by the PIO cold bootloader, but not the warm bootloader.

Table 49: SubID NB_EraseRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_EraseRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	If pass, value is 0. If fail, value is error code *Err_EraseFlash*.

1.17.2.14 SubID NB_WriteFRep Message Format

SubID NB_WriteFRep is sent from receiver to PC. It is one of the reply messages for NB_ProgCmd. Receiver sends out this message after it writes new data to Flash, which can take upto 20 seconds, depending on program size.

Table 50: SubID NB_WriteFRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_WriteFRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	If pass, value is 0. If fail, value is error code *Err_WriteFlash*.

1.17.2.15 SubID NB_Working Message Format

SubID NB_Working is sent from receiver to PC. It is one of the reply messages for NB_ProgCmd. Receiver sends out this message at approximately 1 Hz rate when receiver is erasing Flash or writing data to Flash. It is used to keep PC from timing out because erasing and writing data to flash could take upto 20 seconds.This message is sent by the PIO cold bootloader but not the warm bootloader.

Table 51: SubID NB_Working Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_Working.*
Pass or Fail	U08	1
Valid count	U16	0
Address	U32	0

1.17.2.16 SubID NB_ResetCmd Message Format

SubID NB_ResetCmd is sent from PC to receiver. It is used to tell the PIO cold bootloader to do a software reset after bootloading. The warm bootloader does not require this command, as it resets automatically after reprogramming the flash.

Table 52: SubID NB_ResetCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ResetCmd.*
Pass or Fail	U08	0
Valid count	U16	0
Address	U32	0

1.17.2.17 SubID NB_ResetRep Message

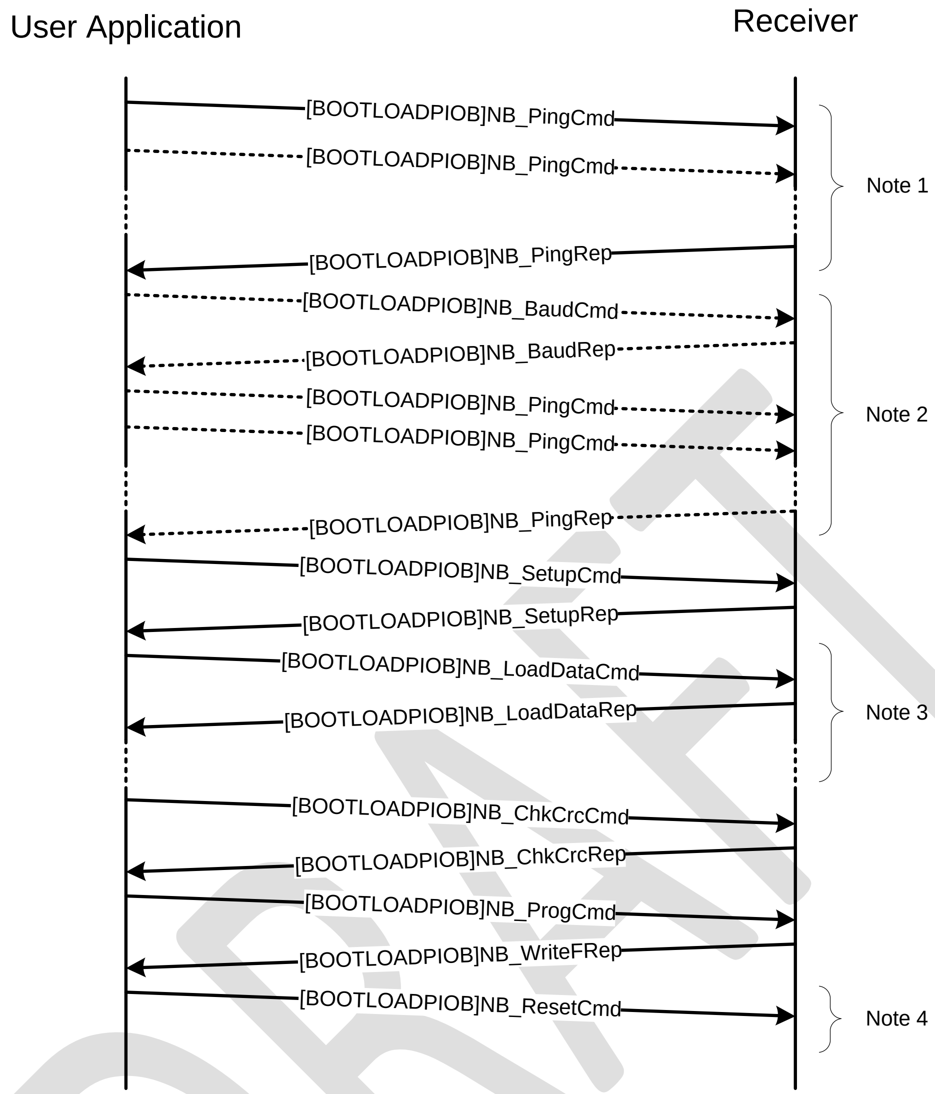
The SubID NB_ResetRep is sent by the cold bootloader in response to NB_ResetCmd. The warm bootloader does not use the NB_ResetCmd, so it does not issue the response.

Table 53: SubID NB_ResetRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ResetRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	0

1.26.3 PIO Software Loading Sequence

The PIO software loading sequence is similar to GNSS board software loading described in the message protocol.



PC should send NB_PingCmd at a rate of 1-2 Hz until a reply is received.

Changing the port baud rate is optional, and is ignored if downloading using the Ethernet or Bluetooth® ports.

The PIO firmware download supports a sliding window if the user choses to use it. If a NB_LoadDataCmd is not acknowleged, the user must retransmit all messages in the window. For high speed ports (Ethernet, Bluetooth®, USB), the window should be kept small.

The NB_ResetCmd and NB_ResetRsp are used by the cold bootloader but not the warm bootloader. If desired, the user may send NB_PingCmd messages to detect when the PIO board has completed the reset sequence.

1.18 BTSET

☒SF-5050 ☐Onyx

This command allows a user to set parameters in the Bluetooth® module.

Command:	[BTSET] RESET | ON | OFF | PIN | DELPIN | SETPIN, <pin> | ADDR | DISCONNECT| CLEARMAP

Table 54: [BTSET] Command Action Keywords (Subcommands)

Keyword		Profile Action
RESET	K	Resets Bluetooth® (software reset); Causes the Bluetooth® device to drop the connection and reboot
ON	K	Turns on Bluetooth® (causes a software reset of Bluetooth® firmware)
OFF	K	Turns off Bluetooth® (Bluetooth® enters "deep sleep" power-saving mode and no text message is output)
PIN	K	Requests the system PIN code
DELPIN	K	Deletes the system PIN code (encryption no longer available)
SETPIN	K	Sets the PIN code (also known as passkey code) for authorized connections. Maximun length of the BT PIN is 16.
ADDR	K	Requests Bluetooth® device address (6-byte string of hex numbers in the format "xx.xx.xx.xx.xx.xx")
DISCONNECT	K	Disconnects the Bluetooth® device and makes it available to pair with another device.
CLEARMAP	K	This keyword, used for the SF-3040, clears the stored port connection information.

The Bluetooth® module can be in two modes:

- Command Mode – in this mode, the module receives commands (e.g., SETPIN, DELPIN).
- Data Mode – in this mode, the module has an active data connection with a connected device; it does not receive commands because commands would be interpreted as data that need to be passed to the connected device.

When the Bluetooth® module is in "data mode," the keywords are ON/OFF/DISCONNECT. The remaining keywords return NAK - "BT module in data mode".

Examples:

[BTSET]ON
Turns on Bluetooth®

Default: *ON*

Turning on Bluetooth® is associated with a software reset of the Bluetooth® firmware, so the system returns the same output as with the RESET command. When Bluetooth® is ON, another in-range Bluetooth® electronic device should be able to detect the existence of the system.

Examples continued on next page…

[BTSET]RESET
Resets Bluetooth® firmware (sample output: “Copyright© 2003-2008 Bluegiga Technologies, Inc.”)

[BTSET]OFF
Turns off Bluetooth®

When the Bluetooth® is OFF, its interface with the UART on the PIO board is disabled and all commands sent to the Bluetooth® module are not accepted by the module (until it is turned on again). No text message is output. Turning off Bluetooth® puts the module into “deep sleep” power-saving mode, thus making the RF invisible, and another in-range Bluetooth® electronic device cannot detect the existence of the system.

[BTSET] PIN
Requests PIN code (sample output: “SET BT AUTH # 1234”)
Returns the PIN code in the system, if one exists; otherwise, returns “No Pin”.

[BTSET]SETPIN, “123456”
Sets Bluetooth® PIN code for authorized connections (sample output: “SET BT AUTH # 1234”)

[BTSET]DELPIN
Deletes PIN code (sample output: “PIN Deleted”)

When the PIN code is deleted, no encryption can be used.

Default: *No PIN*

Any printable character can serve as a PIN. The maximum number of PIN characters is 31.

[BTSET]ADDR
Requests Bluetooth® device address (the 6-byte string of hex numbers in the format “xx:xx:xx:xx:xx:xx” , e.g., “00:07:80:81:66:fe”)

[BTSET]DISCONNECT
Disconnects Bluetooth® from the system (forces Bluetooth® module to drop all connections)

The DISCONNECT command can only be issued from non-Bluetooth® ports.

1.19 CANCELSFLICENSE

☒SF-5050 ☒Onyx

This command is used to cancel the current StarFire license. The receiver time at the time of cancellation is used as the cancellation date.

Command:	[CANCELSFLICENSE]

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

This command requires the receiver to be tracking GPS satellites at the moment the command is entered.

1.20 CHECKCRC

☒SF-5050 ☒Onyx

This command is used to check the CRC of the specified code (or all of the codes) in the flash. It calls the same CRC algorithm that runs prior to executing a [RESET] command. The CRC is calculated over the code's image in the flash, not the RAM, even if the command is called while running from the debugger.

Command:		[CHECKCRC] {code_id}
Parameter		**Definition**
code_id	K	Indicates which code or codes to check. Choices are BOOT1, BOOT2, NAV, and ALL to check all four codes. If no keyword is specified, ALL is assumed.

Default: *ALL*

Examples:

[CHECKCRC] ALL
BOOT1 passed, code is OK
BOOT2 passed, code is OK
NAV failed, need to reprogram flash

Use the keyword ALL to check all four codes with a single command. In this case, there is an error somewhere in the NAV code image.

ALL is also the default if no keyword is specified.

[CHECKCRC]
>[CHECKCRC] BOOT1 passed, code is OK
>[CHECKCRC] BOOT2 passed, code is OK
>[CHECKCRC] NAV passed, code is OK

1.21 COLDSTART

☒SF-5050 ☒Onyx

This command is used to do a receiver Cold Start. After receiving this command, the receiver erases the position, ephemeris, almanac (GPS and SBAS), time stored in NVRAM; invalidates real-time clock; and restarts.

Even though the almanac in NVRAM is erased, there is still a hard-coded almanac in the receiver firmware.

Command:		[COLDSTART] {DEFAULTALM}
Parameter		**Definition**
DEFAULT_ALM	K	Keyword: DEFAULTALM will use the default hard-coded almanac after reset.

Default: [COLDSTART]

The [COLDSTART] command sent without a parameter will not use the hard-coded almanac after reset

Examples:

[COLDSTART]
[COLDSTART] DEFALTALM
Runs the hard-coded almanac after reset

1.22 CONFIGGFA

☒SF-5050 ☒Onyx

This command can be used to change those parameters used in NMEA GFA message: KH, KV, Selected Accuracy Level, HAL.

Command:		[CONFIGGSA] {K_H, K_V, HAL, SAL}
Parameter		**Definition**
K_H	F	K for HPL
K_V	F	K for VPL
HAL	F	Horizontal Alert Level
SAL	F	Selected Accuracy Level

Default: K_H = 4.0
K_V = 3.5
HAL = 25.0
SAL = 10.0

1.23 DATUM ASCII

☒SF-5050 ☒Onyx

This command allows a user to check the current datum (a reference surface to be used in defining the 3D coordinates of a position) or to set a specific datum to be used as the position for all PVT data output.

1.36.1Reference Frame at Default State

At default (when a user does not specify any particular reference frame), the output of the navigation position (i.e., in the PVT1B message) is the data in the default frame.

In this state, there will be no datum transformation to the position data. The navigation library currently provides the solution in one of two reference frames (data), WGS84 (G1762) or ITRF2008 depending on the navigation mode. Refer to Table 189 for the datum used in the solution.

1.36.2 Reference Frame at Non-Default State

When a user selects a non-default datum, an additional transformation process takes place at the navigation library level to transform the solution data into the user-selected target datum. The following table lists the transformation(s) undertaken to transform the default datum to a user-specified datum.

Datum at the Default State	Transformation	Solution in Datum
WGS84 (G1762)[1]	Direct	User-Specified
	Direct	GDA94[2]
ITRF2008 (StarFire related modes)	Direct	User-Specified
	Direct	GDA94
	1. ITRF2008 to ITRF2005 2. ITRF2005 to WGS84 (G1150)	WFS84 (G1150)

The current realization of the WGS84 reference frame is designated as WGS 84 (G1762) since Oct 16 2014. WGS 84 (G1762) closely aligns with ITRF2008 frame. No transformation is needed between WGS84(G1762) and ITRF2008. http://earth-info.nga.mil/GandG/publications/NGA_STND_0036_1_0_0_WGS84/NGA.STND.0036_1.0.0_WGS84.pdf

Because WGS84 (G1762) is aligned at the centimeter level to the ITRF2008, one transformation matrix is used for transforming ITRF2008 and WGS84 (G1762) to GDA94. Apply Dawson and Woods (2010) methodology to transform coordinates between GDA94 and WGS84/ITRF.

http://www.icsm.gov.au/gda/gda-v_2.4.pdf
http://www.ga.gov.au/webtemp/image_cache/GA19050.pdf

1.23.4 Special Considerations for the RTCM and RTK-Based Solutions

These are situations in the base and rover receiver setups, in which the rover outputs the position that is relative to the base position. The reference frame used in solutions from the rover is made consistent with the data it receives from the base. In other words, the base receiver dictates the solution type it outputs, as well as the solution type in the rover receivers who receive the correction from the base. User who sets up the rover is advised to be cautious and made aware of possible effect in the output position accuracy if he wants to select a non-default datum on the rover.

Selecting a non-default datum on the rover can affect the accuracy of the output position. If the user inputs a user datum at the base, the rover should not apply a local datum transformation as this will cause the rover to have applied the datum shift twice (once at the base and once at the rover). In this scenario, the rover is positioning on the base's locally corrected datum. If the base's position is not transformed to the local datum, then the rover must apply a datum transform to achieve a local position. The best practice is to position the rover on a known monument and validate the position accuracy of the receiver prior to positioning field work. If the position is in error, validate that the transform settings are correct.

1.23.5 Command Format and Usage

The datum can be provided by the system (built-in datum), or it can be defined by a user, in which case the user supplies all parameters in the specific format from the command line.

Command:	[DATUM] [DATUM_SELECTION], [PARAMETER1, ..., [PARAMETER17]
Parameter	**Definition**
DEFAULT	Default datum of the system (ITRF2008 or WGS84_G1762). No [PARAMETER_LIST] fields
WGS84	Transform StarFire ITRF 2008 datum to WGS84 G1150. (Only for StarFire mode, if the default datum is WGS84_G1762) No [PARAMETER_LIST] fields required.
GDA94	Geocentric datum of Australia (1994). No [PARAMETER_LIST] fields
USERDATUM	User-defined datum – the user provides the parameters in predefined format, [PARAMETER1], …,[PARAMETER17]

Only one user datum can be stored at one time. Entering a new user datum overwrites that which is currently stored.

[PARAMETER_LIST] Command for the parameter list for user-defined datum.

Table 55: Parameter List for User-Defined Datum

Overall Sequence #	Value	Data Type	Valid Range	Remarks
Keyword	USERDATUM	Text String		
1	Semi-major axis (meters)	double* * double = decimal number (R64 data type)	6377137 to 6379137	Ellipsoid Model
2	Inverse-flat	integer	-9999 to 9999	
3	Source datum reference year	double	1980 to 9999	
4	Translation in x (meters)	double	-1000 to 1000	Used in 3,7,14 parameter transformation
5	Translation in y (meters)	double	-1000 to 1000	
6	Translation in z (meters)	double	-1000 to 1000	
7	Rotation in x (arc-sec)	double	-0.02 to 0.02	Used in 7, 14 parameter transformation
8	Rotation in y (arc-sec)	double	-0.02 to 0.02	
9	Rotation in z (arc-sec)	double	-0.02 to 0.02	
10	Translation scale (ppm (10^{-6}))	double	-0.02 to 0.02	
11	Translation rate in x (meter/year)	double	-0.02 to 0.02	Used in 14 parameter transformation
12	Translation rate in y (meter/year)	double	-0.02 to 0.02	
13	Translation rate in z (meter/year)	double	-0.02 to 0.02	
14	Rotation rate in x (arc-sec/year)	double	-0.02 to 0.02	
15	Rotation rate in y (arc-sec/year)	double	-0.02 to 0.02	
16	Rotation rate in z (arc-sec/year)	double	-0.02 to 0.02	
17	Rotation rate scale (ppm/year; 10^{-6}/year)	double	-0.02 to 0.02	

The parameters contain the following types of information and determine the type of transformation model to be used:

1. Ellipsoid model
2. 3-parameter model
3. 7-parameter model
4. 14-parameter model

Only one user datum can be stored at one time. Entering a new user datum overwrites the one which is currently stored.

Examples:

[DATUM]
Returns the current datum mode and the values of the basic datum parameter

[DATUM]GDA94
Sets the new datum to Geocentric Datum of Australia (1994)

[DATUM]USERDATUM, [PARAMETER1], …,[PARAMETER17]
Sets the datum to a user-defined datum; the user supplies the datum specifications as well as the transformation model in the form of a list of parameters.

The user must provide the following data block:

1. Ellipsoid model:
2. Transformation models
   - 3 parameters (required minimum list for user-defined datum)
   - 7 parameters (optional extended parameter list – in addition to the 3-parameter model)
   - 14 parameters (optional extended list of parameters – in addition to the 7-parameter model)

In the examples below, the datum specifications from GDA94 (with simplification of the data precision length) are used to demonstrate the user-input syntax for datum transformation.

1.23.6 Ellipsoid Model

Table 56: User-Defined Ellipsoid Model (with Sample Values)

Definition	User-Defined Values
Semi-major Axis (a)	6378137.0e0*
Inverse-flat (a/(a-b))	298.2572221010
Source Datum Reference Year	2000

* The user-defined value must be written in scientific notation. A number in scientific notation is written as the product of a number (integer or decimal) and a power of 10. The number has one digit to the left of the decimal point. The power of ten indicates how many places the decimal point was moved (e.g., the scientific notation equivalent of 0.011 is 1.1.e$^{-02,}$ and for 0.125 it is 1.25e^{-1}).

The ellipsoid model parameters are mandatory in any transformation model.

1.23.7 Transformation Models

1.23.7.1 Three-Parameter Transformation

Table 57: 3-Parameter Model Transformation (with Sample Values)

Value Order #	Parameter	User-Defined Values
1	translation in x (in meters)	-0.0761
2	translation in y (in meters)	-0.01
3	translation in z (in meters)	0.04

Example:

[DATUM] USERDATUM, 6378137.0e0, 298.2572221010,2000,-0.0761,-0.01,0.04

1.23.7.2 Seven-Parameter Transformation

Table 58: 7-Parameter Model Transformation (with Sample Values)

Value Order #	Parameter	User-Defined Values
1 – 3	3-parameter model	3-parameter model translation values
4	rotation in x (in arc-sec)	0.008
5	rotation in y (in arc-sec)	0.009
6	rotation in z (in arc-sec)	0.009
7	Translation Scale (in ppm)	7.935e-03

Example:

[DATUM] USERDATUM, 6378137.0e0, 298.2572221010,2000,-0.0761,0.01,0.04,0.008,0.009,0.009,7.935E-03

1.23.7.3 Fourteen-Parameter Transformation

Table 59: 14-Parameter Model Transformation (with Sample Values)

Value Order #	Parameter	User-Defined Values
1 – 7	7-parameter model	7-parameter model translation values
8	translation rate in x (in meter/year)	1.1e-02
9	translation rate in y (in meter/year)	-4.5e-03
10	translation rate in z (in meter/year)	-1.74e-02
11	rotation rate in x (in arc-sec / year)	1.034e-3
12	rotation rate in y (in arc-sec / year)	0.671e-03
13	rotation rate in z (in arc-sec / year)	1.039e-03
14	Rotate rate scale (in ppm / year)	-0.538e-03

Examples:

[DATUM] USERDATUM, 6378137.0e0, 298.2572221010,2000,-0.0761,-0.01,0.04,0.008,0.009,0.009,7.935E-03,1.1e-02,-4.5e-03,-1.74e-02,1.034e-02,0.671e-03,1.039e-03,-0.538e-03

[DATUM]USERDATUM,6378137.0,298.2572220972,2000,0.0001,-0.0008,-0.0058,0,0,0,0.0004,-0.0002,0.0001,-0.0018,0,0,0,0.00008

1.24 DEFINESFSAT (ASCII)

☒SF-5050 ☒Onyx

This command is used to define/delete a user-defined StarFire satellite. Entering this command with no arguments displays the current user-defined satellite.

Command:		[DEFINESFSAT] define_delete, {satellite_id}, {frequency}
Parameter		**Definition**
Define_delete	K	Keyword (DEFINE, DELETE, NONE)
Satellite_id	I	Satellite ID number (integer) (320 to 680); *cannot be the same as an OTA listed Satellite*
Frequency	F	Satellite frequency in kHz (1525000-1560000)

Default: *No user-defined satellite (The satellite ID is usually 500± the longitudinal satellite axis location.*

Examples:

[DEFINESFSAT] define, 670, 1560000
Defines a user-defined StarFire satellite at E 170°

1.25 DNSOVERRIDE

☒SF-5050 ☐Onyx

This command allows the user to override the DNS IP addresses in ETHCONFIG with other DNS IPs. If this command is turned on, then the system will use the DNS IPs specified by DNSOVERRIDE. If turned off, then the system will use the DNS IPs specified by ETHCONFIG.

The purpose of this command is to allow the user to hardcode DNS IPs of their choice regardless of what the DHCP server may assign as DNS IPs.

Command:		[DNSOVERRIDE] ON_OFF, DNS1, DNS2
Parameter		**Definition**
ON_OFF	K	Turns this functionality ON or OFF
DNS1	K	DNS Server IP in xx.xx.xx.xx format
DNS2	K	DNS Server IP in xx.xx.xx.xx format

Default: [DNSOVERRIDE] OFF, 0.0.0.0, 0.0.0.0

Examples:

[ETHCONFIG]AUTO, 192.168.1.100, 255.255.255.0, 192.168.1.1, 2.2.2.2, 3.3.3.3
[DNSOVERRIDE]OFF, 4.4.4.4, 5.5.5.5
The DNS IPs that will be used with this configuration are 2.2.2.2 and 3.3.3.3

[ETHCONFIG]AUTO, 192.168.1.100, 255.255.255.0, 192.168.1.1, 2.2.2.2, 3.3.3.3
[DNSOVERRIDE]ON, 4.4.4.4, 5.5.5.5
The DNS IPs that will be used with this configuration are 4.4.4.4 and 5.5.5.5.

[ETHCONFIG]MANUAL, 192.168.1.100, 255.255.255.0, 192.168.1.1, 2.2.2.2, 3.3.3.3
[DNSOVERRIDE]OFF, 4.4.4.4, 5.5.5.5
The DNS IPs that will be used with this configuration are 2.2.2.2 and 3.3.3.3

[ETHCONFIG]MANUAL, 192.168.1.100, 255.255.255.0, 192.168.1.1, 2.2.2.2, 3.3.3.3
[DNSOVERRIDE]ON, 4.4.4.4, 5.5.5.5
The DNS IPs that will be used with this configuration are 4.4.4.4 and 5.5.5.5

1.26 DYNAMICS (ASCII)

☒SF-5050 ☒Onyx

This command is used for specifying receiver dynamics. The setting affects the RTK rover dynamic, the StarFire dynamic, and the velocity smoothing settings.

Command:		[DYNAMICS] dynamic_mode, {rtk_dynamic_mode}, {sf_dynamic_mode}, {velocity_smoothing}
Parameter		**Definition**
Dynamic_mode	K	Keyword (STATIC/LOW/MEDIUM/HIGH/USER). This is the receiver overall dynamic setting. When user specifies dynamic_mode as STATIC, LOW, MEDIUM or HIGH, the receiver will use the build-in settings in Table 6-52 for RTK rover, StarFire dynamic and velocity smoothing. In this case, no additional parameters are needed. When user specify dynamic mode as USER, additional parameters can be added to configure RTK rover, StarFire dynamic and velocity smoothing.
rtk_dynamic_mode	K	Keyword (STATIC/LOW/MEDIUM/HIGH). RTK rover dynamic model used in navigation
sf_dynamic_mode	K	Keyword (STATIC/LOW/MEDIUM/HIGH). StarFire dynamic model used in navigation
Velocity_smoothing	K	Keyword (ON/OFF). When velocity smoothing option is on, the calculated velocity will be smoothed with a window of 1second. The smoothed velocity has smaller noise but can only be used in static or low dynamic conditions.

Table 60: Dynamic Modes Keywords Description

Keyword	RTK Rover and StarFire Dynamic Model
Static	Keyword that configures RTK rover and SF mode to use static dynamic constraints in navigation
Low	Keyword that configures RTK rover and SF mode to use low dynamic model in navigation. It achieves the best navigation performance in near-static mode.
Medium	Keyword that configures RTK rover and SF mode to use medium dynamic model in navigation. It achieves the best navigation performance in normal dynamic conditions.
High	Keyword that configures RTK rover and SF mode to use high dynamic model in navigation. It achieves the best navigation performance when the platform experiences high accelerations.

Table 61: Dynamic Modes Mapping and Applications

Dynamic Mode	Typical Application	RTK Rover Dynamic Mode	SF Dynamic Mode	Velocity Smoothing
Static	Static land survey ~ 0 mph	STATIC	STATIC	OFF ON (default)
Low	Offshore Survey <5 mph	LOW	LOW	OFF ON (default)
Medium	Highway <100 mph	MEDIUM	MEDIUM	OFF
High	Aerial platform >100 mph	HIGH	HIGH	OFF

Default: *MEDIUM*

The settings in this table assume that the receiver is navigating at a rate of 1 Hz. As a rule of thumb, the higher the rate at which the receiver navigates, the higher the dynamics the settings can accommodate.

Examples:

[DYNAMICS] STATIC
Sets RTK dynamics to static

[DYNAMICS]USER, LOW,, OFF
Sets RTK dynamics to low and turns off velocity smoothing. Leaves StarFire dynamic unchanged.

1.27 ENABLEALL

☒SF-5050 ☒Onyx

This command is used to enable all satellites or all ASIC channels. If any PRNs are currently disabled, they will be enabled and will be searched for, when visible. If any channels are currently disabled, they will be enabled and can be used for acquisition and/or tracking of satellites.

Command:		[ENABLEALL] type
Parameter		**Definition**
type	K	Keyword (SAT, CH); SAT for enabling all satellites, CH for enabling all channels

Examples:

[ENABLEALL] SAT
Enables all satellites

[ENABLEALL] CH
Enables all ASIC channels

1.28 ENABLEGEOFENCE

☒SF-5050 ☒Onyx

This command is used to enable and disable SBAS (WAAS, EGNOS, …) Geofencing.

Command:		[ENABLEGEOFENCE] on_off
Parameter		**Definition**
ON	K	Keyword that enables Geofencing
OFF	K	Keyword that ignores Geofencing

Default: ON

Examples:

[ENABLEGEOFENCE] off
This allows the user to accept potential improved positioning over autonomous GNSS; however, the positioning accuracy is expected to be worse than within the prescribed geofence area. The user accepts the added positioning error without prejudice against the manufacturer.

[ENABLEQUICKSTART] ON
SBAS Geofrencing is enabled (default). Positioning accuracy should meet manufacturer's specifications, if all of the operating parameters are otherwise normal.

SBAS geofencing should be On by default to utilize the broadcast geofence to prevent users from getting position errors reception in areas outside the geofence. If users wish to accept the added positioning risk when operating outside the geofence error, they can purposely set the geofence to Off.

1.29 ENABLERTCM2.3

☒SF-5050 ☒Onyx

The command is used to set rover to accept RTCM 2.3 / 2.2 code corrections.

Command:		[ENABLERTCM2.3] ON_OFF
Parameter		**Definition**
ON	K	Keyword that enables RTCM 2.3
OFF	K	Keyword that ignores RTCM 2.2

Default: ON

Examples:

[ENABLERTCM2.3] on
Configures Rover to accept RTCM2.3 corrections.

[ENABLERTCM2.3] off
Configures Rover to ignore RTCM2.2 corrections.

1.30 ERASEALM

☒SF-5050 ☒Onyx

This command erases the satellite almanac data stored in non-volatile memory.

Command:		[ERASEALM] {type}
Parameter		**Definition**
type	K	Satellite type (keyword) (ALL, GPS, SBAS, STARFIRE, GLONASS, GALILEO)

Default: ALL

⚠ This command is not used during normal operation of the receiver. It will cause all almanac data to be discarded from non-volatile memory. It will take the receiver 12.5 minutes to collect full almanac information data again.

Examples:

[ERASEALM] GLONASS
Erases the GLONASS almanac

1.31 ERASEEPH

☒SF-5050 ☒Onyx

Description: Clears the ephemeris data stored in non-volatile memory.

Command:		[ERASEEPH] {type}
Parameter		**Definition**
keyword	K	Satellite type (ALL, GPS, SBAS, GLONASS, GALILEO) If empty, it defaults to "ALL".

Default: ALL

⚠ This command is not used during normal operation of the receiver. It will cause all ephemeris data to be discarded from non-volatile memory. Ephemeris data is broadcast by each SV every 30 seconds.

Examples:

[ERASEEPH] GLONASS
Erases the GLONASS ephemeris data

1.32 ETHCONFIG

☒SF-5050 ☐Onyx

This command specifies the Ethernet port IP settings (Internet IP address, network mask, default gateway, and DNS servers).

Entering the command without parameters displays the current settings. This is especially useful in dynamic IP mode (AUTO) to reveal the IP settings assigned by a DHCP server.

IP addresses and the network mask are entered in the form of “a.b.c.d”, where a,b,c, and d are decimal integers in the range of 0-255 (e.g., 192.168.0.2).

The local IP address is the destination address for any incoming connections (EVCOM, HTTP, NTRIP, etc.) and must be unique for each unit on the same network.

Command:		[ETHCONFIG] IP mode, IP address, network mask, gateway address, DNS1, DNS2
Parameter		**Definition**
IP mode	K	This keyword may be either “MANUAL” for static IP configuration or “AUTO” for dynamic IP configuration using a DHCP server. When set to “AUTO”, other command parameters are not used.
IP address	K	Specifies the local IP address of the unit.
Network mask	K	Identifies the network part of the IP address, as a.b.c.d (range: 1-255 for each)
Gateway address	K	Identifies the IP address of the default Internet Gateway (0.0.0.0= no default gateway). The gateway must be on the local network (i.e. the network part of the IP address must match the network part of the IP address (the first IP address argument in this command).
DNS1	K	Specifies the IP address of a DNS server. If the server IP address is not on the same network as the local IP address, the DNS queries will be sent through the default gateway.In the absence of a default gateway, the DNS query will fail.
DNS2	K	Specifies the IP address of an alternate DNS server. If a DNS query to the first (DNS1) server fails, an attempt is made to use the DNS2 server address.

Examples:

[ETHCONFIG] MANUAL, 192.168.0.2, 255.255.255.0, 192.168.0.1, 204.54.87.20, 204.54.87.39

Sets local system IP address to 192.168.0.2, network mask to 255.255.255.0, gateway IP address to 192.168.0.1, DNS server 1 IP address to 204.54.87.20, and DNS server 2 IP address to 204.54.87.39

[ETHCONFIG] MANUAL, 0.0.0.0, 0.0.0.0, 0.0.0.0, 0.0.0.0, 0.0.0.0
Disables the Ethernet port

[ETHCONFIG] AUTO, 0.0.0.0, 0.0.0.0, 0.0.0.0, 0.0.0.0, 0.0.0.0
Configures the Ethernet port to query a DHCP server to obtain the IP settings

[ETHCONFIG]
[ETHCONFIG]AUTO, 192.168.0.101, 255.255.255.0, 192.168.0.1, 204.54.87.20, 204.54.87.39
Displays current settings

1.33 ETHSTAT

☒SF-5050 ☐Onyx

This is a status command that does not accept any arguments but provides the current ether status information.

The command returns the following information:

1. Mac Address of the unit
2. Status of the Ethernet link (LINK_UP, LINK_DOWN)
3. Current port speed (100Mbs, 10Mbs)
4. Current duplex setting (FULL_DUPLEX, HALF_DUPLEX)
5. Current status of the cable, whether it is a cross-over cable (MDI-X) or not (MDI, MDI-X)

Examples:

[ETHSTAT]

[ETHSTAT] MAC 00:07:E3:10:66:30, LINK_UP, 100Mbs, FULL_DUPLEX, MDI-X

1.34 ETHVCOM

☒SF-5050 ☐Onyx

This command enables or disables the Ethernet Virtual COM port server application, and may also establish an EVCOM connection with a specific remote user or terminate an existing connection.

An Ethernet Virtual Com port (EVCOM) is similar to an ASYNC serial com port and supports the same set of commands/responses as a serial COM port. It operates in a server/client mode to provide this service to remote clients.

The data stream is encapsulated in IP packets and can be configured to use either the UDP or TCP transport protocol. An IP packet may contain one or more complete message(s) or response(s), a fragment of a message, or any combination of these. It is simply a stream of data that is arbitrarily segmented into one or more UDP or TCP packets.

There are four logical ports that may be used by the EVCOM application (ETH1 – ETH8) for scheduling messages or sending responses to received input commands. Each of the logical ports can be individually configured for operation mode (TCP or UDP), IP port number, scheduled messages, and remote endpoints (client applications), providing four independent data streams.

ETHVCOM is a system command, and the setting is stored in system NVRAM.

An active UDP session will automatically be re-established if the SF-5050 is reset due to power interruption.

This is not possible for a TCP mode connection except under special conditions where the remote will be listening on the configured remote port. This essentially reverses the server/client roles.

Entering this command without any arguments will display the current settings for all four logical ports.

Command:		[ETHVCOM] on_off, remote IP address, remote UDP/TCP port, mode, local UDP/TCP port, logical port
Parameter		**Definition**
on_off	K	Keyword that enables (ON) or disables (OFF) the virtual COM port functionality on the logical port
Remote IP address	K	In UDP2 mode, this specifies the IP address of the remote user the unit will respond to. In a status message, this specifies which user the unit is connected to. If the command is entered with an IP address of 0.0.0.0, the unit breaks any current connection and listens for a new connection from any remote user.
Remote port	I	In UDP2 mode, this specifies the port number of the remote user the unit will respond to. In a status message, this specifies which user the unit is connected to. If the remote IP address is non-zero, the remote port must also be non-zero. Range: 0 – 65535. Normally, the remote port is determined by the incoming UDP/TCP header source port. When configuring the port manually, keep in mind the IANA has reserved ports 0 – 1023, and these ports should be avoided.
Mode	K	Keyword identifying ETHVCOM task transport protocol. UDP1: UDP with no “connection.” Any command responses, or any scheduled output messages will be sent to the IP address and port of the sender of the last received UDP datagram.

		UDP2: UDP witih pseudo session. See notes for description of a UDP "pseudo session." TCP1: The connection operates as a normal TCP session with the exception that if there is a send error, other than a re-transmission of a lost packet, then the connection will be terminated, and the logical port will enter listen mode for a new connection. This may happen if the remote client experiences a power interruption, or some sort of network interruption. TCP2: TCP session with keep-alive timeout.
Local port	I	If non-zero, specifies the local UDP/TCP port number the ETHVCOM task will listen on (range : 1 – 65535). The IANA has reserved ports 0-1023 for specific purposes (e.g. FTP, telnet, Web Servers, etc.) and is therefore avoided.
Logical port	K	ETH1, ETH2, ETH3, or up to ETH8. This is the logical port to be used by ETHVCOM for requesting or scheduling messages.

Default:

>[ETHVCOM]ON,0.0.0.0,0,UDP1,4361,ETH1
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4362,ETH2
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4363,ETH3
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4364,ETH4
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4365,ETH5
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4366,ETH6
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4367,ETH7
>[ETHVCOM]ON,0.0.0.0,0,UDP1,4368,ETH8

Examples:

[ETHVCOM] ON, 192.168.0.100, 5325, UDP2, 4361, ETH1
Instructs the unit to communicate only with a remote user whose IP address and port number is 192.168.0.100:5325, using UDP2 mode. The local port number used to communicate is 4361.

[ETHVCOM] ON, 0.0.0.0, 0, , , ETH2
Breaks current connection (if any) on ETH2, and enables the unit to listen for a connection from the next remote unit that sends a packet to this unit. This is the proper way for a remote user to terminate a UDP connection when in UDP2 mode. It causes the unit to stop sending data and to listen for a new connection from another user. The mode remains the same (UDP or TCP) as it was in the previous session.

[ETHVCOM] ON,0.0.0.0,0,UDP1
Breaks the current connection (if any) and listens for a UDP1 connection. Any scheduled messages for this logical port will be silently discarded.

[ETHVCOM] OFF
Terminates any current connection and disables new EVCOM connections on this logical port (ETH1…ETH4).

[ETHVCOM]

[ETHVCOM] ON, 192.168.0.100, 5042, TCP1, 4361, ETH1

[ETHVCOM] ON, 0.0.0.0, 0, TCP1, 4362, ETH2

[ETHVCOM] OFF, 0.0.0.0, 0, UDP1, 4363, ETH3

[ETHVCOM] ON, 46.153.12.73, 12345, UDP2, 4364, ETH4
Displays EVCOM logical port settings; in this case, ETH1 has an active TCP1 mode

connection with remote user at IP 192.168.0.100, port 5042, to local TCP port 4361. EVCOM logical port ETH2 is listening for a TCP1 mode connection from any remote client. ETH3 is disabled. ETH4 has an active UDP2 mode connection with a remote client at IP address 46.153.12.73, port 12345, on the SF-5050 UDP port 4364).

[ETHVCOM],,,,,ETH3
[ETHVCOM] ON,0.0.0.0,0,TCP1,4363,ETH3
Displays current settings for "ETH3" (Ethernet Virtual COM port enabled, no active connection, listening on TCP port 4363 for a connection from any remote client).

Notes:

- If an ETHVCOM command is issued with no parameters, the status of all ETHVCOM ports is displayed.
- If the only argument entered is the ETHVCOM port number, the status of that port is displayed.
- If any argument is entered, but the ETHVCOM port number is not entered, the command is assumed to be for the port the command was entered from. If this is not an ETHVCOM port, an error message is displayed.
- The current values are used for any parameters not entered.
- Changing any of the EVCOM port settings causes a connected port to disconnect and begin listening for a new connection.
- If the application is connected via TCP and the receiver resets, the application must try to reconnect for the connection to be regained.

Table 61 lists the default settings (when no parameters are specified).

Table 62: Default Settings for Unspecified Parameters

EVCOM Port	Mode	Local IP Port
ETH1	UDP2	4361
ETH2	UDP1	4362
ETH3	UDP2	4363
ETH4	UDP2	4364
ETH5	TCP1	4365
ETH6	TCP1	4366
ETH7	TCP2	4367
ETH8	TCP2	4368

1.34.1 ETHVCOM Application note

An EVCOM session may be established for several reasons, such as for a StarUtil connection, high-speed data logging, or an OEM application interface.

Client application messages scheduled on an ONTIME basis using the [OUTPUT] command must be unscheduled prior to closing the connection; otherwise, the next user opening a connection to that logical port (ETH1 – ETH8) receives the messages even if they are unrequested or unwanted. Additionally, generating unwanted messages causes unnecessary overhead on the GNSS board and consumes unnecessary bandwidth on the SPI bus sending the messages to the Power IO board (where they are silently discarded until the next EVCOM connection is established).Cancel all output messages when the connection is first established, and then schedule only the necessary messages.

UDP1 mode operates in a connection-less manner. Because there is no authentication, and the port never establishes a “connection,” a remote client does not know when that port is already in use by another remote client. A connection attempt by a second client diverts any output stream set up by a previous client to the second remote client. To prevent this, a remote client should not use UDP1 mode.

UDP2 mode (a UDP “pseudo session”) may be established when the ETHVCOM task is in the “listening” mode (remote IP is 0.0.0.0 port 0). While in this listening mode, any messages previously scheduled to be sent to the logical port are silently discarded. Once UDP2 mode is established in this way, any datagrams received from any other UDP IP address/port are silently discarded. The session should be terminated by the remote client by sending an [ETHVCOM]ON,0.0.0.0,0 command, but it can also be terminated by entering that command on any other port (e.g., a serial COM port or a different EVCOM port). The ETHVCOM task then terminates the current “session” and enters its “listen” mode.

1.34.2 ETHVCOM Setup and Configuration Example

Enter the Virtual COM clear command for each port:

[ETHVCOM] ON, 0.0.0.0, 0, UDP1, 4361, ETH1

[ETHVCOM] ON, 0.0.0.0, 0, UDP1, 4362, ETH2

[ETHVCOM] ON, 0.0.0.0, 0, UDP2, 4363, ETH3

[ETHVCOM] ON, 0.0.0.0, 0, UDP2, 4364, ETH4

[ETHVCOM] ON, 0.0.0.0, 0, TCP1, 4365, ETH5

[ETHVCOM] ON, 0.0.0.0, 0, TCP1, 4366, ETH6

[ETHVCOM] ON, 0.0.0.0, 0, TCP2, 4367, ETH7

[ETHVCOM] ON, 0.0.0.0, 0, TCP2, 4368, ETH8

Enter the [ETHCONFIG] with no parameters to see the current settings, for example:
[ETHCONFIG]AUTO,192.168.0.2,255.255.254.0,192.168.0.1,D.D.D.D,d.d.d.d

If this value is entered, the Ethernet can drop offline. If it does you might be able to re-use this IP address, that is; the Ethernet might or might not remember it for you.

If you specify MANUAL, the IP address will not change as the receiver drops offline.

[ETHCONFIG]MANUAL

Change manual to permanent:
[PROFILE]SAVEAS “PROFILENAME”
Power Cycle the receiver

If this does not work the first time, try these additional steps:

[ETHCONFIG]AUTO

[PROFILE] SAVEAS “BOB”

<power cycle the receiver>
....time passes – up to 30 seconds to acquire a DHCP address...

[ETHCONFIG]X.Y.Z.W

If the network is connected using a switch or a router, it sometimes helps to reset that device so it flushes its internal addresses. If the receiver has dropped offline because of an intervening power cycle, this normally brings the network back up.

The receiver firmware handles the process behind the scenes using its inter-board messaging system. When the user enters [ETHCONFIG], the GNSS board remembers the input. If the input is new or different from the previous input, the GNSS tells the PIO board by sending a silent [PIOETHCONFIG] command with the entered parameters. When the profile is saved, it remembers the new setting – if MANUAL, it comes up on that IP address, and if AUTO, it queries the DHCP server for an IP address. In either case, when it gets the IP address and the associated connection data, the PIO board sends a silent [ETHCONFIG] messages to the GNSS board so the GNSS board can update its local data stores for the next time you type in [ETHCONFIG].

1.35 EVENTLATCH

☒SF-5050 ☒Onyx

This command is used to enable the operation of the event latch feature in the two ports available and sets the event latch time tag to be triggered by the rising or falling edge of the external pulse.

Command:		[EVENTLATCH] port, on_off, trigger
Parameter		**Definition**
port	K	Keyword that selects the desired port (A, B)
on_off	K	Keyword that enables (ON) or disables (OFF) the event latch port
trigger	K	Keyword that sets the trigger edge of the pulse (RISING, FALLING)

Default: *Latch A = OFF, RISING; Latch B = OFF, RISING*

Examples:

[EVENTLATCH] A, ON, FALLING
Enables event latch A triggering on a rising edge.

[EVENTLATCH] B, OFF
Disables event latch B.

1.36 EVENTLATCHVOLTSEL

☒SF-5050 ☐Onyx

This command is used to set the detect voltage capability for the Event Latch Input.

Command:		[EVENTLATCHVOLTSEL] detect_voltage
Parameter		**Definition**
detect_ voltage	I	Select the detect voltage capability (12 for 12V, 5 for 5V)

Default: *5*

Examples:

[EVENTLATCHVOLTSEL]5
Set 5 Volts as the detect voltage.

[EVENTLATCHVOLTSEL]12
Set 12 Volts as the detect voltage.

1.37 EXTRAPBASE

☒SF-5050 ☒Onyx

This command is used to enable the MBRTK rover to extrapolate base motion or lack thereof. The receiver must be running in MBRTK rover mode for this command to take effect.

Command:		[EXTRAPBASE] on_off
Parameter		**Definition**
ON	K	Runs MBRTK rover in base-motion extrapolation mode
OFF	K	Turns off base-motion extrapolation mode

Default: *ON*

Examples:

[EXTRAPBASE] ON
Enables base-motion extrapolation mode

[EXTRAPBASE] OFF
Disables base-motion extrapolation mode

[EXTRAPBASE]
Queries base-motion extrapolation status

1.38 FIXBASELINE

☒SF-5050 ☒Onyx

This command is used to enter baseline information for the MBRTK rover.

Command:		[FIXBASELINE] on_off {, length, length_rms}
Parameter		**Definition**
ON_OFF	K	When set to ON, the baseline between base and rover is assumed to be fixed. When ON, the baseline length and its rms can be entered (i.e., both antennae on the same platform for heading applications). *Baseline length and its rms must be entered at the same time when FIXEDBASELINE is set to be ON*. When set to OFF, the baseline is not fixed (i.e., leader follower application).
length	F	Baseline length in meters, between 1.0 and 250.0
length_rms	F	Baseline length tolerance, rms in meters, between 0.001 and 0.2

Default: OFF

Examples:

[FIXBASELINE] ON, 2.2, 0.02
Turns on baseline mode and sets baseline length tolerance to 2.2 meter with 0.02 meter rms.

[FIXBASELINE] OFF
Turns off baseline mode

[FIXBASELINE]
Displays status

1.39 FORCETALKERID

☒SF-5050 ☒Onyx

This command forces the talker of NMEA messages to be GP or GL, regardless of the satellites used. This command does not apply to the following messages: ALM, MLA, PNCTGGA, PNCTGST, PNCTDME, PNCTSET.

Command:		[FORCETALKERID] keyword
Parameter		**Definition**
OFF	K	Talker ID not forced
GP	K	Talker ID forced to GP
GL	K	Talker ID forced to GL

Default: OFF

Examples:

[FORCETALKERID] GP
Forces talker ID to GP

[FORCETALKERID]OFF
Talker ID not forced

1.40 FSCD

☒SF-5050 ☐Onyx

This command is used to change the current working directory. When directory name is not provided, this command returns the current directory.

Command:	[FSCD]"directory_name"

Examples:

[FSCD]
Will return the current working directory. For example:
[FSCD]A:\bgdatalog

[FSCD] "my_directory"
Will change the working directory to "my_directory".

[FSCD] ".."
Will change the working directory to the parent directory of the current working directory

[FSCD] "/"
[FSCD] "\"
Will change the working directory to the root directory

[FSCD] "/directory_1/directory_2/directory_3"
[FSCD] "\directory_1\directory_2\directory_3"
Will change the working directory to the root_directory\directory_1\directory_2\directory_3

[FSCD] "./directory_1/directory_2/directory_3"
[FSCD] ".\directory_1\directory_2\directory_3"
Will change the working directory to the current_directory\directory_1\directory_2\directory_3

Invalid Entries:

[FSCD] "invalid_directory"
If this directory does not exist, the following message will be output:
[FSCD] invalid _directory Not Found

[FSCD] "X:/my_directory"
If this drive does not exist, the following message will be output:
[FSCD] X:/my_directory Invalid Drive

1.41 FSCOPY

☒SF-5050 ☒Onyx

This command is used to copy a file. When a drive name is not specified, the current drive is used.

Command:	[FSCOPY]" source_file_name", "destination_file_name"

Examples:

[FSCOPY]"A:\DataFileSrc.dat","B:\DataFileCopy.dat"

[FSCOPY] copying file
It acknowledges command receipt and starts the copy operation.

[FSCOPY] file copying done. – This message is displayed upon copy completion.

[FSCOPY]? - The runtime help option, which displays:
[FSCOPY] "source file name", "destination file name"

1.42 FSCWD

☒SF-5050 ☐Onyx

This command is used to query the current working directory.

Command:	[FSCWD]

Examples:

[FSCWD]
Returns the current working directory
>[FSCWD]A:\bgdatalog

1.43 FSDELETE

☒SF-5050 ☐Onyx

This command is used to delete a file or directory.

Command:	[FSDELETE] directory_name or file_name

Examples:

[FSDELETE] “my_directory”
Deletes “my_directory”
If the directory does not exist, the following message will be output:
[FSDELETE]UNKNOWN FILE OR DIRECTORY

[FSDELETE] “my_file.dat”
Deletes the file “my_file.dat”

[FSDELETE] “/directory_1/directory_2/directory_3”
Deletes the root_directory\directory_1\directory_2\directory_3

[FSDELETE] “./directory_1/directory_2/my_file.dat”
[FSDELETE] “.\directory_1\directory_2\my_file.dat”
Deletes the file current_directory\directory_1\directory_2\my_file.dat

Invalid Entries:

FSDELETE] “invalid_file”
If this directory does not exist, the following message will be output:
[FSDELETE] invalid _file Not Found

[FSDELETE] “invalid_directory”
If this directory does not exist, the following message will be output:
[FSDELETE] invalid _directory Not Found

[FSDELETE] “X:/my_directory”
If this drive does not exist, the following message will be output:
[FSDELETE] X:/my_directory Invalid Drive

1.44 FSDIR

☒SF-5050 ☐Onyx

This command is used to list the contents in the current directory. It returns the currently selected drive; its volume label, serial number, and current directory name; and sub-directories and files in the current directory.

Command:		[FSDIR]
A	K	Keyword that returns the directory on drive A (internal 2G memory)
C	K	Keyword that returns the directory on drive C (SD Card)

Examples:

[FSDIR)]
[FSDIR] Drive is A:
[FSDIR] Volume has no label
[FSDIR] Volume has no serial number
[FSDIR] Directory is: A:\
[FSDIR] 04/28/2010 23:42:31 <DIR> datalog
[FSDIR] 0 File(s)
[FSDIR] 1 Dir(s)

Invalid Entries:

[FSDIR] “invalid_directory”
If this directory does not exist, the following message will be output:
[FSDIR] invalid _directory Not Found

[FSDIR] “X:/my_directory”
If this drive does not exist, the following message will be output:
[FSDIR] X:/my_directory Invalid Drive

1.45 FSDRIVE

☒SF-5050 ☐Onyx

This command is used to select the current drive. When no option is specified, this command returns the current drive, its FAT, the total space in sectors, and the free space in sectors.

Command:		[FSDRIVE] Drive{A:, C:}
Parameter		**Definition**
Drive	K	A: Keyword that selects the internal EMMC/SD flash
Drive	K	C: Keyword that selects the removable SDCard

When the command option is missing, this command returns the current drive, its FAT type, the total space, free space and bad space in bytes.

Examples:

[FSDRIVE]
Returns the current selected drive, its FAT, and the total space and free space in bytes

```
>[FSDRIVE] Drive  Format        Total          Free         Used          Bad
>[FSDRIVE] ----------------------------------------------------------------------------------
>[FSDRIVE] A:    FAT_32    7853154304    7213539328    639614976
```

[FSDRIVE]A:
Will select the internal EMMC /SD flash as current drive and return:

>[OK] FSDRIVE

1.46 FSFORMAT

☒SF-5050 ☐Onyx

This command is used to format the internal Emmc/SD flash A: and C: for the SD card.

Command:		[FSFORMAT]{A:,C}
Parameter		**Definition**
Format	K	A: Keyword that selects the internal EMMC/ SD flash
Format	K	C: Keyword that selects the removable SDCard

When no option is specified, this command queries the current FAT for both the drives.

Examples:

[FSFORMAT]
Returns the current FAT information for drives A: and C:. for example:
[FSFORMAT] A: FAT_32; B: FAT_32; C: UNKNOWN.

[FSFORMAT]A:
Will format drive A: and return current FAT information for drive A:. for example:
[FSFORMAT]A:
Will format drive A as FAT_32

While doing formatting, the following message will be output:
[FSFORMAT] formatting drive A:...

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

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

1.47 FSLOAD

☒SF-5050 ☐Onyx

This command is used to load firmware from the file system (from any media device). This command will display all the available firmwares available on any of the drives and will provide the user with the ability of loading any or all of the available firmwares.

Command:		[FSLOAD] Command, Drive, “Firmware1.s19” … “Firmware10.s19”
Parameter		**Definition**
mode	K	LOAD : loads between one to ten specified firmwares on a specific drive LOADALL: loads all of the available .s19 files on a specifc drive. SCAN: scans the drives under/ FIRMWARE for all .s19files. **Required for LOAD and LOADALL. If not specified for SCAN, SCAN will scan all drives.*
Drive	K	A: Keyword that selects the internal storage
Drive	K	C: Keyword that selects the external SD card
File	S	Filename

Firmware file name used for LOAD command to load a paticulare firmware in the given order. Accepts up to 10 commands.

Examples:

```
[FSLOAD] SCAN
[FSLOAD] Firmware Scan Results for A: Drive:
[FSLOAD]   PIOAPP     00.00.06  Sep 23 2015  PIOBApp_solsticeD_0.0.6.s19
[FSLOAD]   PIOBOOT1   03.30.00  Sep 23 2015  PIOBBootloader1D_0.0.6.s19
[FSLOAD] Firmware Scan Results for B: Drive:
[FSLOAD]   Drive is not mounted
[FSLOAD] Firmware Scan Results for C: Drive:
[FSLOAD]   BOOT2      03.30.00  Sep 23 2015  Bootloader2D_0.0.6.s19
[FSLOAD]   NAV        00.00.06  Sep 23 2015  GnssReceiverPPND_0.0.6.s19
[FSLOAD]   MTEST      03.30.00  Sep 23 2015  MTestD_0.0.6.s19
[FSLOAD]   PIOAPP     00.00.06  Sep 23 2015  PIOBApp_solsticeD_0.0.6.s19
[FSLOAD]   PIOBOOT1   03.30.00  Sep 23 2015  PIOBBootloader1D_0.0.6.s19
[FSLOAD]   PIOBOOT2   03.30.00  Sep 23 2015  PIOBBootloader2D_0.0.6.s19

[FSLOAD] SCAN, C:
[FSLOAD] Firmware Scan Results for C: Drive:
[FSLOAD]   BOOT2      03.30.00  Sep 23 2015  Bootloader2D_0.0.6.s19
[FSLOAD]   NAV        00.00.06  Sep 23 2015  GnssReceiverPPND_0.0.6.s19
[FSLOAD]   MTEST      03.30.00  Sep 23 2015  MTestD_0.0.6.s19
[FSLOAD]   PIOAPP     00.00.06  Sep 23 2015  PIOBApp_solsticeD_0.0.6.s19
[FSLOAD]   PIOBOOT1   03.30.00  Sep 23 2015  PIOBBootloader1D_0.0.6.s19
[FSLOAD]   PIOBOOT2   03.30.00  Sep 23 2015  PIOBBootloader2D_0.0.6.s19

[FSLOAD]LOAD, C:, "Bootloader2D_0.0.6.s19", "PIOBBootloader2D_0.0.6.s19"
[FSLOAD] Loading C:/FIRMWARE/Bootloader2D_0.0.6.s19
[FSLOAD] Loading ST_UNKNOWN, 0.01%
[FSLOAD] Loading BOOT2, 1.52%
[FSLOAD] Loading BOOT2, 18.15%
[FSLOAD] Loading BOOT2, 39.66%
[FSLOAD] Loading BOOT2, 59.74%
[FSLOAD] Loading BOOT2, 79.88%
[FSLOAD] Loading BOOT2, 100.00%
[FSLOAD] BOOT2 loaded successfully!
[FSLOAD] Loading C:/FIRMWARE/PIOBBootloader2D_0.0.6.s19
```

```
[FSLOAD] Loading PIOBOOT2, 6.89%
[FSLOAD] Loading PIOBOOT2, 46.74%
[FSLOAD] Loading PIOBOOT2, 71.87%
[FSLOAD] Loading PIOBOOT2, 98.87%
[FSLOAD] PIOBOOT2 loaded successfully!
[FSLOAD] All Firmwares have been loaded successfully!

[FSLOAD]LOADALL A:
[FSLOAD] Firmware Scan Results for A: Drive:
[FSLOAD]    PIOAPP      00.00.06  Sep 23 2015  PIOBApp_solsticeD_0.0.6.s19
[FSLOAD]    PIOBOOT1    03.30.00  Sep 23 2015 PIOBBootloader1D_0.0.6.s19
[FSLOAD] Loading A:/FIRMWARE/PIOBApp_solsticeD_0.0.6.s19
[FSLOAD] Loading PIOAPP, 9.53%
[FSLOAD] Loading PIOAPP, 38.45%
[FSLOAD] Loading PIOAPP, 67.70%
[FSLOAD] Loading PIOAPP, 96.60%
[FSLOAD] PIOAPP loaded successfully!
[FSLOAD] Loading A:/FIRMWARE/PIOBBootloader1D_0.0.6.s19
[FSLOAD] Loading PIOBOOT1, 0.02%
[FSLOAD] Loading PIOBOOT1, 42.45%
[FSLOAD] Loading PIOBOOT1, 85.14%
[FSLOAD] PIOBOOT1 loaded successfully!
[FSLOAD] All Firmwares have been loaded successfully!
```

1.48 FSMKDIR

☒SF-5050 ☐Onyx

This command is used to create a new directory in the current working directory.

Command:	[FSMKDIR] directory_name

Examples:

[FSMKDIR] “my_directory”
Creates “my_directory” in the current working directory

Invalid Entries:

[FSMKDIR] “A:/invalid_directory/my_directory”
If this directory path is invalid, the following message will be output:
[FSMKDIR] A:/invalid_directory/my_directory not created – Invalid Directory

[FSMKDIR] “duplicate_directory”
If this directory already exists, the following message will be output:
[FSMKDIR] duplicate _directory not created -- Duplicated

[FSMKDIR] “X:/my_directory”
If this drive does not exist, the following message will be output:
>[FSMKDIR] X:/my_directory not created -- Invalid Drive

1.49 FSRENAME

☒SF-5050 ☐Onyx

This command is used to rename a file or directory.

Command:	[FSRENAME] “original_name”,”new_name”

Examples:

[FSRENAME] “Bigfile.dat”, “Bigfile.000”
Renames Bigfile.dat to Bigfile.000.
[OK] FSRENAME

1.50 FSRMDIR

☒SF-5050 ☐Onyx

This command is used to delete an empty directory.

Command:	[FSRMDIR] “directory_name”

Examples:

[FSMKDIR] “a_directory”
Will delete “a_directory” if a_directory is empty.

[FSRMDIR] “non_empty_directory
[FSRMDIR] non_empty_directory – Not Empty
Will not delete “non_empty_directory” because files are present.

1.51 FSSPACE

☒SF-5050 ☐Onyx

This command is used to check the current size used and the current size available for a particular drive.

Command:	[FSSPACE] Drive letter – A: or C:

Examples:

```
[FSSPACE] "C:"
```

Will display:

```
>[FSSPACE]Format       Total         Free         Used         Bad
>[FSSPACE]---------------------------------------------------------------
>[FSSPACE]FAT_32   1003565056    207192064    796372992         0
```

1.52 FTPCONTROL

☒SF-5050 ☐Onyx

This command is used to control the state of the FTP Server on the PIOB. The server task will run if Enabled and will terminate when Disabled.

Command:		[FTPCONTROL] mode
Parameter		**Definition**
mode	K	*Keywords:* ENABLE: Enable the FTP server DISABLE: Disable the FTP server.
Drive	K	Drive letter – A: or C:

Default: ENABLE

Default drive is A:

Examples:

[FTPSERVER] ENABLE, A:
FTP Server will start running on drive A:

[FTPSERVER] DISABLE
FPT Servier will stop running.

1.53 FTPUSERS

☒SF-5050 ☐Onyx

This command is used to add, update, and remove the FTP users for the FTP server.

The receiver can have a total of 8 non-admin users. The receiver has a permanent administrator account called “admin” with a default password “admin”. This command is stored in NVRAM but is not stored as part of the profile. The admin account name cannot be changed.

Command:		[FTPUSERS] function, username, password, access level
Parameter		**Definition**
function	K	ADD/REMOVE/UPDATE
username	S	The username of the user, case sensitive. Cannot be null, must always be specified.
password	S	The password of the user; cannot be an empty password; case sensitive. Cannot be null while adding a new user

This is a required field, to specify the action of the command whether to add a new user, to remove a current user or to update the password and access level of an existing user.

Examples:

[FTPUSERS]
Displays the current list of users.

[FTPUSERS]"admin", "adminpassword",

[FTPUSERS]"Rodolfo", "mypassword"

[FTPUSERS] ADD, “Dsharp”
Error, need password.

[FTPUSERS] ADD, “Dsharp”, “Sharpness OverWhelming”
Error, need access level.

[FTPUSERS] ADD, “Dsharp”, “uncool”, USER
Will add a new user with username Dsharp, password uncool, and access USER.

[FTPUSERS]REMOVE, “Dsharp”
Will remove Dsharp from the user list.

[FTPUSERS]REMOVE, “admin”
Error, cannot delete admin account.

[FTPUSERS] UPDATE, “Sheldon”, “Super Special Awesome”
Will change Sheldon’s password to Super Special Awesome.

1.54 GEOIDALMODEL

☒SF-5050 ☒Onyx

This command is used to select a geoidal database or to query the currently selected geoidal database.

Command:		[GEOIDALMODEL] model, {action}
Parameter		**Definition**
Model	K	Which geoidal model to use: NONE GGM02 GEOIDAL99 DEFAULT
Action	K	DELETE: Deletes either the GGM02 or GEOIDAL99 model, if loaded.

Default: DEFAULT

If keyword DEFAULT is selected, the receiver will pick the Geoidal model according to the default priority list: GEOIDAL99, GGM02, NONE. i.e, the model listed first will be used if it is available in the receiver; otherwise, the next model in the list will be used if it is available, and so forth. This is the default setting if no user profile is used.

Examples:

[GEOIDALMODEL] DEFAULT
Selects geoidal database according to the default priority list

[GEOIDALMODEL] NONE
Deselects geoidal database

[GEOIDALMODEL] GEOIDAL99
Selects geoidal99 (user-defined) database

[GEOIDALMODEL] GGM02, DELETE
Deletes the GGM02 geoidal database

[GEOIDALMODEL]
Returns the currently selected geoidal database

The GEOIDAL99 (user-defined) database file must be a binary file. It has a header plus a data section, described below.

Table 63: GEOIDAL99 Header Format

Data Item	Data Type	Units	Bytes
Header			
SLAT – Southernmost latitude	R64	Degrees	8
WLON – Westernmost longitude	R64	Degrees	8
DLAT – Distance interval in latitude	R64	Degrees	8
DLON – Distance interval in longitude	R64	Degrees	8
NLAT – Number of rows of latitude	U32		4
NLON – Number of columns of longitude	U32		4
IKIND – Data type The value always should be 1 (=> real *4)	U32		4

The data section of the GEOIDAL99 database file follows immediately after the header. Table 64 displays the format, in which “a” represents a R32 Data Type, R = Row, and C = Column. For example, “a_{R3C2}” = 4 bytes (real number) of data at Latitude Row 3, Longitude Column 2.

The data is variable length. NLAT is the total number of rows. NLON is the total number of columns. (

Table 63 defines NLAT and NLON.)

Table 64: GEOIDAL99 Data Format (variable length)

	1	**2**	**3**	**4**		**NLON**
1	a_{R1C1}	a_{R1C2}	a_{R1C3}	a_{R1C4}	…	$a_{R1CNLON}$
2	a_{R2C1}	a_{R2C2}	a_{R2C3}	a_{R2C4}	…	$a_{R2CNLON}$
3	a_{R3C1}	a_{R3C2}	a_{R3C3}	a_{R3C4}	…	$a_{R3CNLON}$
4	a_{R4C1}	a_{R4C2}	a_{R4C3}	a_{R4C4}	…	$a_{R4CNLON}$
	…	…	…	…	…	
NLAT	$a_{RNLATC1}$	$a_{RNLATC2}$	$a_{RNLATC3}$	$a_{RNLATC4}$		$a_{RNLAT/CNLON}$

The data section is stored in the file beginning with the Westernmost (WLON)/ Southernmost (SLAT) point. In Table 64, this is the first point in Row 1: "a_{R1C1}".
Row 1 (row-major) is stored: "a_{R1C1}", "a_{R1C2}", "a_{R1C3}", "a_{R1C4}", etc. Then Row 2 is stored: "a_{R2C1}", "a_{R2C2}", "a_{R2C3}", "a_{R2C4}", etc. This is continued sequentially for each row until the Easternmost/Northernmost point, "$a_{RNLAT/CNLON}$", is stored. Each row creates a list of 4-byte real values NLON long, with DLON longitudinal intervals along the row of latitude.

1.55 GGAMODE

☒SF-5050 ☒Onyx

This command is used to select the precision mode for the NMEA GGA output sentence. In high precision mode, the GGA sentence outputs latitude as dd.mmmmmm and longitude as ddd.mmmmmm, as opposed to low precision mode, which is dd.mmmm and dd.mmmm. Also, in high precision mode, the GGA sentences show altitude as mm.mmm as opposed to mm.m in low precision mode. The quality FLAG may also be configured to reflect StarFire as RTK instead of DGPS which is a lower quality indicator.

Command:		[GGAMODE] mode, quality
Parameter		**Definition**
Mode	K	High or low precision (HP, LP)
Quality	K	StarFire or RTK (SF,RTK)

Default: [GGAMODE] LP, SF

The command, [USEPROFILE] “NONE”, resets all of the user-controlled configuration parameters to the factory default values. It sets [GGAMODE] to the default, LP. If the high precision mode for GGA is required after the reset of the user-controlled parameters, [GGAMODE] HP must be input into the receiver. Or, NMEAPNCTGGA may be used for high precision.

Examples:

[GGAMODE] HP, RTK
Specifies high precision mode, RTK quality

[GGAMODE] LP, SF
Specifies low precision mode, StarFire quality

1.56 GGM02STATUS

☒SF-5050 ☒Onyx

This command is used to query the GGM02 status. The command does not require any argument. The receiver responds with the keywords, VALID or INVALID.

✓ If the response to this command is INVALID, the GGM02 database is corrupted. Contact NavCom Customer Support at customersupport@navcomtech.com for the procedure to reload the database. Then use the command [GGM02STATUS] to verify that the upload is successful.

Refer to the *LOADBULKB* command for details on loading GGM02 data.

The GGM02 database is not part of the firmware because it is very large and would

significantly increase the loading speed of the firmware.

GGM02 stands for GRACE Gravity Model 02. It is derived from data recorded by the Gravity Recovery And Climate Experiment (GRACE). This model is used to compute geoidal separation, the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid).

Command:	[GGM02STATUS]

Examples:

[GGM02STATUS]
[GGM02STATUS] VALID
GGM02 database in the receiver is valid

[GGM02STATUS]
[GGM02STATUS] INVALID
GGM02 database in the receiver is invalid

1.57 GLALM1B

☒SF-5050 ☒Onyx

This binary command is used to enter Galileo almanac data manually. It is also used internally to store and retrieve the almanac to and from the NVRAM.

Command:	[GNALM1B] {Binary message}

1.58 GNALM1B

☒SF-5050 ☒Onyx

This binary command is used to enter GLONASS almanac data manually. It is also used internally to store and retrieve the almanac to and from the NVRAM.

Command:	[GNALM1B] {Binary message}

Table 65: Data Type for GNALM1B Message

Data Item	Data Type
Header	uint16_t
GPS week of almanac	int16_t
GPS msec of almanac	int32_t
Time quality	uint8_t
Satellite type (-1=NONE, 0=GPS, 1=GALILEO, 2=SBAS, 3=GLONASS)	uint8_t
Almanac data	see below

The almanac data contains the packed almanac data for 24 GLONASS satellites. The almanac for each satellite contains two strings. The message structure is listed in the table below.

Table 66: Message Structure for GLONASS Satellites

Data Item (600 Bytes)	DataType
String 5 of GLONASS time information (3 words * 4 bytes, in the order of word 0, word 1, word 2)	12 byte
String 14 of GLONASS time information (3 words * 4 bytes)	12 byte
Even string (3 words * 4 bytes) for satellite 1	12 bytes
Odd string (3words * 4 bytes) for satellite 1	12 bytes
...	
…	
Even string (3 words * 4 bytes) for satellite 24	12 Byte
Odd string (3words * 4 bytes) for satellite 24	12 bytes

The data bits [84, 83...53] within string is stored in the word 0, MSB is the bit 84; the data bits [52, 52...21] within string is stored in the word 1, MSB is the bit 52; the data bits [20, 19...1] within string is stored in the word 2, LSB is the bit 1.

1.59 GPSALM1B

☒SF-5050 ☒Onyx

This binary command is used to enter GPS almanac data manually. It is also used internally to store and retrieve the almanac to and from the NVRAM.

Command:	[GPSALM1B] {Binary message}

Table 67: Message Structure for GPS Satellites

Data Item (853 Bytes)	**Data Type**
GPS week of collection	U16
GPS millisecond of collection	U32
Almanac reference week	U16
Almanac reference time, second-of-week	U32
Almanac source prn	U08
Subframe for SV ID 1 (almanac data for SV 1)	24 bytes
Subframe for SV ID 2 (almanac data for SV 2)	24 bytes
…	…
Subframe for SV ID 32 (almanac data for SV 32)	24 bytes
Subframe for SV ID 51 (SV health data for SV 1 through 24, the almanac reference time, the almanac reference week number)	24 bytes
Subframe for SV ID 56 (ionospheric and UTC data)	24 bytes
Subframe for SV ID 63 (A-S flags/SV configurations for 32 SV's, plus SV health for SV 25 through 32)	24 bytes

1.60 GREETING

☒SF-5050 ☒Onyx

This command is used to turn on/off the greeting messages on COM1 when receiver starts. This command has no effect on SF-5050 COM2. The greeting message on COM2 is always on. The greeting message may look something like this: “Nav SW Start, Onyx! Port 1.”

Command:		[GREETING] {on_off}
Parameter		**Definition**
On	K	Enable Greeting
Off	K	Disable Greeting

Default: ON

Examples:

[GREETING] OFF
Disable greeting

1.61 INCLINECONSTR

☒SF-5050 ☒Onyx

This command is used to set and control the maximum inclination angle of the MBRTK base and rover. When it is turned ON, the maximum inclination angle allowed needs to be specified.

Command:	[INCLINECONSTR] on_off {angle }
Parameter	**Definition**
On	Keyword that turns on maximum inclination angle constraint for ambiguity search
Off	Keyword that turns off maximum inclination angle constraint for ambiguity search
Angle	Maximum inclination angle value (between 5 and 90 degrees)

Default: ON, 30 degrees

Once candidate ambiguities are obtained, the corresponding inclination angles for each candidate will be calculated. Inclination angles larger than the specified maximum value will be removed from the candidates. In most applications, the inclination angle between moving base and rover will be roughly zero, meaning that they are installed levelly. But some applications have larger inclination angles. A 30-degree threshold is set so that if the constraint is erroneously turned on, there is still room to provide correct ambiguity.

Examples:

[INCLINECONSTR] ON, 25
Maximum inclination angle set to 25 degrees

[INCLINECONSTR] OFF
Maximum inclination angle constraint is set to be off

[INCLINECONSTR]
Status will be displayed.

1.62 INPUTSFLICENSE

☒SF-5050 ☒Onyx

This command is used to input a StarFire license code.

Command:	[INPUTSFLICENSE] licensecode
Parameter	**Definition**
Code_partN	String of 8 numeric characters each, forming the 32 numeric character license code.

The format for the license file is the same as the license.dat file, which is 32 character strings in this format: xxxxxxxx-xxxxxxxx-xxxxxxxx-xxxxxxxx

Figure 2: Example of StarFire License File Contents

Serial Number: 13452
Date: Fri Sep 11 19:21:56 2009

Authorization Issue Day: 3907
Authorization Issue Sec: 8516
License Type: Calendar License
Start Day: 3909
End Day: 3939
Precision: StarFire Precise
Regions: All
Authorized Net: All Nets
Actions: Cancel Current License & Load New License
License Code: 4A2A6C82-F2EB1CEE-8D682E3C-95B83A16

The contents of the StarFire License file are subject to change.

Example:

[INPUTSFLICENSE] 4A2A6C82-F2EB1CEE-8D682E3C-95B83A16

1.63 INPUTSWOPTION

☒SF-5050 ☒Onyx

This command is used to input a StarFire Software Option string.

Command:	[INPUTSWOPTION] optionstring
Parameter	**Definition**
optionstring	An encoded 32-character string in the following format (hexadecimal): xxxxxxxx xxxxxxx xxxxxxxx xxxxxxxx.

Figure 3: Example of Software Option File Contents

Serial Number : 10280-3
Date : 07/24/09 15:15:22
Options : 10 Hz Nav Rate
25 Hz Data Rate
RTK Base
RTK Extend
Move Base RTK
Network RTK
GPS Signals L1
GPS Signals L2
GPS Signals L2C
GPS Signals L5
GLONASS Signals G1
GLONASS Signals G2
Galileo Signals E1
Galileo Signals E5a
SBAS Corrections
StarFire Corrections
0xBB/0xBA Output Disabled
SFNetwork Team Disabled
Customer :
PO Number :
Options Code : 7BE97A5F 68F87279 2D61DDE3 3D8D8D1A

The contents of the Software Options file are subject to change.

Example:

[INPUTSWOPTION] 7BE97A5F 68F87279 2D61DDE3 3D8D8D1A

Sometimes the option generation tool inserts an extra character space. This can be corrected in Microsoft Notepad, or via the Input Terminal using the method described below:

This is what the error looks like (extra space between the colon and the first character, the letter “A”):

Options Code: A4DEB10C 22A16D18 644AA8AD 451CF5D3

This is the correct format (no space between the colon and the first character, “A”)

Options Code: A4DEB10C 22A16D18 644AA8AD 451CF5D3

1.64 L1FALLBACK

☒SF-5050 ☒Onyx

The command Enables/disables L1 fallback (or optimized shading) option. When L1 fallback is ON, dGPS mode precedence is set to Dual 3D → Single 3D→ Dual 2D →Single 2D.

Command:		[L1FALLBACK] on_off
Parameter		**Definition**
on	K	Enable L1 fallback
off	K	Disable L1 fallback

Default: OFF

The L1FALLBACK feature is designed for challenging operating environments, such as briefly running along a tree line, and may benefit general navigation in this scenario.

Examples:

[L1FALLBACK] ON
Turns on L1 fallback

1.65 LOADBULKB

☒SF-5050 ☒Onyx

This message is used to install any bulk message/data through a serial port into NVRAM. The message format is defined below. It is different from the regular binary message format. Currently supported data types are GRACE GGM02 model and Geoid99 model.

The primary use of this command is to download Geoidal model files.

Data Item	Data Type	Description
[LOADBULKB]	char[]	Message ID
Length	U16	The total length of the message body plus the length field (in bytes)
Message body	var.	
*	U08	Delimiter Character
CRC32	U32	The CRC32 of the length field and message body
\r\n	U16	

1.66 LOGFILE

☒SF-5050 ☐Onyx

This command is used to start and stop optional logging as well as to set delay and duration. This command with no parameters returns the current logging status, delay and duration values.

Command:	[LOGFILE]]{START|STOP}, DelayHours{0-23}, DelayMinutes{0-59}, DurationHours{0-23}, DurationMin{0-59}

Default: [LOGFILE]STOP – Optional data logging is not started.

Examples:

[LOGFILE]
Will return current logging status as well as the current delay and duration if logging.

[LOGFILE] Start, 1,2,3,4 Activate data logging starting 1 hour, 2 minutes from command entry. Logging duration will be 3 hours and 4 minutes after logging starts.

[LOGFILE] Start, 1,2 Activate data logging starting 1 hour, 2 minutes from command entry. Logging duration will be continuous.

[LOGFILE] START
Starts data logging with start delay and duration set to the default settings (immediate start and continuous logging).

[LOGFILE]STOP
Stop data logging.

This command operates on the optional logging modes (User Mode).

Setting both the Duration hours and Duration minutes to 0 sets logging to continuous logging.

When choosing Start with delay and duration settings, the delay and duration settings are applied to the next Start. The delay and duration values are not saved and made available for the next start.

When a reset occurs after Start, logging is not automatically restarted on the next power on (See [LogFileAutoStart]).

1.67 LOGFILEAUTOSTART

☒SF-5050 ☐Onyx

This command is used set or clear the profile option which is used to automatically start optional data logging after receiver power-on.

Command:	[LOGFILEAUTOSTART] {ON,OFF}

Data logging starts automatically after the receiver is powered on.

Examples:

[LOGFILEAUTOSTART]
Returns current setting for automatic start of data logging.

[LOGFILEAUTOSTART] ON
Enables automatic start of optional data logging for the next power-on or reset. Setting it to on does not immediately start data logging.

[LOGFILEAUTOSTART] OFF
Disables automatic start of optional data logging for the next power-on or reset. Setting it to off does not immediately stop data logging.

This command operates solely on the user mode of the SF-5050.

1.68 LOGFILEBGDELETE

☒SF-5050 ☐Onyx

Delete the currently logged background (Black Box) log files.

Command:	[LOGFILEBGDELETE]

Default: none

Examples:

[LOGFILEBGDELETE]

Delete the background log files.

Logging state (on or off) is unchanged. The background logging directory (GNSSDATA) remains.

1.69 LOGFILEBGENABLE

☒SF-5050 ☐Onyx

Set or return background logging state.

Command:	[LOGFILEBGENABLE] {ON|OFF}

Default: ON

Examples:

[LOGFILEBGENABLE] OFF
Disable background logging.

[LOGFILEBGENABLE] ON
Enable background logging.

When setting from On to Off, logging is immediately disabled. Background logfiles and GNSSDATA directory remain. They are deleted at the next system start.

1.70 LOGFILEBGSETTIMELIMIT

☒SF-5050 ☐Onyx

Sets Rollover period for background log files.

Command:	[LOGFILEBGSETTIMELIMIT]TimeInMinutes

Default: 2880 Minutes (48 hours)

Examples:

[LOGFILEBGSETTIMELIMIT] 2900
Sets the background log file rollover time to 2900 minutes.

- While logging, stale log files are purged as they become older than the rollover period.
- When restarting the system, log files are purged if they are older than the rollover period.
- This command is independent of LOGFILETIME.
- The units for this command are expressed in minutes.
- Range 360 – 5760 minutes (6 hours to 96 hours).
- A power cycle is required when this value is changed.

1.71 LOGFILEDRIVE

☒SF-5050 ☐Onyx

This command sets or returns the optional logging's drive letter.

Command:	[LOGFILE] {A: or C:}

Where A: is the internal eMMC Flash and C: is the removable SD Card.

Default: A:

Examples:

[LOGFILEDRIVE] C:
Sets the optional log drive to C:

[LOGFILENAME]<Enter>
Returns the current log drive letter.

This command does not affect background logging. This command operates on user mode for SF-5050.

1.72 LOGFILEDRIVEFULLSEL

☒SF-5050 ☐Onyx

This command sets or returns the action taken when the logging drive is full.

Command:		[LOGFILEDRIVEFULLSEL] {STOPLOG | MAKESPACE}
Parameter		Definition
Drive Full Action	K	STOPLOG – Stop logging when drive is full MAKESPACE – Make 15% more space by deleting files.

Where A: is the internal eMMC Flash and C: is the removable SD Card.

Default: STOPLOG

Examples:

[LOGFILEDRIVEFULLSEL] STOPLOG
Sets the Drive Full Action to Stop Logging. That is logging on removable media stops when the drive is full.

[LOGFILEDRIVEFULLSEL] Enter>
Returns the current option.

This command does not affect background logging. This command operates on the USERLOG -optional logging mode.

Selecting MAKESPACE option will result in files being deleted once the memory is intitially full.

1.73 LOGFILENAME

☒SF-5050 ☐Onyx

This command is used to set or return the string to be appended to the base log file name of optional logging files.

Command:	[LOGFILENAME] {log file string}
Parameter	**Definition**
Naming Convention	userdata_<last three digits of prod serial number>_<six digit sequence number>_ <GPS week number>_<GPS time of week>.dat

This command does not affect background logging.

Default: Base name for SF-5050 is "user_data".

Examples:

[LOGFILENAME] "udata"
Sets a base log file name to "udata"

[LOGFILENAME]<Enter>
Returns the current base file name.

This command does not affect background logging (GNSS). This command operates on optional logging modes.

These characters cannot be part of base name "\,/,:,*,?,<,>,|,_".

The default base name for BGLOG (background data logging) is "gnssdata"

1.74 LOGFILESTATUS

☒SF-5050 ☐Onyx

This is command used to provide data logger task status.

Command:	[LOGFILESTATUS] {log file string}

Default: N/A

Examples:

[LOGFILESTATUS]

[LogFileStatus] Mode:Bkgrnd Drive:A:; Enabled:1; AutoStart:1; RsrvdSpace:5368709120; Captured:0; -Logged:31918

[LogFileStatus] Mode:USER Drive:A:; Enabled:0; AutoStart:0; RsrvdSpace:5368709120; Captured:0; -Logged:1230

1.75 LOGFILETIME

☒SF-5050 ☐Onyx

This command is used to set and review the duration and rollover period of the log files associated with optional logging.

Command:	[LOGFILETIME] {DurationMinutes}, {RolloverPeriodMinutes}

As data is logged it is stored into a file. That file contains data for a user-defined maximum duration time (DurationMinutes). Once that file's time expires, it is closed and another log file is created for data storage. The close / create process is repeated until there are RolloverPeriodMinutes of data files. At that point, a final file is created and filled. Once the final file's time expires, the oldest log file is deleted and a new log file is created. A minimum of RolloverPeriodMinutes of data is maintained.

	(minutes)
Default Duration	15
Minimum Duration	15
Maximum Duration	120
Default Rollover	2880
Minimum Rollover	360
Maximum Rollover	5760

Examples:

[LOGFILETIME]<CR>

[LOGFILETIME]15, 360

[LOGFILETIME] 60, 1440

Individual log files store 1 hour of data for a total of 24 hours.

Upon board reset, old files are purged. Files that are older than RolloverPeriodMinutes are deleted.

Duration Range: 15 minutes to 24 hours. Rollover Range: 6 hour to 96 hours.

A system reset is required for changes to take affect.

When the DurationMinutes field is not entered, the previous setting is used.

When the RolloverPeriodMinutes field is not entered, the previous setting is used.

1.76 MPAUTOCONNECT

☒SF-5050 ☐Onyx

This command is used to set multiple mount points for the NTRIPCLIENT connection.

Command:		[MPAUTOCONNECT] mode,"mp1","mp2","mp3",..."mp10"
Parameter		**Definition**
Mode	K	Keyword (ON, OFF) ON: The user must specify at least one mount point for the ntripclient to attempt to connect to. The NTRIPCLIENT will try to connect to each of the listed mount points in order if the current mount point times out and will attempt to reconnect 10 times. After reaching the last mountpoint, NTRIPCLIENT will continue to try to reconnect by starting all over again using the first mountpoint listed. This command will override [NTRIPCONFIG] mountpoint arg after setting up the new mount point. OFF: The user will not need to specify any additional mountpoints. The NTRIPCLIENT will only attempt to reconnect using the current mount point specified in NTRIPCONFIG
MP1-10	K	Keyword (dynamic caster mount points) If the Mode is ON, then the user can specify up to 10 mount points for the NTRIPCLIENT to attempt to make a connection. These mountpoints must follow the RTCM mount point naming convention which allows only the use of alphanumeric characters, ".", "-", and "_". [NTRIPCLIENT] will continue to attempt to make a reconnection based on the given mount point.

Default: mode = OFF.

This command will NOT take effect if the NTRIPCONFIG command does not set the client to autoconnect.

Examples:

[MPAUTOCONNECT]ON, "RTCM3.0","RTCM2.3","RTCM3.1"

The receiver will cycle through each of these mountpoints as needed. If RTCM3.0 fails to automatically establish a connection after 10 tries, then RTCM2.3 will be tried and NTRIPCONFIG will be overridden with this mountpoint information, and so forth. If RTCM3.1 fails to establish a connection, then RTCM3.0 will retry and the cycle will continue.

[MPAUTOCONNECT]ON, "RTCM2.3","StarFireGNSS"

Overrides the list with RTCM2.3 and StarFireGNSS mountpoints

[MPAUTOCONNECT]OFF

Clears the list and disables the MP AUTOCONNECT. NTRIPCONFIG will alter the last mountpoint until the user manually changes it.

[MPAUTOCONNECT]ON

Indicates an error. The user must specify at least one mountpoint.

1.77 MSGSTANDARD

☒SF-5050 ☒Onyx

This command is used to set configures the format of the NMEA output messages to a specific standard and version.

Format: [MSGSTANDARD] <standardtype>, <version>

standard [IEC61162, DEFAULT] as defined in in the table below

Command:		[MSGSTANDARD] <standardtype>, <version>
Parameter		**Definition**
standard	K	[IEC61162, DEFAULT] as defined in in the table below
Version	F	version number of the standard

Default: [MSGSTANDARD] DEFAULT

Message Standard Configuration

Keyword Mnemonic	**Message Standard Configuration**
IEC61162	Standard type for the NMEA messages. Requires a version number.
DEFAULT	Sets receiver to the default setting, currently identified as [MSGSTANDARD] IEC61162, 4.

Examples:

[MSGSTANDARD] IEC61162, 4
Configures the NMEA messages to correspond to IEC61162, Version 4

[MSGSTANDARD] IEC61162, 3
Configures the NMEA messages to correspond to IEC61162, Version 3

[MSGSTANDARD] DEFAULT
Configures the NMEA messages to correspond to the default setting, which is currently IEC61162, Version 4.

1.78 NAVELEMASK

☒SF-5050 ☒Onyx

This command is used to set the elevation limit for the code-based (pseudorange) navigation solution, the RTK navigation solution, and the phase navigation solution. The velocity navigation solution is also set to 2 less than the elevation given in this command. Measurements from satellites below the elevation limit will not be used in the solution.

Command:		[NAVELEVMASK] elevation
Parameter		**Definition**
elevation	F	Elevation limit for the code-based (pseudorange) navigation solution (float, degrees) (0.0 to 60.0)

Default: 7.0 degrees

Setting the elevation limit to use satellites lower than the default value may introduce additional error in the navigation solution due to increased unmodeled atmospheric errors. Setting the elevation mask higher than the default value may affect availability of a navigation solution and may also cause higher PDOP values.

If their signals are strong enough, satellites below the navigation elevation mask (but above the tracking elevation mask) will still be tracked and measurements will be generated for them. They will be included in the raw data output.

Example:

[NAVELEVMASK] 8.0
Sets the elevation mask angle at 8 degrees

1.79 NAVMEASUSE

☒SF-5050 ☒Onyx

This command is used to enable or disable the receiver's use of various signals or frequencies for navigation. When a GPS signal or frequency is enabled or disabled, it applies to all GPS satellites broadcasting that signal.

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

Enabling a specific measurement is necessary to allow the receiver to use the signal measurement, but it is not sufficient. The receiver must also be licensed for that tracking mode, and the signal must be available.

Command:		[NAVMEASUSE] signal1, on_off, {signal2, on_off, signal3, on_off, …, signal_N, on_off}
Parameter		**Definition**
signal	K	Keyword, defined in Table 65 (TRACKINGMODE command), which specifies the signal or frequency to be enabled or disabled.
on_off	K	Keyword (ON or OFF)

Default:L1,ON,L2,ON,L2C,ON,L5,OFF,WAASEGNOS,OFF,GLONASS,ON,GALILEO ,OFF, BEIDOU, OFF

Table 68: Signals and/or Frequencies Keywords for NAVMEASUSE Command

Keyword Mnemonic	Signal or Frequency
ALL	Used to specify all signals and frequencies
L1	GPS L1/CA
L2	GPS L2/P2(Y)
L2C	GPS L2C
L5	GPS L5
WAASEGNOS	WAAS or EGNOS SBAS systems
GLONASS	GLONASS G1 and G2
GALILEO	GALILEO E5, E2-L2-E1 (Not Supported)

Enabling a specific measurement is necessary to allow the receiver to use the signal measurement, but it is not sufficient The receiver must also be licensed for that tracking mode, and the signal must be available.

Multiple signals can be enabled or disabled at one time by repeating pairs of signal names and on/off keywords.

L1 measurement usage is critical to the operation of the receiver. The disabling of the L1 measurement (L1,OFF) places the receiver in an "undefined configuration," which may produce unpredictable results.

⚠ Never use WAAS set to ON outside of the American WAAS iono grid footprint. Doing so outside of this footprint may result in poor Base Station usage of satellites and/or limit the number of satellites the rover might otherwise use in an RTK solution.

Examples:

[NAVMEASUSE] L2C, OFF
Disables nav usage of L2C for all satellites broadcasting it

[NAVMEASUSE] ALL, ON
Enables nav measurement usage for all signals and frequencies

[NAVMEASUSE] L1, ON, L2, OFF, L2C, OFF
Enables nav measurement usage of L1, but disables L2 and L2C

1.80 NTRIPCLIENT

☒SF-5050 ☐Onyx

This command controls the behavior of the NTRIP client. If no keyword is specified, the current status will be displayed.

Command:	[NTRIPCLIENT] {keyword} {keyword}
Parameter	**Definition**
None	Keyword that displays the NTRIP client status
Connect	Keyword that connects to the caster mountpoint
Disconnect	Keyword that disconnects from the caster mountpoint
SRCTBL	Keyword that retrieves the current source table from the client and uploads it to the user
NEWSRCTBL	Keyword that retrieves the updated source table from the caster and uploads it to the user

NEWSRCTBL can only be executed when the NTRIP client is idle. If it is not idle, an error message will be displayed. SRCTBL however can be executed at any time.

NMEA messages may be scheduled for output on the NTRIP port. If they are scheduled, they will be sent to the NTRIP server on the mountpoint the client is connected to.

The user should NOT schedule any message other than NMEAGGA on the NTRIP port since many casters may not handle them properly. Also, NMEAGGA should not be scheduled any faster than 1Hz in order to avoid clouding the connection.

The client connection will timeout and disconnect if there is no data coming from the receiver for either 30 seconds or 5 times the fastest stream rate, whichever is bigger. This is determined dynamically on connection when the receiver asks for the Source Table. If the correction stream is one message every 60 seconds, the receiver will disconnect if no corrections are received for 300 seconds.

The NTRIP client reports status messages back through the same port from which it received the [NTRIPCLIENT] command. This port number is saved in RAM and is initialized to an invalid port number at power-on. Status messages are only displayed after the first [NTRIPCLIENT] command after power-on. Refer to Table 69 for details.

Table 69: NTRIP Client Status Messages

State	Action	Message	Description
ANY	CONNECT command	NTRIP CLIENT BUSY	NTRIP client not in idle state. Command will not be processed.
		NTRIP SERVER BUSY	NTRIP server not in idle state. Command will not be processed.
IDLE	CONNECT command	INVALID CASTER INFO – Name: Port: Mountpoint:	Necessary caster information unavailable. Command will not be processed.

IDLE	Auto-connect field set to CLIENT	AUTOCONNECTING NTRIP CLIENT	NTRIP client is attempting to auto-connect with current configuration information.
WAIT FOR MOBILE	Attempting to connect via modem	COULD NOT MAKE MOBILE CONNECTION	Failure to connect to the wireless service provider. Return to IDLE state.
CONNECT TCP/IP	Attempting TCP/IP connection	COULD NOT ALLOCATE SOCKET	Internal TCP/IP stack error. Return to IDLE state.
		COULD NOT BIND SOCKET	Internal TCP/IP stack error. Return to IDLE state.
		COULD NOT MAKE TCP/IP CONNECTION	Time-out attempting TCP/IP connection. Return to IDLE state.
		COULD NOT CONNECT. PLEASE CHECK CASTER NAME.	Error response from DNS server. Probably an invalid caster URL or IP address. Return to IDLE state.
GET GGA	Waiting for GGA	NO RESPONSE TO NMEA GGA REQUEST	Time-out waiting for GGA from GNSS receiver. Return to IDLE state.
GET CASTER RESPONSE	Waiting for caster response	NO RESPONSE FROM CASTER – RETRYING	Time-out waiting for caster response to NTRIP handshake. Disconnect from wireless service provider and attempt to reconnect.
		INVALID USERNAME OR PASSWORD	Caster rejected the username or password. Return to IDLE state.
		Other caster error message	Depends on message. Return to IDLE state.
		Sourcetable displayed	This is either a proper response to a NEWSRCTBL command, or it indicates the requested mountpoint is not available. Return to IDLE state.
GET SRC TBL	NEWSRCTBL command	TIMEOUT WAITING FOR SOURCETABLE	Time-out waiting for sourcetable. Return to IDLE state.
		SOURCETABLE OVERFLOW	Insufficient memory to store sourcetable. Return to IDLE state.
CONNECTED	Receiving corrections	TIMEOUT WAITING FOR CORRECTION DATA - RECONNECTING	Time-out waiting for corrections. Disconnect from wireless service provider and attempt to reconnect.

Examples:

[NTRIPCLIENT]
Returns the client status

[NTRIPCLIENT]CONNECT
Connects to the NTRIP caster
[NTRIPCLIENT]CONNECTED

[NTRIPCLIENT]SRCTBL
Causes the receiver to upload any existing source table to the host

[NTRIPCLIENT]NEWSRCTBL
Requests that a new source table be downloaded from the caster

1.81 NTRIPCONFIG

☒SF-5050 ☐Onyx

This command specifies the information the NTRIP client or server need in order to connect to an NTRIP caster. If no configuration information is specified, the current settings will be displayed.

Table 70: NTRIP Client Configuration Data

Command:	Format: [NTRIPCONFIG] {Caster name} {Caster port} {Mountpoint} {Username} {Password} {NMEA GGA} {Autoconnect} {Correction port} {Authentication}	
Parameter	**Definition**	**Values**
Caster name	Name of the NTRIP caster to connect to (see note 1)	string (128 character max)
Caster port	Caster port number to connect to (see note 1)	int (0 – 65535)
Mountpoint	Name of the mountpoint to connect to	string (70 character max)
Username	Username for authentication	string (128 character max)
Password	Password for authentication	string (128 character max)
NMEA GGA	Whether transmission of NMEA GGA is required	Keyword: OFF, ON
Autoconnect	Whether to connect automatically	Keyword: OFF, CLIENT, SERVER
Correction port	Which local port to use for NTRIP connection	Keyword: ETH, WIFI, MOBILE
Authentication	Which authentication method to use for NTRIP connection	Keyword: BASIC, DIGEST

Caster name Name of the NTRIP caster to connect to. This may be specified as an IP address (e.g., “69.44.86.66”) or a URL

Caster port Port number to connect to on the caster

Mountpoint Name of the mountpoint to connect to on the caster

Username Username, if required for authentication

Password Password, if required for authentication

NMEA GGA Whether the NTRIP server requires the transmission of the GNSS receiver’s NMEA GGA sentence as part of the NTRIP handshake

Autoconnect Indicates whether the NTRIP should try to automatically connect to a caster at power-on or when idle. The unit can be configured to not connect, connect as a client, or connect as a server.

Correction port Whether to use Ethernet, Wi-Fi, or mobile cellular modem to connect to the caster. Note that the modem must be connected to COM2 on the SF-5050.

Authentication Whether to use Basic or Digest authentication. Before SB3, the unit could only do BASIC authentication. However to fully support NTRIP2.0, the unit will now handle DIGEST authentication. If the user selects either DIGEST, the unit will attempt to figure out which method the server uses, if the server returns 401 with “WWW-Authenticate: <AuthType>” Where <AuthType> is either Digest or Basic, then the unit will be able to connect using that appropriate Authentication method. If Basic is selected, the unit will only attempt Basic.

Examples:

[NTRIPCONFIG] “69.44.86.66”, 2101, “LASC_RTCM3”,,,ON,, MOBILE, DIGEST
Configure to use the caster at IP address 69.44.86.66, on port 2101. Get corrections from the server connected to mountpoint LASC_RTCM3. Use the mobile cellular modem

to connect to the Internet. Send a NMEA GGA sentence as part of the handshake. And attempt either Digest or Basic authentication depending on the response.

[NTRIPCONFIG]
[NTRIPCONFIG] “69.44.86.68”, 2101, “LASC_RTCM3”, “”, “”, OFF, OFF, ETH, Basic
Display current settings

Some NTRIP casters, such as SmartNet Aus, have a nonstandard interface to the NTRIP server/source/base station. In this situation, the caster makes a TCP/IP connection to the NTRIP server, rather than the server connecting to the caster. In order to accommodate this feature, if the special caster name, RTK Network, is used in the NTRIPCONFIG command, the server will listen to and accept TCP/IP connections on the port specified as the caster port in the NTRIPCONFIG command, using the IP address specified using the ETHCONFIG command.

Some NTRIP casters, such as Iowa DOT return 401 without any other header information such as “WWW-Authenticate: <AuthType>”, in which case the unit will not only be able to determine which authentication method to use, but it will not be able to do Digest authentication at all since the caster is not following the NTRIP standards. In this case, the user should use BASIC arg and attempt to connect with Basic authentication.

The NTRIPCONFIG will initially get the Source Table of any caster, if the format argument (4th arg) is NCT, then the client will know that it is talking with a StarFire Caster. If that is the case, then it will use DIGEST authentication with username <ProductType>.<SerialNum> and password <ProductType><SerialNum><WeekNum> to connect to the StarFire Mountpoint regardless of the user input for username and password. For example, if [PRODUCTINFO] returns SF-3040,12345 and the current week is 1694. Then the client will use username SF-3040.12345 and password SF-3040123451694

1.82 NTRIPSERVER

☒SF-5050 ☐Onyx

This command controls the behavior of the NTRIP server. If no keyword is specified, the status is displayed.

Command:	[NTRIPSERVER] {NONE} {CONNECT} {DISCONNECT} {RECONNECT}
Parameter	**Definition**
None	Keyword that displays the NTRIP server status
Connect	Keyword that commands the server to connect to the caster mountpoint
Disconnect	Keyword that commands the server to disconnect from the caster
Reconnect	Disconnects and then connects again to the caster mountpoint

Examples:

[NTRIPSERVER] CONNECT
Connects to the NTRIP caster

[NTRIPSERVER]
Displays current status
[NTRIPSERVER]MAKING MOBILE CONNECTION

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.

- NTRIP Server Status Messages

The NTRIP server reports status messages back through the same port from which it received the [NTRIPSERVER] command. This port number is saved in RAM and is initialized to an invalid port number at power-on. Status messages are only displayed after the first [NTRIPSERVER] command after power-on. Refer to Table 71 for details.

Table 71: NTRIP Server Status Messages

State	Action	Message	Description
ANY	CONNECT command	NTRIP CLIENT BUSY	NTRIP client not in idle state. Command will not be processed.
		NTRIP SERVER BUSY	NTRIP server not in idle state. Command will not be processed.
IDLE	CONNECT command	INVALID CASTER INFO – Name: Port: Mountpoint:	Necessary caster information unavailable. Command will not be processed.
IDLE	Auto-connect field set to SERVER	AUTOCONNECTING NTRIP SERVER	NTRIP server is attempting to auto-connect with current configuration information.
WAIT FOR MOBILE	Attempting to connect via modem	COULD NOT MAKE MOBILE CONNECTION	Failure to connect to the wireless provider. Return to IDLE state.

State	Action	Message	Description
CONNECT TCP/IP	Attempting TCP/IP connection	COULD NOT ALLOCATE SOCKET	Internal TCP/IP stack error. Return to IDLE state.
		COULD NOT BIND SOCKET	Internal TCP/IP stack error. Return to IDLE state.
		COULD NOT MAKE TCP/IP CONNECTION	Time-out attempting TCP/IP connection. Return to IDLE state.
		COULD NOT CONNECT. PLEASE CHECK CASTER NAME.	Error response from DNS server. Probably an invalid caster URL or IP address. Return to IDLE state.
CONNECT TCP/IP	Attempting TCP/IP connection in nonstandard mode	LISTEN FAILED	Internal TCP/IP stack error. Return to IDLE state.
		WAITING TO ACCEPT A CONNECTION	Waiting for a connection from a remote user. Proceed to WAIT FOR CASTER state.
WAIT FOR CASTER	Remote caster connection	ACCEPTED A CONNECTION FROM ip addr:port #	Accepted a connection from a remote user. Proceed to CONNECTED state.
GET CASTER RESPONSE	Waiting for caster response	NO RESPONSE FROM CASTER	Time-out waiting for caster response to NTRIP handshake. Return to IDLE state.
		INVALID USERNAME OR PASSWORD	Caster rejected the username or password. Return to IDLE state.
		Other caster error message	Depends on message. Return to IDLE state.
		CONNECTED	Connected to caster. Proceed to CONNECTED state.
CONNECTED	Sending corrections	ERROR SENDING DATA TO CASTER - DISCONNECTING	Unexpected disconnection from caster. Return to IDLE state.

1.83 NUMANTENNAS

☒SF-5050 ☒Onyx

This command specifies the number of antennas attached to the receiver.

Command:		[NUMANTENNAS] numantennas
Parameter		**Definition**
numantennas	I	Number of antennas (1 or 2)

Default: 1

Examples:

[NUMANTENNAS] 2
Sets the number of antennas to 2

1.84 OUTPUT

☒SF-5050 ☒Onyx

This command is used to control which data the Onyx engine or SF-5050 outputs on its data ports. The receiver output data are organized into different types of output messages, also called output streams. The receiver Output Messages and provides detailed descriptions of their formats. Each receiver output stream or message is identified by a unique mnemonic. The [OUTPUT] command uses these mnemonics, and other optional arguments, to set up and control the output scheduling for the different output streams.

Command:		[OUTPUT] mnemonic, {timing}, {interval}, {port}, {keyword}
Parameter		**Definition**
mnemonic	K	Keyword that identifies the name of the output stream to be scheduled. If the keyword “NONE” is used for this argument, all outputs are turned off on the specified port, including the [OK] and [??] outputs used to acknowledge or reject input commands.
timing	K	Keyword that identifies scheduling or timing method. (see Table 72**Error! Reference source not found.**; some messages are limited based on purchased options)
interval[1]	I	Time interval between outputs, truncated to the nearest 0.01 second (float, seconds) (0.01 to 9999.9). This field is also used to indicate PRN number when Timing field is ONCE for the following mnemonic: • EPHEM1B: The ranges are: GPS(1-32), GLONASS (38-61 for prn 1-24), SBAS(120-138) • RTCM3_1019: The valid ranges are: GPS (1-32) • RTCM3_1020: The valid ranges are: GLONASS (1-24) • If this field is 0 or no value, it means to output all PRNS. ⚠ Do not request EPHEM1B, RTCM3_1019, or RTCM3_1020 more often than once every 60 seconds when requesting all ephemerides. If this field is 0 or no value, all PRNs are output
port	K	Keyword that identifies the data port to use for the output stream, or -1 to mean “all ports” (see Table 72**Error! Reference source not found.**). If ONTIME is selected, and the interval specified is finer than the rate at which the data contained in the message are updated, then the message output interval will average out to the specified interval rather than occurring exactly at the specified interval. For example, if the navigation computation rate is set to 10 Hz, but the PVT1B message is scheduled to be output ONTIME every 5.12 seconds, then the interval between consecutive PVT1B messages will dither between 5.10 seconds and 5.20 seconds, averaging out to 5.12 seconds. An example of data that would likely be scheduled ONCHANGE is GPS satellite ephermis data. Ephemeris data normally change every two hours, but are received from the satellites every 30 seconds. EPHEM1B is a special case message. It can be output for the entire list of

		satellites (tracked or not) or specified for a specific satellite. These two special cases are typically used at base station startup or hub software startup in a network solution. The ability to poll the receiver for a specific PRN's ephemeris allows the network to easily recover from data outages that might occur on an Ethernet link, for example. The third (and normal usage) case is to schedule EPHEM1B "Onchange." In this mode, the receiver unpacks and passes on satellite ephemerides as they are received from the satellite (the normal, ongoing operational condition). ⚠ When incorporated into an end-user program, do not poll the receiver for the complete EPHEM1B list more than once every 60 seconds. End-user programs can request the entire EPHEM1B LIST "Once" and immediately follow this command with "Onchange." Record all of the settings before using -1 as the port number (see caution note, below).
keyword	K	Extra keyword; meaning depends on the mnemonic. If the keyword is defined for the mnemonic, it is accepted as an input and included in the query response. If the keyword is not defined for the input mnemonic, it is ignored in the input and not included in the query response.

If values for the optional arguments (timing, interval, port) are not provided, the following default values will be used:

timing_mode – ONTIME for CHNLSTATS1B; ONCHANGE for all the other messages

interval – 1 second

port – the port the [OUTPUT] command was received on

Default: *OFF for all messages*

Any time interval within the range will be accepted, but the actual interval used is determined by the software at the nearest interval. Time intervals are limited to the purchased option rate, or as predefined based on the message type, to limit the possibility of buffer overflow and processor loading.

Table 72: Output Command Scheduling/Timing Methods

Keyword Mnemonic	Scheduling or Timing Method
ONTIME	Outputs the message at a rate ≤ the purchased rate
ONCHANGE	Outputs the message at the highest rate the system can output
ONCE	Outputs the message once as soon as the [OUTPUT] command is received
OFF	Stops output of this message for the specified port

Messages RTCM3_1019 and RTCM3_1020 are not allowed to be scheduled with trigger type "Once"

Table 73: Output Command Port Mnemonics

Keyword Mnemonic	Data Port
1	RS232 Serial port 1
2	RS232 serial port 2
3	RS232 serial port 3
4	RS232 serial port 4
BT	Bluetooth®
USB1	USB port 1
USB2	USB port 2 (not supported at product launch)
ETH1	Ethernet/Wifi port 1
ETH2	Ethernet/Wifi port 2
ETH3	Ethernet/Wifi port 3
ETH4	Ethernet/Wifi port 4
ETH5	Ethernet/Wifi port 5
ETH6	Ethernet/Wifi port 6
ETH7	Ethernet/Wifi port 7
ETH8	Ethernet/Wifi port 8
RADIO	PIO radio port
USERLOG	User Logging to Internal, USB, SD
DATALOG	Background Logging Binary Data to Internal Storage

Examples:

[OUTPUT] PVT1B,ONTIME,1,1
Outputs PVT1B messages every second on port 1

[OUTPUT] PVT1B,,2,1
Command rejected. Timing argument is required when interval is set

[OUTPUT] NMEAGGA
Outputs GGA messages on the current port using default values, or current profile values for timing and interval

[OUTPUT] PVT1B,ONCE,,1
Outputs one PVT1B message through port 1 immediately after this command is received

[OUTPUT] PVT1B,OFF,,1
Disables output of PVT1B messages through port 1

[OUTPUT] PVT1B,OFF
Disables output of PVT1B messages through current port

1.85 PACKB

☒SF-5050 ☐Onyx

This message is used to pack navigation corrections into NavCom command format. This message follows standard binary format. This message is issued whenever the sender accumulates 512 bytes of data, or the time from last transfer exceed 500ms.

Table 74: PackB Command Format

Data Item	Data Type
Format	U08
Port	U08
Correction Data	U08[]

1.85.1 Format

Table 75: PackB Command Format Field Mnemonics

Format Field Value	Meaning
0	Unknown
1	NCT proprietary
2	RTCM 2.3
3	RTCM 3.0
4	Reserved

Specifying the data format, although optional, can result in improved performance. However, if the format field is set to Unknown and the data type is supported by the receiver firmware, the correction data will be successfully sent and processed.

1.85.2 Port

This value is reserved; it is always 0.

1.85.3 Correction Data

This is actual correction data, up to 512 bytes. Each byte of the correction data is encoded by being XORed with 0x55.The parsers on the receiver are highly adaptable. If correction data are not encoded, the parsers may become confused and start switching between correction mode and command mode. The receiver decoding function of the PACKB command returns the data to their original values by XORing it with 0x55 again.

See example function (C#) below for building the PACKB message.

```
Private void SendCorrectionsOut(byte[] data, Uint16 len)
{
byte[] CorrectionsByteArray = new byte[2048];
// this is the data buffer plus the binary header
Uint16 Length = (Uint16)(len + 9 + 2);
// arbitrary gps week and time
Uint16 GPSWeek = 0x064A;
Uint32 GPSTime = (((2 * 24 + 8) * 60 * 60) + (15 * 60)) * 1000; // Tuesday, 8:15AM
byte TimeVersion = 0x00;        // time is unknown; message version 0

int I = 0;
int lenidx = 0;
CorrectionsByteArray[i++] = (byte)'[';
CorrectionsByteArray[i++] = (byte)'P';
```

```
CorrectionsByteArray[i++] = (byte)'A';
CorrectionsByteArray[i++] = (byte)'C';
CorrectionsByteArray[i++] = (byte)'K';
CorrectionsByteArray[i++] = (byte)'B';
CorrectionsByteArray[i++] = (byte)']';

lenidx = I;

CorrectionsByteArray[i++] = (byte)Length;
CorrectionsByteArray[i++] = (byte)(Length >> 8);

//CorrectionsByteArray[i++] = (byte)GPSWeek;
//CorrectionsByteArray[i++] = (byte)(GPSWeek >> 8);
// TFS 17877
Uint16 shadowLength = (Uint16)~Length;
CorrectionsByteArray[i++] = (byte)(shadowLength);
CorrectionsByteArray[i++] = (byte)(shadowLength >> 8);

CorrectionsByteArray[i++] = (byte)GPSTime;
CorrectionsByteArray[i++] = (byte)(GPSTime >> 8);
CorrectionsByteArray[i++] = (byte)(GPSTime >> 16);
CorrectionsByteArray[i++] = (byte)(GPSTime >> 24);
CorrectionsByteArray[i++] = TimeVersion;

CorrectionsByteArray[i++] = 0; // corrections type
(0=unk,1=nct,2=rtcm2.3,3=rtcm3.0,4=cmr/cmr+
CorrectionsByteArray[i++] = 0; // logical port


/*/////////////////////////////////////////////////////////////////////////
* XOR ALL correction data with 0x55.
* If we send correction data without encoding it parsers on the receiver may get
confused.
* So on sender side we encode it with 0x55 and on receiver side we will decode it
with the
* same value

*/////////////////////////////////////////////////////////////////////////
for (int ix = 0; ix < len; ++ix)
{
    data[ix] ^= 0x55;
}
Buffer.BlockCopy(data,0,CorrectionsByteArray,I,len);

// tricky! Short cut way to convert 0xABCD to "ABCD"
Uint32 crc = crc_CCITT(lenidx, Length, CorrectionsByteArray);
string crcBytes12 = ConvertByteToString((byte)((crc >> 8) & 0x0FF));
string crcBytes34 = ConvertByteToString((byte)(crc & 0x0FF));

CorrectionsByteArray[len + i++] = (byte)('*');
CorrectionsByteArray[len + i++] = (byte)crcBytes12[0];
CorrectionsByteArray[len + i++] = (byte)crcBytes12[1];
CorrectionsByteArray[len + i++] = (byte)crcBytes34[0];
CorrectionsByteArray[len + i++] = (byte)crcBytes34[1];
CorrectionsByteArray[len + i++] = (byte)(0x0D); // CR/LF
CorrectionsByteArray[len + i++] = (byte)(0x0A);

if (serialPortOctagon.IsOpen)
{
   serialPortOctagon.Write((byte[])CorrectionsByteArray, 0, Length + i);
```

```
        _packBOut++;
      }
    }
```

1.85.4 Theory of Operation

This command is used when both NavCom commands and corrections are transmitted to the receiver via one communication port. Typical usage consists of a handheld device connected to a receiver via Bluetooth®. The handheld device runs custom software such as surveyor software capable of generating and receiving Nova commands. The handheld device also receives corrections either via a built-in radio or an externally connected modem. These corrections can be passed to the GNSS receiver using the [PACKB] message.

1.85.5 Limitations and Points of Interest

1.85.5.1 Header Format

PACKB should be formatted as a standard binary message, in standard Nova binary header format, as described in Binary Output Message Organization

GPS time fields do not need to contain valid GPS time, since those fields are ignored. The GPSWeek field of standard header is used in non-standard way.That 16 bit field is used to verify the integrity of length field. It is used to verify the integrity of the length field. The version field should be 0 for the current version.

1.85.5.2 Correction Data/Onyx Command Sequence

Correction data and Onyx commands cannot be sent together. Send an entire PACKB command prior to sending a Onyx command and vice versa.

1.85.5.3 Error Handling

The receiver processes PACKB messages regardless of what port receives them. However, certain error conditions are handled only if PACKB messages are received via a Bluetooth® connection, so the PACKB command should not be used with any other port. The parsers for the PACKB message will be reset and any data contained in an unfinished message will be lost under the following conditions:

- the PACKB transmission is not completed within three seconds
- the Bluetooth® connection is lost during transmission of PACKB

1.87 PASSTHRU

☒SF-5050 ☐Onyx

This command is used to enable a data pass through from one serial port to another. Once a pass through session is enabled between two ports, all input data received on one port will be output to the other port with no processing performed by the receiver. This continues until a pass through OFF command is received on any port. During the time that pass through is enabled, all receiver messages scheduled to be output to either port are disabled. Only one pass through can be configured at a time. If a pass through ON command is received while a pass through is already enabled, the new request will receive an NAK.

Command:		[PASSTHRU] on_off, port_dst, port_src
Parameter		**Definition**
on_off	K	Keyword that turns pass through mode on and off
port_dst	K	Keyword that identifies the destination data port to be used for the output stream (refer to OUTPUT command port definition.
port_src	K	Optional keyword that identifies the source data port to be used for the output stream. If not specified, the port on which the command is input is used. SF-5050 ports (refer to OUTPUT command port definition). If ONTIME is selected, and the interval specified is finer than the rate at which the data contained in the message are updated, then the message outputinterval will average out to the specified interval, rather than occurring exactly at the specified interval. For example, if the navigation computation rate is set to 10 Hz, but the PVT1B message is scheduled to be output ONTIME every 5.12 seconds, then the interval between consecutive PVT1B messages will dither between 5.10 seconds and 5.20 seconds, averaging out to 5.12 seconds. An example of data that would likely be scheduled ONCHANGE is GPS satellite ephemeris data. Ephemeris data normally change every two hours but are received from the satellites every 30 seconds. EPHEM1B is a special case message. It can be output for the entire list of satellites (tracked or not) or specified for a specific satellite. These two special cases are typically used at base station startup or hub software startup in a network solution. The ability to poll the receiver for a specific PRN’s ephemeris allows the network to easily recover from data outages that might occur on an Ethernet link, for example. The third (and normal usage) case is to schedule EPHEM1B “Onchange.” In this mode, the receiver unpacks and passes on satellite ephemerides as they are received from the satellite (the normal, ongoing operational condition). ⚠ When incorporated into an end-user program, do not poll the receiver for the complete EPHEM1B list more than once every 60 seconds. End-user programs can request the entire EPHEM1B list “Once” and immediately follow this command with “Onchange.”

DEFAULT: OFF

⚠ When a pass through session is enabled between two ports, subsequent commands input on either port will be ignored i.e. they will be treated as data to be passed through.. The sole exception to this is the [PASSTHRU] command to turn off the pass through session. Sending the [PASSTHRU]OFF command may also get passed through partially or fully.

Examples:

[PASSTHRU] ON, 2
(Assuming the command was input on serial port 1)
All data coming in on port 1 will be passed to port 2.
All data coming in on port 2 will be passed to port 1.
None of the data will be parsed by the receiver.
All scheduled messages for ports 1 and 2 will be stopped.

Response : The [OK] PASSTHRU response will occur twice. Once from the PIOB and once from the Onyx Board

[OK] PASSTHRU
[OK] PASSTHRU

[PASSTHRU] OFF
Turns off pass through mode

[PASSTHRU]

Query the PASSTHRU Command

Response : The response will occur twice. Once from the PIOB and once from the Onyx Board

[PASSTHRU]OFF
[PASSTHRU]OFF

1.88 PDOPLIMIT

☒SF-5050 ☒Onyx

This command is used to set the maximum position dilution of precision (PDOP) allowed for a valid navigation solution. If the satellites available for navigation have a geometry that results in a PDOP value that exceeds this limit, the receiver will report that a navigation solution is not available.

Command:		[PDOPLIMIT] pdop
Parameter		**Definition**
pdop	F	PDOP limit (float, dimensionless) (2.0 to 100.0)

Default: 10.0

Example:

[PDOPLIMIT] 10
Sets the PDOP limit to 10

When the PDOP reaches higher values, large errors can occur in the navigation solution. If the PDOP limit is set too low, availability of the navigation solution may decrease.

1.89 PING

☒SF-5050 ☒Onyx

This command is used to query a port. It provides a convenient method for an external device to determine if it is properly connected to the Onyx unit. This command causes a response, which includes the [PING] mnemonic followed by the current port number, to be sent out through the current port or the specified port.

Command:		[PING] {port}
Parameter		**Definition**
port	K	Keyword that identifies the data port to send a response to. If this argument is empty, the port number is defaulted to the port where the ping command was issued.

Default: Port through which the command is entered.

Examples:

[PING]	Issue through port 3
[PING] 3	Response defaulted to current serial port
[PING] 1	Issue through port 1
[PING] 1	Response output through port 1
[PING] 1	Issue through port 3
[OK] PING	Response output through port 3
[PING] 1	Response output through port 1

1.90 PORT

☒SF-5050 ☒Onyx

This command is used to set the configuration of the serial ports.

Command:		[PORT] {port#}, {baud}, {data_bits}, {stop_bits}, {parity}
Parameter		**Definition**
port#	I	Serial port number
baud	I	Baud rate (integer) (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400)
data_bits	I	Number of data bits (integer) (8)
stop_bits	I	Number of stop bits (integer) (1 or 2)
parity	K	Parity (keyword) (NONE, ODD, EVEN)

Default: At start up, all serial ports are set to baud rate = 115200, data bits = 8, 1 stop bit, no parity. After start up, if USEPROFILE is different from NONE, profile settings for the ports are applied.

While the receiver allows a setting of the data rate as high as 230400 bps, no device following the RS-232 standard will accept a data rate higher than 115200. A USB RS232 serial convertor supports speeds greater than 115200 bps.

Example:

[PORT], 9600
Sets the baud rate of the current active serial port to 9600

1.91 POWERMODE

☒SF-5050 ☒Onyx

This command is used to set the power on mode for the receiver.

Command:	[POWERMODE] mode
Parameter	**Definition**
Mode	Power mode. Keyword: OFF, ON, SWITCH as defined in Table 76.

Default: OFF

Table 76: Power Modes

Keyword Mnemonic	Power Modes
OFF	When power is applied the receiver will remain off.
ON	When power is applied the receiver will turn on. If the power button is pressed, the receiver will Reset rather than shut down.
SWITCH	When power is applied the receiver will turn on if the button was in the on position when power was removed. If the button was in the off position when power was removed the receiver will remain off.

Example:

[POWERMODE] ON
Change to power mode on. When power is applied the receiver will turn on.

1.92 PRDGPSMODE

☒SF-5050 ☒Onyx

This command is used to enable or disable the use of dGPS, code-base (pseudorange) corrections from specific sources.

Command:		[PRDGPSMODE] dGPS_mode, on_off, SF_Source
Parameter		**Definition**
dGPS_mode	K	Keyword which specifies the code-based, dGPS mode or source of corrections to be enabled or disabled. Table 77 defines the keywords and their associated dGPS mode.
on_off	K	Keyword to enable (ON) or disable (OFF) dGPS mode
SF_Source	K	Keyword to select which StarFire source to use, see Table 77 for more information. This feature only works with StarFire (SF).

Default: Mode = ALL, ON, INTERNAL

Table 77: Code-Based dGPS Modes Controlled by the PRDGPSMODE Command

Keyword Mnemonic	Code-based (pseudorange) Navigation Mode	Default Correction Timeout (sec)
ALL	Used to specify all code-based dGPS modes	
RTCM1	RTCM type 1 or 9 pseudorange corrections.	300
WAASEGNOS	WAAS or EGNOS SBAS systems	300
SF	StarFire™	1200

Table 78: SF_Source Controlled by the PRDGPSMODE command (SF Only)

Keyword Mnemonic	Description
INTERNAL	Used for SF corrections from Over The Air ONLY
EXTERNAL	Uses SF corrections from Serial/Eth ports ONLY

Enabling a specific differential navigation mode is necessary to allow that mode to be executed, but it is not sufficient for its operation. The receiver must also be licensed to use that mode, a source of dGPS corrections for the enabled mode must be available, and the mode must be the highest precedence dGPS mode currently available.

Example:

[PRDGPSMODE] WAASEGNOS, OFF
Disables navigation using dGPS corrections from WAAS or EGNOS

[PRDGPSMODE] SF, ON, INTERNAL
Enables navigation using dGPS corrections from StarFire. When [STARFIREMODE] is set to GPS, [3RDPARTYRTKX] shall be turned OFF in order for this command to work as expected.

1.93 PRDGPSTIMEOUT

☒SF-5050 ☒Onyx

This command is used to set the dGPS correction timeout or age limit for specific code-based (pseudorange) differential GPS navigation modes. When communication with the base station is lost, the last set of corrections received will continue to be used until this time limit is reached. At this point, operation in dGPS mode will cease until a new set of corrections is received.

Command:		[PRDGPSTIMEOUT] dGPS_mode, timeout
Parameter		**Definition**
dGPS_mode	K	Keyword which specifies the code-based, dGPS mode as defined in PRDGPSMODE.
timeout	I	The desired timeout or age limit for that mode (positive integer, seconds) (no upper limit)

Default: The default correction timeout values for each pseudorange, code-based navigation mode are listed in the table for the command PRDGPSMODE.

Example:

[PRDGPSTIMEOUT] WAASEGNOS, 300
Sets the dGPS correction age limit for WAAS or EGNOS to 300 seconds

1.94 PROCESSRATE

☒SF-5050 ☒Onyx

This command is used to query the rate at which the navigation solution and measurement solutions are updated. Internally the receiver determines these rates based on the scheduled output rates for messages that use the navigation solution and measurement solutions. Output messages that change the navigation rate are PSEUDORANGESTATSB, SFDATABA, and PVT1B, and the NMEA messages GBS, GGA, GLL, GRS, GST, RMC, RRE, VTG, ZDA, PNCTGGA, GSA, and PNCTSET. Messages that change the data rate are MEAS1B and SFMEAS1B.

Command:	[PROCESSRATE]

When messages are scheduled “onchange” the rate is set to the highest rate licensed for navigation rate and data rate.

Example:

[PROCESSRATE]
Returns [PROCESSRATE]10,10 – 10Hz navigation rate and 10Hz measurement rate.

1.95 PROFILE

☒SF-5050 ☒Onyx

The Onyx 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. This command is used to perform various operations such as creating, saving, and deleting user profiles.

Command:		[PROFILE] action, {"name"}
Parameter		**Definition**
action	K	Keyword that specifies the action to be performed on the user profile, as described in Table 79.
name	S	String argument (up to 20 characters) that defines the name of the user profile. This argument is case-insensitive, so "STATION12" is considered the same profile name as "Station12". As noted in Table 79, this argument is optional in some cases. As is the case for all string type arguments in Onyx commands, it must be enclosed in quotes. There are two reserved profile names: ALL This profile name is used only with the DELETE action when it is desired to delete (erase) all of the user profiles from non-volatile memory. NONE This profile name is not used with this command but it is used with the [USEPROFILE] command to specify that no user profile is to be used. (refer to USEPROFILE command)

Table 79: [PROFILE] Command Action Keywords

Keyword Mnemonic	Profile Action
DELETE	Deletes (erases) the specified profile from non-volatile memory
LISTALL	Outputs a list of all the profile names currently stored in non-volatile memory. The profile name argument is not used for this action.
OUTPUT	Causes an entire profile to be output to the port issuing the command. If a valid profile name is specified, that profile will be output from non-volatile memory. Any changes not saved in the profile are not included in the output. If a profile name is not specified, the current receiver settings will be output, i.e., the output will contain the last user profile invoked plus any configuration changes that have entered.
SAVEAS	Causes the current receiver settings to be saved in non-volatile memory as a user profile with the specified name
SAVE	Causes the current receiver settings to be saved in non-volatile memory using the current user profile.
LISTNAME	Print the current profile's name.
NUMCMDS	Report the number of command types that are reported by a PROFILE command.

Examples:

[PROFILE]SAVEAS, “MyFirstProfile”
Saves the current configuration settings of the receiver in non-volatile memory as a user profile with the name MYFIRSTPROFILE

[PROFILE]DELETE, “ABLINE28”
Deletes the user profile named ABLINE28 from non-volatile memory

[PROFILE]DELETE, “ALL”
Deletes all of the user profiles stored in non-volatile memory

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

All commands that schedule other messages (i.e. RTKMODE, WRAPPEDRTK, NTRIPCONFIG, RADIO) are placed before [OUTPUT] in order to guarantee that the user’s settings are preserved if [OUTPUT] is ever changed to modify the automatically scheduled messages.

This means that if the user wishes to change [RTKMODE] in the profile text, the corrections will not be scheduled unless the user manually writes them into the [OUTPUT] list in the profile, or simply put the modified [RTKMODE] after [OUTPUT] in the edited profile

1.96 RADIO

☒SF-5050 ☐Onyx

This command controls the plug-in radio module for the SF-5050.

Command:		[RADIO] {on_off}, {TX frequency}, {TX power}, {RX threshold}, {network ID}, {channel width}, {protocol}, {FEC}
Parameter		**Definition**
ON / OFF	K	ON - Turns on power to the radio (default) OFF- Turns off power to the radio
TX FREQUENCY	F	Commands radio to transmit frequency in MHz (403.0 to 473.0 MHz)
TX POWER	I	Commands radio to transmit power in milliwatts (100, 200, 500, or 1000 mW)
RX THRESHOLD	I	Commands the radio to receive the signal threshold in dBm (-118 to -80 dBm)
NETWORK ID	I	Displays network ID (0 to 4090); 0-255 Pacific Crest, -1 to disable
CHANNEL WIDTH	F	Transmit channel bandwidth in kHz, 25 or 12.5 (default)
PROTOCOL	I	0, 1, 2, or 3, where: 0 = Satel 3AS (default) 1 = Pacific Crest 4-FSK 2 = Pacific Crest GMSK 3 = TRIMTALK GMSK (only supported with 25 kHz channel width)
FEC	K	Enables or disables REC for Satel modes (ON/OFF). Default OFF

Default: OFF, 464.75, 100, -117, 0, 12.5, 0, OFF

Examples:

[RADIO] ON 464.75000, 1000, -100, 1, 12.5, 0, ON
Turns radio on, frequency = 464.75 MHz, TX power = 1000 mW, RX threshold = -100 dBm, network ID = 1, channel width 12.5 kHz, default Satel protocol, FEC is enabled

[RADIO]
[RADIO] ON, 464.75000, 1000, -100, 1, 12.5, 0, ON
Queries current radio settings

This is a user profile command. Settings can be stored in NVRAM to allow them to survive a power cycle.

If any of the command parameters are not specified, the current setting will be maintained.

This command specifies the values for the radio and will return the last values set using this command. To fetch the values the receiver is using, specify [OUTPUT]RADIOSTAT.

It is the intent of the design for these values to be the same, but know that it takes the receiver a bit of time, potentially seconds, to update this value. Programmers should allow a short delay for this value to “take” before following a [RADIO] command with an [OUTPUT] RADIOSTAT message.

RADIOSTAT can only be scheduled ONCE or ONTIME. Scheduling it ONCHANGE (which is what [OUTPUT]RADIOSTAT with no other parameters does) is not allowed and will result in an error message.

The closer the RX threshold is to 0 (zero), the less sensitive the receiver is. This means that the transmitter and receiver will have less usable range between them. The default value is -117.

Addressing:

For Satel mode, if both the transmitter and receiver have addressing disabled (-1) or if both have addressing enabled (any number greater than or equal to 0 as long as they match) then the two can communicate properly. If the transmitter has addressing enabled and the receiver has it disabled, then the receiver will be able to understand the data. However, if the transmitter has addressing disabled and the receiver has it enabled, then the data will not be received.

For Pacific Crest, both receivers have to have the same addressing modes (either both enabled or both disabled) to be able to communicate properly.

1.97 RADIOVERSION

☒SF-5050 ☐Onyx

Displays the Radio module version string. This only works if the Radio was enabled at least once via RADIO command after a reset, otherwise the version is unknown.

Command:	[RADIOVERSION]

Examples:

[RADIOVERSION] V07.22.2.0.3.2

1.98 RAPIDRECOVERY

☒SF-5050 ☒Onyx

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 (Figure of Merit – FOM, representing the best-guess accuracy of the horizontal position).

Command:		[RAPIDRECOVERY] command <, FOM>
Parameter		**Definition**
Command	K	Keyword: either (“ENABLE<,FOM>” or “DISABLE”) ENABLE may optionally include a new value for FOM, but DISABLE may not.
FOM	I	An Integer; value from 1 to 255, representing horizontal accuracy in cm. NavCom recommends using a FOM value in the range 5-10. If “DISABLE” is specified, an error return will generate indicating invalid input.

Default: [RAPIDRECOVERY] ENABLE, 10

- FOM is optional with the ENABLE keyword. If not specified the current FOM will be used. FOM should not be specified with the DISABLE keyword.
- NavCom recommends using a FOM value in the range 5 to 15.
- This feature is available only on the GPS portion of the StarFire correction, which constitutes the larger weighted component of the correction.
- This feature is not available for the first 5 minutes after the StarFire QuickStart process is complete.
- When a lower FOM value is input, the receiver is more constrained in completing a Rapid Recovery process.
- Supports navigation outages up to 55 seconds in duration. It may take up to three minutes to recover to an FOM level consistent to that prior to the outage. A flag is set in PVT1B for ten seconds when rapid recoevery is successful.

Examples:

[RAPIDRECOVERY] - view current state of Rapid Recovery and the FOM:
>[RAPIDRECOVERY]ENABLE, 14 … or,
>[RAPIDRECOVERY]DISABLE

[RAPIDRECOVERY]Enable
Enable use of Rapid Recovery using the existing FOM

[RAPIDRECOVERY]Disable
Disable use of Rapid Recovery

[RAPIDRECOVERY]Enable,12
Enable use of Rapid Recovery, and use a FOM of 12

1.99 REFNAME

☒SF-5050 ☒Onyx

This command is used to define the reference station name for base station mode of operation. When the receiver has been configured to operate as a dGPS base station, the reference station name is used to support the transmission of a character string indicating the name of the reference station.

Command:		[REFNAME] "name"
Parameter		**Definition**
name	S	Reference station name (string) (1 to 30 characters; must be captured within quotation marks "")

Default: REF1

The stored reference station name will be used while composing the following messages:

RTCM Type 16 (starting at position 7)

RTCM Type 1033 (receiver name field)

The format is as follows:

- "COMPANYNAME RECEIVERNAME:REFNAME", where
- "COMPANYNAME" is "NAVCOM" depending on licensing,
- RECEIVERNAME is the product name
- REFNAME is the string set by the [REFNAME] command
- RTCM Type 1033 (receiver name field)
- RTCM Type 1033 Example: "NAVCOM SF5050:TOR1"

Example:

[REFNAME] "REDBARN"
Sets base station reference name to REDBARN

1.100 REFSTNPOS

☒SF-5050 ☒Onyx

This command is used in dGPS mode to set the known position of the base station.

Command:		[REFSTNPOS] Lat-deg , Lat-min , Lat-sec , Lon-deg , Lon-min , Lon-sec , Height, Source, Month, Day, Year, Datum
Parameter		**Definition**
Lat-deg	F	Degree portion of latitude (-90 to 90, positive North). Note that this is a float so that latitude may be entered as a decimal fraction or as deg, min, sec.
Lat-min	I	Minute portion of latitude (integer) (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	F	Second portion of latitude (float) (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	F	Degree portion of longitude, (-180 to 180, positive East). Note that this is a float so that longitude may be entered as a decimal fraction or as deg, min, sec.
Lon-min	I	Minute portion of longitude (integer) (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	F	Second portion of longitude (float) (0 to <60, assumed to be in same direction as Lon-deg)
Height	F	Ellipsoidal height, or Height over Ellipsoid (float, meters) (-1000 to 18,000)
Source	K	Source of position (USER, SELF-SURVEY, UNKNOWN). If the user enters a position without specifying the source it will be saved and displayd as USER. If a self-survey has been performed and the user queries or saves the profile the source will be source will be SELF-SURVEY.
Month	I	Month position was measured. Note that the date of the position is for human use and may be entered in any time zone. If the user enters a position without specifying the date it will be saved and displayed as '0,0,0'. If a self-survey has been performed and the user queries or saves the profile the date wll be the UTC date of when the survey completed.
Day	I	Day position was measured
Year	I	Year position was measured
Datum	K	Datum of position (WGS84, GDA94, ITRF2005, ITRF2008, USER, UNKNOWN). If the user enters a position without specifying the datum it will be set to UNKNOWN. If a self-survey has been performed and the user queries or saves the profile the datum will be set to the datum active in the receiver when the survey was performed.

Default: 00,00,00,00,00,00,00

Minus sign for South or West must only precede the Lat-deg and Lon-deg fields.

Though the receiver will accept a maximum position offset up to 90 meters, errors in a user entered position will cause a corresponding positioning error for all connected rovers. A post processed reference coordinate typically provides the best field results.

Example:

[REFSTNPOS] 33, 30, 22.649,-118, 20, 33.123, 65.89
Set the base station known position to: latitude North 33'30"22.649,
longitude West 118'20"33.123, height 65.89 meters.

1.101 RTKFIXMODE

☒SF-5050 ☒Onyx

This command is used to configure the receiver to either fix carrier phase ambiguities to integer values or leave them as float values.

Command:	[RTKFIXMODE]
Parameter	**Definition**
keyword	(FIXED, FLOAT)

Default: *FIXED*

Examples:

[RTKFIXMODE] FIXED
Configures RTK to fix carrier phase ambiguities to integer values

[RTKFIXMODE] FLOAT
Configures RTK to leave carrier phase ambiguities as float values

1.102 RTKFLOATTIMEOUT

☒SF-5050 ☒Onyx

This command is used to set the timeout in seconds for RTK Float.

Command:	[RTKFLOATTIMEOUT] timeout
Parameter	**Definition**
timeout	RTK float limit (positive integer) (0 to 2147483647)

Default: 300 seconds

Example:

[RTKFLOATTIMEOUT] 600
Sets correction age limit to 600 seconds

1.103 RTKMODE

☒SF-5050 ☒Onyx

This command is used to configure the receiver as a base or rover with options for type of correction, station id, port, and dynamics.

Command:		[RTKMODE] mode, type, id, port, dynamics, scheduling type, rtk-x mode
Parameter		**Definition**
mode	S	This is a required field. Keywords are listed in Table 80
type	K	Keywords (RTCM,NCT) For a rover, this is a required field. This field is only used to validate the siteID, based on the correction type. The receiver, when configured as a rover, uses any type of supported corrections as long as the siteID is 0 or matches a valid user entry. For a base, this field must be empty; otherwise, it will be rejected as an invalid argument. *Default:* ROVER, RTCM
id	I	Table 80 lists the id range for the rover site id request and Table 82 lists the base station id range. The receiver will use the default value for the id if this field is empty. *Default:* id is set to 0 in rover mode id is set to 1 in base mode
Port[1]	K	keyword (1, 2, 3, 4, BT, ETH1, ETH2, ETH3, ETH4, ETH5, ETH6, ETH7, ETH8, NTRIPS, RADIO, USB1, USB2) This field shall be empty for rover mode. USB2 is not supported at product launch.
Dynamics[2]	K	The keywords are Static or Dynamic. This is an optional field that is set to Static by default. When setting the base station to output moving base DGPS/RTK corrections or setting the moving base RTK rover, set this field to Dynamic. Moving base RTK is only supported in NCT format and requires a seperate option code. See the Example for the configuration of moving base RTK base and rover. The does not support the Dynamic keword.
scheduling type	K	This is an optional field specifying whether or not messages are scheduled and de-scheduled automatically. Auto – This is the default value and causes a predetermined list of messages to be scheduled on the port and in the profile. Manual – Enter this value followed by the appropriate messages to schedule or de-schedule; see Example.
RTK-X Mode	K	This is an optional field specifying whether or not the user would like the receiver to transition into RTK-X mode. The keyword X_ON means to enable transitioning into RTK-X mode, and the keyword X_OFF means to disable this feature. If the user does not specify this keyword, nothing changes, and the receiver will stay in the current mode. The receiver default mode is to enable the RTK-X function.

For a Base, the user must set the output port. A rover accepts the identified correction format on any input port.

When a Base Mode is activated, all necessary RTK messages required to support it are automatically turned on. For example, when BaseRTCM1003 is ON, the 1003, 1011, and 1033 messages are automatically scheduled. It is easy to determine which messages are scheduled by either saving the current receiver settings to a profile (see the PROFILE command) or by querying the appropriate port for the current settings.

Table 80: RTK Modes

Mode	Description
Rover	Receiver operates as a rover; all ports accept corrections
BaseRTCM1	Receiver operates as an RTCM type 1 and type 31 base station
BaseRTCM9	Receiver operates as an RTCM type 9 and type 34 base station
BaseRTCM1819	Receiver operates as an RTCM type 18/19 base station.
BaseRTCM2021	Receiver operates as an RTCM type 20/21 base station
Base5B	Receiver operates as a proprietary 5B (10 km) base station; supports legacy products
BaseRTCM1001	Receiver operates as an RTCM 3.0 type 1001 base station
BaseRTCM1002	Receiver operates as an RTCM 3.0 type 1002 base station
BaseRTCM1003	Receiver operates as an RTCM 3.0 type 1003 base station
BaseRTCM1004	Receiver operates as an RTCM 3.0 type 1004 base station
BaseNCT62	Receiver operates as a proprietary 62 base station. (Default; also supports Sapphire, SF-3040, and SF-3050 with most current firmware)
BaseMSM3	Receiver operates as a proprietary MSM3 base station.
BaseMSM4	Receiver operates as a proprietary MSM4 base station.
BaseMSM5	Receiver operates as a proprietary MSM5 base station.
BaseMSM6	Receiver operates as a proprietary MSM6 base station.
BaseMSM7	Receiver operates as a proprietary MSM7 base station.

Default: Base62

The Base5B message must be used when the NCT-2100D product family (NCT-2030, RT-3010, RT-3020, SF-2040, or SF-2050) will be receiving the RTK corrections. Base5B schedules the x5B message to support this older generation of products.

Table 81: Rover Site ID Request

dGPS Correction Type	Station ID Range
RTCM (Includes RTCM1, RTCM9, RTCM1819, RTCM2021)	0 – 1023
RTCMv3 (Includes RTCM1001, RTCM1002, RTCM1003, RTCM1004)	0 – 4095
NCT (Includes 5B, 62)	0 – 1023

Table 82: Rover Site Station ID

dGPS Correction Type	Station ID Range
RTCM (Includes RTCM1, RTCM9, RTCM1819)	1-1023
RTCMv3 (Includes RTCM1001, RTCM1002, RTCM1003, RTCM1004, MSM3, MSM4, MSM5, MSM6, MSM7)	0-4095
NCT (Includes 5B)	1-1023

Table 83: Base Station ID

dGPS Correction Type	Station ID Range
RTCM (Includes RTCM1, RTCM9, RTCM1819)	1-1023
RTCMv3 (Includes RTCM1001, RTCM1002, RTCM1003, RTCM1004)	0-4095
NCT (Includes 5B, 62)	1-1023

Examples:

[RTKMODE]BaseRTCM1,,,3, Static,MANUAL
Configures the receiver to be an RTCM type 1 base station; the default station id is default 1, with the output port set to 3 and the base station in static mode. This command is set to not allow automatic scheduling and de-scheduling of messages.

Moving base RTK Examples:

[RTKMODE]ROVER,NCT,,,DYNAMIC
Configures the receiver as an NCT moving base RTK rover

[RTKMODE]ROVER,NCT,,,,,X_OFF
Configures the receiver to be an NCT moving base disabling RTK-X and enabling StarFire.

Only set RTKMODE once with Static and Manual. It does not matter which mode is scheduled. Once any mode is scheduled (to turn on the base correction code module),simply schedule any additional messages.

For example, if the end-user sets:

[RTKMODE]BASE5B,,1,1,STATIC

The receiver schedules the following:

[OUTPUT]NCT5B,ONTIME,1,1
[OUTPUT]NCT5C,ONTIME,10,1
[OUTPUT]NCT5D,ONTIME,10,

At this point, the end-user can schedule any other message or change the existing message timing as he pleases (including RTCM).

The following RTCM messages are supported:

1 – Code corrections
3 – Base station info
9 – Code corrections
18 – RTK L1 observations
19 – RTK L2 observations
20 – RTK L1 corrections
21 – RTK L2 corrections
22 – Extended base information
31 – Differential GLONASS Corrections
34 – GLONASS Partial Correction Set
1001 – GPS L1 Observations
1002 – GPS L1 Observations (expanded set)
1003 – GPS L1/L2 Observations
1004 – GPS L1/L2 Observations (expanded set)
1005 – Stationary RTK Reference Station Antenna Reference Point (ARP) (Base Position)
1006 – Stationary RTK Reference Station ARP with Antenna Height.
1007 – Antenna Descriptor (supports NGS antenna model designations)
1008 – Antenna Descriptor & Serial Number (Supports NGS antenna model designations)
1009 – GLONASS G1 Observations
1010 – GLONASS G1 Observations (expanded set)
1011 – GLONASS G1/G2 Observations
1012 – GLONASS G1/G2 Observations (expanded set)
1019 – GPS Satellite ephemeris data
1020 – GLONASS satellite ephemeris data
1033 – Receiver and Antenna Descriptor (Must to support NGS antenna model designations)

Once the RTK Mode is set, any other supported RTCM message can be scheduled.

Example:

[OUTPUT]RTCM1020,ontime,600,eth4

Once the RTK Mode is set, any other supported RTK base correction output protocol can be scheduled simultaneously on the same or another port.

Once the RTK Base Mode is enabled, the end-user is able to schedule additional RTK corrector messages or formats on the same port or on separate ports.

Example (partial profile shown):

```
[RTKMODE]BASERTCM1004,,5,ETH4,STATIC
[OUTPUT]NCT5B,ONTIME,0.20,2
[OUTPUT]NCT5C,ONTIME,4,2
[OUTPUT]NCT5D,ONTIME,4,2
[OUTPUT]??,ONCHANGE,,ETH1
[OUTPUT]OK,ONCHANGE,,ETH1
[OUTPUT]PANICA,ONCHANGE,,ETH1
[OUTPUT]PVT1B,ONTIME,1,ETH1
[OUTPUT]CHNLSTATUS1B,ONTIME,1,ETH1
```

```
[OUTPUT]SFSTATUS1B,ONCHANGE,,ETH1
[OUTPUT]RTCM3_1004,ONTIME,1,ETH4
[OUTPUT]RTCM3_1005,ONTIME,5,ETH4
[OUTPUT]RTCM3_1012,ONTIME,1,ETH4
[OUTPUT]RTCM3_1033,ONTIME,60,ETH4
[OUTPUT]RTCM3_1007,ONTIME,10,ETH4
[OUTPUT]RTCM3_1008,ONTIME,10,ETH4
[OUTPUT]RTCM3_1019,ONTIME,60,ETH4
[OUTPUT]RTCM3_1020,ONTIME,60,ETH4
[OUTPUT]NONE,,,NTRIP
[OUTPUT]NONE,,,HTML
[PORT]1,57600,8,1,NONE
[PORT]3,19200,8,1,NONE
[PORT]2,19200,8,1,NONE
[PORT]4,57600,8,1,NONE
[REFSTNPOS]-37,48,37.785300,144,48,22.239500,38.270000
[MULTIPATH]W1
[MULTISATTRACK]OFF
[L1FALLBACK]OFF
[RTKMULTIPATH]OPENSKY
[RTKSYNCMODE]LOWLATENCY
[RTKFIXMODE]FIXED
[GEOIDALMODEL]GGM02
[ETHCONFIG]MANUAL,192.168.0.3,255.255.255.0,192.168.0.1,0.0.0.0,0.0.0.0
[ETHVCOM]ON,0.0.0.0,0,TCP1,4361,ETH1
[ETHVCOM]ON,0.0.0.0,0,TCP1,4364,ETH4
[SERIALMODE]RS232
[USBMODE]DEVICE,COMPORT
```

1.104 RTKMULTIPATH

☒SF-5050 ☒Onyx

This command is used to set the multipath environment the RTK rover receiver experiences.

Command:	[RTKMULTIPATH] keyword (OPENSKY, SURVEYENVIRON, HIGHMULTIPATH, URBANCANYON)

Default: SURVEYENVIRON

Table 84: RTK Multipath Environments

Keyword	RTK Dynamic Model
OPENSKY	This configures the RTK rover receiver to expect an open sky environment.
SURVEYENVIRON	This configures the RTK rover receiver to expect a near open sky environment, such as the typical surveying environment.
HIGHMULTIPATH	This configures the RTK rover receiver to expect high multipath in the measurements.
URBANCANYON	This configures the RTK rover receiver to expect severe satellite signal blockage and multipath.

Example:

[RTKMULTIPATH] OPENSKY

1.105 RTKNAVRESET

☒SF-5050 ☒Onyx

This command is used to reset the RTK processing. If an integer ambiguity search is in progress, it will be re-initialized and restarted. If the RTK navigation is in progress, it will be interrupted and a new, initial ambiguity search will be initiated.

Command:	[RTKNAVRESET]

This command must not be used in normal operation. It is typically used in engineering tests to do repeated searches to validate integer ambiguity search performance under different conditions.

1.106 RTKSYNCMODE

☒SF-5050 ☒Onyx

This command is used to configure the RTK measurement synchronization mode.

Command:		[RTKSYNCMODE] keyword (LOWLATENCY, TIMESYNC)
Keyword		**Definition**
LOWLATENCY	K	This configures the RTK rover receiver to use the latest RTK corrections from the base receiver in RTK mode.
TIMESYNC	K	This configures the RTK rover receiver to synchronize its measurements with RTK corrections and then process in RTK mode.

Default: LOWLATENCY

Examples:

[RTKSYNCMODE] LOWLATENCY
Sets RTK measurement synchronization in low latency mode

[RTKSYNCMODE] TIMESYNC
Sets RTK measurement synchronization in Timesync mode

1.107 RTKTIMEOUT

☒SF-5050 ☒Onyx

This command is used to set the timeout for RTK carrier phase correction applied during RTK navigation mode using fixed integer ambiguities. When communication with the RTK base station is lost, the last set of carrier phase corrections received continues to be used until this time limit is reached. At that point, operation in RTK with fixed carrier phase integer ambiguities ceases.

Command:		[RTKTIMEOUT] timeout
Parameter		**Definition**
Timeout	I	RTK correction age limit (positive float) (0 to no upper limit, seconds)

Default: *15 seconds*

Examples:

[RTKTIMEOUT] 30
Sets correction age limit to 30 seconds

1.108 SBASLIST

☒SF-5050 ☒Onyx

This command redefines the configuration of the SBAS satellites. Normally, the receiver locates and tracks the SBAS satellites at run-time, periodically building a list of the satellites that will contribute to the navigation solution. This command creates a fixed list of SBAS satellites to track or returns the SBAS list to its default values. If the list generated through this command does not contain any visible satellites, using this command will effectively disable the use of SBAS corrections in the navigation solution.

Command:		[SBASLIST] default, user, {prn1}, {prn2}, {prn3}, {prn4}
Parameter		**Definition**
Default	K	Keyword that tells the receiver to rebuild the list
User	I	Keyword that allows the user to build a list of satellites that overwrites the default list (prn1 – prn4 include numbers ranging from 120 – 138)

Default: DEFAULT

Examples:

[SBASLIST]<cr>
[SBASLIST]USER,120,135,138

[SBASLIST]<cr>
[SBASLIST]DEFAULT

[SBASLIST]?<cr>
[SBASLIST][DEFAULT]|[USER prn, prn, prn, prn : (1-4, each 120-138)]

1.109 SELFSURVEY

☒SF-5050 ☒Onyx

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 command supports the parameters in the following list.

Command:		[SELFSURVEY] command, <time duration>
Parameter		**Definition**
Command	K	START – Start self-survey STOP – Stop self-survey. If 4 or more self-survey points have been calculated it will save the survey results, otherwise it will discard them. QUICK-START – Start self-survey with a time of 1440 minutes QUICK-SURVEY – Same as QUICK-START CANCEL – Cancel self-survey and discard the survey results.
Time duration	I	Number of minutes to run the self-survey (1-10080, default = 1440)

The receiver will wait for a period of time (nominally 60 minutes) to allow the StarFire readings to "settle". This means there will be no valid survey results until this time. The exception to this rule happens when the user specifies less than this value as the time limit, in which case the survey will continue for that number of minutes and then will stop. Querying the command will report the current state of the survey (OFF, RUNNING, LOCKED, NOT ACTIVE). If the survey is running it will also report the number of minutes remaining. "NOT ACTIVE" indicates the receiver is waiting to allow the StarFire readings to "settle"; "RUNNING" indicates that the StarFire readings have already settled and the survey is running; "LOCKED" indicates the survey is completed and position is stored.

Schedule the message SELFSURVEYSTATUS1A to display the status of the current survey. The SELFSURVEYSTATUS1A message returns the duration and remaining time in seconds.

Example:

[SELFSURVEY] START, 60
Start a self-survey for 60 minutes

1.110 SERIALMODE

☒SF-5050 ☐Onyx

This command selects either the RS232 or RS422 mode for the SF-5050 COM2 or COM4 serial interface.

Command:		[SERIALMODE] {mode},{port}
Parameter		**Definition**
Mode	K	Keyword (RS232 or R2422) specifying the interface mode
Port	K	Optional parameter: PIO serial communication port

Default: Displays RS232 serial mode for 2 and 4.

Examples:

[SERIALMODE] RS422, 2
Sets the serial mode to RS422 for port 2

[SERIALMODE] RS422
Sets the serial mode to RS422 for the current port ONLY if it is COM2 or 4, error otherwise

[OK][SERIALMODE]

[SERIALMODE]
Displays the current serial mode for all the ports (COM2 and 4)

[SERIALMODE] RS232,2

[SERIALMODE] RS422,4

[SERIALMODE] ,4
Displays current serial mode for port 4.

[SERIALMODE] RS422,4

1.111 SETPOSITION

☒SF-5050 ☒Onyx

This command is used to set the approximate initial position in the receiver to aid when starting from a position more than 500 miles from the last known position. If the receiver is already generating navigation solution from tracking live signals, this command will have no effect.

Command:		[SETPOSITION] Lat-deg, Lat-min, Lat-sec, Lon-deg, Lon-min, Lon-sec, Height
Parameter		**Definition**
Lat-deg	I	Degree portion of latitude (integer) (-90 to 90, positive North)
Lat-min	I	Minute portion of latitude (integer) (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	F	Second portion of latitude (float) (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	I	Degree portion of longitude, (integer) (-180 to 180, positive East)
Lon-min	I	Minute portion of longitude (integer) (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	F	Second portion of longitude (float) (0 to <60, assumed to be in same direction as Lon-deg)
Height	F	Ellipsoidal height or Height over Ellipsoid (float, meters) (-1000 to 18,000)

This command is typically used, in conjunction with the [SETTIME] command, to aid the receiver with startup.

Minus sign for South or West must only precede the Lat-deg and Lon-deg fields.

If this command is given without any argument, it responds with the current system position.

Examples:

[SETPOSITION] 33, 30, 22.649,-118, 20, 33.123, 65.89
Sets position to latitude North 33’30”22.649, longitude West 118’20”33.123, height 65.89 meters.

1.112 SETSFALMSWITCHMODE

☒SF-5050 ☒Onyx

This is a user command that configures the receiver to provide user control of receiver processing of a new over-the-air StarFire Almanac

The receiver can be configured to AUTO update its StarFire Almanac to the new StarFire Almanac after a user-specified delay, or to await a MANUAL switch-over confirmation from the user.

When set to AUTO mode, this configures the receiver to automatically switch over and enable the new over-the-air StarFire Almanac received after the user-specified delay. The [NEWSFALMREADY] output message will trigger onChange upon receipt of a new over-the-air StarFire Alamanc that is different than the current one in-use. The [SFALMENABLENEW] user command is invalid and rejected in this mode, since the receiver will handle the switch-over automatically.

The MANUAL mode is used in conjunction with the [NEWSFALMREADY] output message and [SFALMENABLENEW] user command to manually switch over to the new StarFire Almanac that has been received. The receiver will continue to use its local StarFire Almanac and not switch over to the new StarFire Almanac until the [SFALMENABLENEW] command is sent by the user. This is particularly useful if the receiver is in the middle of a critical operation and the user doesn’t want any updates to almanac until the operation is completed.

Command:		[SETSFALMSWITCHMODE] CONFIG,HRS,MINS
Parameter		**Definition**
CONFIG	K	Keyword: (AUTO, MANUAL) AUTO: Receiver is configured to automatically switch over and enable the new over-the-air StarFire Almanac received after the user-specified delay. MANUAL: Receiver is configured to wait for the manual [SFALMENABLENEW] user command to be sent by the user before switching over to the new StarFire Almanac that has been received.
HRS	I	Number of hours (integer) (0 to 24) to wait in AUTO mode
MINS	I	Number of minutes (integer) (0 to 60) to wait in AUTO mode

Default: CONFIG = AUTO, HRS = 0; MINS = 0

By default, the receiver is configured to automatically switch over to the new StarFire Almanac upon receipt, with 0-time delay.

Examples:

[SETSFALMSWITCHMODE] AUTO, 15, 25
Configures the receiver to automatically enable and switch-over to the new StarFire Almanac 15 hours and 25 minutes after the receipt of the new almanac.

[SETSFALMSWITCHMODE] MANUAL
Configures the receiver to wait for the [SFALMENABLENEW] user command to be sent by the user before switching over to the new StarFire Almanac.

1.113 SETTIME

☒SF-5050 ☒Onyx

This command is used to set the approximate time and date in the receiver which aids the receiver at first startup or after a reset. If the receiver already has accurate time and date from tracking a live GNSS signal, then this command will not take effect.

Command:		[SETTIME] year, month, {day}, {hour}, {minute}, {second}, {offset hr}, {offset min}
Parameter		**Definition**
year	I	full calendar year (integer) (1980 to 2999)
month	I	calendar month (integer) (1 to 12)
day	I	calendar day (integer) (1 to 31)
hour	I	hour portion of the time of the day (integer) (0 to 23)
minute	I	minute portion of the time of the day (integer) (0 to 59)
second	I	second portion of the time of the day (integer) (0 to 59)
offset hr	I	difference between UTC and time zone of time entered, in hours (integer) (-13 to +13)
offset min	I	difference between UTC and time zone of time entered, minute portion (integer) (0 to 59). If the offset hours are negative, the minutes will be construed as negative. An additional minus sign is not required.

Default: offset hr = 0; offset min = 0

This command is typically used in conjunction with the [SETPOSITION] command to aid the receiver with startup, and is particularly useful when operating with a GPS simulator.

The date and time entered with this command is only used during receiver startup. It is not stored in the unit. Issuing this command with date and time information while navigating will result in an error message.

Example:

[SETTIME] 2018, 07, 13, 11, 30
Set the date and time to 2018/7/13, 11:30:00

1.114 SETUTCOFFSET

☒SF-5050 ☒Onyx

This command is used to set the local time zone offset from UTC. This is used by the NMEA ZDA message.

Command:		[SETUTCOFFSET] {hours}, {minutes}
Parameter		**Definition**
hours	I	hour portion of the offset (integer) (-13 to 13)
minutes	I	minute portion of the offset (integer) (0 to 59)

Default: 0:00

If the command is entered without any arguments the current offset is displayed. If the offset has not been set, the command will respond 'Not Set'.

Example:

[SETUTCOFFSET] -8,30
Set the local time zone offset from UTC to -8 hours and 30 minutes.

1.115 SFALMENABLENEW

☒SF-5050 ☒Onyx

This is a one-time user command that allows the end-user to manual switch-over and enable a new over-the-air StarFire Almanac that has been received.

This command is intended to be used in conjunction with [SETSFALMWITCHMODE] set to MANUAL mode, and real-time indication from the [NEWSFALMREADY] output message that a new StarFire Almanac has been received that's different than the current one in-use. The receiver will continue to use its local StarFire Almanac and not switch over to the new StarFire Almanac until this command is sent by the user. This is particularly useful if the receiver is in the middle of a critical operation and the user doesn't want any updates to almanac until the operation is completed.

The receiver will only accept this command when:

1. [SETSFALMSWITCHMODE] is set to MANUAL mode. Command is rejected in AUTO mode.
2. A valid StarFire Almanac has been received and is different (e.g. frequency change) than the current almanac that the receiver is using.

Otherwise, the command is invalid and will be rejected, unless these three conditions are met.

Command:	[SFALMENABLENEW]

This command is issued with no parameters.

Example:

[SFALMENABLENEW]

1.116 SFCORRSELECT

☒SF-5050 ☒Onyx

This command allows the user to override the default StarFire Triple L-band scoring configuration to use the StarFire correction stream with the second highest score at that moment in real-time.

Command:		[SFCORRSELECT] {DEFAULT/SECONDARY}
Parameter		**Definition**
default	K	This is the default StarFire Triple L-band scoring configuration mode, wherein Onyx checks for and utilizes the highest-scored StarFire correction stream to navigate in StarFire mode.
secondary	K	Keyword that activates the secondary StarFire Triple L-band scoring configuration mode. This mode forces the receiver 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. Once this “next available” secondary StarFire correction stream is selected and utilized, the receiver will categorize and prioritize its usage, and scale its correction score accordingly compared to the other available correction streams. If the quality of this next available, secondary stream drops below a defined proprietary threshold score compared to another correction stream available, the StarFire Triple L-band scoring configuration may still switch correction streams. If [SFCORRSELECT] is toggled back to DEFAULT, the default Starfire Triple L-band scoring configuration mode will likely treat the current StarFire correction stream (secondary) in-use as the highest-scoring correction stream based on its default dynamic scoring algorithm. For example, if a user switches from SECONDARY to DEFAULT, the receiver may remain on the same Starfire correction stream. To “switch” to yet another correction stream, you can toggle it back from DEFAULT to SECONDARY, and it will once-again select the next available, second-highest scoring correction stream in real-time.

DEFAULT: [SFCORRSELECT] DEFAULT

While the scoring is objectively calculated, the result is not completely deterministic, and two different receivers in the same location may decide on two different primary StarFire correction streams.

This command should be toggled after boot-up only after all available StarFire satellites are successfully acquired, hence providing the up to three StarFire correction streams available for scoring and comparison.

Examples:

Using the example of a receiver tracking 98W, 178E, and 54W upon boot-up:

Assume the correction scores are close, but 98W is acquired first by the receiver.

[SFCORRSELECT]

> [SFCORRSELECT] DEFAULT
Original default configuration. Receiver is using 98W in StarFire Mode, which it calculates as the highest-scoring Starfire correction stream on boot-up.

[SFCORRSELECT] SECONDARY

>[OK] SFCORRSELECT
Toggle secondary configuration. Receiver checks for and selects next available StarFire correction stream scored in real-time, which is provided by 178E (or 54W).

Receiver begins using 178E in StarFire Mode.

[SFCORRSELECT] DEFAULT

>[OK] SFCORRSELECT
Switch back to original default configuration. Receiver's default scoring algorithm will most likely stay in 178E since its default scoring will scale the current Starfire in-use and continue prioritizing 178E as the primary StarFire correction stream.

[SFCORRSELECT] SECONDARY

>[OK] SFCORRSELECT
Toggle secondary configuration. Receiver checks for and selects next available StarFire correction stream scored in real-time, which is now provided by 98W. (or 54W)

1.117 SFNETPRIORITY

☒SF-5050 ☒Onyx

This command is used to set a StarFire™ priority net.

Command:		[SFNETPRIORITY] {DEFAULT, NET1, NET2}
Parameter		**Definition**
default	K	Keyword that allows a user to set the StarFire™ satellite with the highest elevation angle, regardless of Net1 or Net2, but subject to authorized nets (Net1-only, Net2-only, or Net1 and Net2)
net1	K	Keyword that allows a user to set the StarFire™ Net1 as the priority net, which allows the receiver to select a Net1 StarFire™ satellite with the highest elevation angle. If there are no visible Net1 satellites, or if the receiver is licensed as Net2 only, the receiver will select the Net2 StarFire™ satellite with the highest elevation angle.
net2	K	Keyword that allows a user to set the StarFire™ Net2 as the priority net, which allows the receiver to select a Net2 StarFire™ satellite with the highest elevation angle. If there are no visible Net2 satellites, or if the receiver is licensed as Net1 only, the receiver will select the Net1 StarFire™ satellite with the highest elevation angle.

DEFAULT: [SFNETPRIORITY] {DEFAULT}

	Net 1 Licensed	**Net 2 Licensed**	**Net 1 & Net2 Licensed**
Default selection	Net 1	Net 2	Highest satellite within either network
Net 1 selection	Net 1	Fallback when Net 1 is not licensed or no Net 1 satellite is visible	Net 1
Net 2 selection	Fallback when Net 2 is not licensed or no Net 2 satellite is visible	Net 2	Net 2

If no keyword is entered, the command is treated as a query and the system returns the current StarFire™ priority net setting.

Examples:

[SFNETPRIORITY]
Returns the current StarFire™ priority net settings

[SFNETPRIORITY]DEFAULT
Commands the receiver to select the StarFire™ satellite with the highest elevation angle, subject to authorized nets

[SFNETPRIORITY]NET1
Sets StarFire™ Net1 as the priority net, which commands the receiver to select the Net1 StarFire™ satellite with the highest elevation angle

1.118 SFQUICKSTART

☒SF-5050 ☒Onyx

The StarFire™ navigation solution requires 30 minutes or more to converge to its highest level of position accuracy. This convergence time can be significantly shortened by entering an accurate starting position for the antenna. This is referred to as an StarFire QuickStart. This command is used to manually set the QuickStart position for StarFire.

Command:		[SFQUICKSTART] Action, {Lat-deg, Lat-min, Lat-sec, Lon-deg, Lon-min, Lon-sec, Height, Datum}
Parameter		**Definition**
Action	K	Specifies QuickStart actions. The following arguments are required only when "START" is specified as action.
Lat-deg	I	Degree portion of latitude (integer) (-90 to 90, positive North; ITRF-05)
Lat-min	I	Minute portion of latitude (integer) (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	F	Second portion of latitude (float) (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	I	Degree portion of longitude (integer) (-180 to 180, positive East; ITRF-05)
Lon-min	I	Minute portion of longitude (integer) (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	F	Second portion of longitude (float) (0 to <60, assumed to be in same direction as Lon-deg)
Height	F	Ellipsoidal height (float, meters;-1000 to no upper limit)
Datum	K	ITRF (the coordinates given are in the latest ITRF format, default if not given) WGS84 (the coordinates given are in WGS84-G1762 format).

Minus sign for South or West must precede only the Lat-deg and Lon-deg fields.

The StarFire reference frame has been transitioned to ITRF 2008 in November 2011. For best performance, it is recommended to use the position collected after November 2011 to initiate QuickStart.

Table 85: [SF QUICKSTART] Action Keywords

Keyword Mnemonic	StarFire QuickStart Action
START	Initiates a QuickStart to the entered position
CANCEL	Cancels a QuickStart that is in progress
RESET	Cancels a QuickStart that is in progress and causes a full reset of StarFire navigation

Example:

[SFQUICKSTART] START, 33, 50, 28.5506, -118, 20, 37.4839, 9.03
[SFQUICKSTART] START, 33, 50, 28.5506, -118, 20, 37.4839, 9.03, ITRF
Set StarFire QuickStart position to latitude North 33'50"28.5506, longitude West 118'20"37.4839, height 9.03 meters in the latest ITRF datum used by the receiver, currently at 2008.

[SFQUICKSTART] START, 33, 50, 28.5506, -118, 20, 37.4839, 9.03, WGS84
Set StarFire QuickStart position to latitude North 33'50"28.5506, longitude West 118'20"37.4839, height 9.03 meters in the WGS84 format, which will then get converted to the latest ITRF datum format internally.

The QuickStart process requires approximately 50 seconds to complete. The status of the QuickStart process is available in the response, when the command is input with no argument. The format of the response is as follows:

[SFQUICKSTART] mode, total_time, current_time, lat, lon, ht

Mode	0 Idle 1 QuickStart has been initiated 2 QuickStart is in progress 3 QuickStart has been completed 4 QuickStart has failed due to nav proximity
Total_time total	Time required for quick start (seconds)
Current_time	The length of time that quick start has been running (seconds)
Lat	Latitude in degrees
Lon	Longitude in degrees
Ht	Height in degrees

⚠ The QuickStart position should be accurate to better than 30cm, however best performance is achieved from a previously fully converged position (i.e. 5cm) and is referenced to ITRF with Solid Earth Tide effect compensated. Depending on how accurate the QuickStart position is, there will be some residual drift, or pull-in, as the solution converges. A gross check on the QuickStart position is made before the process is initiated. If it is different from the current navigation position by more than 25 meters, the QuickStart is aborted and the QuickStart status reports FAILED.

1.119 SHUTDOWN

☒SF-5050 ☐Onyx

This command shuts down the Onyx and Power I/O boards.

Command:		[SHUTDOWN] {action} {delay}
Parameter		**Definition**
Action	K	Keywords (HALT, REBOOT). HALT tells the system to execute an orderly shutdown and to power down the system. REBOOT tells the system to execute an orderly shutdown and reboot.
Delay	I	A value in seconds defining how long to wait before shutting down (default = 0 seconds)

When no arguments are entered, the command is treated as a query and responds with the most recent action request and remaining time until shutdown.

When the ignition power is not present, the HALT keyword causes a shutdown. The REBOOT keyword causes a shutdown and restart.

When the ignition power is present, the HALT keyword is handled the same as the REBOOT keyword. I.E. The unit will always reboot after shutdown.

When running on battery power, both the HALT and REBOOT keywords cause a shutdown.

Interaction of different Solstice system components for powered on/off state. External power, ignition switch, batteries, power switch and the [SHUTDOWN] command are considered.

Table 86: Shutdown Modes

	IGNITION ON	**IGNITION OFF**
External POWER ON	• Power Button - Reboot behavior: Off then On (remaining on) • [Shutdown] Reboot behavior: Off then On (remaining on) • [Shutdown] Halt: Off then On (remaining on)	• Power Button – Controls On & Off. Typical power switch behavior • [Shutdown] Reboot – Off then On (remaining on) • [Shutdown] Halt – Off
External POWER OFF – NO BATTERY	Not supported The Ignition signal is provided from the same power source as Power	Unit off
External POWER OFF – RUNNING ON BATTERY POWER	Not supported The Ignition signal is provided from the same power source as Power	• Power Button – Ignored • [Shutdown] Reboot – Off and remains off • [Shutdown] Halt – Off and remains off • Cannot start from batteries alone

Examples:

[SHUTDOWN] HALT
Request immediate halt
OK [SHUTDOWN]
Response from the receiver

[SHUTDOWN] REBOOT, 10
Request a reboot in 10 seconds
OK [SHUTDOWN]
Response from the receiver

[SHUTDOWN]
Request shutdown status
[SHUTDOWN] REBOOT, 7
Response = current shutdown status

1.120 SIMULATORSTART

☒SF-5050 ☒Onyx

This command is used for the receiver to do repeated simulator tests. After receiving this command, the receiver will erase position, ephemeris, time, invalidate real-time clock and restart.

Example:

[SIMULATORSTART]
Causes the receiver to dump the current position, ephemeris, and time; invalidate real-time clock; and restart

1.121 SOLIDEARTHTIDE

☒SF-5050 ☒Onyx

This command is used to enable or disable the correction of solid earth tide. It causes a response, which includes the *[SOLIDEARTHTIDE]* mnemonic followed by the *ON/OFF* setting.

Command:		[SOLIDEARTHTIDE] {mode}
Parameter		**Definition**
Mode	K	Keyword (ON, OFF) to enable/disable the solid earth tide correction. If this argument is empty, the receiver will return the current setting of the enable flag.

Default: ON

When solid earth tide is on, its correction will be automatically applied to the StarFire™ single and dual position solution. It will not be applied to non-differential and SBAS mode solutions as these corrections are too small compared to the solution accuracy appropriate in those modes. It also will not be applied to the position solution in relative positioning modes of RTK, RTK-X, and code dGPS.

Examples:

[SOLIDEARTHTIDE]ON
Request to enable solid earth tide correction

[SOLIDEARTHTIDE]
Request for solid earth tide correction enable status

[SOLIDEARTHTIDE]ON
Response shows solid earth tide correction is enabled

[SOLIDEARTHTIDE]OFF
Request to disable solid earth tide correction

1.122 STARFIREALTSAT

☒SF-5050 ☒Onyx

The receiver has three channels dedicated to tracking the StarFire™ global DGPS signal. This signal is broadcast on channels (assigned frequency bands) from several geostationary communication satellites, each located to provide signal coverage over a portion (roughly one third) of the earth. Each geographic region has a default frequency or channel assigned. These default channels are programmed into the receiver firmware. In normal operation, the receiver automatically selects the appropriate default channel based on the current position and licensed net assignment [SFNETPRIORITY]. This command can be used to override selection of the default satellite ID for StarFire. Note that the alternative channel is selected by its satellite ID. The selected ID must match one of the known satellite ID's for the selection to be successful. Optionally, the user can specify a new satellite using the DEFINESFSAT command, then use the STARFIREALTSAT command to select this one.

⚠ This command is used only in rare circumstances when temporary channel assignments are made to support satellite vehicle maintenance or changes.

Command:		Format: [STARFIREALTSAT] on_off, {satellite_id}, {manual_auto}
Parameter		**Definition**
on_off	K	Keyword (ON, OFF)
satellite_id	I	Satellite ID number. Query SFSATLIST1B for a list of available satellite ID's
manual_auto	K	MANUAL - Use only the satellite specified or to allow the receiver to potentially use another satellite if signal quality is better. If no option is selected MANUAL is the default. AUTO - Use the satellite specified unless the receiver determines that there is a satellite available with better signal quality.

Default: [STARFIREALTSAT] OFF

Example:

[STARFIREALTSAT] ON, 402
Override the default StarFire satellite ID selection with an alternate value

[STARFIREALTSAT] ON, 643, AUTO
Override the default StarFire satellite ID selection with an alternate value, but allow the receiver to use a different satellite if it has better signal quality

[STARFIREALTSAT] OFF
Receiver will track up up to 3 satellites simultaneously from the visible list generated by the StarFire Almanac. Receiver will dynamically score the 3 StarFire correction streams to determine which correction stream to use in StarFire Mode.

[STARFIREALTSAT] ON, {satellite_id}, MANUAL
Receiver will only use the StarFire corrections from {satellite_id} to enter StarFire Mode. If the correction stream from {satellite_id} is not satisfactory, the receiver may not be able to enter and maintain StarFire Mode. In this configuration, the receiver essentially behaves as if it's using only one L-band channel, thereby not utilizing the full Triple L-band capability provided by Onyx and the SF-5050.

[STARFIREALTSAT] ON, {satellite_id}, AUTO
User ensures {satellite_id} is being tracked (or attempting to be tracked) by the receiver using 1 of the 3 L-band channels. The other 2 Lband channels are tracking satellites from the visible list generated by the StarFire Almanac.

> Receiver will still dynamically score the 3 StarFire correction streams (including the user-specified one {satellite_id}) to determine which correction stream to use in StarFire Mode.
>
> In this configuration, the receiver could use any of the 3 StarFire correction streams to enter in StarFire Mode. This only guarantees {satellite_id} is being tracked, and is one of the StarFire correction stream options.

Use-cases:

Scenario 1: {satellite_id} is not part of the StarFire Almanac, so the user uses [DEFINESAT] to add the satellite, and configure the receiver to track it as 1 of the 3 StarFire correction streams to potentially use, but not forced to use.

> For example, a new frequency could be added to a StarFire satellite that's not published in the StarFire Almanac, that we wish to be made available for only certain users.

Scenario 2: {satellite_id} is part of the StarFire Almanac, but is the 4th optimal visible satellite – meaning 3 other satellites in the StarFire Almanac are always more optimal for tracking and hence {satellite_id} is never considered for potential use. Using [STARFIREALTSAT] would "promote" this satellite as one of the 3 StarFire satellites that Onyx or the SF-5050 to track to potentially use.

Scenario 3: allows the user some control over a satellite they want the receiver to track, while not overriding the Triple L-band redundancy provided by Onyx or the SF-5050 to achieve optimal StarFire performance.

1.123 STARFIREMODE

☒SF-5050 ☒Onyx

This command directs the receiver to use the StarFire GPS service or the StarFire GNSS service, or both. The StarFire GPS service uses GPS satellite corrections contained in the legacy correction message, and the StarFire GNSS service uses both GPS and GLONASS satellite corrections contained in the new correction message. In addition, if this command specifies BOTH, the receiver calculates both, but uses the StarFire GNSS calculations, backing off to use the StarFire GPS calculations if the receiver cannot succeed in computing the position using the StarFire GNSS corrections.

If receiver operates in single frequency mode and uses the "BOTH" keyword, then position output in Starfire mode will use the StarFire GPS service only from the legacy message.

Command:		[STARFIREMODE] gps_gnss
Parameter		**Definition**
GPS	K	Keyword that directs the receiver to use the StarFire GPS service (10cm service)
GNSS	K	Keyword that directs the receiver to use the StarFire GNSS service (5cm service)
BOTH	K	Keyword that directs the receiver to use both the GPS and the GNSS service

Examples:

[STARFIREMODE] GPS
Use only GPS satellites (old format). [3RDPARTYRTKX] shall be turned OFF in order for this command to work as expected.

[STARFIREMODE] GNSS
Use GPS and GLONASS satellites (new format)

[STARFIREMODE] BOTH
Use new format satellites unless there is a data error, in which case use old format

1.124 STDDEVMODE

☒SF-5050 ☒Onyx

This command is used to configure how the receiver processes and displays the latitude and longitude standard deviation values in GST and PVT1B messages, based on how the receiver transitions from code to phase after a defined threshold comparison.

Command:		[STDDEVMODE] mode
Parameter		**Definition**
Mode	K	Standard deviation mode configuration (FIX, SMOOTH).

Default: [STDDEVMODE] FIX

Examples:

[STDDEVMODE] FIX
Receiver does standard code to phase transition. Code to phase transitions may result in position jumps. Though the jumps are typically small, if this characteristic is not desired, set this mode to SMOOTH.

[STDDEVMODE] SMOOTH
Receiver performs transition from code to phase only after a defined threshold comparison is triggered.

1.125 TRACKELEVMASK

☒SF-5050 ☒Onyx

This command is used to manually set the satellite tracking elevation mask angle. Satellites below this mask angle will not be tracked or used by the receiver, based on available Almanac data.

Command:		[TRACKELEVMASK] {degree}
Parameter		**Definition**
Degree	F	tracking elevation mask (integer, degrees) (0.0 to 60.0)

Default: 0.0 degrees

Example:

[TRACKELEVMASK] 5
Sets the tracking elevation mask angle to 5.0 degrees

1.126 TRACKINGMODE (ASCII)

☒SF-5050 ☒Onyx

This command is used to enable or disable the receiver's tracking of various signals or frequencies. When a GNSS signal or frequency is enabled or disabled, it applies to all GNSS satellites broadcasting that signal.

Enabling a specific tracking mode is necessary to allow the receiver to acquire and track the signal, but this alone is not sufficient. The receiver must also be licensed for that tracking mode, and the signal must be available.

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

Command:		[TRACKINGMODE] signal1, on_off, {signal2, on_off, signal3, on_off, …, signal_N, on_off}
Parameter		**Definition**
signal	K	Keyword, defined below, which specifies the signal or frequency to be enabled or disabled.
on_off	K	Keyword (ON or OFF)

Default: L2,ON,L2CL,ON,L5Q,OFF ,WAASEGNOS,ON,STARFIRE,ON,G1,ON,G2,ON, E1B,OFF, E5AQ,OFF,E5BQ,OFF, B1I, OFF, B2I, OFF

Table 87: Signals and/or Frequencies Keywords for TRACKINGMODE Command

Keyword Mnemonic	Signal or Frequency
ALL	Used to specify all signals and frequencies except L5Q, E1B, E5AQ, E5BQ, B1I, and B2I (see notes)
L2	GPS L2/P2(Y)
L2CL	GPS L2C (see notes below)
L5Q	GPS L5Q (see notes below)
WAASEGNOS	WAAS, EGNOS, MSAS, or GAGAN SBAS systems
STARFIRE	StarFire™ global dGPS correction signals
G1	GLONASS G1
G2	GLONASS G2 (see notes below)
E1B	Galileo E1B (see notes below)
E5AQ	Galileo E5AQ (see notes below)
E5BQ	Galileo E5BQ (see notes below)
B1I	Beidou B1I (see notes below)
B2I	Beidou B2I (see notes below)

Multiple signals can be enabled or disabled at the same time, by repeating the pair of signal names and the on/off keyword.

L1 cannot be turned off.

G2 requires G1. When G1 is turned off, the other GLONASS signals are forced off.

Galileo and Beidou signals will only enable the ability to output measurements, almanac, and ephemeris for these constellations. These constellations are not supported in the navigation solution (PVT1B) at product launch.

When Beidou measurements are enabled, the measurement quality indicator (MQI) is negatively impacted in the launch firmware version.

The launch firmware will only allow up to three (3) constellations to be active at any given time and always requires GPS to be active.

GPS L2C and L5 are not supported in the navigation solution (PVT1B) at product launch.

Activating signals not in use (i.e. PVT1B) significantly increases CPU loading. The launch firmware is optimized utilizing GPS and GLONASS signal processing. Code optimization techniques are developed for post-launch releases to dramatically improve CUP performance when the newer signals are supported in the navigation solution.

Examples:

[TRACKINGMODE] L2C, OFF
Disables tracking of L2 for all satellites broadcasting it

[TRACKINGMODE] ALL, ON
Enables tracking for all signals and frequencies except L5

[TRACKINGMODE] G1, ON, L2, OFF, L2CL, OFF
Enables tracking of G1, but disables L2 and L2CL

[TRACKINGMODE]L2,ON,L2CL,ON,L5Q,OFF
,WAASEGNOS,ON,STARFIRE,ON,G1,ON,G2,ON, E1B,OFF, E5AQ,OFF,E5BQ,OFF, B1I, OFF, B2I, OFF
This is the default setting

1.127 UPTIME

☒SF-5050 ☒Onyx

This command is used to retrieve the total time the receiver has been running since boot up OR since the last time the user rest the timer. It is normally entered as a query.

Command:	[UPTIME] RESET
Parameter	**Definition**
RESET	RESET will reset the start time to the current time, so that the user can use this as a counter from a specific point in time. If the RESET parameter is not specified, the command will return the total time the receiver has been running or since the last time the time has been reset.

Examples:

[UPTIME]
>[UPTIME]1 day, 20:56:19

[UPTIME]RESET
[OK] UPTIME

[UPTIME]
>[UPTIME]00:00:02

1.129 USBMODE

☒SF-5050 ☐Onyx

This command is used to check the current USB mode, or to set a specific USB mode.

Command:		[USBMODE]{mode, option}
Parameter		**Definition**
Mode	K	HOST - USB Host mode DEVICE - USB Device mode
Option	K	COMPORT - USB virtual com port mode (default) MASSSTORAGE - USB mass storage mode The option key words apply only to the DEVICE mode. When the option key word is absent, the command defaults to COMPORT.

Default: If no Device mode option keyword is specified, the USB defaults to COMPORT.

SF-5050 supports USB On-The-Go (OTG) connections. OTG works by detecting whether the USB_ID pin is grounded or high, which indicates operation as a USB host or as a USB device. Unique USB cables are required for OTG support. When a USB device cable is attached, device mode is activated. When USB host cable is attached, host mode is activated. USBMODE command operations vary according to host or device cabling.

Examples:

[USBMODE]
Returns current USB mode.

[USBMODE] DEVICE, COMPORT
- only when a Device cable is attached.

[USBMODE] DEVICE, MASSSTORAGE
- only when a Device cable is attached.

[USBMODE] HOST
- only when a Host cable is attached

[USBMODE]DEVICE
[USBMODE]DEVICE, COMPORT
Sets USB to virtual com port device mode if its current mode is not virtual com port device mode; otherwise, the USB remains in virtual com port device mode.

[USBMODE]DEVICE, MASSSTORAGE
Sets the USB port to mass storage device mode if the current mode is not mass storage device; otherwise, the USB remains in mass storage device,

When the user desires to save [USBMODE] as part of a profile, the selected device mode that is saved is one of the following:

[USBMODE]DEVICE, COMPORT

[USBMODE}DEVICE, MASSSTORAGE

⚠ Issuing a [USBMODE] HOST command through the USB port results in a COMMAND FAILED error message because executing this command disconnects the USB port.

⚠ Issuing a "[USBMODE] DEVICE, MASSSTORAGE" or "[USBMODE] DEVICE, COMPORT" command when the attached cable is a host cable will result in a COMMAND FAILED error message. Correct cabling is required.

⚠ Issuing a [USBMODE]DEVICE, MASSSTORAGE command through the USB port results in a COMMAND FAILED error, since executing the command would result in disconnecting the USB port.

⚠ Removing the USB cable when the USB port is in an open state in StarUtil 5000 results in connection difficulty when the USB cable is plugged back into the PC. If this happens, the receiver must be power cycled, or StarUtil 5000 restarted, to recover the connection. The best practice is to close the USB port from StarUtil 5000 first, and then remove the USB cable.

1.130 USEPROFILE

☒SF-5050 ☒Onyx

The Onyx receiver provides for storage of up to 20 user profiles in its non-volatile memory. Each user profile is stored with a name (refer to the PROFILE command) and contains a complete set of user-controlled configuration parameters. This command is used to query the name of the last profile invoked from memory or to request a different profile to be read from memory and installed as the operating configuration.

Command:		[USEPROFILE] {“name”}
Parameter		**Definition**
Name	S	Optional string argument (up to 20 characters; must be captured within quotation marks “”). If a name is specified, the list of stored profiles will be searched for a match, and if one is found, that profile will be read from non-volatile memory and installed. If this argument is missing, the receiver will respond with the name of the last profile installed. As is the case for all string type argument commands, it must be enclosed in quotes. After a profile has been successfully invoked with this command, its name is saved in the area of non-volatile memory used to specify the profile that is to be used at power-on or after a reset i.e. the last invoked user profile will automatically be installed each time the receiver starts up or is reset. This argument is case-insensitive: *STATION12* is considered as the same profile name as *Station12*. There are two reserved profile names: ALL This profile name is not used with this command, but it is used to specify operations with the [PROFILE] command that apply to all stored user profiles (refer to [PROFILE] command). NONE This profile name is used to specify that no user profile is to be used. It will cause the receiver to reset all of the user-controlled configuration parameters to their system default values, and the profile to be used at power-on startup will also be set to *None*.

When the profile name specified is the same as the last profile installed (current configuration), the profile is still read from non-volatile memory and re-installed. This can be used to reset any changes that have been made manually with individual configuration commands since the last time the profile was invoked.

⚠ After a profile has been invoked, individual commands can be entered to modify specific, individual control parameters, but these changes are *not* automatically saved in the non-volatile memory copy of the last user profile invoked unless the user does one of the following:

- Enters [PROFILE] SAVEAS to save the profile (refer to the [PROFILE] command)
- Enters [USEPROFILE] to invoke the same or another profile
- Gracefully powers down the receiver using the ignition pin or the receiver panel ON/OFF button
- Gracefully reset the receiver using command.

If the receiver power is removed abruptly before the profile is saved, the changes will be lost. It is recommended that user use the “[PROFILE] SAVEAS” command to save the profile explicitly to avoid changes being lost.

Examples:

[USEPROFILE] “Station12”
Causes the receiver to find the user profile saved in non-volatile memory, with the name STATION12, and install it as the current receiver configuration after start up.

[USEPROFILE] “NONE”
Causes the receiver to reset all of its user configuration parameters to their factory default values after start up, and to set the profile to none

1.131 USERANTTYPE

☒SF-5050 ☒Onyx

This command allows the user to enter up to two user-defined custom antenna types, one at a time.

Command:		[USERANTTYPE] ant id, {ant name}, {num freq recs}, {freq rec index}, {22 PCO/PCV values}
Parameter		**Definition**
Ant id	I	User specified antenna (1 or 2)
Ant name	S	The antenna name (2 to 20 characters)
Num freq recs	I	The number of frequency records contained in this message (1-8)
Freq rec index	I	Index (0-7) for a single frequency record
PCO/PCV	F	PCO and PCV values for this frequency (22 float points)

This command is sent multiple times to setup the lengthy antenna data. See example.

Examples:

The example below shows a user setting up User Defined Antenna Type 1 with the name “NAVAN2008T   NONE” with two frequency records from the igs08 file:

NAVAN2008T entry from the igs08 file:

```
NAVAN2008T      NONE                                        TYPE / SERIAL NO
FIELD               NGS                      3     25-MAR-11 METH / BY / # / DATE
     0.0                                                    DAZI
     0.0  80.0   5.0                                        ZEN1 / ZEN2 / DZEN
     2                                                      # OF FREQUENCIES
IGS08_1864                                                  SINEX CODE
CONVERTED FROM RELATIVE NGS ANTENNA CALIBRATIONS            COMMENT
   G01                                                      START OF FREQUENCY
      1.38      0.13      11.45                             NORTH / EAST / UP
   NOAZI    0.00    1.17    1.70    1.97    1.68    1.18    0.64    0.11   -0.27   -
0.51   -0.36   -0.09    0.47    1.35    2.32    3.79    5.57
   G01                                                      END OF FREQUENCY
   G02                                                      START OF FREQUENCY
      0.22     -0.99      26.15                             NORTH / EAST / UP
   NOAZI    0.00    0.67    1.09    1.12    0.91    0.42   -0.29   -1.07   -1.91   -
2.51   -2.85   -2.66   -2.03   -0.73    1.17    3.89    7.55
   G02                                                      END OF FREQUENCY
```

Command Sequence (in-sequence from start-up with NVRAM clear):

```
[useranttype]1
>[USERANTTYPE] User Defined Type: 1 "USER DEFINED TYPE  1"
>[USERANTTYPE] 0,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 1,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 2,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 3,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 4,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 5,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 6,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 7,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00

[useranttype]2
>[USERANTTYPE] User Defined Type: 2 "USER DEFINED TYPE  2"
>[USERANTTYPE] 0,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 1,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 2,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 3,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 4,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 5,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 6,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 7,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
```

Setting User Defined Antenna 1 name to "NAVAN2008T   NONE" and the number of frequency records to 2.

Only displays 2 frequency records and the default values are unchanged.

```
[USERANTTYPE]1,"NAVAN2008T      NONE", 2
>[OK] USERANTTYPE

[useranttype]1
>[USERANTTYPE] User Defined Type: 1 "NAVAN2008T      NONE"
>[USERANTTYPE] 0,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
>[USERANTTYPE] 1,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
```

Setting User Defined Antenna 1 frequency record 0 values from the G01 values of the IGS08 entry:

```
   G01                                                         START OF FREQUENCY
      1.38      0.13      11.45                                NORTH / EAST / UP
   NOAZI     0.00     1.17     1.70     1.97     1.68     1.18     0.64     0.11    -0.27    -
0.51    -0.36    -0.09     0.47     1.35     2.32     3.79     5.57
   G01                                                         END OF FREQUENCY
```

The last value (5.57) is replicated twice to fill out the record. The default values for record 1 are unchanged.

```
[useranttype]1,,,0,1.38, 0.13, 11.45, 0.00, 1.17, 1.70, 1.97, 1.68, 1.18, 0.64, 0.11,
-0.27, -0.51, -0.36, -0.09, 0.47, 1.35, 2.32, 3.79, 5.57, 5.57, 5.57
>[OK] USERANTTYPE


[useranttype]1
>[USERANTTYPE] User Defined Type: 1 "NAVAN2008T      NONE"
>[USERANTTYPE] 0,   1.38,   0.13,  11.45,   0.00,   1.17,   1.70,   1.97,   1.68,
1.18,   0.64,   0.11,  -0.27,  -0.51,  -0.36,  -0.09,   0.47,   1.35,   2.31,   3.79,
5.57,   5.57,   5.57
>[USERANTTYPE] 1,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
0.00,   0.00,   0.00
```

Setting User Defined Antenna 1 frequency record 1 values from the G02 values of the IGS08 entry:

The last value (7.55) is replicated twice to fill out the record.

```
   G02                                                         START OF FREQUENCY
      0.22     -0.99      26.15                                NORTH / EAST / UP
   NOAZI     0.00     0.67     1.09     1.12     0.91     0.42    -0.29    -1.07    -1.91    -
2.51    -2.85    -2.66    -2.03    -0.73     1.17     3.89     7.55
   G02                                                         END OF FREQUENCY

[useranttype]1,,,1,0.22, -0.99, 26.15, 0.00, 0.67, 1.09, 1.12 , 0.91, 0.42, -0.29, -
1.07, -1.91, -2.51, -2.85,  -2.66, -2.03, -0.73, 1.17, 3.89, 7.55, 7.55, 7.55
>[OK] USERANTTYPE


[useranttype]1
>[USERANTTYPE] User Defined Type: 1 "NAVAN2008T      NONE"
```

```
>[USERANTTYPE] 0,   1.38,   0.13,  11.45,   0.00,   1.17,   1.70,   1.97,   1.68,
1.18,   0.64,   0.11,  -0.27,  -0.51,  -0.36,  -0.09,   0.47,   1.35,   2.31,   3.79,
5.57,   5.57,   5.57
>[USERANTTYPE] 1,   0.22,  -0.99,  26.15,   0.00,   0.67,   1.09,   1.12,   0.91,
0.42,  -0.28,  -1.07,  -1.91,  -2.50,  -2.85,  -2.66,  -2.02,  -0.73,   1.17,   3.89,
7.55,   7.55,   7.55
```

1.133 USERANTTYPEB

☒SF-5050 ☒Onyx

This binary command allows the user to enter up to two user-defined custom antenna types, one at a time. Two internal binary commands, USERANTTYPE0B and USERANTTYPE1B are used to store and retrieve this information to/from NVRAM.

Command:	[USERANTTYPEB]{binary data}

The format of the binary data is defined in Table 88.

Table 88: Binary Data Format

Data Item	Data Type	Description
Antenna number	U08	Which user-defined antenna (0 or 1)
Name	ASCIIZ	The antenna name. (2 – 21 characters, including the NULL terminator)
Number of frequency records	U08	The number of frequency records contained in this message (1 – 8)
Frequency record 0	23 – S16's	PCO and PCV values for this frequency
…	…	…
Frequency record n	23 – S16's	PCO and PCV values for this frequency

This command does not produce a status message if it is entered without an argument. To output the current user-defined antenna types, schedule the USERANTTYPEB message.

1.134 VERSION

☒SF-5050 ☒Onyx

This command is used to query the receiver on a one-time basis to request information on the version of various installed software components. The response to this command includes the version number, date, and time stamp for the requested firmware component.

Command:		[VERSION] {component}
Parameter		**Definition**
component	K	Keyword, defined in Table 89, that specifies the firmware component for which version of information is being requested

Default: Displays BOOT1, BOOT2, NAV, MTEST, PIOBOOT1, PIOBOOT2, PIOAPP, STM8, PIOMGG, GNSSMFG, OCEANTIDE, GLOBALGEOIDGRID, GLOBALPLATEBOUNDARY

Table 89: VERSION Keywords for Software Components

Component Keyword	Description
BOOT1	GNSS bootloader 1
BOOT2	GNSS bootloader 2
GLOBALGEOIDGRID	Global geoidal grid data
GLOBALPLATESBOUNDARY	Global plate boundary data
GEOID99	Geoid in the United States
GGM02	Earth Gravity field model.
NAV	GNSS receiver application
OCEANTIDE	Ocean tide loading table
PIOAPP	Peripheral I/O board application
PIOBOOT1	Peripheral I/O board bootloader 1
PIOBOOT2	Peripheral I/O board bootloader 2

The response format is:

[VERSION] SwType, “ProductType, MajorVer.MinorVer.BuildNum.SpinNum BuildDate BuildTime”

The Software type corresponding to the component keyword is listed in Table 90.

Table 90: VERSION Command Response Format

SWType	Software Type
ProductType	The product type name
MajorVer	Major version number
MinorVer	Minor version number
BuildNum	Build number
SpinNum	Spin number. For production releases spin number is always 0 and is not displayed
BuildDate	Build date, in the format: Mon dd yyy (e.g., Oct 18 2013)
BuildTime	Build time, in the format: hh:mm:ss

Example:

```
[VERSION]
>[VERSION] BOOT1, "ONYX, 3.40E.0, Jun 16 2016 15:38:23"
>[VERSION] BOOT2, "ONYX, 3.40E.0, Jun 16 2016 15:39:43"
>[VERSION] NAV, "ONYX, 3.40E.0, Jun 17 2016 12:03:27"
>[VERSION] PIOBOOT1, "SF-5050, 3.40E.0, Jun 16 2016 15:45:40"
>[VERSION] PIOBOOT2, "SF-5050, 3.40E.0, Jun 16 2016 15:45:49"
>[VERSION] PIOAPP, "SF-5050, 3.40E.0, Jun 16 2016 16:03:09"
>[VERSION] OCEANTIDE, Ver. 1.01 Jan 23 2015 16:41:15
>[VERSION] GLOBALGEOIDGRID, Ver. 1.01 Dec 15 2014 11:51:58
>[VERSION] GLOBALPLATESBOUNDARY, Ver. 1.01 Jan 20 2015 15:10:40
>[VERSION] GEOID99: User-Defined
>[VERSION] GGM02, "VERSION 1 GGM02C 2008/2/19", Jun  6 2016 13:16:06
```

1.135 WARMSTART (ASCII)

☒SF-5050 ☒Onyx

This command is used to implement a receiver warm start. After receiving this command, the receiver erases ephemeris and restarts.

Example:

[WARMSTART]
Causes the receiver to erase ephemeris and restart the navigation algorithm.

1.136 WEBCONTROL

☒SF-5050 ☐Onyx

This command is used to enable/disable the web server on the receiver as well as direct the source of the webpages. Although this command is accepted by legacy units, it only affects the performance of the SF-5050 unit.

Command:		[WEBCONTROL] mode,source
Parameter		**Definition**
Mode	K	Keyword: (ENABLE/DISABLE) This keyword will either Enable or Disable the web server on the unit, if this command was previously enabled and then set to disable, then the unit will have a listener already set to accept connections, however it will not do anything with the requests that come in, but will simply ignore them. Therefore, in order to fully disable the web server and prevent any TCP connections to port 80, it is recommended that this command be set to disable, save the profile, and then reboot the unit for it to fully take effect. This keyword is independent of the source argument. It will enable/disable the webpage regardless of the source. *Default*: ENABLE
Source	K	Keyword: (NCT/OEM) The webpages are stored in the internal storage of the SF-5050 under a specific directory: A:/WEB/NCT or A:/WEB/OEM. This allows the user to access either the NCT webpages or the OEM webpages with the effect of this argument. Both locations can have webpages stored in them simulatinously, however only one can be accessed at a time depending on this argument variable *Default*: NCT

The [WEBCONTROL] command can only be used to change the mode or source arguments when connected using a local port (serial or USB) on the receiver. Refer to section: Web and Ftp Commands in Appendix H.

Examples:

[WEBCONTROL]DISABLE
Will disable the access to the web server

[WEBCONTROL]ENABLE, NCT
Will enable the access to the web server and will change the web server to look under A:/WEB/NCT in the hidden webdrive for the web pages

[WEBCONTROL] , OEM
Will change the web server to look under A:/WEB/OEM in the hidden webdrive for the web pages

[WEBCONTROL]
Will display [WEBCONTROL]ENABLE, OEM

[WEBCONTROL]
Will display [WEBCONTROL]ENABLE, OEM

1.137 WEBLOADB

☒SF-5050 ☐Onyx

This command is used for downloading new SF-5050 Webpages. The binary software downloading message has message ID [WEBLOADB]. It goes through the following steps:

1. Initialize the webloadb structure
2. Send the first filename and size info
3. Send the file
4. Send file CRC + save in temporary memory
5. Repeat 2-4 for as many files necessary (up to 100 files)
6. Write files to drive
7. Reboot

Webpages Limits:

1. All webpages locations to be stored on the receiver are to start with:
   a. A:\WEB\NCT\ ← For NavCom Webpages
   b. A:\WEB\OEM\ ← For non-NavCom Webpages
2. The maximum number of files that can be stored on each is 100.
3. The maximum file size that can be stored is 5 MB.
   a. The maximum filename + filepath length is 256.
   b. 256 including A:\WEB\NCT\ or A:\WEB\OEM\.
   c. 245 not including A:\WEB\NCT\ or A:\WEB\OEM\.

It uses the simplified Onyx binary header format.

1.137.1 Message General Format

The message general format is defined in the following table:

Table 91: WEBLOADB Binary Message

Data Item (8 Bytes + data)	DataType
Function Type SubID (enum)	U08
Pass or Fail (1 = pass, 0 = fail)	U08
Valid count	U32
Address (reserved)	U32
Data	U08[ ]

1.137.1.2 Function Type

Function Type provides a Function/SubID of the command. The following function type subIDs are defined as enum: (Enums ending with “Cmd” are commands sent from the PC to the receiver. Enums ending with “Rep” are replies sent from the receiver to the PC).

Table 92: WEBLOADB Message Function SubID Enum Definition

Value	Enum Name
1	WB_PingCmd
2	WB_PingRepV0 (SF3050)
3	WB_SetupCmd
4	WB_SetupRep
5	WB_LoadDataCmd
6	WB_LoadDataRep
7	WB_ChkCrcCmd
8	WB_ChkCrcRep
9	WB_WriteFCmd
10	WB_WriteFRep
11	WB_PingRepV1
12	WB_EnumLast

1.137.1.3 Pass or Fail

For reply messages, this field indicates if the previous command passed or failed.

For command messages, this field is not used.

1.137.1.4 Valid Count

This field indicates how many bytes in the data field are valid. However, it indicates the size of the file that is being transferred when sending the file header info from the PC to the receiver in WB_SetupCmd.

1.137.1.5 Address

Not used, reserved for future use.

1.137.1.6 Data

In WB_LoadDataCmd message, this field contains the data. It has other meanings in other subID messages. The maximum size of this field is 2048 bytes. If loading through the Ethernet port using UDP, the maximum size should be less than 1400 bytes. For all the responses from the receiver to the PC, this field will be left 0 for all passed acknowledgement. However, it will be a null terminated string that specifies the error that occurred in the process.

1.137.2 WEBLOADB SubID Message Format

1.137.2.1 SubID WB_PingCmd Message Format

SubID WB_PingCmd is sent from the PC to the receiver. It is used for the PC to ping the receiver webloadb software and to start the webloadb initialization process. It is also used to clear the temporary memory where the webpages are loaded from. The format is defined in the table below.

This command should be sent if anything goes wrong in any of the next steps. Doing so will ensure that the PIO webpages info will go back to a normal state.

Table 93: SubID WB_PingCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_PingCmd. (1)
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0. There is no data following the address field
Address	U32	0, reserved
Data	U08[ ]	0

1.137.2.2 SubID WB_PingRep Message Format

SubID WB_PingRep is sent from the receiver to the PC. It is the reply message for WB_PingCmd. Its primary function in the webpage load process is to verify the PIO is ready to begin the download process. Its format is defined in the table below.

Table 94: SubID WB_PingRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_PingRep. (11)
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0 or length of error string
Address	U32	0, reserved
Data	U08[ ]	0 or error string

1.137.2.3 SubID WB_SetupCmd Message Format

SubID WB_SetupCmd is sent from the PC to the receiver. It is used for the PC to specify the filename and the size of the file that will be transmitted. Its message format is defined in the table below.

Table 95: SubID WB_SetupCmd Message Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_SetupCmd. (3)
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	The file size (in bytes)
Address	U32	0, reserved
Data	U08[ ]	The null terminated filename string, starting with either A:\WEB\NCT or A:\WEB\OEM depending on the directory being loaded.

1.137.2.4 SubID WB_SetupRep Message Format

SubID WB_SetupRep is sent from the receiver to the PC. It is the reply message for WB_ SetupCmd. It could fail if the file size exceeds the maximum filesize allowed by the receiver (5

MB) or if the filename is too long (256 bytes including “A:\WEB\NCT\” or “A:\WEB\OEM”). Its format is defined in the table below.

Table 96: SubID WB_SetupRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_ BaudRep. (4)
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0 or length of error string
Address	U32	0, reserved
Data	U08[ ]	0 or error string

1.137.2.5 SubID WB_LoadDataCmd Message Format

SubID WB_LoadDataCmd is used for sending the actual webpages content or images from PC to receiver. Its format is defined in the table below.

Table 97: SubID WB_LoadDataCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_LoadDataCmd. (5)
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	Number of data bytes in the data field.
Address	U32	0, reserved
Data	U08[ ]	Webpage chunk data

1.137.2.6 SubID WB_LoadDataRep Message Format

SubID WB_LoadDataRep is sent from the receiver to the PC. It is the reply message for WB_LoadDataCmd. It could fail if the number of bytes transmitted in this process exceed the number of total bytes promised to be transmitted. Its format is defined in the table below.

Table 98: SubID WB_LoadDataRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_LoadDataRep. (6)
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0 or length of error string
Address	U32	0, reserved
Data	U08	0 or error string

1.137.2.7 SubID WB_ ChkCrcCmd Message Format

SubID WB_ ChkCrcCmd is sent from the PC to the receiver. It is used to tell the receiver that the data loading process has completed. The PC will generate a CRC based on the previous file loaded and will then transmit that to the receiver. The receiver will do the same thing with the file that it received and compare the two CRCs. Its format is defined in the table below.

Table 99: SubID WB_ChkCrcCmd Format

Field	DataType	Value and Description

Function Type SubID	U08	Enum WB_ChkCrcCmd. (7)
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0 or length of error string
Address	U32	0, reserved
Data	U08[ ]	The 2 byte CRC of the file

1.137.2.8 SubID WB_ChkCrcRep Message Format

SubID WB_ChkCrcRep is sent from the receiver to the PC. It is the reply message for WB_ChkCrcCmd. This could fail if the CRC does not match, or if the total length of data transmitted does not equal the promised length. Its format is defined in the table below.

Table 100: SubID WB_ChkCrcRep Message Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_ChkCrcRep. (8)
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0 or length of error string
Address	U32	0, reserved
Data	U08[ ]	0 or error string

1.137.2.9 SubID WB_WriteCmd Message Format

SubID WB_WriteCmd is sent from the PC to the receiver. This is sent once all the files have been loaded and transferred successfully to the receiver. It tells the receiver to start writing the files into the storage device and if successful, reboot the receiver. Its format is defined in the table below.

Table 101: SubID WB_WriteCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_WriteCmd. (9)
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0
Address	U32	0, reserved
Data	U08[ ]	0 or error string

1.137.2.10 SubID WB_WriteRep Message Format

SubID WB_WriteFRep is sent from the receiver to the PC. It tells the receiver if the webpages were written properly to the storage device. If it is a pass, then the receiver will reboot. Its format is defined in the table below.

Table 102: SubID WB_WriteRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum WB_WriteRep. (10)
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0 or length of error string
Address	U32	0, reserved
Data	U08[ ]	0 or error string

1.137.3 PIO Webpage Loading Sequence

Table 103: WEBLOADB message protocol

PC	WB_PingCmd →	Receiver
	← WB_PingRep	
	WB_SetupCmd →	Repeat for N files
	← WB_SetupRep	
	WB_LoadCmd →	
	← WB_LoadRep	
	WB_ChkCrcCmd →	
	← WB_ChkCrcRep	
	WB_WriteCmd →	
	← WB_WriteRep	

If at any point the receiver sends a failed response, the PC will send a Ping to cancel the entire process and return the web handler to a known state.

1.138 WEBUSERS

☒SF-5050 ☐Onyx

This command is used to add, update, and remove the web users for the Web server. There are 3 access levels:

USER: Able to view all webpages with the exception of Input Terminal, Manage Accounts, and Firmware Update page

TECH: Same as USER but is able to view Input Terminal and Firmware Update page

ADMIN: Able To view all pages and modify user accounts

The receiver can have a total of 8 non-admin users. The unit has a default admin account called *admin* with password *admin*. This command is stored in the NVRAM but is not stored in the profile. The admin account name cannot be changed, and the admin account itself cannot be removed.

Command:		[WEBUSERS] function,username,password,accesslevel
Parameter		**Definition**
Function	K	Keyword: (ADD/REMOVE/UPDATE) This is a required field, to specify the action of the command whether to add a new user, to remove a current user, or to update the password and access level of an existing user.
Username	S	The username of the user, case sensitive. Cannot be null, must always be specified.
Password	S	The password of the user. Cannot be an empty password, case sensitive. Cannot be null while adding a new user
AccessLevel	K	Keyword: (USER/TECH/ADMIN) The access privilege of the user to be added, updated, or displayed. Cannot be null while adding a new user.

Examples:

[WEBUSERS]
Will display the current list of users

[WEBUSERS] ADD, “Sheldon”, “SL062L”, TECH
Will add a new user with username: Sheldon, password: SL062L, and access: TECH

[WEBUSERS] ADD, “Dsharp”
Error, need password

[WEBUSERS] ADD, “Dsharp”, “Sharpness OverWhelming”
Error, need access level

[WEBUSERS] ADD, “Dsharp”, “prep”, USER
Will add a new user with username: Dsharp, password: prep, and access: USER

[WEBUSERS] REMOVE, “Dsharp”
Will remove Dsharp from the user list

[WEBUSERS] UPDATE, “Sheldon”, “96G0”
Will change Sheldon’s password to 96G0

This command only works when it comes from the web pages, the only user that may be UPDATED with a new password via StarUtil 5000 is the admin user.

Users can only be added, updated, or removed using the [WEBUSERS] command via the HTTP interface with the exception of the ADMIN user. The ADMIN user's password can also be updated using the [WEBUSERS] command over the serial, USB, or ethernet interfaces.

1.139 WIFICLIENT

☒SF-5050 ☐Onyx

This is a system command used to manage all the Wifi access point (AP) connections and information. This will allow scanning for any neighboring access points (when in CLIENT mode) and will also allow them to connect or disconnect from those access points given the right passkey if required. This command will manage a list of user specified access points and will append access point information upon a successful connection.

Command:		[WIFICLIENT] ACTION, SSID, PASSKEY
Parameter		**Definition**
ACTION	K	SCAN: Does a scan of available AP and outputs the results. Will list name, security type, channel number, and signal strength in a table sorted according to signal strength. CONNECT: Will associate the module with a specific AP which was listed in the Scan result. Must specify SSID and PASSKEY if necessary. Upon successful connection, the AP info will be added to the history list and stored in NVRAM. If the right AP information is in the system's AP list, the PASSKEY will not be necessary. DISCONNECT: Leaves the already connected AP. See Note 3. ADD: Adds an AP to the list. Must specify SSID and PASSKEY if necessary. REMOVE: Removes a specific AP from the list. Must specify SSID. REMOVEALL: Clears the AP list. LIST: Shows all the AP information (maximum of 20) which are stored in the system with the type of security associated with the connection. This is sorted with the latest successful connection at the top.
SSID	S	The name of the AP (case sensitive). Must be used with actions: CONNECT, ADD, and REMOVE.
PASSKEY	S	(string) The passkey associated with the AP (case sensitive). Can be used if necessary with actions: CONNECT and ADD.

SCAN will only work when the Wifi module is enabled and it is not connected to any AP. When the scan completes, the list of access points is displayed, preceded with the string: *Scan Result (current):*

When connected to an AP, SCAN returns the most recently acquired list. The list is preceded with the string: Scan Result (received HHh:MMm:SSs ago):

The system can store upto 20 AP in memory. When the list is full and the receiver is connected to a new AP, it will be added to the top and the oldest AP will be removed from the list.

The system will attempt to connect to AP that are in the list every 10 seconds. If an AP is manually removed from the system then the receiver will not connect to it automatically, until the system is restarted or AP is manually added again.

Examples:

```
[WIFICLIENT] LIST
[WIFICLIENT] Access Point List is Empty
```

[WIFICLIENT]
```
[WIFICLIENT] Not Connected
```

[WIFICLIENT] SCAN
```
[OK] WIFICLIENT
[WIFICLIENT] Scan Result (current):
[WIFICLIENT] | Name       | Mode   | Ch | RSS% |
[WIFICLIENT] |-----------+-------+----+------|
[WIFICLIENT] | MFRNP      | WPA2   | 6  | 100  |
[WIFICLIENT] | EODINET    | WPA2E  | 1  | 66   |
[WIFICLIENT] | CK         | WPA2   | 1  | 66   |
[WIFICLIENT] | 3apt1s     | WPA2E  | 1  | 66   |
[WIFICLIENT] | m0b1l3     | WPA2E  | 1  | 64   |
[WIFICLIENT] | NETGEAR38  | WPA2   | 2  | 60   |
[WIFICLIENT] | NewAP      | WPA2   | 6  | 60   |
```

[WIFICLIENT] CONNECT, “NewAP”, “NewAPPasskey”
```
[OK] WIFICLIENT
[WIFICLIENT] Join Status (NewAP): SUCCESSFUL [CLIENT]
```

[WIFICLIENT]
```
[WIFICLIENT] Connected as a CLIENT to NewAP
```

[WIFICLIENT] DISCONNECT, “NewAP”
```
[OK] WIFICLIENT
[WIFICLIENT] Disconnected Properly
```

[WIFICLIENT] CONNECT, “PreviouslyAddedAP”
```
[OK] WIFICLIENT
[WIFICLIENT] Join Status (PreviouslyAddedAP): SUCCESSFUL
[CLIENT]
```

[WIFICLIENT] ADD, “HelloAP” (open network, no passkey required)
```
[OK] WIFICLIENT
```

[WIFICLIENT] ADD, “CoolPeopleAP” “SuperCool” (passkey required)
```
[OK] WIFICLIENT
```

[WIFICLIENT] LIST
```
[WIFICLIENT] PreviouslyAddedAP, SECURED
[WIFICLIENT] NewAP, SECURED
[WIFICLIENT] HelloAP, OPEN
[WIFICLIENT] CoolPeopleAP, SECURED
```

[WIFICLIENT] REMOVE “CoolPeopleAP”
```
[OK] WIFICLIENT
```

```
[WIFICLIENT] LIST
[WIFICLIENT] PreviouslyAddedAP, SECURED
[WIFICLIENT] NewAP, SECURED
[WIFICLIENT] HelloAP, OPEN

[WIFICLIENT] REMOVEALL
[OK] WIFICLIENT

[WIFICLIENT] LIST
[WIFICLIENT] Access Point List is Empty
```

1.140 WIFICONFIG

☒SF-5050 ☐Onyx

This command configures the network interface for the WiFi module; i.e. IP settings (Internet IP address, network mask, default gateway, and DNS servers).

Entering the command without parameters will cause the current settings to be displayed. This is especially useful in dynamic IP mode (AUTO) to discover the IP settings that were assigned by a DHCP server.

IP addresses and the network mask are entered in the form of “a.b.c.d” where a,b,c and d are decimal integers in the range of 0-255 (e.g. 192.168.0.2).

Command:		[WIFICONFIG] IP Mode, IP address, network mask, gateway address, DNS1, DNS2
IP mode	K	Either “MANUAL”, for static IP configuration, or “AUTO” for dynamic IP configuration using a DHCP server. When set to “AUTO”, the other command parameters are not used.
IP address	K	Specifies the local IP address of this unit. In “MANUAL” mode, the special IP address 0.0.0.0 disables the Ethernet port.
Network mask	K	Identifies the network part of the IP address, as a.b.c.d (range: 1-255 for each)
Gateway address	K	Identifies the IP address of the local default Internet Gateway (0.0.0.0 = no default gateway). The gateway must be on the local network (i.e. the network part of the IP address must match the network part of the IP address (the first IP address argument in this command).
DNS1	K	Specifies the IP address of a DNS server. If the server IP address is not on the same network as the local IP address, then DNS queries will be sent through the default gateway. In that case there must be a default gateway or the DNS query will fail.
DNS2	K	Specifies the IP address of an alternate DNS server. If a DNS query to the first (DNS1) server fails, the DNS resolver will try again using the DNS2 server address.

Default: AUTO

Examples:

[WIFICONFIG]MANUAL, 192.168.0.2, 255.255.255.0, 192.168.0.1, 204.54.87.20, 204.54.87.39
Set local system IP address to 192.168.0.2, network mask to 255.255.255.0, gateway IP address to 192.168.0.1, DNS server 1 IP 204.54.87.20, and DNS server 2 IP 204.54.87.39

[WIFICONFIG]MANUAL, 0.0.0.0, 0.0.0.0, 0.0.0.0, 0.0.0.0, 0.0.0.0
Disable WiFi port

[WIFICONFIG]AUTO
Configure the Ethernet port to query a DHCP server to obtain the IP settings.

[WIFICONFIG]
[WIFICONFIG]AUTO, 192.168.0.101, 255.255.255.0, 192.168.0.1, 204.54.87.20, 204.54.87.39
Displays the current settings.

1.141 WIFICONTROL

☒SF-5050 ☐Onyx

This command controls the Wifi module Power State and Role. The user can turn ON or OFF the Wifi module and is able to change the behavior of the module so that it can act as a Client to connect to Wifi Access Points or as an Access Point to have other Wifi modules connect to it.

Command:		[WIFICONTROL] PowerState, Role, Band
Parameter		**Definition**
PowerState:	K	Keyword: (ENABLE/DISABLE/RESET) This field will turn the Wifi module ON or OFF. Reset (Hard Reset) will turn OFF and then turn ON the Wifi module.
Role:	K	Keyword: (CLIENT/ACCESSPOINT) CLIENT will reset the Wifi module and put it in a Personal Client state so that it can be able to scan and connect to other access points in the area (does not support Access Points with Enterprise Security) ACCESSPOINT will reset the Wifi module and put it in an Access Point mode so that other Wifi modules can connect directly to it (up to 4 clients). The name of this Access Point will look like ProductType:SerialNumber (i.e. SF-5050:12002)..
Band	K	Keyword: (2.4 /5.0) This will set the Wifi module’s band in GHz. Changing this foeld will reset the module. If the scan results do not return any access point information then switching this band is adviced.

Default: ENABLE, CLIENT, 5.0

In CLIENT mode, the user will only be allowed to connect to OPEN, Personal WPA/WPA2 Access Points.

In ACCESSPOINT mode, the system will change WIFICONFIG to MANUAL (cannot be changed back) and will set it up to its default IP information. This is done to configure the DHCP server to allow other devices to acquire a valid IP. Users that connect to this Access Point can do so with DHCP settings, or with STATIC IP settings that correspond to the default WIFICONFIG info.

Power Control Examples:

[WIFICONTROL]
Will display the state of the Wifi Module and Role

[WIFICONTROL] ENABLE
Will turn the Wifi Module ON and will Initialize it according to previous Role

[WIFICONTROL] DISABLE
Will turn the Wifi Module OFF

[WIFICONTROL] ENABLE
Will turn the Wifi Module ON and will Initialize it according to previous Role

Role Examples:

[WIFICONTROL] ENABLE, CLIENT
Will turn the Wifi Module ON and will Initialize it to be a normal Client

[WIFICONTROL], ACCESSPOINT
Will Reset and Initialize the Wifi Module to be an Access Point

Band Examples:

[WIFICONTROL] ENABLE, CLIENT, 2.4
Will turn the Wifi Module ON and will Initialize it to be a Client with 2.4GHz Band

[WIFICONTROL], , 5.0
Will Reset and Initialize the Wifi Module to use 5.0GHz Band

1.142 WIFIPASSKEY

☒SF-5050 ☐Onyx

This command allows the user to configure the Access Point security information. This is only applicable when the Wifi is enabled and WEBCONTROL is set to ACCESSPOINT. The user can specify to have no security or standard Personal WPA/WPA2 security with a specific Passkey.

Command:		[WIFIPASSKEY] Type, Passkey
Parameter		**Definition**
Type:	K	(OPEN/WPA1/WPA2) Specifies the level of security that the Access Point will require. OPEN means that there will be no Passkey required upon connection. WPA1 or WPA2 are two different types of protocol the user can specify which both require a Passkey.
Passkey:	S	This is a required argument if Type is set to WPA1 or WPA2. Minimum length of the Passkey is 8 characters long per module requirement.

Default: OPEN

If the Wifi module is already in Access Point mode and is enabled, the system will Soft Reset the Wifi module to ensure that the settings are applied properly.

Examples:

[WIFIPASSKEY]
Will display the current Access Point Passkey settings

[WIFIPASSKEY] OPEN
Will set the Access Point to have no security requirements

[WIFIPASSKEY] WPA1
Will REJECT the command since no Passkey has been provided

[WIFIPASSKEY] WPA1, “SuperSpecialAwesomePasskey”
Will set the Passkey to have Personal WPA1 authentication with the given Passkey

[WIFIPASSKEY] WPA2, “Even Better Than WPA1!”
Will set the Passkey to have Personal WPA2 authentication with the given Passkey

If the Wifi module is already in Access Point mode and is enabled, the system will Soft Reset the Wifi module to ensure that the settings are applied properly.

1.144 WIFIVERSION

☒SF-5050 ☐Onyx

Displays the Wifi module version string. This only works if the Wifi was enabled at least once via WIFICONTROL command after a reset, otherwise the version is unknown.

Command:	[WIFIVERSION]

Example:

[WIFIVERSION]
[WIFIVERSION] 2.6.2,1.7.7

1.145 WRAPPEDRTK

☒SF-5050 ☐Onyx

This command is used to configure the receiver to output wrapped RTK corrections of different modes (RTCM, NCT) with the PackB Wrapper. This feature is only available when the receiver is configured as a Base.

Each of these corrections is exactly the same as the ones configured using [RTKMODE] but contained within the [PACKB] wrapper. These wrapped messages can also be scheduled separately using [OUTPUT] command, just like the normal corrections.

Command:		[WRAPPEDRTK] mode,port
Parameter		**Definition**
Mode	K	SET/OFF This is a required field. If SET is selected, the unit will output the wrapped corrections based on the current RTKMode If OFF is selected, all wrapped messages will be de-scheduled on all ports.
Port	K	Keyword (0 – 3, RADIO, BT, USB1)

The state of this command is dependent on the mode type of RTKMODE. If the user wishes to change the first argument, mode type, of RTKMODE after setting WRAPPEDRTK, he/she must explicitly set or turn off WRAPPEDRTK again to reschedule the proper wrapped corrections.

Default: OFF

Examples:

[RTKMODE]BaseRTCM1819,,1,1
[WRAPPEDRTK] SET, 2
Schedules the necessary BaseRTCM1819 messages wrapped with the PackB wrapper on port 2

[RTKMODE]Base5B,,1,1
5B corrections are scheduled on Port 1
Wrapped RTCM1819 corrections are scheduled on Port 2

[WRAPPEDRTK]SET
5B corrections are scheduled on Port 1
Wrapped 5B corrections are scheduled on Port 2

1.145.1 PackB Wrappter Format

In contrast with the normal PackB wrapper, the [WRAPPEDRTK] message does NOT encode the corrections by XORing with 0x55. This is done to make things easier on the user. The wrapper looks like this:

[PACKB] L_0L_1 ~L_0~L_1 $T_0T_1T_2T_3$ T_V C_t P _MSG_ *$C_0C_1C_2C_3$

Table 104: PackB Wrapper Format

Keyword	Description	Size (byte)
[PACKB]	PackB Header	7
L0L1	Length of msg (not including [PACKB])	2
~L0~L1	Inverse of length	2
T0T1T2T3	TOW (ms)	4
TV	Time version (unused)	1
Ct	Correction Type 0=unknown, 1=NCT, 2=RTCM2, 3=RTCM3, 4=CMR	1
P	Logical Port (unused)	1
MSG	RTK Message	??
*C0C1C2C3	CRC	5

Table 105: Wrapped Base Modes

[RTKMode]	[WrappedRTK]SET
Rover	Error: No Wrapped Corrections available for Rover mode
BaseRTCM1	Receiver outputs the following corrections: WRAPPED_RTCM1,ONTIME,1 WRAPPED_RTCM2,ONCHANGE WRAPPED_RTCM3,ONTIME,5 WRAPPED_RTCM16,ONTIME,60 WRAPPED_RTCM22,ONTIME,5 WRAPPED_RTCM31,ONTIME,1
BaseRTCM9	Receiver outputs the following corrections: WRAPPED_RTCM2,ONCHANGE WRAPPED_RTCM3,ONTIME,5 WRAPPED_RTCM9,ONTIME,1 WRAPPED_RTCM16,ONTIME,60 WRAPPED_RTCM22,ONTIME,5 WRAPPED_RTCM31,ONTIME,1
BaseRTCM1819	Receiver outputs the following corrections: WRAPPED_RTCM3,ONTIME,5 WRAPPED_RTCM16,ONTIME,60 WRAPPED_RTCM18,ONTIME,1 WRAPPED_RTCM19,ONTIME,1 WRAPPED_RTCM22,ONTIME,5 WRAPPED_GLNS_RTCM18,ONTIME,1 WRAPPED_GLNS_RTCM19,ONTIME,1
BaseRTCM2021	Receiver outputs the following corrections: WRAPPED_RTCM3,ONTIME,5 WRAPPED_RTCM16,ONTIME,60 WRAPPED_RTCM20,ONTIME,1 WRAPPED_RTCM21,ONTIME,1 WRAPPED_RTCM22,ONTIME,5 WRAPPED_GLNS_RTCM20,ONTIME,1 WRAPPED_GLNS_RTCM21,ONTIME,1
BaseCMR	Receiver outputs the following corrections: WRAPPED_CMROBSERVATIONS,ONTIME,1 WRAPPED_CMRREFLOCATION,ONTIME,1 WRAPPED_CMRREFDESCRIPTION,ONTIME,1 WRAPPED_GLNS_CMROBSERVATIONS,ONTIME,1
BaseCMRPLUS	Receiver outputs the following corrections: WRAPPED_CMROBSERVATIONS,ONTIME,1 WRAPPED_CMRPLUSREFDESCRIPTION,ONTIME,1 WRAPPED_GLNS_CMROBSERVATIONS,ONTIME,1
Base5B	Receiver outputs the following corrections: WRAPPED_NCT5B,ONTIME,1 WRAPPED_NCT5C,ONTIME,10 WRAPPED_NCT5D,ONTIME,1 WRAPPED_NCT61,ONTIME,1

2 Onyx Output Messages Detailed Formats

This section provides the Onyx Output Messages in alphabetical order according to their identifying mnemonics. Each message (data output stream) is provided in a table with definitions of each parameter. Refer to section 3 and section 4 for information on “correction” output strings supported by the Onyx receiver.

2.1 1PPSA (ASCII)

☒SF-5050 ☒Onyx

This output message reports UTC time that the next PPS will occur. The 1PPSA message is sent out approximately 100 ms before the 1PPS pulse.

Output Stream:	[1PPSA]week,time,fom*CRC
Parameter	**Definition**
Week	GPS week number
Time	GPS seconds in the week (0.000 to 604799.999999999)
FOM	Figure of merit

Table 106: Figure of Merit

Code	Description
0	Time is unknown
1	Time has been set from the real time clock
2	Time has been set from the serial port
3	Time has been obtained from a satellite
4	Time has been obtained from a navigation solution
5	Time has been obtained from a stable navigation solution

Example:

[1PPSA]1411,503312.0730,5*8DB6

2.2 ALM1B (Version 1)

☒SF-5050 ☒Onyx

From a cleared memory without an almanac present, it takes about 13 minutes after satellite lock to obtain and display complete almanac information. With an almanac present, it takes only a matter of seconds.

Almanac data for satellites are available to be output and each satellite type has its own data format.

Table 107: ALM1B Binary Message Data

Data Item	Data Type	Section
Satellite type (-1=NONE, 0=GPS, 1=GALILEO, 2=SBAS, 3=GLONASS)	U08	
Almanac data		2.4.1 to 2.4.3

2.2.1 GPS Almanac

Table 108 lists the body of the GPS ALM1B message. The length of this message is 862 bytes, including 853 bytes for the message body and 9 bytes for the message header.

Table 108: GPS ALM1B Binary Message Data

Data Item (Message Body: 853 Bytes)	Data Type
GPS week of collection	U16
GPS millisecond of collection	U32
Almanac reference week	U16
Almanac reference time, second-of-week	U32
Almanac source prn	U08
Subframe for SV ID 1 (almanac data for SV 1)	24 bytes
Subframe for SV ID 2 (almanac data for SV 2)	24 bytes
…	…
Subframe for SV ID 32 (almanac data for SV 32)	24 bytes
Subframe for SV ID 51 (SV health data for SV 1 through 24, the almanac reference time, the almanac reference week number)	24 bytes
Subframe for SV ID 56 (ionospheric and UTC data)	24 bytes
Subframe for SV ID 63 (A-S flags/SV configurations for 32 SV's, plus SV health for SV 25 through 32)	24 bytes

2.2.2 GLONASS Almanac

This record contains the packed almanac data for 24 GLONASS satellites. The almanac for each satellite contains two strings.

Table 109: GLONASS ALM1B Binary Message Data

Data Item (600 Bytes)	Data Type
String 5 of GLONASS time information (3 words * 4 bytes, in the order of word 0, word 1, word 2)	12 bytes
String 14 of GLONASS time information (3 words * 4 bytes)	12 bytes
Even string (3 words * 4 bytes) for satellite 1	12 bytes
Odd string (3 words * 4 bytes) for satellite 1	12 bytes
...	
...	
Even string (3 words * 4 bytes) for satellite 24	12 bytes
Odd string (3 words * 4 bytes) for satellite 24	12 bytes

The data bits [84, 83...53] within the string are stored in word 0. The MSB is bit 84.
The data bits [52, 52...21] within the string are stored in word 1. The MSB is bit 52.
The data bits [20, 19...1] within the string are stored in word 2. The LSB is bit 1.

2.2.3 SBAS Almanac

The almanac should be entered in the following packed format. Internally it is stored unpacked, with each element on 4-byte boundaries.

Table 110: SBAS ALM1B Binary Message Data

Data Item (N * 22 + 1Bytes)		Data Type
Number of Almanacs; each almanac has the format of the following definitions:		U08
Satellite 1 Almanac	PRN (120 – 138)	U08
	Health and status	U08
	ECEF X coordinate at t0 (2600 meters/LSB)	S32
	ECEF Y coordinate at t0 (2600 meters/LSB)	S32
	ECEF Z coordinate at t0 (26000 meters/LSB)	S32
	Rate of change for X coordinate at t0 (10meters/sec)	S16
	Rate of change for Y coordinate at t0 (10meter/sec/LSB)	S16
	Rate of change for Z coordinate at t0 (60meter/sec/LSB)	S16
	Time of Day(t0 64 seconds/LSB)	U16
Satellite 2 Almanac		
…		
Satellite N Almanac		

2.3 BASEINFOA

☒SF-5050 ☒Onyx

This message outputs the base's position in ASCII format from a rover receiver.

This message will output the base's position when the following messages are received from a base:

RTCM3 & 22

RTCM1005

RTCM1006

x5C

This message contains the Latitude, Longitude, and height (ellipsoidal; meters) information in the following format:

[BASEINFOA]xx.xxxxxx,N/S, yyy.yyyyyy,E/W,hhhhh.hhh

Where 0<= xx.xxxxxx <= 90 is the latitude in degrees;

"N" indicates North;

"S" indicates South;

Where 0<= yyy.yyyyyy <= 180 is the longitude in degrees

"E" indicates East;

"W" indicates West;

hhhhh.hhh is the height in meters

When base's position is not available, all those fields are empty:

[BASEINFOA],,,,

The base position will not be saved in NVRAM, which means after power cycling, the base position will not be available until it is received from a base again.

This message can be scheduled as OnTime by [OUTPUT] command, with a maximum rate of 1Hz.

This message can be scheduled as OnChange by [OUTPUT] command, which means it will be output whenever the base position is received.

Example:

[BASEINFOA]33.841179,N,118.343621,W,8.9

2.4 CHNLSTATUS1B (Version 3)

☒SF-5050 ☒Onyx

This output message reports status information on all of the ASIC channels that are searching or tracking, as well as the status of the StarFire™ channel. The body of the CHNLSTATUS1B message is listed below.

Table 111: CHNLSTATUS1B Binary Message Data

Data Item (9 + (4 + 6 * M) * N Bytes)	Data Type
Cooperative tracking setting and StarFire CNØ	U08
StarFire tracking status	U08
StarFire satellite ID	U32
Start type and number of visible satellites visible	U08
Position status and number of satellites tracked	U08
Almanac available and satellite block count	U08
Start here with one Block per PRN	

2.4.1 Cooperative Tracking and StarFire CNØ

The MSB (bit 7) describes the setting for cooperative tracking, where a “1” means cooperative tracking is ON and a “0” means it is off. The remaining bits in this field represent the signal-to-noise ratio for the StarFire channel, in db/Hz, scaled so the LSB represents 0.25 db/Hz.

2.4.2 StarFire Tracking Status

This value indicates the tracking status of the StarFire Channel. If the channel is not in use, the value will be 1. When the signal is locked and data bits are being produced, the value will be 9.

Table 112: StarFire Tracking Status Values

Code	Description
0	Wait for power
1	Processing is disabled
2	Wait for AGC to settle
3	Start of processing
4	Signal detection
5	Signal detection failed
6	Frequency verify
7	Signal acquisition with AFC and code pull-in
8	AFC plus Costas pull-in
9	Locked; creating data bits

2.4.3 StarFire Satellite ID

The StarFire satellite ID ranges from 320 to 680. The CHNLSTATUS1B message is the only way to know the "Primary" StarFire Satellite, which is the StarFire satellite providing the corrections currently in use. To view the status of the other StarFire satellites, refer to the SFSTATUS1B message.

Table 113: CHNLSTATUS1B block per PRN

Data Item (4 + 6 * M Bytes)	Data Type
PRN	U08
Number of channel blocks for this PRN	U08
Satellite azimuth and elevation (azimuth 9 MSB, elvevation 7 LSB)	U16
Block per channel assigned to this PRN	

2.4.4 Start Type and Number of Satellites Visible

The start type resides in the two MSB (7:6) and represents one of the conditions described below.

Table 114: Start Type

Number	Data Item
0	Cold Start
1	Warm Start
2	Hot Start
3	Reserved

The number of visible satellites uses the six LSB(5:0) and represents the current count of visible satellites (GPS, GLONASS, and WAAS).

2.4.5 Position Status and Number of Satellites Tracked

The position status occupies the two MSB and the number of satellites tracked occupies the six LSB.

Table 115: Position Status

Number	Data Item
0	Position is invalid
1	Position is old
2	Position from normal navigation
3	Reserved

2.4.6 Almanac Available and Number of Satellite Blocks in This Message

If the almanac is available for this position solution, the MSB (bit 7) is set to "1". A zero ("0") means no almanac. The next MSB (bit 6) is reserved, and the remainder of this field (5:0) is a count of the number of satellite blocks that complete this message, starting immediately with the next byte.

2.4.8 Block per PRN

This section of the CHNLSTATUS1B binary message data displays a block containing the information for one satellite. The table below shows the values contained in this block, with descriptions of the fields in the sections indicated.

Table 116: CHNLSTATUS1B Satellite Block, One per PRN

Data Item (4 + 6 * M Bytes)	Data Type	Section
PRN	U08	2.15.7.1
Constellation type and Channel block count for this PRN	U08	2.15.7.2
Satellite azimuth and elevation	U16	2.15.7.3
Start here with one block per channel		2.15.8

2.4.8.1 PRN

- This field displays the PRN number of the satellite being tracked. This field is coded to allow determination of the constellation type from the PRN number (1-37 for GPS, 120-138 for WAAS\EGNOS, 38-61 for GLONASS, 62-97 for GALILEO, 139-173 Beidou). Use this field in conjunction with the constellation type field (next) to determine which.

2.4.8.2 Constellation Type and Channel Block Count

The constellation type describes which type of satellite data is displayed in this block. This is the 3 MSB (bits 7:5) describing the constellation according to following table. The 5 LSB (bits 4:0) count the number of channel blocks that follow for this PRN.

Data Item	Number
GPS	0
Galileo	1
SBAS	2
GLONASS	3

2.4.8.3 Satellite azimuth and elevation

The upper 9 MSB (bits 15: 7) describe the azimuth in units of 1 degree, ranging from 0 to 359 degress. The lower 7 MSB (bits 6:0) describe the satellite elevation in units of 1 degree, ranging from 0 to 90 degrees.

2.4.9 Block per Channel

This section of the CHNLSTATUS1B binary message data displays a block containing information for each channel allocated to the PRN in the satellite block above.

Table 117: CHNLSTATUS1B Blocks per Channel

Data Item (6 Bytes)	Data Type
Channel number	U08
Code type and allocation mode	U08
Tracking status and loop bandwidth	U08
CN_0	U08
Reserved	U08
Reserved	U08

2.4.9.1 Channel Number

This field displays the channel number to which the rest of the data applies. This will be a number between 0 and 53.

2.4.9.2 Code Type and Allocation Mode

This field displays the code type, which is being tracked by the channel listed above. The possible code types are represented by the six MSB (7:2).

Table 118: Code Type

Code	Description	Control Display
0	codeless L1	CWL1
1	codeless L2	CWL2
2	codeless L5	CWL5
3	C/A on L1	CAL1
4	C/A on L2	CAL2
5	L2C medium code	L2CM
6	L2C long code	L2CL
7	L5 I code	L5I
8	L5 Q code	L5Q
9	4*1023 bit Memory code	MEM4
10	5*1023 bit Memory code	MEM5
11	clear P on L1	PL1
12	clear P on L2	PL2
13	P(Y) and C/A on L1 P channel	YL1
14	P(Y) acqisition on L2 x L1 on Y channel	YL2A
15	P(Y) acqisition on L1 x L1 on Y channel	YL1A
16	P(Y) Tracking on L2 x L1 on Y channel	YL2T
17	P(Y) Tracking on L1 x L1 on Y channel	YL1T
18	Galileo E5A I code (data messages)	E5AI
19	Galileo E5A Q code (no data messages)	E5AQ

Code	Description	Control Display
20	Galileo E5B I code (data messages)	E5BI
21	Galileo E5B Q code (no data messages)	E5BQ
22	Galileo E1 B code (data messages)	E1B
23	Galileo E1 C code (no data messages)	E1C
24	Reserved	--
25	Reserved	--
26	GLONASS Civil G1 code (data messages)	G1C
27	GLONASS Civil G2 code (no data messages)	G2C
28	GLONASS Military G1 Code	G1P
29	GLONASS Military G2 Code	G2P
30	L1C BOC(1,1)+BOC(6,1) for data channel	L1CD
31	L1C BOC(1,1)+BOC(6,1) for pilot channel	L1CP
32	SBAS L1 temporary place holder	SBAS_L1
33	SBAS L2	SBAS_L2
34	SBAS L5	SBAS_L5
35	BeiDou B1I	B1I
36	BeiDou B2I	B2I
37	QZSS L1 CA	QZSS_CA_L1
38	QZSS L1CD	QZSS_L1CD
39	QZSS L1CP	QZSS_L1CP
40	QZSS l2CM	QZSS_L2CM
41	QZSS l2CL	QZSS_L2CL
42	QZSS L5I	QZSS_L5I
43	QZSS L5Q	QZSS_L5Q
44	QZSS SAIF	QZSS_L1_SAIF
45	Reserved	Reserved
46	QZSS LEX	QZSS_LEX

If the constellation is SBAS, use following table for code type instead of table above.

Table 119: SBAS Code Type

Code	Description	GUI Display
0	SBAS L1	SBAS_L1
1	SBAS L2	SBAS_L2
2	SBAS L3	SBAS_L5

Table 133 has new entry code 8 and 9 and following codes are shifted by 2.

Table 120: SBAS Code Type

Code	Description	GUI Display
0	Channel is disabled	IDLE
1	The requested start was invalid or too far in future	INVD
2	Signal detection fail	SGDF
3	Frequency Verify fail	FRQF
4	Bit synchronization failed.	BTSF
5	Waiting for ASIC channel to start	WAIT
6	Start command written to ASIC, wait for Ctreg == 0	STRT
7	Wait for first CT epoch after start (Ctreg != 0)	STRD
8	Wait till a new PR latch to compute the start time	HNDW
9	Wait for synchronous transition	SYTW
10	Coherent Move channel Start-up	MOVE
11	Coherent Handover Start-up	HAND
12	Non-coherent Signal detection	NCHS
13	Resume signal detection from Frequency Verify	SGDR
14	Coherent Signal detection	COHS
15	Verify detection frequency	FREQ
16	Pull-in of only PxP coders in Y mode	YPIN
17	Pull-in of PxY code and phase in Y mode	YYIN
18	First cycle of AFC processing	AFCI
19	AFC processing	AFCP
20	AFC + Costas processing	AFCC
21	Non-coherent Costas Loop	NCHC
22	Bit synchronization in progress	BTSP
23	Frame synchronization in progress	FRMS
24	Coherent Costas pull-in after synchronous start	CSTS
25	w code tracking pull in	WCDE
26	Locked up for C/A satellites, measurements ready	LOCK
27	Coherent Y Tracking, measurements ready	COHY
28	Dedicated noise tracking only state	NOIS

The allocation mode is represented by the two LSB (1:0), perTable 121.

Table 121: Allocation Mode

Code	Description	Value
NONE	None	0
NORMAL	Normal channel allocation mode	1
DEGRADED	Search the sky	2
COMMANDED	User input mode for engineering test	3

This field defines one more parameter, a single bit occupying the MSB of the code type field; this is bit value 0x20, which, if set to "1" indicates this is a P1 channel.

2.4.9.3 Tracking Status and Loop Bandwidth

Tracking status is in the 5 MSB (7:3) and represents one of the data items in Table 122.

Table 122: Channel Status Codes

Code	Description	GUI Display
0	Channel is disabled	IDLE
1	The requested start was invalid or too far in future	INVD
2	Signal detection fail	SGDF
3	Frequency verify fail	FRQF
4	Bit synchronization failed	BTSF
5	Waiting for ASIC channel to start	WAIT
6	Start command written to ASIC, wait for CTreg == 0	STRT
7	Wait for first CT epoch after start (CTreg != 0)	STRD
8	Coherent Move channel Start-up	MOVE
9	Coherent Handover Start-up	HAND
10	Non-coherent Signal detection	NCHS
11	Resume signal detection from Frequency Verify	SGDR
12	Coherent Signal detection	COHS
13	Verify detection frequency	FREQ
14	Pull-in of only PxP coders in Y mode	YPIN
15	Pull-in of PxY code and phase in Y mode	YYIN
16	First cycle of AFC processing	AFCI
17	AFC processing	AFCP
18	AFC + Costas processing	AFCC
19	Non-coherent Costas Loop	NCHC
20	Bit synchronization in progress	BTSP
21	Frame synchronization in progress	FRMS
22	Coherent Costas pull-in after synchronous start	CSTS

Code	Description	GUI Display
23	w code tracking pull in	WCDE
24	Locked up for C/A satellites, measurements ready	LOCK
25	Coherent Y Tracking, measurements ready	COHY
26	Dedicated noise tracking only state	NOIS

Loop bandwidth is in the 3 LSB (2:0) and represents one of the data items in Table 123.

Keep in mind that these values start at 2 instead of 0.

Table 123: Loop Bandwidth

Code	Description
2	Bandwidth 20 Hz
3	Bandwidth 10 Hz
4	Bandwidth 5 Hz
5	Bandwidth 2.5 Hz

2.4.9.4 CN_o

This field displays the signal to noise ratio for the channel listed above, in db/Hz. The LSB represents 0.25 db/Hz. Please note that this field will not likely have a value if the tracking status field is not greater than 18.

2.5 EPHEM1B

☒SF-5050 ☒Onyx

This record contains the packed ephemeris data for a satellite. Table 124 lists the message structure; descriptions of the fields can be found in the sections indicated.

Table 124: EPHEM1B Binary Message Header

Data Item	Data Type
Satellite type -1=NONE 0=GPS 1=GALILEO 2=SBAS 3=GLONASS 4=BEIDOU 5=QZSS 6>=Reserved	U08
Ephemeris data	

2.5.1 GPS Ephemeris

Table 125: GPS EPHEM1B Binary Message

Data Item (73 Bytes)	Data Type
PRN (1-32)	U08
Subframe 1 (3 words * 8 bytes)	24 bytes
Subframe 2 (3 words * 8 bytes)	24 bytes
Subframe 3 (3 words * 8 bytes)	24 bytes

2.5.2 GLONASS Ephemeris

This record contains the packed ephemeris data for a GLONASS satellite (string 1, 2 and 3, 4). Table 126 lists the message structure.

Table 126: GLONASS EPHEM1B Binary Message

Data Item (49 Bytes)	Data Type
PRN (1-24)	U08
string 1 (3 words * 4 bytes) Bit20-Bit31 of word2 is for GLONASS frequency number. Negative frequency numbers of GLONASS are offset by 32 as indicated in Table 4.10 of the GLONASS ICD.	12 bytes
string 2 (3 words * 4 bytes) Bit20-Bit31 of word2 is reserved	12 bytes
string 3 (3 words * 4 bytes) Bit20-Bit31 of word2 is reserved	12 bytes
string 4 (3 words * 4 bytes) Bit20-Bit31 of word2 is reserved	12 bytes

Each string is in the order of word0, word1, and word2.The first bit of the string number field is the MSB of word0, and the last bit of the Hamming code (KX) field is the LSB of word2. The bit mapping example of string 1 is listed in Table 127.

Table 127: Bit Mapping of GLONASS String 1

(S is the sign bit of the following field)

W0	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
S1	m				P2		P1		tk_h			tk_m								tks	S	Vel[0]										
W1	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
S1	Vel[0]												S	Acc[0]				S	Pos[0]													
W2	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
S1	Frequency Number (reserved field for other strings)												Pos[0]												KX							

2.5.3 Galileo Ephemeris

Table 128: Galileo EPHEM1B Binary Message

Data Item	Data Type
PRN (1-36)	U08
I/NAV word 1 (128 bits)	16 bytes
I/NAV word 2 (128 bits)	16 bytes
I/NAV word 3 (128 bits)	16 bytes
I/NAV word 4 (128 bits)	16 bytes
I/NAV word 5 (128 bits)	16 bytes

2.5.4 Beidou Ephemeris

Table 129: Beidou EPHEM1B MEO and IGSO Binary Message

MEO and IGSO Data Item	Data Type
PRN (6-30)	U08
D1 subframe 1 (9 words * 24 bits) (bit 1-22 data)	27 bytes
D1 subframe 2 (9 words * 24 bits)	27 bytes
D1 subframe 3 (9 words * 24 bits)	27 bytes

Table 130: Beidou EPHEM1B GEO Binary Message

GEO Data Item	Data Type
PRN (1-5)	U08
D2 sf 1 page 1 (4 words * 24 bits) (bit 1-22 data)	12 bytes
D2 sf 1 page 2 (4 words * 24 bits)	12 bytes
D2 sf 1 page 3 (4 words * 24 bits)	12 bytes
D2 sf 1 page 4 (4 words * 24 bits)	12 bytes
D2 sf 1 page 5 (4 words * 24 bits)	12 bytes
D2 sf 1 page 6 (4 words * 24 bits)	12 bytes
D2 sf 1 page 7 (4 words * 24 bits)	12 bytes
D2 sf 1 page 8 (4 words * 24 bits)	12 bytes
D2 sf 1 page 9 (4 words * 24 bits)	12 bytes
D2 sf 1 page 10 (4 words * 24 bits)	12 bytes

2.5.5 QZSS Ephemeris

Table 131: QZSS EPHEM1B Binary Message

Data Item (73 Bytes)	Data Type
PRN (1-5)	U08
Subframe 1 (3 words * 8 bytes)	24 bytes
Subframe 2 (3 words * 8 bytes)	24 bytes
Subframe 3 (3 words * 8 bytes)	24 bytes

2.5.6 SBAS Ephemeris

Table 132: SBAS EPHEM1B Binary Message

Data Item (73 Bytes)	Data Type
PRN (120 – 138)	U08
WORD 1 to 8 (SBAS type 9 message; 250 bits long)	U32

The MSB of WORD 1 is the MSB of type 9 message; the LSB of WORD 8 is the LSB of type 9 message; the 6 MSBs of WORD 8 is reserved.

This message can be scheduled OnTime with a minimum interval of 60 seconds. When scheduled OnTime, the whole set of ephemeris messages, which consists of multiple messages each containing the ephemeris for one satellite, will be output at the specified interval. Within the set, each ephemeris message will be output one second at a time.

2.6 EVENTLATCHA

☒SF-5050 ☒Onyx

This output message reports the time of events that are captured by either of the two event latch ports. It should be scheduled using the 'ONCHANGE' mode of the [OUTPUT] command. User should not schedule this message as 'ONTIME' or 'ONCE'.

Command "[output]eventlatcha,off" will suppress the sending of the message even if it is triggered.

Command:	[EVENTLATCHA]latch,week,time,fom*CRC
Parameter	**Definition**
Latch	Latch that event occurred on. (Onyx only supports port A)
Week	GPS week number
Time	GPS seconds in the week. (0.000 to 604799.999999999)
Fom	Figure of merit. (See Table 133)

Table 133: Figure of Merit

Code	Description
0	Time is unknown
1	Time has been set from the real time clock
2	Time has been set from the serial port
3	Time has been obtained from a satellite
4	Time has been obtained from a navigation solution
5	Time has been obtained from a stable navigation solution

Example:

[EVENTLATCHA]A,1411,241740.535058372,5*0259

2.7 INPUTSFLICENSE

☒SF-5050 ☒Onyx

The INPUTSFLICENSE output stream contains the Over-The-Air StarFire license key information that will be sent the same way the INPUTSFLICENSE input command will be sent. This can be scheduled ONCHANGE or ONCE.

If if the unit is displaying RTK or StarFire corrections over the port on which this command is scheduled, it will halt the corrections output for as long as the period of dataGapTimeout is set, which is currently 5.0 seconds.

This command is used to input a StarFire license.

Command:	[INPUTSFLICENSE]licensecode

The format for license string is the same as the license.dat file, consisting of a 32 character string in this format: xxxxxxxx-xxxxxxxx-xxxxxxxx-xxxxxxxx

2.8 MBRTK1B

☒SF-5050 ☒Onyx

This message is used to output the moving base RTK solution. Some of the data are analogous to PVT1B data.

Table 134 lists the MBRTK1B message body data items and their data types.

Table 134: MBRTK1B Binary Message Body

Data Item (49 Bytes)	Data Type
TOW(ms)	U32
Base station ID	U16
MBRTK navigation status	U08
Heading (deg)	R32
Heading RMS (deg)[1]	R32
Baseline North (meters)	R32
Baseline East (meters)	R32
Baseline Up (meters)	R32
Baseline RMS North (mm)	U16
Baseline RMS East (mm)	U16
Baseline RMS Up (mm)	U16
Baseline Velocity North (meters/second)	R32
Baseline Velocity East (meters/second)	R32
Baseline Velocity Up (meters/second)	R32
RTK Latency (ms)	U16
Base Delta Position Latency (ms)	U16

[1]Use the equation 0.6/L (whre L is length in meters) degree as a rough 1-sigma estimate of heading accuracy. The minimum antenna separation is 1m. For heading applications, no maximum is given. MBRTK operation is possible up to a 40km baseline length with the same degredation in positioning performance accuracy as normal RTK over the same baseline length.

[2]The baseline velocity refers to the relative velocity of MBRTK rover relative to the MBRTK Base in NEU frame.

2.8.2 MBRTK Navigation Status

The most significant bit of data type U08 is used to label the MBRTK solution valid or not valid. The least significant bit is reserved; 1 bit is used to indicate that the navigation solution is 2D or 3D, 2 bits are used to output RTK mode, and 3 bits are used for navigation mode:

U08 valid:1;

U08 is3d:1;

U08 mbrtk_mode:2;

U08 nav_mode:3;

U08 amb_fixed:1;

Table 135 lists the codes and code descriptions for MBRTK mode.

Table 135: MBRTK Solution Mode

Code	Description
0	Not in MBRTK mode (use [MBRTK] command to change)
1	Reserved
2	MBRTK without latency[1] (use [MBRTK] command to change)
3	MBRTK with latency[2] (use [MBRTK] command to change)

[1] *Without latency* means that extrapolation is required to propagate the MBRTK solution to the current time. In this case, the MBRTK solution time is the current time.

[2] *With latency* means that the MBRTK solution time corresponds to the most recent base delta position (x23) time. Since message transmission always causes delay, the MBRTK solution time will not be the current time.

Table 136: Navigation Mode

Code	Description
0	Non-diff
1	DGPS code
2	WAAS
3	WCT
4	StarFire
5	RTK
6	Not known

See Appendix for further details

2.10 MEAS1B (Version 2)

☒SF-5050 ☒Onyx

The MEAS1B output stream contains raw measurement data collected from the receiver's tracking channels. The data is organized as a sequence of measurement blocks, preceded by a short header, which contains the number of blocks in the record and key clock information.

Table 137: MEAS1B

Data Item (1 + number of satellites * length of satellite clock)	Data Type
Number of satellites	U08
Satellite block…	

2.10.1 Satellite Block

Table 138: Satellite Block

Data Type	Data Item (5 bytes + 8 bytes * number of code types)	Length (bits)	Scale	Units
U08	PRN/Slot number	U08	1	-
U32	Number of code type	U04	1	-
	Coarse range	U19	100	meter
	Coarse Doppler	S09[1]	10	meter/sec
	Signal block			

[1] The value must be two's complement, with the sign bit occupying the MSB. Most MSB are signed.

2.10.2 Signal Block

Table 139: Signal Block

Data Type	Data Item (8 bytes)	Length (bits)	Scale	Units
U16	Half Cycle Adjust	U01	1	
	Frequency Number	U02	1	
	CPA Quality	U01	1	
	Code Type	U02	1	
	CN0	U06	1	dB-Hz
	Cycle Slip Count	U04	1	
S16	Delta range[1]	S16	0.01	meter
U32	Delta phase[2]	S20	1/256	cycle
	Delta_doppler[3]	S12	0.005	meter/sec

[1] Delta range = code range – coarse range
[2] Delta phase = carrier phase – code range
[3] Delta Doppler = doppler – coarse doppler

2.10.3 PRN Slot Number

Table 140: PRN Slot Number

Constellation	PRN Number
GPS	1-37
GLONASS	38-61
Galileo	62-97
SBAS	120-138
Beidou	139-173
QZSS SAIF	183-187
QZSS	193-197

2.10.4 Frequency Number

Table 141: Frequency Number

GPS Frequency Type	Number
L1	0
L2	1
L5	2
Reserved	3
GLONASS Frequency Type	**Number**
G1	0
G2	1
Reserved	3
Galileo Frequency Type	**Number**
E1	0
E5a	1
E5b	2
E5AltBOC	3
SBAS Frequency Type	**Number**
L1	0
L5	2
Reserved	1, 3
Beidou Frequency Type	**Number**
B1	0
B2	1
B3	2
Reserved	3

QZSS Frequency Type	Number
L1	0
L2	1
L5	2
Reserved	3

2.10.5 Code Type

Table 142: Code Type

GPS Code Type	Number
L1CA,L2CL,L5Q	0
L1PY, L2PY, L5I	1
L1CI, L2CM	2
L1CQ	3
GLONASS Code Type	**Number**
G1C, G2C	0
G1P, G2P	1
Reserved	2
Galileo Code Type	**Number**
E1B, E5AI, E5BI, E6B	0
E1C, E5AQ, E5BQ	1
E5AltBOC	2
Reserved	3
SBAS Code Type	**Number**
C/A	0
Reserved	1-3
Beidou Code Type	**Number**
B1I, B2I, B3I	0
B1Q, B2Q, B3Q	1
Reserved	2, 3
QZSS Code Type	**Number**
L1CA, L2CL, L5Q	0
L5I	1
L1CI, L2CM	2
L1CQ	3

2.10.6 Invalid Measurement Field

For invalid measurements (pseudorange, carrier phase or Doppler), the delta-range field has the minimum negative value. For example, if carrier phase is invalid, the delta phase field is 0x80000; if pseudorange is invalid, the delta range field is 0x8000.

2.10.7 Bit Alignment

The alignment of each field starts from the MSB. For example, in the Satellite Block, the alignment is as follows:

<table>
<tr><td>31</td><td>30</td><td>29</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>2</td><td>1</td><td>0</td></tr>
<tr><th colspan="4">Number of code type</th><th colspan="19">Coarse range</th><th colspan="9">Coarse Doppler</th></tr>
<tr><td colspan="4">4 Bits</td><td colspan="19">19 Bits</td><td colspan="9">9 Bits</td></tr>
</table>

2.11 MSGCANCELCODESB

☒SF-5050 ☒Onyx

This message reports the number of cancel code and the content of cancel codes. The content of the cancel code information is encrypted, and a special decryption algorithm is needed to decode it.

Data Item	Data Type
Number of Cancel Codes (0, 1 or 2)	U08

Table 143: MSGCANCELCODESB

Data Item	Data Type
Serial Number	U16
License Type	U08
Start Date	U16
End Date	U16
Days Left	U16
Date of Cancellation	U32
Reserved (0)	U08

2.12 MSGCANCELHISTORYB

☒SF-5050 ☒Onyx

This message reports detailed information on the last two cancelled StarFire licenses. It contains information on the original StarFire license, and the reason it was cancelled. The message arrives in two parts. The first part contains a reserved byte and a count of the number of elements in the second part.

Table 144: MSGCANCELHISTORYB Part 1

Data Item	Data Type
Reserved	U08
Number of Cancel Histories	U08

2.12.1 Number of Cancel Histories

This field counts the number of instances in Table 145. The value is 0, 1 or 2.

The second part of the message consists of the ‘Number’ of instances in Table 145.

Table 145: MSGCANCELHISTORYB Part 2

Data Item	Data Type
License Issue Date	U32
License End Date	U16
Date of Cancellation	U32
Days Left (Unused Days)	U32
Cancel Reason	U08
Cancellation Source	U08

2.12.2 License Issue Date

This is the date the license was issued. It consists of two fields embedded within the U32 data definition. Using Little-Endian notation, bits 17:0 are seconds, and bits 32:18 are days. Combined, these form a count of seconds since January 1, 1999.

2.12.3 License End Date

This is the date the license will expire. Using Little-Endian notation, bits 15:0 are days, for use to create a count of seconds since January 1, 1999.

2.12.4 Date of Cancellation

This is the date the license was cancelled. It consists of two fields embedded within the U32 data definition. Using Little-Endian notation, bits 17:0 are seconds, and bits 32:18 are days. Combined, these form a count of seconds since January 1, 1999.

2.12.5 Days Left (Unused Days)

This is the number of days remaining to use this license. Using Little-Endian notation, bits 15:00 are the LSB and 31:16 the MSB, forming a single 32-bit count of unused days.

2.12.6 Cancel Reason

This field defines bit 0x80 as an elapsed time license, bit 0x40 as a time stamp pending, and used bit mask 0x3F for more status, as 1 for Expired, 2 for User Canceled, 3 for Switched License, with all other fields undefined.

2.12.7 Cancellation Source

Bits 0-2 of this field are reserved for internal use. Bits 3-7 indicate the source port that generated the command to execute the cancellation.

Table 146: MSGCANCELHISTORYB Cancellation Source

Port #	Port Name
0	COM 1
1	COM 3
4	Over The Air (OTA) StarFire Licensing
8	Bluetooth®
9	COM 2
10	COM 4
13	USB
17	Ethernet (ETH 1-8)
26	HTTP (WEB 1-4)
31	Expired

2.13 MSGPRODUCTINFO

☒SF-5050 ☒Onyx

This command reports a receiver's product type, digital serial number, and system revision number. The max rate to schedule this message is once every 60 seconds.

The system revision number is incremented at every hardware change.

NavCom is continually looking for new OEM partners. The GNSS board that comprises products in this family is shared between a multitude of NavCom and OEM product lines. As new product lines or OEM partners are introduced, the MSGPRODUCTINFO data will likely change to include those variations.

Command:	[MSGPRODUCTINFO]

Examples:

[MSGPRODUCTINFO]
Request for product type, digital serial number, and system revision number

[MSGPRODUCTINFO]SF-5050,12345,1
Response shows the product type, digital serial number, and system revision number

These product type strings are supported:

SF-5050

Onyx

C-NAV5000

2.14 MSGVERSION

☒SF-5050 ☒Onyx

This command is used to query the receiver on a recurring basis to request information on the version of various installed software components. The response to this command includes the version number, date and time stamp for the requested firmware component. The max rate to schedule this message is once every 60 seconds. This command has the same format as command [VERSION].

MSGVERSION is used with the OUTPUT command.

Example:

[OUTPUT]MSGVERSION, ONTIME, 600, 1
Outputs version for firmware BOOT1, BOOT2, NAV, PIOBOOT, PIOAPP, and BLUETOOTH® (default) ONTIME every 600 seconds on port 1

Use [VERSION] to query the receiver on a one-time basis to request version information.

Command:	[MSGVERSION] {component}
Parameter	**Definition**
component	Keyword, defined in Table 147, that specifies the firmware component for which version of information is being requested

Default: Displays BOOT1, BOOT2, NAV, PIOBOOT, PIOAPP, and BLUETOOTH

Table 147: MSGVERSION Keywords for Software Components

Keyword Mnemonic	Firmware Component
NAV	Navigation, CoreNav, LBAND DSP
BOOT1	Boot loader part 1
BOOT2	Boot loader part 2
PIOBOOT	PIO cold bootloader
PIOAPP	PIO application
BLUETOOTH	Bluetooth®

2.15 NAVCONFIG1B

☒SF-5050 ☒Onyx

This message reports the current configuration of the core navigation module.

Table 148: NAVCONFIGB Data Fields

Data Item	Data Type
2D Mode	U08
2D Manual Height	R64
2D Manual Height Valid	U08
Non- Differential Ionospheric Correction Enable	U08
Non-Differential Tropospheric Correction Enable	U08
PDOP Limit	R64
Minimum Number of Satellites	S32
Number of Navigation Modes	U08
Minimum Number of Satellites (per mode)	S32 [#1]
Number of Nav Mode Precedence	U08
Nav Mode Precedence	U08 [#2]
Elevation Mask Degrees	R64
DGPS input enable	U08
DGPS input tropospheric corrections enable	U08
Reject Non DGPS Nav Mode	U08
DGPS Input No TGD	U08
DGPS Dual Nav Enabled	U08
DGPS Output No RTCM Code	U08
DGPS Output No RTCM RTK	U08
DGPS Output No StarFire	U08
DGPS Output No WAAS	U08
Reserved	U08
DGPS Output No RTK	U08
DGPS Output No RTK StarFire	U08
DGPS RTCM Code Max Age Seconds	S32
DGPS StarFire Max Age Seconds	S32
DGPS WAAS Max Age Seconds	S32
DGPS RTK Max Age Seconds	S32
No RTK Nav	U08
CA Code Smoothing Period	S32

Table continued on next page…

Data Item	Data Type
Iono Free Smoothing Period	S32
RTK Fix Enable	U08
RTK Search Elevation Mask Degrees	R64
RTK Nav Elevation Mask Degrees	R64
L1PNav Elevation Mask Degrees	R64
RTK Input Max Age	R64
Base Option Site Id	U16
Base Option RTK	U08
Base Option DGPS	U08
Base Option Elevation Mask	R64
Base Option Dynamic	U08
Base Option RTCM No TGD	U08
Base Option RTK Source Type	S16
Base Option DGPS Type	S16
Base Option RTCM3 GPS On	U08
Base Option RTCM3 Glonass On	U08
Reserved	U08
Base Option RTCM3 Height On	U08
Position Domain Filter Enable	U08
Disable L1 Fallback	U08
RMS Threshold L1 Fallback	R64
Calculate NMEA GBS	U08
Use Velocity Smoothing	U08
Use Height Adjustment	U08
Antenna Height Adjustment	R32
Enable Solid Earth Tide Corrections	U08
Enable RTK Dynamic	U08
Phase Filter Option Pos Model	U16
Phase Filter Option StarFire Option Enable	U08
Phase Filter Option Used Avg Code Phase	U08
Phase Filter Option StarFire Report All Sats	U08
Phase Filter Option StarFire Dual Only	U08
RTK Nav Option Pos Model	U16
RTK Nav Option Time Synchronized	U08
RTK Nav Option Multipath	U16

2.16 NCT5B

☒SF-5050 ☒Onyx

This output message is used to send the RTK corrections from the RTK base site to the rover receiver. Refer to Chapter 3 Legacy Proprietary RTK Correction Messages.

This block extends the range of the corrections from +/-256 to +/-4096. The block length is the same as the RTK correction block 1 (0x5e).

To use Onyx as a base and a NCT 2100D product (e.g., SF-2050) as rover, configure Onyx to output the NCT5B message. The NCT5B message provides the same navigation performance as the Starlight 0x5B message, based on the hardware configuration (NCT-2000D or NCT-2100D respectively).

If the input Survey position is greater than 1 km from base determined navigation solution, the RTK correction block (0x5b) will not be output. Furthermore, the message 0x5c, the RTK reference position block, will be output with an unhealthy indication and a site id of 0xffff.

2.17 NCT5C

☒SF-5050 ☒Onyx

This output message is used to send the base coordinates from an RTK base site to the rover receiver. Refer to *Chapter* 3, *Legacy Proprietary RTK Correction Messages*, for the description of legacy Starlight message 0x5C.

2.18 NCT62

☒SF-5050 ☒Onyx

This output stream creates an RTK correction message from the base to the rover.

This block extends the range of the corrections from +/-256 to +/-4096.

To use Onyx as a base and a Sapphire family product (e.g., SF-3040, SF-3050) as rover, the rover must be updated to navigation firmware version 3.6.9.0 or later. Then configure Onyx to output the NCT62 message. The NCT62 message provides the same navigation performance as the Sapphre 0x5E message, based on the hardware configuration (Sapphire, SF-3040, or SF-3050 respectively).

2.19 NCTBB

☒SF-5050 ☒Onyx

This command requires the BB Option.

[3RDPARTYRTKX] shall be turned OFF in order for this command to work as expected.

2.20 NCTBD and NCTBE

☒SF-5050 ☒Onyx

These output messages are scheduled via the [OUTPUT] command.

This command requires the BB option.

Examples:

[OUTPUT]NCTBD, ONCHANGE, , 1
Outputs NCTBD when the data is available on port 1

[OUTPUT]NCTBD, ONTIME,1,2
Outputs NCTBD once per second on port 2

[OUTPUT]NCTBE, ONCHANGE, , 1
Outputs NCTBE when the data is available on port 1

[OUTPUT]NCTBE, ONTIME,1,2
Outputs NCTBE once per second on port 2

2.21 NCTCB

☒SF-5050 ☒Onyx

This output message requires the *L-Band ENC* option. It can only be sent if SFSEARCHPOSB is provided to the receiver at least once every 15 minutes.

[3RDPARTYRTKX] shall be turned OFF in order for this command to work as expected.

2.23 NCTCD and NCTE

☒SF-5050 ☒Onyx

These messages require the *L-Band ENC* option. They can only be sent if SFSEARCHPOSB is provided to the receiver at least once every 15 minutes.

2.25 NEWSFALMREADY

☒SF-5050 ☒Onyx

This output message indicates to the end-user that a new StarFire Almanac has been received that is ready to be enabled / switched-over to.

The receiver is configured to regualarly receive and process a new StarFire Alamnac over-the-air at the top of each hour. If the newly arrived StarFire Almanac contains a StarFire satellite constellation or frequency change, the receiver outputs this message on active ports to inform the user that a new StarFire Almanac has been received which is different than the current one in-use.

In the event that the newly arrived StarFire Almanac is the same as the current one in-use, the new almanac is discarded, and no message is output.

The message is displayed in ASCII format for human readability.

For example, when [OUTPUT] NEWSFALMREADY, onChange is scheduled, the following output is displayed:

Table 149: NEWSFALMREADY ASCII message data

[OUTPUT] NEWSFALMREADY, onChange	
No OTA StarFire Almanac Pending. Current StarFire Almanac in-use – Set Number: 0, Set Size: 7.	Start with an almanac with set = 0, records = 7. No pending OTA almanac received. Set to MANUAL mode
New StarFire Almanac Ready – Set Number: 0, Set Size: 6. Current StarFire Almanac in-use – Set Number: 0, Set Size: 7	Simulate OTA almanac set = 0, records = 6
Issue [SFALMENABLENEW] command	
No OTA StarFire Almanac Pending. Current StarFire Almanac in-use – Set Number: 0, Set Size: 6.	
New StarFire Almanac Ready – Set Number: 1, Set Size: 6. Current StarFire Almanac in-use – Set Number: 0, Set Size: 7	Simulate OTA almanac set = 1, records = 6. Set to AUTO mode of 1 minute
No OTA StarFire Almanac Pending. Current StarFire Almanac in-use – Set Number: 1, Set Size: 6.	After one-minute, NEWSFALMREADY automatically output onChange

2.27 NMEA Messages Overview

☒SF-5050 ☒Onyx

Selected sentences defined in the National Marine Electronics Association (NMEA) document 0183 "Standard For Interfacing Marine Electronic Devices", Version 4.10 are defined in the ensuing sections. These messages are all prefixed with the string value "NMEA", and can be viewed as a common set of sentences describing navigation data.

These NMEA sentences describe mechanics for GPS, GLONASS and WAAS satellites. To differentiate them, NMEA defines the following naming convention for satellite ids:

1. GPS satellites are identified by their PRN numbers, which range from 1 to 32.
2. The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.
3. The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by "64 + satellite slot number". The slot numbers are 1 through 24 for the full GLONASS constellation, giving a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

The NMEA sentences describe the satellite population using the following naming convention:

- $GPxxx, describes data generated from GPS satellites only
- $GLxxx, describes data generated from GLONASS satellites only
- $GNxxx, describes data generated from mixed GPS and GLONASS or GALILEO satellites.

Table 150: Supported Standard NMEA Message

NMEA Message	Description
ALM	GPS almanac data
MLA	GLONASS almanac data
DTM	Datum Reference
GBS	GNSS Satellite Fault Detection
GGA	Global Positioning System Fix Data
GFA	GNSS fix accuracy and integrity
GLL	Geographic Position – Latitude/Longitude
GNS	GNSS Fix Data
GRS	GNSS Range Residuals
GSA	GNSS DOP and Active Satellites
GST	GNSS Pseudorange Error Statistics
GSV	GNSS Satellites in View
HDT	Heading, Degrees True
RMC	Recommended Minimum Specific GNSS Data
ROT	Rate of Turn
TTM	Tracked Target Message
VTG	Course Over Ground and Ground Speed
ZDA	Time and Data

Table 151: Supported Nonstandard NMEA Message

NMEA Message	Description
PNCTGGA	Global Positioning System Fix Data, with additional 286tation ID information
PNCTMDE	Marginally Detectable Error
PNCTGST	Scaled Pseudorange Noise Statistics
PNCTSET	Solid Earth Tide correction
PNCTDTM	Datum Reference
RRE	Range Residual Error

2.29 NMEAALM (ASCII)

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

ONCE = output immediately once

OnChange = when GPS almanac is received

OnTime = minimum interval of 60 seconds

This output message reports orbital data (almanac) for the specified GPS satellite.

This message can now be scheduled ONTIME, with a minimum interval of 60 seconds. When scheduled OnTime, the whole set of NMEAALM messages, which consists of multiple messages each containing the almanac for one satellite, will be output at specified intervals. Within the set, each almanac message will be output at one second at a time.

Refer to the section NMEA Messages Overview for general information.

Table 152: ALM Message Output Format

Output Format:	$GPALM,total,message,prn,week,health,eccentricity,reftime,inclination,ascension,axis,perigee,node,anomaly,F0clock,F1clock,*hh<CR><LF>

Field#	Field Name	Description
F1	total	Total number of messages (decimal 01 to 32)
F2	message	Message number (decimal 01 to 32)
F3	Prn	GPS satellite PRN number (decimal 01 to 32)
F4	week	Extended GPS week number (decimal 0 to 9999)
F5	health	SV health (hexadecimal)
F6	eccentricity	Eccentricity (hexadecimal)
F7	reftime	Almanac reference time (hexadecimal)
F8	inclination	Inclination angle (hexadecimal)
F9	ascension	Rate of right ascension (hexadecimal)
F10	axis	Root of semi-major axis (hexadecimal)
F11	perigee	Argument of perigee (hexadecimal)
F12	node	Longitude of ascension node (hexadecimal)
F13	anomaly	Mean anomaly (hexadecimal)
F14	F0clock	F0 clock parameter (hexadecimal)
F15	F1clock	F1 clock parameter (hexadecimal)
F16	*CRC	Checksum

Example:

$GPALM,32,1,01,1423,00,35BF,7B,1F38,FD5B,A10D8B,78C23F,B7E3C6,
379706,080,001*36

2.30 NMEADTM

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☐OnTime

ONCE = output immediately once

OnChange = same rate as the fastest NAV Message (PVT, GGA, etc…)

OnTime = highest rate licensed

This output stream reports the local geodetic datum and datum offsets from a reference datum.

The output format for this message is described in the following table.

Default: The NMEADTM message will be scheduled to display automatically before the most frequent NAV msg (NMEAGGA, NMEAGLL or NMEARMC). If the frequency of any other NAV msg is changed, the adjusted NMEADTM message will automatically display before the most frequent one.

When datum code is unknown (e.g. RTK mode), the output will be empty.

Table 153: DTM Message Output Format

Field#	Field name	Description
F1	Local datum code	Local Datum Code W84 = WGS84 W72 = WGS72 S85 = SGS85 P90 = PE90 999 = User defined
F2	Local datum subdivision code	Local datum subdivision code (if available)
F3	Lat offset	Latitude offset from reference position (in minutes)
F4	N/S	Direction of latitude (N=north, S=south)
F5	Lon offset	Longitude offset from reference position (in minutes)
F6	E/W	Direction of longitude (E=east, W=west)
F7	Altitude offset	Altitude offset from reference position (in meters)
F8	Reference datum code	Reference Datum Code W84 = WGS84 W72 = WGS72 S85 = SGS85 PE90 = P90
F9	*CRC	Checksum

Output values depend on navigation mode and [DATUM] selection. Table below is a quick reference for DTM outputs for each navigation mode and [DATUM] selection.

Table 154: DTM Message Output for Each Nav Mode

Navigation Mode	[DATUM] (user command)	Local Datum	Reference Datum	Offsets
Non-Diff, SBAS	DEFAULT or WGS84	W84	W84	0
	GDA94 or USERDATUM	999	W84	Offsets from WGS84
StarFire	DEFAULT	999	999	0
	WGS84	W84	W84	0
	GDA94 or USERDATUM	999	W84	Offsets from WGS84
RTK, RTK-X, RTCM-code	Any	blank	blank	blank

This message will be scheduled onchange automatically on the port that NMEAGGA, NMEAGLL, or NMEARMC is scheduled on. This applies to all ports except NTRIP port.

Example:

>[OUTPUT]NMEAGGA,ontime,1,1

>[OUTPUT],,,1

[OUTPUT]NMEAGGA,ONTIME,1,1

[OUTPUT]NMEADTM,ONCHANGE,,1
*NMEADTM will come out right before NMEAGGA once a second

>[OUTPUT]NMEAGLL,ONTIME,0.1,1
*NMEADTM will come out right before NMEAGLL ten times a second

2.31 NMEAGBS

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output stream reports Receiver Autonomous Integrity Monitoring (RAIM) data. Given that a GNSS receiver is tracking enough satellites to perform integrity checks of the positioning quality of the position solution, this sentence reports the output of this process.

Table 155: GBS Message Output Format

Output Format:	$GPGBS,UTC,Lat,Long,Alt,SVID,Det,Bias,StdDev,*hh<CR><LF>

Field#	**Field Name**	**Description**
F1	UTC	UTC time of the associated GGA or GNS fix (hhmmss.ss)
F2	Lat	Expected error in latitude (+/-9.9)
F3	Long	Expected error in longitude (+/-9.9)
F4	Alt	Expected error in altitude (+/-9.9)
F5	SVID	ID number of the most likely failed satellite (01-32)
F6	Detection	Probability of missed detection (9.9)
F7	Bias	Bias estimate on most likely failed satellite (9.9 meters)
F8	StdDev	Standard deviation of bias estimate (9.9)
F9	System ID	1 for GPS, 2 for GLONASS
F10	Signal ID	Specific frequency likely failed for the given satellite (see Note 1)
F11	*CRC	Checksum

Example:

$GPGBS,161816.00,0.0,-0.0,-.0,13,0.8,0.0,0.0, 1, 0*6C

The Signal ID is designed to show which Signal failed for that particular satellite. For our receivers, we are only tracking satellites in the GPS constellation is using 0, 1, 2, 4, and for GLONASS constellation, we are only using 0, 1, and 3. In the event the receiver is configured for dual-frequency and multiple signals failed, a 0 is reported. 0 is not used in single-frequency mode.

Signal ID	Signal/Channel
0	All signals
1	L1 C/A
2	L1 P(Y)
3	L1 M
4	L2 P(Y)
5	L2C-M
6	L2C-L
7	L5-I
8	L5-Q
9-F	Reserved

0	All signals
1	G1 C/A
2	G1 P
3	G2 C/A
4	GLONASS (M) G2 P
5-F	Reserved

2.32 NMEAGFA

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = highest rate licensed

This sentence is used to report the results of the data quality check associated with a position solution. If only a single constellation (GPS, GLONASS, GALILEO, etc.) is used for the reported position solution, the talker ID is GP, GL, GA, etc. and the data pertain to the individual system. If satellites from multiple systems are used to obtain the reported position solution, the talker ID is GN and the parameters pertain to the combined solution. This provides the quality data of the position fix and is associated with the GNS sentence.

Table 156: GFA Message Output Format

Output Format:	$GPGBS,UTC,Lat,Long,Alt,SVID,Det,Bias,StdDev,*hh<CR><LF>

Field#	**Field Name**	**Description**
F1	UTC	UTC time of the associated GGA or GNS fix (hhmmss.ss)
F2	HPL	Horizontal protection level in meters (xxxx.x). Computed as: HPL = K_H * Std_X Where K_H is default to 4.0; configurable by [CONFIGGFA] Std_X is defined in F4 in the same message
F3	VPL	Vertical protection level in meters (xxxx.x). Computed as: VPL = K_V * Std_H Where K_V is default to 3.5; configurable by [CONFIGGFA] Std_H is defined in F7 in the same message
F4	Std_X	Standard deviation of semi-major axis of error ellipse in meters (xxx.xx)
F5	Std_Y	Standard deviation of the semi-minor axis of error ellipse in meters (xxx.xx)
F6	Theta	Orientation of semi-major axis of error ellipse (xxx.xxxx degrees from true north)
F7	Std_H	Standard deviation of altitude in meters (xxx.xx)
F8	SAL	Selected accuracy level in meters (xxxx.x)
F9	IntStatus	Integrity status: The integrity status field is a variable length character field which indicate the status of the various integrity sources, with three currently defined; RAIM (first character), SBAS (second character) and Galileo integrity (GIC). This field shall not be Null. The characters shall take one of the following values: V = Not in use S = Safe (when integrity is available and Horizontal Protection Limit (HPL) < Horizontal Alert Level (HAL) C = Caution (when integrity is not available) U = Unsafe (when integrity is available and HPL>HAL)
F10	*CRC	Checksum

Example:

$GNGFA,224229.00,0001.7,0002.9,000.43,000.22,014.4868,000.83,0010.0,SCC*0C

In RTK mode, fields F2, F3, F4, and F5 are zeros. They are correct values since RTK provides very accurate solutions, beyond the resolution provided by the NMEA standard.

2.33 NMEAGGA

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output stream reports position and fix related status information. Refer to the [GGAMODE] command to understand how to add two digits of precision for the latitude, longitude, and altitude parameters.

The [GGAMODE] command is used to select the standard NMEAGGA output stream or high precision for NMEAGGA output. The NavCom proprietary NMEA type message, NMEAPNCTGGA, also provides high precision.

Table 157: GGA Message Format

Output Format	$GPGGA,time,lat,N/S,lon,E/W,quality,used,hdop,alt,M,separation,M,age,id*hh<CR><LF>

Field#	**Field name**	**Description**
F1	Time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	Lat	Latitude in decimal degrees and minutes (ddmm.mmmm) (0000.0000 to 8959.9999) High precision: (ddmm.mmmmmm) (0 to 8959.999999)
F3	N/S	Direction of latitude (N=north, S=south)
F4	Lon	Longitude in decimal degrees and minutes (dddmm.mmmm) (00000.0000 to 17959.9999) High precision: (dddmm.mmmmmm) (0 to 17959.999999)
F5	E/W	Direction of longitude (E=east, W=west)
F6	quality	Position fix quality (0 to 8) 0= Fix not available or invalid; *= GPS SPS Mode, fix valid; 1= Differential GPS, SPS Mode, fix valid; 1= GPS PPS Mode, fix valid 2= Real Time Kinematic, fixed integers; 5= Float RTK, floating integers 6= estimated (dead reckoning) Mode; 7= Manual input mode; 8= Simulator mode
F7	used	Number of used satellites in the position fix, 00-12.
F8	hdop	Horizontal Dilution of Precision, 1 (ideal) to >20 (poor).
F9	Alt	Altitude above mean sea level (geoidal height) in meters, a theoretical value that for practical purposes can range from -50 or so for low places on Earth, to very large positive values for the heights. mm.m; High precision: mm.mmm
F10	M	Units for altitude (M=meters)
F11	separation	Geoidal Separation: the difference between the WGS-84 earth ellipsoid surface and mean-sea-level (geoid) surface, "-" = mean-sea-level surface below WGS-84 ellipsoid surface. Note: If no geoid is loaded, geoidal separation will be reported as 0.
F12	M	Units for geoidal separation (M=meters)
F13	age	Time since last Dgps data was received, in seconds.
F14	Id	Reference station ID number (0000 – 1023). In StarFire mode this is the StarFire satellite ID.
F15	*CRC	Checksum

⚠ The low-precision GGA mode was created to resolve the problem of the default GGA sentence exceeding the maximum allowed length of 80 characters. However, the low-precision sentence can still exceed 80 characters under worst- case conditions:

Field	Length
$GxGGA,	7
UTC (hhmmss.ss,)	10
Lat (ddmm.mmmm,N/S,)	12
Lon (dddmm.mmmm,E/W,)	13
Quality (q,)	2
# Sats used (ss,)	3
HDOP (dd.d,)	5
Alt (aaaa.a,M,)	9
Geoidal sep (-ggg.g,M,)	9
Age (ss.s,)	5
Ref ID (iiii,)	5
Checksum (*cc)	3
Total	83

Examples:

$GNGGA,161611.00,3350.4771,N,11820.6248,W,2,15,0.8,8.911,M,0.0,M,10.0,2*42

High precision:
$GNGGA,161611.00,3350.477102,N,11820.624805,W,2,15,0.8,8.911,M,0.000,M,10.0,0402*42

The SF-5050 outputs all of these messages with the talker ID based on the current navigation mode:

‘$GN’ = Multi-constellation and is the default mode of operation.

‘$GP’ = GPS and requires the receiver to only track and use GPS satellites; all other navigation satellite tracking and modes must be disabled.

‘$GL’ = GLONASS and requires the receiver to only track and use GLONASS satellites; all other navigation satellite tracking and modes must be disabled.

The $GL and $GA IDs are not available for the GGA message as the navigation software is not tuned to provide a position solution in these singular constellation modes.

Use StarUtil-5000 to constrain the mode to GPS only using the following commands:

[TRACKINGMODE]

[NAVMEASUSE]

When the GGA message goes invalid, the time of the last known position fix is output as is the last known position, and the quality flag in field 6 is changed to ‘0’ or invalid. This is the correct behavior as defined by international regulatory agencies.

2.34 NMEAGLL

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output message reports geographic position (latitude and longitude) information.

Table 158: GLL Message Output Format

Output Format:	$GPGLL,lat,N/S,lon,E/W,time,status*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	Lat	Latitude in degrees and decimal minutes (ddmm.mmmmmm) (0000.000000 to 8959.999999)
F2	N/S	Direction of latitude (N=north, S=south)
F3	lon	Longitude in degrees and decimal minutes (dddmm.mmmmmm) (00000.000000 to 17959.999999)
F4	E/W	Direction of longitude (E=east, W=west)
F5	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F6	status	Status V = void (invalid data) A = active (valid data)
F7	mode	Mode indicator A = autonomous mode D = differential mode N = Data not valid
F8	*CRC	Checksum

Example:

$GPGLL,3713.870070,N,12148.058706,W,032618.00,A,D*7C

2.35 NMEAGNS

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output stream reports fix data for single or combined satellite navigation systems. Refer to the [GGAMODE] command to understand how to add two digits of precision for the latitude and longitude parameters.

Refer to the [GGAMODE] command to understand how to add two digits of precision for the latitude and longitude parameters.

Table 159: GNS Message Output Format

Output Format:	$GPGNS,time,lat,N/S,lon,E/W,mode,used,HDOP,alt,separation,age,ID,status*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	Time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	Lat	Latitude in decimal degrees and minutes (ddmm.mmmm) (0000.0000 to 8959.9999); High precision: (ddmm.mmmmmm) (0 to 8959.999999)
F3	N/S	Direction of latitude (N=north, S=south)
F4	Lon	Longitude in decimal degrees and minutes (dddmm.mmmm) (00000.0000 to 17959.9999); High precision: (dddmm.mmmmmm) (0 to 17959.999999)
F5	E/W	Direction of longitude (E=east, W=west)
F6	Mode indicator	A variable length character field with the first two characters defined: the first character indicates use of GPS satellites and the second character indicates use of GLONASS satellites. A = Autonomous. Non-differential mode D = Differential F = RTK Float N = No fix P = Precise R = RTK Fixed
F7	Used	Total number of satellites in use, 00-99.
F8	HDOP	Horizontal Dilution of Precision, 1 (ideal) to >20 (poor).
F9	Alt	Altitude above mean sea level (geoidal height) in meters, a theoretical value that for practical purposes can range from -50 or so for low places on Earth, to very large positive values for the heights. NMEAGNS: mm.m
F10	Separation	Geoidal Separation: the difference between the WGS-84 earth ellipsoid surface and mean-sea-level (geoid) surface, "-" = mean-sea-level surface below WGS-84 ellipsoid surface. Note: If no geoid is loaded, geoidal separation will be reported as 0.
F11	age	Time since last dGPS data was received, in seconds.
F12	ID	Reference station ID number (0000 – 1023). In StarFire mode this is the StarFire satellite ID.

Field#	Field Name	Description
F13	Status	Navigational Status Indicator (see note below) S = Safe C = Caution U = Unsafe V = Not Valid
F14	*CRC	Checksum

The Navigational Status Indicator (F13) is determined by comparing the Horizontal Position Error to the Selected Accuracy Level. The Selected Accuracy Level value is configured by means of the [CONFIGGFA] command and is set to 10 meters by default. The Horizontal Position Error is calculated as part of the RAIM data which is reported in the [NMEARRE] message (not an NMEA message). For example, in RTK mode, this error typically has a value of 0.1 meters.

- If the Horizontal Position Error is less than or equal to the Selected Accuracy Level, the Navigational Status Indicator is set to “S” (Safe).
- If the Horizontal Position Error is greater than or equal to the Selected Accuracy Level, the Navigational Status Indicator is set to “U” (Unsafe).
- If there is no valid Horizontal Position Error (no RAIM data), the Navigational Status Indicator is set to “C” (Caution).
- If there is no Nav Solution, the Navigational Status Indicator is set to “V” (Not Valid).

Examples:

Tracking both GPS and GLONASS satellites and both in Precise mode:

$GNGNS,232439.00,3350.4708,N,11820.6172,W,PP,16,0.8,45.0,-36.0,,,S*28

$GPGNS,232439.00,,,,,,08,,,,6.0,0402,S*1B

$GLGNS,232439.00,,,,,,08,,,,6.0,0402,S*07

Tracking both GPS and GLONASS in Autonomous mode (note: one GNGNS message):

$GNGNS,233839.00,3350.4710,N,11820.6173,W,AA,16,0.7,43.6,-36.0,,,S*22

Tracking only GPS satellites in Precise mode:

$GPGNS,232744.00,3350.4708,N,11820.6172,W,PN,08,1.3,45.0,-36.0,6.0,0402,S*0A

Tracking only GPS satellites in Autonomous mode:

$GPGNS,232939.00,3350.4708,N,11820.6172,W,AN,08,1.2,44.8,-36.0,,,U*3F

Tracking GPS and GLONASS satellites in Differential mode:

$GNGNS,233459.00,3350.4709,N,11820.6173,W,DD,16,1.2,44.1,-36.0,,,S*24

$GPGNS,233459.00,,,,,,08,,,,5.0,0138,S*13

$GLGNS,233459.00,,,,,,08,,,,5.0,0138,S*0F

2.36 NMEAGRS (ASCII)

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output stream reports Receiver Autonomous Integrity Monitoring (RAIM) data, reporting Range Residuals.

Table 160: GRS Message Output Format

Output Format:	$GPGRS,UTC,Mode,Res…,Res,*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	UTC	UTC time of the associated GGA or GNS fix (hhmmss.ss)
F2	Mode	How the residuals were calculated (see note 1)
F3	Res	Up to 12 range residuals (+/999 meters) (see note 2)
F9	System ID	1 for GPS, 2 for GLONASS, 3 for GALILEO
F10	Signal ID	1 for Single Mode, and 0 for Dual Mode (see note 3)
F11	*CRC	Checksum

Examples:

$GPGRS,162404.00,0,-0.2,-0.9,-0.3,0.9,-0.5,0.2,0.4,0.1,0.6,0.7,0.5,1,1*4F

$GNGRS,213029.00,0,,-2.3,-9.7,0.1,1.0,,,,,,,,2,0*57

[1]Mode 0 means the residuals were used to calculate the position given in the matching GGA or GNS sentence. Mode 1 means the residuals were recomputed after the GGA or GNS position was computed.

[2]The order of the range residuals must match the order of the satellite ID numbers given in the GSA command.

[3]The Signal ID is designed to show the Signals that are being tracked, but since the GRS shows the risiduals for multiple sats that are being used in the navigation solution, the Signal ID will be used to inform the user of the signals that are being used for the nav solution. If the nav solution is based on a Single Frequency, then this Signal ID will be 1 for GPS and 1 for GLONASS, corresponding to the L1C/A and G1C/A signal. If the nav solution is based on a Dual Frequency, then the Signal ID will be 0 for both GPS and GLONASS, since there are multiple signals contributing to the solution. The All signals ID mean that we are using L1C/A and L2 P(Y) signals.

Signal ID	Signal/Channel
0	All signals
1	L1 C/A
2	L1 P(Y)
3	L1 M
4	L2 P(Y)
5	L2C-M
6	L2C-L
7	L5-I
8	L5-Q
9 – F	Reserved

0	All signals
1	G1 C/A
2	G1 P
3	G2 C/A
4	GLONASS (M) G2 P
5 – F	Reserved

2.37 NMEAGSA

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output stream reports 2D/3D solution mode, DOP values and active satellite information.

Table 161: GSA Message Output Format

Output Format:	$GPGRS,UTC,Mode,Res…,Res,*hh<CR><LF>	
Field#	**Field Name**	**Description**
f1	mode	Mode M = manual solution (forced to operate in 2D or 3D mode) A = automatic (automatically switches between 2D and 3D)
f2	solution	Solution 1 = fix not available 2 = 2D 3 = 3D
f3	used	PRN of satellites used in navigation solution (12 fields, null for empty fields)
f4	pdop	Positional Dilution of Precision, 1 (ideal) to >20 (poor).
F5	hdop	Horizontal Dilution of Precision, 1 (ideal) to >20 (poor).
F6	vdop	Vertical Dilution of Precision, 1 (ideal) to >20 (poor).
F7	System ID	1 for GPS, 2 for GLONASS
F8	*CRC	Checksum

Examples:

$GPGSA,A,3,03,08,13,16,20,23,25,27,,,,,2.4,1.4,1.9,1*36

$GNGSA,M,3,69,70,84,85,,,,,,,,,4.2,3.1,2.8,2*39

2.38 NMEAGST (ASCII)

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output message reports pseudo-range noise statistic information.

Table 162: GST Message Output Format

Output Format:	$GPGST,time,rms,majoraxis,minoraxis,orientation,laterr,lonerr,alterr*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	rms	Total RMS standard deviation of ranges inputs to the navigation solution
F3	majoraxis	Standard deviation of semi-major axis of error ellipse in meters
F4	minoraxis	Standard deviation of semi-minor axis of error ellipse in meters
F5	orientation	Orientation of semi-major axis of error ellipse in true north degrees (0 to 180º)
F6	laterr	Standard deviation of latitude error in meters
F7	lonerr	Standard deviation of longitude error in meters
F8	alterr	Standard deviation of altitude error in meters
F9	*CRC	Checksum

Example:

$GPGST,032746.00,22236.0738,0.0552,0.0355,019.4414,0.0543,0.0368,0.0991*6A

2.39 NMEAGSV (ASCII)

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output message reports data associated with satellites in view, based on almanac data. Data includes PRN number, elevation, azimuth and SNR values.

This output stream reports data associated with satellites in view, based on almanac data. Data includes PRN number, elevation, azimuth and SNR values. Note that one GSV sentence can only provide data for up to 4 satellites, so there several sentences may be required for full "satellite in view" information.

The output format for this message is described in the following table.

Table 163: GSV Message Output Format

Output Format:	$GPGSV,total,message,totalsv,prn1,elev1,azim1,snr1,…..,prn4,elev4,azim4,snr4*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	Total	Total number of messages for full information
F2	Message	Message number
F3	Totalsv	Total number of satellites in view that will be included in the messages (up to 4 satellites per message)
F4	Prn	Satellite PRN number
F5	Elev	Elevation for the corresponding satellite in degrees (0 to 90)
F6	Azim	Azimuth for the corresponding satellite in degrees (0 to 359)
F7	Snr	Signal to Noise ratio for the corresponding satellite
F8	Signal ID	1 for L1CA, and 0 for L1+L2 (see note 1) (v4 only)
F9	*CRC	Checksum

Examples:

$GPGSV,3,1,11,13,68,347,50,23,66,87,50,25,56,40,50,27,45,277,46*78

$GPGSV,3,2,11,16,23,44,45,20,22,174,36,08,21,259,38,03,21,103,36*43

$GPGSV,3,3,11,19,09,128,32,04,05,266,34,02,01,301,30,,,,*44

In order to accomodate for the new Signal ID Requirement for IEC61162 v4, some arrangement needed to be made in the GSV message. The GSV may be output in two groups, one group with Signal ID 1, which are the Satellites that are being tracked with L1CA or G1C only. The other group will then be sent out with the rest of the satellites that are being tracked with L1CA/G1C and L2P/G2C with Signal ID 0, indicating multiple signals. An example would look like this:

$GPGSV,3,1,10,26,20,048,47,06,19,316,46,,,,,,,,1*66
$GPGSV,3,2,10,18,71,254,53,21,65,360,51,29,46,145,52,15,43,083,51,0*6C
$GPGSV,3,3,10,22,29,237,49,30,22,265,50,16,21,298,48,03,04,320,43,0*69

```
$GLGSV,2,1,07,81,77,060,54,66,66,018,54,67,56,229,51,82,34,331,51,1*7D
$GLGSV,2,2,07,88,28,132,49,65,12,034,,68,05,219,46,,,,,1*4C
```

A signal ID 0 is given to a group of sats once they have LOCKED on an L2 signal.

2.40 NMEAHDT

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output stream reports Heading, Degrees True. This message is only valid when the receiver is an MBRTK rover, when it is in one of the RTK navigation modes, and when the baseline is good.

Table 164: HDT Message Output Format

Output Format	$GNHDT,DD.D,T* hh<CR><LF>	
Field #	**Field Name**	**Description**
F1	Heading	Degrees
F2	Unit of reference	True
F3	*CRC	Checksum

Example:

$GNHDT,73.4,T*1B

2.41 NMEAMLA

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

ONCE = output immediately once

OnChange = when GLONASS almanac is received

OnTime = minimum interval of 60 seconds

This output stream reports orbital data (almanac) for the specified GLONASS satellite.

This message can now be scheduled ONTIME with a minimum interval of 60 seconds. When scheduled OnTime, the whole set of NMEAMLA messages, which consists of multiple messages each containing the almanac for one satellite, will be output at specified intervals. Within the set, each almanac message will be output at one second at a time.

Table 165: MLA Message Output Format

Output Format	$GLMLA,T.T,S.S,sID,N.N,CH,EEEE,Tn,pppp,tMSB,dtnaco,tascmd,llllll,iaiaia,tLS, tss*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	total	Total number of sentences (24)
F2	Sentence	Sentence number (01 to 24)
F3	SID	Satellite ID (slot) number (01 to 24)
F4	Na	Calendar day count within the four-year period beginning with the previous leap year
F5	CH	Cn(a) and Hn(a), generalized health of the satellite (0x80) and carrier frequency number (0x7F)
F6	eccentricity	Eccentricity (S32)
F7	Tn	DOT, rate of change of the draconitic circling time (S32)
F8	perigee	Argument of perigee (S32)
F9	tMSB	16 MSB of system time scale correction (U16)
F10	dtnaco	Correction to the average value of the draconitic circling time (S32)
F11	tascmd	Time of the ascension node, almanac reference time (S32)
F12	Long_asc	Greenwich longitude of the ascension node (S32)
F13	Corr_incl	Correction to the average value of the inclination angle (S32)
F14	tLSB	12 LSB of system time scale correction (U16)
F15	tss	Course value of the time scale shift (S32)
F16	*CRC	Checksum

Example:

$GLMLA,24,1,65,441,81,0183,000F,81C1,0000,F4C05E,0F6471,F68B01,001B7B,000,202*62

2.42 NMEARMC

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output stream reports minimum recommended GPS information, including position, velocity, and time information.

Table 166: RMC Message Output Format

Output Format:	$GPRMC,time,status,lat,N/S,lon,E/W,speed,course,date,variation,E/W,mode*hh<CR><LF>	
Field#	**Field Name**	**Description**
f1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
f2	status	V = void (invalid data) A = active (valid data) Value set to V for all modes listed in f12 except for A and D
f3	Lat	Latitude in degrees and decimal minutes (ddmm.mmmmmm) (0000.000000 to 8959.999999)
f4	N/S	Direction of latitude (N=north, S=south)
f5	long	Longitude in degrees and decimal minutes (dddmm.mmmmmm) (00000.000000 to 17959.999999)
f6	E/W	Direction of longitude (E=east, W=west)
f7	speed	Speed over ground in knots (limited by the physical constraints of walking or riding a vehicle, practically speaking less than mach 3, in all cases no more than 299,792,458 meters/second)
f8	course	Course over ground in degrees true (0 to 359.9)
f9	date	Current date in the format ddmmyy
F10	Variation	Magnetic variation in degrees (0- 359.9)
F11	E/W	Direction of variation (E=east, W=west)
F12	mode	Position mode indicator A = autonomous D = DGPS E = Estimated (dead reckoning) S = Simulator N = Data not valid P = Precise (see note 1) R = RTK (see note 1) F = Float (see note 1)
F13	Nav Status	S = Safe C = Caution U = Unsafe V = Not valid
F14	*CRC	Checksum

Example:

$GPRMC,033341.00,A,3713.870096,N,12148.058706,W,0.03,0.0,180407,0.0,E,D*19

According to the IEC 61162 ver4 standard, a new mode indicator field has been added : P for Precise, R for RTK, and F for RTK Float.

- P will be used for all Dual Frequency StarFire related Solution
- D will be used for all other DGPS solution such as WAAS and RTCM Code.
- R will be used for all RTK related solutions except RTK Float, these solutions include RTK Dual, RTK-X, RTK WL.
- F will be used for RTK Float solution.

2.43 NMEAROT (ASCII)

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output stream reports Rate of Turn and direction of turn. This message is only valid when the receiver is an MBRTK rover, when it is in one of the RTK navigation modes, and when the baseline is good.

The reported rotation rate is an average of the last 3 seconds of rotation rate calculations. If the rotation rate is less than one rotation per hour, the rate is reported as 0 degrees per minute.

Table 167: ROT Message Output Format

Output Format:	$GNROT,488.2,A*hh<CR><LF>	
Field #	**Field Name**	**Description**
F1	Rate of return	Degrees per minute, negative = bow turns to port
F2	Status	A = data valid, V = data invalid
F3	*CRC	Checksum

Example:

$GNROT,488.2,A*29

2.44 NMEARRE (ASCII)

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output stream reports Receiver Autonomous Integrity Monitoring (RAIM) data, reporting Range Residual Errors. Note that this command is not defined in NMEA 0183 Standard version 4.10.

Table 168: RRE Message Output Format

Output Format:	$GPRRE,count,<SVID,res>,…,Herr,Verr,*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	count	Count of satellites included here (01-12)
F2	SVID	Satellite ID for this residual (01-32)
F3	Res	Residual for this satellite (+/-999)
F4	Herr	Horizontal position error (+/-9999)
F5	Verr	vertical position error (+/-9999)
F6	*CRC	Checksum

Example:

$GPRRE,10,03,-0.2,07,-0.1,08,0.3,10,-0.5,13,-0.3,19,0.5,23,-
.5,25,0.5,27,0.6,28,0.0,000.1,000.1*7E

2.45 NMEATTM

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [MBRTK1B]

OnTime = highest rate licensed

This output stream is only supported on an MBRTK Rover and displays baseline information including the baseline distance, bases speed and direction, and closest point of approach.

Table 169: TTM Message Output Format

Output Format:	$GNTTM,Base Number,Base Distance,…,UTC,Type of Acq,*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	Base Number	Last 2 digits of the MBRTK BaseID
F2	Base Distance	3D Baseline Distance (m)
F3	Base Bearing	Base 2D bearing from the Rover, N=0º, E=90º (0º-360º)
F4	Bearing Units	True or Relative (T/R), R is not supported
F5	Base Speed	3D speed of the Base (m/s)
F6	Base Coruse	Base 2D direction, N=0º, E=90º (0º-360º)
F7	Course Units	True or Relative (T/R), R is not supported
F8	CPA Dist	Distance at the closest point of approach, this is how close the Base and Rover would ever get given their course and speed in 2D (m)
F9	CPA Time	Time until 2D CPA, - means it has passed (min)
F10	Speed/Dist Units	K = Kilometers (metric, used) N = Knots (unused) S = Statute miles (unused)
F11	Base Name	Full Base ID
F12	Base Link Status	Tracking status of the Base: L = Lost track of Base (Non RTK Mode) Q = Query, acquiring (RTK Float) T = Tracking (RTK Fixed)
F13	Tracking Ref	R if base is used to determine own position (always true)
F14	UTC	Standard UTC time (hhmmss.ss)
F15	Type of Acqusition	A = Automatic (used) M = Manual (unused)
F16	*CRC	Checksum

Example:

$GNTTM,30,16.75,134.27,T,0.03,34.96,T,15.99,2.63,K,530,T,R,201345.00,A*45

There will be some noise in the base velocity due to the baseline velocity of the rover. This noise will increase if the rover is moving in a non-linear path.

The conventional use of the TTM message is to carry the information on a ‘tracked’ target generated by the ARPA section of a radar on the ship where it is being used. Usual usage on the ship is to convey the target information to an ECDIS or ECS for display on the navigational chart. However, when the TTM message is used from the GNSS rover receiver, it is not intended to be used in this manner. An example of the intended use is to give MBRTK users ASCII access to the rover - base distance; for example, where the rover is mounted on a seismic cable tail buoy with TTM message sent back to the vessel by radio.

2.46 NMEAVTG

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output message reports velocity and course over ground information.

Table 170: VTG Message Output Format

Output Format:	$GPVTG,track,T,track,M,speed,N,speed,K,mode*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	track	True track (course over ground) in degrees (0 to 359.9)
F2	T	True track orientation (T=true north)
F3	track	Magnetic track in degrees (0 to 359.9)
F4	M	Magnetic track orientation (M=magnetic north)
F5	speed	Speed over ground in knots (0 to 1000)
F6	N	Speed over ground units (N=knots)
F7	speed	Speed over ground in kilometers (0 to 1852)
F8	K	Speed over ground units (K=km/h (kilometers/hour))
F9	mode	Position mode indicator A = autonomous D = DGPS E = Estimated (dead reckoning) S = Simulator N = Data not valid
F10	*CRC	Checksum

Example:

$GPVTG,0.0,T,,M,0.03,N,0.06,K,D*0D

According to the IEC 61162 edition 4 standard, a new mode indicator field has been added, P for Precise, in order to distinguish Precise solution from DGPS solution.

- P will be used for all Dual Frequency StarFire and RTK related Solution
- D will be used for all other DGPS solution such as WAAS, RTCM Code, and StarFire Single.

2.47 NMEAZDA

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output message reports date and time information.

Table 171: ZDA Message Output Format

Output Format:	$GPZDA,time,day,month,year,offset_hour,offset_min*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	day	Current day (01 to 31)
F3	month	Current month (01 to 12)
F4	year	Current year (0000 to 9999)
F5	offset_hour	Local zone hours (-13 to +13)
F6	offset_min	Local zone minutes (00 to 59)
F7	*CRC	Checksum

UTC offset is configured using the [SETUTCOFFSET] command.

Example:

$GPZDA,035751.00,18,04,2007,00,00*6B

2.48 NMEAPNCTDTM

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

ONCE = output immediately once

OnChange = same rate as the fastest NAV Message (PVT, PNCTGGA, etc…)

OnTime = highest rate licensed

This output stream reports local geodetic datum and datum offsets from a reference datum.

Default: The NMEAPNCTDTM message will be scheduled automatically to display before the most frequent NAV msg. If the frequency of any other NAV msg is changed, the adjusted NMEAPNCTDTM message will automatically display before the most frequent one.

This is a nonstandard NMEA message.

The difference from NMEADTM is that we added new datum code for ITRF2005, ITRF2008 and GDA94. When datum code is unknown (e.g. RTK mode), the output will be empty.

Table 172 PNCTDTM Message Output Format

Field#	Field name	Description
F1	Local datum code	W84 = WGS84 W72 = WGS72 S85 = SGS85 P90 = PE90 999 = User defined I05 = ITRF2005 I08 = ITRF2008 G94 = GDA94
F2	Local datum subdivision code	Local datum subdivision code (if available)
F3	Lat offset	Latitude offset from reference position (in minutes)
F4	N/S	Direction of latitude (N=north, S=south)
F5	Lon offset	Longitude offset from reference position (in minutes)
F6	E/W	Direction of longitude (E=east, W=west)
F7	Altitude offset	Altitude offset from reference position (in meters)
F8	Reference datum code	W84 = WGS84 W72 = WGS72 S85 = SGS85 PE90 = P90 I05 = ITRF2005 I08 = ITRF2008 G94 = GDA94
F9	*CRC	Checksum

Output values depend on navigation mode and [DATUM] selection. Table below is a quick reference for DTM outputs for each navigation mode and [DATUM] selection.

Table 173 PNCTDTM Message Output for Each Nav Mode

Navigation Mode	[DATUM]	Local Datum	Reference Datum	Offsets
Non-Diff, SBAS	DEFAULT or WGS84	W84	W84	0
	GDA94	G94	W84	Offsets from WGS84
	USERDATUM	999	W84	Offsets from WGS84
StarFire	DEFAULT	I05	I05	0
	WGS84	W84	W84	0
	GDA9	G94	W84	Offsets from WGS84
	USERDATUM	999	W84	Offsets from WGS84
RTK, RTKX, RTCM-code	Any	blank	blank	blank

This message will be scheduled onchange automatically on the port that NMEAPNCTGGA is scheduled on. This applies to all ports except NTRIP port.

2.49 NMEAPNCTGGA

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output message reports position and fix related status information. It is a NavCom proprietary NMEA type message, and it conforms to the header, checksum, and electrical characteristics of a standard NMEA string, but is not recognized by the NMEA governing body as an officially sanctioned message.

NMEAGGA provides two modes: low and high precision. The low precision mode is the standard NMEAGGA output stream.The high precision mode is an extended mode for the NMEAGGA output sentence. It is not in compliance with the NMEA-0183 Standards in terms of message length. The high precision mode adds two digits of precision for the latitude, longitude, and altitude parameters. NMEAPNCTGGA also provides the same high precision.

The NMEAPNCTGGA output can be scheduled to change at a set frequency which reflects any changes in position. The changed NMEAPNCTGGA output will automatically be preceeded by a changed NMEAPNCTDTM output.

Refer to the NMEAGGA and GGAMODE sections for more information. GGAMODE is used to select low or high precision for NMEAGGA output.

Table 174: PNCTGGA Message Output Format

Output Format:	$PNCTGGA,time,lat,N/S,lon,E/W,quality,used,hdop,alt,M,separation,M,age,id*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	Lat	Latitude in degrees and decimal minutes (ddmm.mmmmmm) (0000.000000 to 8959.999999)
F3	N/S	Direction of latitude (N=north, S=south)
F4	Lon	Longitude in degrees and decimal minutes (dddmm.mmmmmm) (00000.000000 to 17959.999999)
F5	E/W	Direction of longitude (E=east, W=west)
F6	quality	Quality of the position fix (0 to 8) 0 = invalid solution 1 = Standalone GPS fix 2 = DGPS fix 3 = PPS fix 4 = Real Time Kinematic 5 = Float RTK 6 = estimated (dead reckoning) 7 = Manual input mode 8 = Simulation mode
F7	used	Number of used satellites in the position fix, 00-12
F8	hdop	Horizontal dilution of precision, 1 (ideal) to >20 (poor)
F9	Alt	Altitude above mean-sea-level (geoidal height) in meters

Field#	Field Name	Description
F10	M	Units for altitude (M=meters)
F11	separation	Geoidal separation (difference between the WGS-84 earth ellipsoid and mean-sea-level, where "-" means mean-sea-level is below ellipsoid) in meters. Note: If no geoid is loaded, geoidal separation is reported as 0.
F12	M	Units for geoidal separation (M=meters)
F13	age	Time since last dGPS data was received in seconds
F14	Id	4-digit integer as denoted as XXYY, where XX is the StarFire satellite beam in use (see Table 175), and YY is the GPS correction signal type being used (see Table 176).
F15	*CRC	Checksum

Table 175: Beam Selection ID

Code (XX)	Designation	Satellite ID	Longitude	Uplink Site
00	N/A	N/A	Unknown	Unknown
01	4F3	402	98W	Laurentides
02	4F2	525	25E	Burum
03	4F1	643	143.5E	Auckland
04	3F3	678	178E	Santa Paula, CA
05	3F4	446	54W	Southbury
06	3F1	564	64E	Perth
09	N/A	N/A	Manual Override	

Table 176: Navigation Mode

ID (YY)	GPS Correction Signal
00	Non dGPS
01	Reserved
02	Reserved
03	WAAS/EGNOS Dual Freq., (See GSA for SBAS ID in use)
04	Reserved
05	Reserved
06	Reserved
07	Reserved
08	Reserved
09	Reserved
10	Dgps, RTCM type 1 or 9, Dual Freq.
11	StarFire dual freq. (no 'Tide' Adjustment)
12	Reserved
13	Reserved
14	Reserved
15	Reserved
16	Code base Nav, Dual Freq., NCT Proprietary Format
17	Code base Nav, Dual Freq., RTCM 18/19
18	Code base Nav, Dual Freq., RTCM 20/21
19	Reserved
20	RTK Mode, NCT Proprietary Format (62/5c or 5b/5c)
21	RTK Mode, RTCM 18/19
22	RTK Mode, RTCM 20/21
23	Reserved
24	Reserved
25	StarFire , Dual Freq., Adjusted for "Tides" (GPS)
26	RTK Extend Active (StarFire filling in for missing RTK epochs)
33	Reserved
34	GNSS, dual freq., No "Tides"
35	Reserved
36	GNSS, dual freq., Adjusted for "Tides"

Example:

$PNCTGGA,032215.00,3713.870081,N,12148.058703,W,2,08,1.8,59.608,M,
-33.440, M,8.0, 0122*47

2.50 NMEAPNCTGST

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This is a nonstandard NMEA message.

This message satisfies the UKOOA compliance requirements by starting with the standard NMEA GST message and scaling all error statistics by 1.96, and by adding a value for fisher test.

Table 177: PNCTGST Message Output Format

Output Format:	$PNCTGST,time,rms,majoraxis,minoraxis,orientation,laterr,lonerr,alterr,fisher*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	time	UTC time of the GGA or GNS fix associated with this sentence, represented as hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	rms	RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudoranges and DGNSS corrections.
F3	Majoraxis*	Standard deviation of semi-major axis of error ellipse in meters
F4	Minoraxis*	Standard deviation of semi-minor axis of error ellipse in meters
F5	Orientation	Orientation of semi-major axis of error ellipse in degrees from true north
F6	Laterr*	Standard deviation of latitude error in meters
F7	Lonerr*	Standard deviation of longitude error in meters
F8	Alterr*	Standard deviation of altitude error in meters
F9	Fisher	Fisher Test Result
F10	*CRC	Checksum

Indicates the result is scaled by 1.96 This output stream reports pseudo-range noise statistic information.

Examples:

$GNGST,192518.00,0.3762,0.1054,0.0953,074.8583,0.0960,0.1048,0.2168*7A

$PNCTGST,193028.00,0.2993,0.1722,0.1448,084.7181,0.1451,0.1720,0.3391,1*65

2.51 NMEAPNCTMDE

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output stream reports the Marginally Detectable Error (MDE) generated by core nav as part of the self-monitoring duties performed to support Receiver Autonomous Integrity Monitoring (RAIM). It is a NavCom proprietary NMEA type message, and it conforms to the header, checksum and electrical characteristics of a standard NMEA string, but is not recognized by the NMEA governing body as an officially sanctioned message.

Table 178: PNCTMDE Message Output Format

Output Format:	$PNCTMDE,hhmmss.ss,s,t,b.b,MM,l.l,g.g,a.a*hh<CR><LF>	
Field#	**Field Name**	**Description**
F1	Time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	svid	The GNSS svId
F3	Type	Measurement type: 0 = CA, 1 = P1, 2 = L1 , 3 = P2, 4 = L2, 5 = RC CODE, 6 = RC PHASE
F4	bias	standardized bias which is noncentrality parameter for w-test
F5	mde	MDE in meters
F6	laterr	Expected error in latitude (meters)
F7	longerr	Expected error in longitude (meters)
F8	alterr	Expected error in altitude (meters)
F9	*CRC	Checksum

Example:

$PNCTMDE,165535.00,,,,,,,*6A

2.52 NMEAPNCTSET

☒SF-5050 ☒Onyx

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output message reports a NavCom proprietary SET (solid earth tides), PT (polar tides) and Ocean Loading values. It is a NavCom proprietary NMEA type message, and it conforms to the header, checksum and electrical characteristics of a standard NMEA string, but is not recognized by the NMEA governing body as an officially sanctioned message.

Table 179: NCTSET Message Output Format

Output Format:	$PNCTSET,SET_dN,SET_dE,SET_dU,PT_dN,PT_dE,PT_dU,OL_dN,OL_dE,OL_dU*hh <CR><LF>

Field#	**Field Name**	**Description**
F1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	SET dN	Solid earth tides, delta North (meters)
F3	SET dE	Solid earth tides, delta East (meters)
F4	SET dU	Solid earth tides, delta Up (meters)
F5	PT dN	Polar Tides, delta North (meters)
F6	PT dE	Polar Tides, delta East (meters)
F7	PT dU	Polar Tides, delta Up (meters)
F8	Ocean Loading dN	Ocean Loading, delta North (meters)
F9	Ocean Loading dE	Ocean Loading, delta East (meters)
F10	Ocean Loading dU	Ocean Loading, delta Up (meters)
F11	*CRC	Checksum

Example:

$PNCTSET,214040.00,-0.060,-0.018,0.110,,,,,,*47

2.53 NTRIPSTAT

☒SF-5050 ☐Onyx

This message is used to report events associated with the NTRIPCLIENT command. This is a PowerIO board message. It can be scheduled as OnChange output message for a specific port, and turned off by using command [OUTPUT]. This message format is comma-delimited.

The following examples were output on week 1690 and TOW 486398.

Table 180: NTRIPSTAT Message Output Examples

Output Format:	[NTRIPSTAT]week,TOW, <Message>
Action	**Message**
Issue a source table request	[NTRIPSTAT] 1690,486398, Requesting Source Table
Download the source table	[NTRIPSTAT] 1690,486398, Downloading SourceTable
Connect to a mount point	[NTRIPSTAT] 1690,486398, Connecting to mountpoint <mp name>…
Connect properly	[NTRIPSTAT] 1690,486398, Connection Established
Disconnect	[NTRIPSTAT] 1690,486398, Disconnected
Connection fail due to a connection error	[NTRIPSTAT] 1690,486398,ERROR: Connection Failed
Inability to transmit any message to the caster	[NTRIPSTAT] 1690,486398, ERROR: Transmission failed, check what is being output in NTRIP port. Disconnecting.
Inability to reconnect with the same mountpoint 10 times	[NTRIPSTAT] 1690,486398, ERROR Disconnected 10 times, retrying with %s …

2.54 PHASENAVSTATUS1B (Version 1)

☒SF-5050 ☒Onyx

This is a message for reporting Phase Nav Status information.

Table 181: PHASENAVSTATUS1B Message Body

Data Item	Data Type	Scale
Latitude	S32	1/2048 arc seconds
Longitude	S32	1/2048 arc seconds
Lat/Lon LSB	U08	1/32768 arc seconds
Ellipsoidal height	S32	1/1000m
RMS North (1/1024m)	U16	
RMS East (1/1024m)	U16	
RMS Up (1/1024m)	U16	
Filter Time (seconds)	U16	
Ambiguity Process Count	U08	
Number used in code	U08	
Number used in phase	U08	
Number used in rover	U08	
GPS Satellites Used	U32	
GLONASS Satellites Used	U32	
SBAS Satellites Used	U32	
Correction Data Source (enum)	U08	
Error Code (enum)	U08	
Reserved	U08	
Minimum Age	U08	
GPS Ambiguity Set (Bitmap)	U32	
GLONASS Ambiguity Set (Bitmap)	U32	
WAAS Ambiguity Set (Bitmap)	U32	
Formal Scale (millimeters)	U16	
Troposphere (millimeters)	S16	
Troposphere Sigma (millimeters)	U16	

Table continued on next page…

Data Item	Data Type	Scale
Quick Start Mode (enum)	U16	
Start Status (enum)	U16	
StarFire Delay Time (milliseconds)	U16	
Number of Satellite Blocks	U08	
Satellite Block		See Table 182

Table 182: PHASENAVSTATUS1B Satellite Block

Data Item	Data Type
Satellite ID and constellation	U08
Satellite Status	U32
Satellite Azimuth (2 degrees resolution)	U08
Satellite Elevation (degrees)	U08
Refraction Corrected Code (millimeters)	S16
Refraction Corrected Phase (millimeters)	S16
Ambiguity (millimeters)	S16
Ambiguity Sigma (millimeters)	U16
Orbit/clock Correction (millimeters)	S16
Iono Correction (millimeters)	S16
Correction Age (seconds)	U16

2.55 PHASENAVSTATUS2B (Version 1)

☒SF-5050 ☒Onyx

This is a message for reporting Phase Nav Status information for StarFire GNSS. The structure is the same as that of PHASENAVSTATUS1B with the addition of Satellite Blocks containing GLONASS data.

2.56 PHASENAVSTATUS2B (Version 2)

☒SF-5050 ☒Onyx

This is a message for reporting Phase Nav Status information for StarFire GNSS. The structure is the same as version 1, with the exception that the Start Status Mode has been split into two fields: bits 0:7 still contain the start status information, and bits 8:15 now contain the StarFire Extend status:

Data Item	Data Type
Start Status (enum)	U08
StarFire Extend Status (enum)	U08

2.57 POINTRADIUSDATAB

☒SF-5050 ☒Onyx

This function fetches the latitude, longitude, and radius information defined in the Point Radius license entered prior to entering this command.

Table 183: POINTRADIUSDATAB

Data Item	Data Type
Count of entries (0 or 1)	U08
Reserved, reported as zero	U08
Radius LSB, km	U08
Radius MSB, km Bit 0x80 Longitude sign bit, 0x40 Latitude sign bit	U08
Latitude LSB, units of 10 seconds	U08
Latitude MSB, units of 10 seconds	U08
Longitude LSB, units of 10 seconds	U08
Longitude MSB, units of 10 seconds	U08

2.58 POWERSTAT

☒SF-5050 ☐Onyx

This ASCII output stream displays power and battery status: GPS week number, GPS time, External voltage, Ignition voltage, Battery voltage, Battery health, Battery temperature, Battery charging rate, and Push button voltage.

Table 184: POWERSTAT

Field		Description
GPS Week	I	GPS Weekstamp
GPS Time	S	GPS Timestamp
External voltage	F	Applied DC input voltage to receiver
Ignition voltage	F	Applied DC input voltage to receiver's ignition pin
Battery voltage	F	Measured DC voltage of internal battery pack
Battery health	K	TBD
Battery temperature	F	Measured temperature of internal battery pack used to determine charge rate
Battery charging rate	F	Applied input current to battery pack
Push button voltage	F	Measured DC voltage of front panel power switch

2.58.1 Battery Pack

The SF-5050 battery option uses batteries connected in series, creating a battery pack providing a total of 12.3 Volts. The battery circuit as well as the controlling battery charger firmware treat the battery pack as a single battery.

Table 185: Charge Start And Battery Operation Voltages

Range	Battery Voltage	External Power available[1]	External Power not available
Good:	11.9 ≥ VBAT ≤ 12.3	No Charging	Run
Medium:	11.1 ≥ VBAT < 11.9	No Charging	Run
Low:	10.8 ≥ VBAT < 11.1	Charging[2]	Run
Very Low:	9.0 > VBAT < 10.8	Charging[2]	Run
Ultra Low:	8.1 ≥ VBAT < 9.0	Attempt charge at power-on[2]	Off
Dead:	5.0 ≥ VBAT	Battery installed	Off
Not Present:	0.0 ≥= VBAT < 5.0	Battery not installed.	Off

Notes:

[1]External power is greater than 9V.

[2]Recharge attempt. 100mA. Out-of-range temperature is monitored.

[3]Batteries are installed, have very low voltage, may be rechargeable. Battery operation is not allowed.

2.58.2 Battery Temperature Ranges

Normal Range: >= -20.0 ^{0}C and <= 50.0^{0}C

Extended Range: >= -40.0 ^{0}C and < -20.0 ^{0}C; > -50.0 ^{0}C and < 85.0 ^{0}C (20 mA charge limit)

Examples:

[POWERSTAT] 1917, 170602.10, Ext:12.01V, Ign:12.14V, Bat:10.68V, Hlth:VERY LOW, Temp:29.85C, Rate:1205mA, Btn:4mV

[OUTPUT]POWERSTAT will display at a 10Hz interval

[OUTPUT]POWERSTAT, ONTIME, 1 will display at a 1 Hz interval

2.59 PSEUDORANGESTATSB

☒SF-5050 ☒Onyx

This output message reports pseudo-range noise statistical information.

Table 186: PSEUDORANGESTATSB Binary Message Data

Data Item (56 Bytes)	Data Type
RMS of the standard deviation of the range of inputs to the Navigation Process	R64
Orientation of semi-major axis of the error ellipse	R64
Standard Deviation of semi-major axis of the error ellipse	R64
Standard Deviation of semi-minor axis of the error ellipse	R64
Standard deviation of Latitude error	R64
Standard deviation of Longitude error	R64
Standard deviation of Altitude error	R64

Zero value is invalid for standard deviation of altitude error in PSEUDORANGESTATSB and NMEA GST.

2.60 PVT1B (Version 2)

☒SF-5050 ☒Onyx

In the Onyx Core Navigation Module, several different navigation solutions may be computed at a 1 Hz rate. For example, a navigation solution using global dGPS corrections from the StarFire system may be computed in parallel with an independent RTK solution using corrections from a local base station. For position, velocity, and time (PVT) output at rates greater than 1 Hz, the Onyx Core Navigation Module automatically selects the best available source of position information to control the fast (>1 Hz) navigation process. The PVT1B binary output stream contains this automatically selected navigation solution.

This message can vary in size based on the data in the field marked “GNSS satellite constellation (bit mask, by satellite type)”. This bit mask denotes the data that follows it in the message. This can be no additional data at all, or up to 24 additional bytes. Adding the 9 byte binary header to the data described here, this is how the message size works out for each of the combinations of bits in this field, with provision for versions 1 and 2 of this message:

The PVT1B message length is 76 bytes counted from **4C** through **00** byte before 2A.

[PVT1B]**4C** 00 76 06 20 7E 3E 1E 25 AF CF 50 E4 0E 91 20 32 CC 2D 5E CC 00 00 7A 76 FF 55 01 51 01 26 02 0A 0A 19 00 00 00 01 00 00 FE FF FF 10 22 64 00 00 00 2F 01 EC FF CA FF 00 00 03 0A 0B 01 00 1A 0B 01 09 00 00 00 00 05 E0 03 00 **00** 2A 33 30 43 32 0D 0A

2A = asterisk ‘*’
33 30 43 32 = four characters of CRC. In this case, it is ‘0x30C2’
0D = carriage return ‘\r’
0A = new line ‘\n’

Table 187: PVT1B Version Size Differences

Data Bits in Constellation Mask	Version 2 Message Size
None	60 bytes
One of GPS, GLONASS or SBAS	68 bytes
Two of GPS, GLONASS or SBAS	76 bytes
All	84 bytes

Table 188: PVT1B Binary Message

Data Item (59 – 83 Bytes)	Data Type
Navigation solution status (bit mask)	U08
Latitude (arc-seconds, LSB = 1/2048)	S32
Longitude (arc-seconds, LSB = 1/2048)	S32
Lat/Lon LSB (two four-bit fields, each LSB = 1/32768)	U08
Height (meters, LSB 1/1000)	S32
Geoid – ellipsoid separation (meters, LSB = 1/1024)	S24
Latitude standard deviation (meters, LSB = 1/1024)	U16
Longitude standard deviation (meters, LSB = 1/1024)	U16
Height standard deviation (meters, LSB = 1/1024)	U16
PDOP North (LSB = 1/10)	U08

Data Item (59 – 83 Bytes)	Data Type
PDOP East (LSB = 1/10)	U08
PDOP Up (LSB = 1/10)	U08
Velocity North (meters/second, LSB = 1/1024)	S24
Velocity East (meters/second, LSB = 1/1024)	S24
Velocity Up (meters/second, LSB = 1/1024)	S24
Number of satellites tracked	U08
Navigation solution mode	U08
Maximum dGPS correction age (seconds, LSB = 1/10)	U16
dGPS base station ID	U16
Figure Of Merit (1-255)	U08
Failure code	U08
SET Delta North (meters, LSB = 1/1000)	S16
SET Delta East (meters, LSB = 1/1000)	S16
SET Delta Up (meters, LSB = 1/1000)	S16
GNSS satellite constellation (bit mask, by satellite type)	U08
GNSS 1 satellites in the position solution (optional, depends on Constellation bit set, may not exist)	U32
GNSS 1 satellites in the velocity solution (optional, depends on Constellation bit set, may not exist)	U32
GNSS 2 satellites in the position solution (optional, depends on Constellation bit set, may not exist)	U32
GNSS 2 satellites in the Velocity solution (optional, depends on Constellation bit set, may not exist)	U32
…(optional, depends on Constellation bit set, may not exist)	U32
…(optional, depends on Constellation bit set, may not exist)	U32
Additional Navigation solution status (bit mask)	U08

2.60.1 Navigation Solution Status

This field displays a status code for the navigation solution, as shown in Table 189.

Table 189: Navigation Solution Status

Bit Mask	Description
0x01	Nav valid (if set, the navigation engine has found a solution; if clear the rest of these fields will be zero)
0x02	SET applied (if set, the navigation engine used Solid Earth Tide effects in the solution)
0x04	3D solution (if set, the navigation engine created a 3D solution; if clear, a 2D one)
0x08	Dual frequency (if set, the navigation engine used both L1 and L2 in the solution; if clear, just L1.)

Bit Mask	Description
0x10	Non-default datum flag (If set, a non-default datum is being used with the position solution. If not, the default datum is being used based on the solution type – StarFire, non-differential, RTCM, etc.)
0x20	The setting to this bit is applicable only if the prior bit, “Non-default datum”, is not set; otherwise, this bit will be clear. When applicable, this bit is set if ITRF is being used; otherwise, WGS 84 (G1150) is being used. The receiver automatically selects either ITRF or WGS84, depending upon the Navigation mode.
0x40	Geoid99 (If set, GGM02 must be clear)
0x80	GGM02 (If set, Geoid99 must be clear)

2.60.2 Latitude, Longitude, Height, and Geoid-Ellipsoid Separation

These indicators display position information for latitude, longitude, height above mean sea level, and geoidal separation. Positive values for latitude and longitude indicate North and East, respectively. Latitude and longitude are 32-bit signed integer values that represent arc-seconds with a precision of 1/2048th of an arc-second. To convert to degrees, use this formula:

Degrees = (<arc-seconds> / 2048) / 3600, where,

- <arc-seconds> is either latitude or longitude from the table,
- dividing by 2048 converts that value to arc-seconds, and
- dividing by 3600 converts that value to degrees

Adjust that with the LSB portions of the latitude and longitude, where the latitude is the high four bits and the longitude is the low four bits.

LSB = four-bits at 1/32768th arc-second, so:

- Divide by 16 to get to 1/2048th of an arc-second
- Add this to the base value
- Convert starting with “dividing by 2048”

Height is relative to ellipsoid, scaled to 1/1000th of a meter, and the geoid-ellipsoid separation is scaled to 1/1024th of a meter. The geoid-ellipsoid separation is calculated as the ellipsoidal height minus the geoidal height and is a positive number when the geoid is above the ellipsoid. Altitude is the 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).

2.60.3 Standard Deviations of Latitude, Longitude and Height

The navigation engine maintains an estimate of the PVT position and clock solution errors in the form of a 4 x 4 covariance matrix generated from navigation solution measurement residuals and other factors, for example, atmospheric error and dGPS correction quality. The values here are the square root of the North, East, and Up terms of this matrix, presented as unsigned 16-bit integers scaled to 1/1024th of a meter. To convert to meters, divide by 1024.

2.60.4 PDOP North, East, and Up

These values represent the Position Dilution of Precision (PDOP) in the North, East, and Up directions, each provided as an unsigned 8-bit integer. The PDOP measures how strongly the satellite geometry contributes to the navigational fix. When the satellites are close, the geometry is weak, and the DOP value is high. When the satellites are more widely separated, the geometry is stronger and the DOP value is low. As a rule of thumb, a value of less than five or six can be considered as “good”, a value under three, excellent. Higher values represent weaker geometry.

2.60.5 Velocity North, East, and Up

These indicators display the estimated velocities in the North, East, and Up directions, output as 24-bit integers scaled to 1/1024th of a meter per second. To convert to floating point meters per second, implement the steps in the following list.

```
typedef struct
{
   U08 low;
   U08 middle;
   U08 high;
}  S24;

   S24 sVal= <value>
   S32 sTmp = sVal.high;
   sTmp = (sTmp << 8) + sVal.middle;
   sTmp = (sTmp << 8) + sVal.low;
   if ((n141_vel_north.high & 0x80) != 0)
   {
       sTmp = -sTmp;
   }
   R32 xTmp = sTmp;         // convert S32 to R32
   xTmp = xTmp / 1024.0;      // convert to meters
```

2.60.6 Number of Satellites Tracked

This indicates the number of satellites being tracked by the receiver. This number can be different (larger) than both the number of satellites used in the position solution and in the velocity solution. This can occur when satellites are being tracked at elevations below the elevation cutoff for navigation; or software detects that satellites are unhealthy or measurement have outlier. This value presents as an eight bit unsigned integer.

2.60.7 Navigation Solution Mode

This is really two fields, the first of which identifies the navigation mode, bits one through four, which form a number that defines the contents of bits five through eight.

Table 190: Navigation Mode and Source Type Fields

Bits (Starting from MSB)	Description
1-4	Navigation mode
5-8	Source type (DGPS, RTK, StarFire)

Table 191: Navigation Solution Mode

Number	Navigation Mode
0	Non-differential
1	DGPS (WAAS, RTCM Code)
2	StarFire dual
3	RTK Float
4	RTK X
5	RTK WL[1] fixed
6	RTK L1 fixed
7	RTK dual fixed
8	StarFire LP
9-15	Reserved

[1]RTK WL operating mode is a transitioning mode much like RTK Float. When RTK WL is indicated, the receiver is typically in a corner-case condition without full open-sky view. If the DOP's are not severly constrained by the user (i.e. HDOP limit of 4.0 or less), the resultant fix is likely to be well beyond the specified limit. The best practice is to put the reciever in a position where mode 7 RTK fix can be obtained or to reject the RTK WL fix, unless otherwise verified to be correct.

Table 192: dGPS Source Type

Number	dGPS Source Type (WAAS, RTCM Code, StarFire single)
0	WAAS
1	WAAS Test mode
2	StarFire GPS
3	RTCM1
4	RTCM9
5	EGNOS
6	MSAS
7	GAGAN
8	StarFire GNSS
9-15	Reserved

Table 193: RTK Source Type

Number	RTK Source Type
0	Proprietary 5B
1	Reserved
2	RTCM18/19
3	RTCM20/21
4	Reserved
5	Reserved
6	RTCM3-L1 Compact
7	RTCM3-L1 Full
8	RTCM3-Dual Compact
9	RTCM3-Dual Full
10	RTCM3.2 MSM
11	Proprietery 62
12-15	Reserved

2.60.8 Maximum dGPS Correction Age

The GPS engine calculates an age for the corrections for each satellite used in each differential mode used in the navigation solution, for example, SBAS (WAAS/EGNOS), StarFire WAdGPS and local base station modes (RTCM code based and RTK). The correction age is computed for a satellite by subtracting the GPS reference time of the last correction received from the current GPS reference time. This value is the largest correction age value among the satellites used in the navigation solution.

2.60.9 dGPS Base Station ID

The dGPS base station ID is the value reported by the local base station in the received correction messages. It is not meaningful for SBAS, StarFire, or non-differential modes of operation.

2.60.10 Figure of Merit

This value represents the estimated position and clock errors, valid only when the navigation engine has found a valid solution. The code creates the FOM by using the 2D RMS horizontal error estimate, as shown here, where [0] is North and [2] is East:

```
fom = sqrt(R->covariance[0] + R->covariance[2]) * 100;
```

This creates a value that is normalized to a value from 1-255, where the lower the number, the lower the error, and the better the solution.

2.60.11 Failure Code

While the code does not have a valid solution, it makes available the information in the following table to describe the reason why there is not yet a solution. Code 1 means there is a solution; all of the others represent a reason there is not one.

Table 194: Failure Code

Code	Description
1	Navigation solution available
2	Too few measurements for navigation initialization
3	Initialization failed
4	Navigation initialization completing
5	Too few measurements for navigation
6	Navigation PDOP too high
7	No velocity solution
8	Navigation update too large
9	Export height/velocity limits exceeded
10	Available navigation modes are disabled or not authorized

2.60.12 Solid Earth Tides

As the earth rotates within the gravitational fields of the Sun and Moon, it deforms because it has a certain degree of elasticity. These deformations are called solid earth tides or terrestrial tides. The amplitude of terrestrial tides can be as large as 55 cm in the vertical at the equator (15 cm of which are due to the Sun), and they are nearly in phase with the Moon. Solid earth tides can be accurately predicted (within a few centimeters) with a model that takes position on the earth, date and time as its inputs and produces a three dimensional deformation vector (North, East and vertical).

The StarFire correction processing hubs combine data from a global network of reference stations. Solid earth tides are estimated for the location of each reference station in real time, and are used to adjust the reference station locations utilize in the computation of the StarFire global satellite clock and orbit corrections. Likewise, when the Nova receiver is operating in StarFire differential mode using global StarFire corrections, the solid earth tide is estimated in real time for the navigation position and used to correct the latitude, longitude and height reported in the PVT1B message. The values of the 3D deformation vector are reported in the PVT1B message as floating point values scaled in meters.

Solid earth tide corrections are not applied to the reported position in any other modes of navigation other than StarFire, although the deformation vector is still computed and output in the PVT1B message.

These values are presented as signed sixteen bit integers scaled to 1/1000th of a meter.

2.60.13 Bit Mask of GNSS Satellite Constellation Usage

The bits set in this field denote the satellites by type that will show up in the next two data fields. For example, if GPS (bit mask value 0x01) is set, the GNSS satellite used field will be filled by used GPS satellites.If GLONASS bit is set, the following GNSS satellite used field will be filled with used GLONASS satellites, and otherwise it will be filled by other constellation satellites or not exsists at all if no more constellation used. Note that the fields here are ordered, meaning when two bit mask values are set, the lower bit number occupies GNSS1, below and the higher GNSS2.

Table 195: GNSS Satellite Constellation Usage Bit Mask

Bit	Data Item
0	GPS
1	GLONASS
2	Galileo
3	COMPASS
4	SBAS

2.60.14 Bit Mask of GNSS Satellites Used

These indicators display a bit mask of the satellites used in the position and velocity solutions.

The number of satellites used in the position solution can be different than the number of satellites used in the velocity solution. This can occur because operation in differential GPS modes requires that all satellites used in the position solution must have a valid dGPS correction. However the velocity solution, which uses sequential time differences of the integrated carrier phase measurements, does not require dGPS corrections. Similarly, in dual frequency navigation modes, satellites used in the position solution must be tracking on both the L1 and L2 frequencies, whereas the velocity solution only requires tracking on L1.

The number of satellites tracked can be different (larger) than both the number of satellites used in the position solution and in the velocity solution. This can occur when satellites are being tracked at elevations below the elevation cutoff for navigation.

The satellites used in the position and velocity navigation solutions are output as 32 bit unsigned integers. The bit is set if that PRN was used. For GPS and GLONASS, the least significant bit represents PRN 1 and the most significant bit represents PRN 32. If the WAAS constellation usage field is set, the least significant bit represents the lowest SBAS PRN, number 120. The bit 1 represents SBAS number 121, etc.

2.60.15 Additional Navigation Solution Status

This field displays additional status codes for the navigation solution; refer to the Navigation Solution Status (the first byte of this message, above), for more information.

Table 196: Additional Navigation Solution Status

Bit Mask	Description
0x01	Doppler applied (if set, the velocity was calculated based on Doppler measurements)
0x02	MBRTK applied (if set, Navigation Mode of 3-7 indicates Moving Base RTK)
0x04	SBAS geofence source (0 – NavCom-defined geofence table; 1- Broadcast geofence table)*
0x08	Reserved
0x10	Rapid Recovery mode engaged
0x20	Reserved
0x40	Reserved
0x80	Reserved

*WAAS and MSAS systems do not broadcast geofence tables. Thus bit 3 of SBAS geofence source is used for EGNOS only

2.61 PVT3B

☒SF-5050 ☒Onyx

This output stream is identical to PVT1B except that this output always provides GPS and GLONASS satellite bit masks, regardless of whether they are used in the position or velocity solutions. This message does not provide SBAS satellite bit masks. The intention of this message is to provide a single fixed-length message.

The size of this message is precisely 76 bytes. The format is slightly altered from PVT1B, as shown in Table 195. Refer to section for details about the data fields in this table.

Table 197: PVT3B Message

Data Item (76 Bytes)	Data Type
Navigation solution status (bit mask)	U08
Latitude (arc-seconds, LSB = 1/2048)	S32
Longitude (arc-seconds, LSB = 1/2048)	S32
Lat/Lon LSB (two four-bit fields, each LSB = 1/32768)	U08
Height (meters, LSB 1/1000)	S32
Geoid – ellipsoid separation (meters, LSB = 1/1024)	S24
Latitude standard deviation (meters, LSB = 1/1024)	U16
Longitude standard deviation (meters, LSB = 1/1024)	U16
Height standard deviation (meters, LSB = 1/1024)	U16
PDOP North	U08
PDOP East	U08
PDOP Up	U08
Velocity North (meters/second, LSB = 1/1024)	S24
Velocity East (meters/second, LSB = 1/1024)	S24
Velocity Up (meters/second, LSB = 1/1024)	S24
Number of satellites tracked	U08
Navigation solution mode	U08
Maximum dGPS correction age (seconds, LSB = 1/10)	U16
dGPS base station ID	U16
Figure of merit (1-255)	U08
Failure code	U08
SET Delta North (meters, LSB = 1/1000)	S16
SET Delta East (meters, LSB = 1/1000)	S16
SET Delta Up (meters, LSB = 1/1000)	S16
GNSS satellite constellation (bit mask, by satellite type)	U08
GPS satellites in the position solution (depends on Constellation bit set, may be zero)	U32

Table continued on next page…

Data Item (76 Bytes)	Data Type
GPS satellites in the velocity solution (depends on Constellation bit set, may be zero)	U32
GLONASS satellites in the position solution (depends on Constellation bit set, may be zero)	U32
GLONASS satellites in the velocity solution (depends on Constellation bit set, may be zero)	U32
Additional Navigation solution status (bit mask) see 0	U08

2.62 QUICKSTARTPOSA

☒SF-5050 ☒Onyx

The QUICKSTARTPOSA output message provides the user inputs to the [SFQUICKSTART] command along with the time-stamp. This provides a diagnostic troubleshooting reference when determining how the user-input coordinates impact subsequent performance.

When invoked once, it provides the last input coordinates from a successful SFQUICKSTART.

This message can only be toggled once and on-change.

Table 198: QUICKSTART Position

Field		**Description**
GPS Time	S	GPS Timestamp
SF-Start-Status	S	"NONE" - StarFire Quickstart not Start, "INITATE" – StarFire Quickstart Initiate, "PROGRESS" – StarFire Quickstart Progress, "COMPLETE" – StarFire Quickstart Complete, "FAILED PROXIMITY" - StarFire Quickstart Failed Proximity
Lat-deg	I	Degree portion of latitude (-90 to 90, positive North)
Lat-min	I	Minute portion of latitude (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	F	Second portion of latitude (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	I	Degree portion of longitude (-180 to 180, positive East)
Lon-min	I	Minute portion of longitude (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	F	Second portion of longitude (0 to <60, assumed to be in same direction as Lon-deg)
Height	F	Ellipsoidal height (meters) (-1000 to 18000)
Datum	K	ITRF (the coordinates given are in the latest ITRF format, default if not given) WGS84 (the coordinates given are in WGS84 format)..

Examples:

[QUICKSTARTPOSA] Oct 27 2017, 18:35:35, NONE, 33, 50, 28.55, -118, 20, 37.48, 9.03, ITRF*E699

[OUTPUT]QUICKSTARTPOSA,ONCE will output the QUICKSTARTPOSA message immediately. It will report the last know values. However, if SFQUICKSTART have never been issued,the output will be similar to the following.

[QUICKSTARTPOSA] INVALID -1 -1, -1:-1:-1, NONE, 0, 0, 0.00, 0, 0, 0.00, 0.00, WGS84*4A39

2.63 RADIOSTAT

☒SF-5050 ☐Onyx

This message reports the current radio status. This is an ASCII message.

Table 199: RADIOSTAT Message

Condition	Response
Radio off	[RADIOSTAT] Radio off
Radio not responding	[RADIOSTAT] No response from radio
Radio on and responding	[RADIOSTAT] RX field strength (dBm), TX frequency (MHz), TX power (Mw), RX threshold (dBm), Network ID (integer), software version number (Vxx.yy.etc), serial number (9-digit number), channel width (kHz), software protocol (1-digit number), GPS week number, GPS time of week in seconds, FEC enabled/disabled.

Examples:

[RADIOSTAT] -55 dBm, 464.75000 MHz, 100 Mw, -117 dBm, 1, V06.16.3.48.10, 114200013, 12.5 kHz, 0, 1660, 237465.000

[RADIOSTAT] -70 dBm, 464.75000 MHz, 100 Mw, -115 dBm, , V06.16.3.46.3, 114200014, 25.0 kHz, 3, 1660, 238383.600

[RADIOSTAT] Radio off, 1660, 238334.800

The values reported here are the current radio status and settings. The TX frequency, TX power, RX threshold, and network ID should match what was specified in the previous [RADIO] command.

RADIOSTAT cannot be scheduled ONCHANGE. Doing so would require continuously polling of the radio, which disrupts data communications.

⚠ Requesting status from the radio temporarily interrupts data received from the radio. If this message is scheduled too frequently it may prevent proper operation. It is recommended that this message be scheduled ONCE as needed, or no faster than approximately every 10 seconds in the case of receiving RTK corrections.

⚠ This message will also cause some data loss with other messages such as PVT1B and MEAS1B.

2.64 RTKSTATUS1B (Version 1)

☒SF-5050 ☒Onyx

RTKSTATUS1B contains a variety of information about the RTK navigation process. This message varies in size based on the data in the field marked “bit mask of GNSS satellite constellation usage”. This bit mask denotes the data that follows it in the message. This can be no data at all, or up to 36 additional bytes. Adding the 9 byte binary header to the data described here, this is how the message size works out for each of the combinations of bits in this field:

Data Bits in Constellation Mask	Message Size
None	38
One of GPS, GLONASS or SBAS	50
Two of GPS, GLONASS or SBAS	62
All	74

Table 200: RTKSTATUS1B contents

Data Item (38-74 Bytes)	Data Type
Navigation solution status (enum) cf. PVT1B	U08
Navigation solution mode (cf. PVT1B)	U08
Reference station ID (0 to 1023)	U16
Number of satellites tracked at base station	U08
Number of satellites tracked at rover	U08
Number of used L1 carrier phase measurements	U08
Number of used L2 carrier phase measurements	U08
RTK search flag (enum)	U16
Bit mask of GNSS satellite constellatioin usage	U08
GPS L1 fixed ambiguities in KF (optional, depends on the constellation set)	U32
GPS L2 fixed ambiguities in KF(optional, depends on the constellation set)	U32
GPS WL fixed ambiguities in KF(optional, depends on the constellation set)	U32
GLONASS L1 fixed ambiguities in KF(optional, depends on the constellation set)	U32
GLONASS L2 fixed ambiguities in KF(optional, depends on the constellation set)	U32
GLONASS WL fixed ambiguities in KF(optional, depends on the constellation set)	U32
SBAS L1 fixed ambiguities in KF(optional, depends on the constellation set)	U32
SBAS L5 fixed ambiguities in KF(optional, depends on the constellation set)	U32
SBAS WL fixed ambiguities in KF(optional, depends on the constellation set)	U32
Baseline North component (LSB = 2^-11 meters)	S32
Baseline East component (LSB = 2^-11 meters)	S32
Baseline Up component (LSB = 2^-11 meters)	S32
RTK correction or raw data age from base (LSB = 0.01 second)	U16

2.64.1 Bit mask of GNSS satellite constellation usage

The constellation bit mask describes ambiguity data present for each type of satellite in the bit mask. This bit mask denotes the data that follows it in the message, with bit 0 denoting GPS, bit 1 denoting GLONASS and bit 2 denoting SBAS. For example, for GPS only, bit 0 would be set, creating a data value of 0x01, where for SBAS only, bit 2 would be set, creating a data value of 0x04.

This can be no data at all, or up to 36 additional bytes. The data follows the constellation, one set of three four-byte fields per bit, arranged to follow the constellation mask as shown in the following table.

Table 201: Bit mask of GNSS satellite constellation

Constellation Mask Bits	1st 3	2nd 3	3rd 3
0x00 (None)	None	None	None
0x01 (GPS)	GPS	None	None
0x02 (GLONASS)	GLONASS	None	None
0x03 (GPS, GLONASS)	GPS	GLONASS	None
0x04 (SBAS)	SBAS	None	None
0x05 (GPS, SBAS)	GPS	SBAS	None
0x06 (GLONASS, SBAS)	GLONASS	SBAS	None
GPS, GLONASS, SBAS	GPS	GLONASS	SBAS

Table 202: RTK Search Flag

Code	Description
0	FIX_NOT_READY,
1	FIX_TOO_FEW_STATS,
2	FIX_BAD_RMS,
3	FIX_BAD_PDOP,
4	TOO_FEW_SATS_SEARCH,
5	NOTHING_TO_FIX,
6	WAITING_FOR_CONSISTENT_WINNER,
7	FIX_SUCCESS,
8	STATUS_SINGULAR_MATRIX

Bit mask of GNSS satellite constellation usage.The bits set in this field denote the satellites by type that will show up in the next three data fields. For example, if GPS (bit mask value 0x01) is set, the GPS L1 ambiguity field, GPS L2 ambiguity, GPS WL ambiguity field will be filled by GPS. If GPS constellation is not set, these three fields will be filled by other constellation, for example if GLONASS bit is set, they will be filled by GLONASS. If more than one constellation are used, the three data pairs are filled in the order of the constellation usage bit mask, for example, GPS first, followed by GLONASS, Galileo, etc, as long as the constellation usage bit is set.

2.65 SATSUSEDB (Binary)

☒SF-5050 ☒Onyx

This message describes all the tracked PRN's and any reasons why a PRN is not used in the Code and StarFire navigation. Table 203 lists the body of the SATSUSEDB message. The table starts with a single byte showing the count of entries in the table. For each count, the table follows sequentially with an entry for each. Each PRN is followed by the failure bit-map associated with that PRN.

There are eight bytes per PRN. This means that the message is (#PRN) * 8, plus one byte for the leading count byte.

Table 203: SATSUSEDB Binary Message Data

Data Item	Data Type
Number of satellites reported failures in the message	U08
PRN for the first satellite with failures	U16
Bit-map of Failure Condition Bitmap (see below)	U08(6)
…	
PRN for the last satellite with failures	U16
Bit-map of Failure Condition Bitmap (see below)	U08(6)

Table 204 shows the failure conditions encoded for the Failure Condition Bitmap for each satellite. The conditions are listed in the order they appear in the bitmap from the MSB. There is a total of 6 bytes in the bitmap, resulting in 48 bits. If a bit is set (equal to 1), the corresponding failure condition has occurred for the satellite.

Table 204: Failure Conditions

MSB	Failure Condition Enum	Failure Condition
1	FAILED_CP_DISCONTINUITY	Carrier Phase discontinuity detected
2	FAILED_HALF_CYCLE	Half cycle ambiguity not resolved
3	FAILED_RESID	Failed residual edit in resid_edit
4	FAILED_MEASTIME	Wrong measurement time in MeasProc
5	FAILED_DUPPRN	Duplicate PRN
6	FAILED_NOL1	L1 marked invalid
7	FAILED_EXSMOOTH	Slip detected in MeasSmooth()
8	FAILED_ELEV	Elevation below mask
9	FAILED_L1CYCLE	Cycle slip detected on L1
10	FAILED_EPHEM	No ephemeris data available
11	FAILED_NOPREV	Previous measurement was not valid
12	FAILED_NEWPRN	PRN number changed since previous meas epoch

Table continued on next page…

MSB	Failure Condition Enum	Failure Condition
13	FAILED_HEALTH	Sat marked unhealthy in ephemeris
14	FAILED_TIMESMALL	Delta measurement time too small
15	FAILED_TIMELARGE	Delta Measurement time too large
16	FAILED_NODGPS	No DGPS correction available
17	FAILED_SF_BROKEN	StarFire correction was broken
18	Reserved	
19	Reserved	
20	Reserved	
21	Reserved	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	
26	Reserved	
27	Reserved	
28	Reserved	
29	Reserved	
30	FAILED_NOT_LOCKED	Not locked onto any signal
31	FAILED_CN0_CA	CN0 value above threshold for CA signal
32	FAILED_COSTAS_CA	Costas ratio above threshold for CA signal
33	FAILED_CN0_P1	CN0 value above threshold for P1 signal
34	FAILED_COSTAS_P1	Costas ratio above threshold for P1 signal
35	FAILED_CN0_P2	CN0 value above threshold for P2 signal
36	FAILED_COSTAS_P2	Costas ratio above threshold for P2 signal
37	FAILED_CN0_L2C	CN0 value above threshold for L2C signal
38	FAILED_COSTAS_L2C	Costas ratio above threshold for L2C signal
39	FAILED_CN0_L5	CN0 value above threshold for L5 signal
40	FAILED_COSTAS_L5	Costas ratio above threshold for L5 signal
41	FAILED_CN0_G1C	Cross Correlation check is in progress
42	Reserved	
43	Reserved	
44	Reserved	

Table continued on next page…

MSB	Failure Condition Enum	Failure Condition
45	Reserved	
46	Reserved	
47	Reserved	
48	Reserved	
49	Reserved	
50	Reserved	
51	Reserved	
52	Reserved	
53	Reserved	
54	Reserved	
55	Reserved	
56	Reserved	
57	Reserved	
58	Reserved	
59	Reserved	
60	Reserved	
61	Reserved	
62	Reserved	
63	Reserved	

2.66 SDCARD

☒SF-5050 ☐Onyx

This message is used to report events associated with the removable SD card. It can be scheduled as an OnChange output message for a specific port (e.g. [OUTPUT]SDCARD,OnChange,,2) or turned off by using command (e.g. [OUTPUT]SDCARD,Off,,2) .

Table 205: SDCARD Output Messages for the

Message	Event
PRESENT	Indicates the SD card is present in the receiver when the unit is powered on
REMOVED	Indicates the SD card is not present in the receiver when the unit is powered on or that the SD card has been removed
INSERTED	Indicates the SD card has been inserted
LOCKED	Indicates the SD card is write-protected
UNLOCKED	Indicates the SD card is not write-protected
REMOVED WHILE LOGGING DATA	Indicates the SD card was removed while data logging was in progress
MOUNTED	Indicates the SD card mounted successfully [SDCARD] {FAT12, FAT16, FAT32}; nnnnnn TOTAL BYTES; nnnnnn FREE BYTES
MOUNTING FAILED	Indicates mounting of the SD card failed
MOUNTING…5 (numeral varies)	This message, triggered by the user commands [LOGFILE] and [FSFORMAT] indicates that mounting is in progress; the numeral indicates the mounting time in seconds

Table 206: SD FLASH Output Messages for the SF-5050

Message	Condition
MOUNTED	Indicates the SD flash mounted successfully
MOUNTING FAILED	Indicates mounting of the SD flash failed
MOUNTING…5 (numeral varies)	This message, triggered by the user commands [LOGFILE] and [FSFORMAT], indicates that mounting is in progress; the numeral indicates the mounting time in seconds

Examples:

If an SD card is present when the unit is powered on, the following [SDCARD] message is output:

[SDCARD] PRESENT

If an SD card is not present when the unit is powered on, the following [SDCARD] message is output:

[SDCARD] REMOVED

If an SD card is inserted, the following [SDCARD] message is output:

[SDCARD] INSERTED

If an SD card is write-protected, the following [SDCARD] message is output:

[SDCARD] LOCKED

If an SD card is not write-protected, the following [SDCARD] message is output:

[SDCARD] UNLOCKED

If an SD card is removed, the following [SDCARD] message is output:

[SDCARD] REMOVED

If the SD card is removed during data logging, the following [SDCARD] message is output:

[SDCARD] REMOVED WHILE LOGGING DATA

If an SD card (internal SD flash for the SF-5050) is mounted successfully, the following [SDCARD] message is output:

[SDCARD] MOUNTED

[SDCARD] {FAT12, FAT16, FAT32}; nnnnnn TOTAL BYTES; nnnnnn FREE BYTES

If an SD card (internal SD flash for the SF-5050) mounting fails, the following [SDCARD] message is output:

[SDCARD] MOUNTING FAILED

The following [SDCARD] message indicates mounting of the SD card (internal SD flash for the SF-5050) is in progress:

[SDCARD] MOUNTING... 5

[SDCARD] MOUNTING... 6

[SDCARD] MOUNTING... 7

[SDCARD] MOUNTING... 8

The numeral indicates the mounting time in seconds.

2.67 SELFSURVEYSTATUS1A

☒SF-5050 ☒Onyx

This output message reports the current values of the averaged position available during self-survey mode.

Table 207: SELFSURVEYSTATUS1A Message Output Format

Output Format:	[SELFSURVEYSTATUS1A] time,lat,lon,ht,count,duration,elapsed*CRC

Field#	Field Name	Description
F1	Time	GPS seconds in the week. (0.000 to 604799.999)
F2	Lat-deg (Floating Point)	Degree portion of latitude (-90 to 90, positive North). Note that this is a float so that latitude may be entered as a decimal fraction or as deg, min, sec.
F3	Lat-min	Minute portion of latitude (0 to 59, assumed to be in same direction as Lat-deg)
F4	Lat-sec (Floating Point)	Second portion of latitude (0 to <60, assumed to be in same direction as Lat-deg)
F5	Lon-deg (Floating Point)	Degree portion of longitude, (-180 to 180, positive East). Note that this is a float so that longitude may be entered as a decimal fraction or as deg, min, sec.
F6	Lon-min	Minute portion of longitude (0 to 59, assumed to be in same direction as Lon-deg)
F7	Lon-sec (Floating Point)	Second portion of longitude (0 to <60, assumed to be in same direction as Lon-deg)
F8	ht	Averaged value for height in meters. (-inf to inf)
F9	count	Number of position samples in average (0 to 4294967296)
F10	Duration	Length (seconds) of survey in progress set by the self survey command. If survey length is not specified duration is zero. (0-604800)
F11	Remaining	Time (seconds) remaining for the the current survey. (0-604800)
F12	*CRC	Checksum

Example:

[SELFSURVEYSTATUS1A] 410168.0000,33,50,28.249548,-118,20,37.040235,8.8664,49,60,11*2780

2.68 SFLICENSEB

☒SF-5050 ☒Onyx

This output message reports the StarFire license status. The field from “Net Authorization” to “Days Left” is the license block, and it is repeated x times if “Number of Licenses” is x.

Table 208: SFLICENSEB Binary Message Body

Data Item	Data Type	Section/Description
Number of Licenses	U08	Number of license blocks reported in this message
Reserved	U08	
Serial Number	U32	
Start of first license block		
Net Authorization	U08	Table 209
Status	U08	Table 210
License Issue Date	U32	Bits 0 – 16 are for seconds; Bits 17 – 31 are for days since Jan. 1, 1999
License Start Date	U16	Days since Jan. 1, 1999
License End Date	U16	Days since Jan. 1, 1999
Region Selection	U16	0x8000: Global license 0x4000: Land Only license 0x2000: Reserved
Days Licensed	U16	
Days Left	U16	
Next license block, if applicable…		

Table 209: Net Authorization

Bit 1	Bit 0	Authorized Nets
0	0	All Nets
0	1	Net 1
1	0	Net 2
1	1	Undefined

Table 210: Status

Bits 0 – 2 are License Type

Bit 2	Bit 1	Bit 0	License Type
x	x	1	Precise
x	x	0	Good
x	1	x	Run-time license
x	0	x	Calendar license
1	x	x	Inactive
0	x	x	Active

Bits 3 – 7 indicate the port from which the license was input

Port #	Port Name
0	COM 1
1	COM 3
4	OTA
8	Bluetooth®
9	COM 2
10	COM 4
13	USB
17	Ethernet (ETH 1-8)
26	HTTP (WEB 1-4)

2.69 SFSATLIST1B (Binary)

☒SF-5050 ☒Onyx

This record describes the StarFire satellite constellation, to support a GUI display that shows the StarFire satellites by ID, look angle, longitude, and mode. This message provides the data described in the following table, for the standard StarFire satellites, and for any user-defined satellite that might be defined.

The table will include one Satellite Block for each satellite in the constellation, with any user-defined satellite as the last entry.

The body of the message is listed in Table 211 with a description of the size of each file.

Table 211: SFSATLIST1B Binary Message Data

Data Item (1 + N * 12)	Data Type
Count of StarFire satellites	U08
Holding for the first StarFire satellite block	

Table 212: StarFire Satellite Block

StarFire Satellite Block (12 bytes)	Data Type
Satellite ID (320 to 680)	U16
Longitude (-180 to +180 degrees)	R64
Look Angle from present position (~0 to 90 degrees)	U08
Mode (bit-field; see below)	U08

Notes:

1. The count of StarFire satellites will include from zero to sixteen authorized standard satellites, plus potentially one more user-defined satellite. If the user has selected an alternate satellite, that status will show up in the Mode field.
2. The satellite ID is the standard name for StarFire satellites, computed as the result of the value 500 plus the longitude, for example 98 West Longitude becomes 500 + -98 = 402
3. The longitude is minus for West and plus for East
4. The look angle is the calculated elevation from the perspective of a viewer on the ground at the present calculated position, looking “up” at the satellite. Note that negative look angles provide no useful information, since the satellite is below the horizon.
5. The mode provides the bits of information defined here:
   a. 0x01: Authorized as part of NET 1
   b. 0x02: Authorized as part of NET 2
   c. 0x04: Potentially unhealthy satellite
   d. 0x10: Alternate, meaning this is the selected alternate satellite, one in the StarFire constellation, or a user-defined satellite.
   e. 0x20: User-Defined.

2.70 SFSEARCHPOSB

☒SF-5050 ☒Onyx

This is a scheduled as periodic message. This command will be used for the High Latitude StarFire Solution. It will be transmitted from the GNSS receiver to the StarFire receiver. It can be set ONCHANGE and ONTIME at any rate, however the message will output once every 10 seconds for both modes regardless of the users rate specification.

The message will be used only if the STARFIRE-ONLY option is enabled on the unit, which will use the time information to verify if the SF License is valid, and use the position in order to verify the valid SF region and also to calculate the lookup angle in order to search for SF Satellites.

If the StarFire receiver does not get this message within 15 minutes, it will cease to output corrections until the command is provided again.

2.71 SFSTATUS1B

☒SF-5050 ☒Onyx

This record shows the status of StarFire signals. The body of the SFSTATUS1B message is listed in Table 213 with descriptions of the fields in the sections indicated.

Table 213: SFSTATUS1B Binary Message Data

Data Item (35 Bytes)	Data Type
Number of SF status blocks	U08
STATUS BLOCK STARTS	
Reserved	U32
Current StarFire downlink beam indicator	U08
Current StarFire signal status	U08
Current StarFire signal strength (Eb/N0)	R32
Reserved	R32
Good packet counts (percentage)	R32
Idle packet counts (percentage)	R32
Re-synchronization counts	U32
Reserved	R32
Hub ID's and StarFire license status	U08
Reserved	U32
STATUS BLOCK ENDS	
StarFire beam indicator	U08
External Hub ID	U08

2.71.1 Current StarFire downlink beam indicator

This field represents the current StarFire downlink beam indicator.

(Version 1)

This field represents the current StarFire satellite ID, in the range 320 to 680. This value is calculated by adding the satellite longitude to 500. For example, for the satellite at 98 West Longitude, this value becomes 500 + (-98), or 402, and for the satellite at 109 East Longitude. It becomes 500 + 109 = 609.

(Version 2)

This field represents the current StarFire satellite ID, as described above for Version 1, shifted up to occupy bits 31:22. Bits 20:0 are reserved for factory use. Bit 21 is a "valid" bit, meaning the ID is valid: "1" indicates valid, "0" indicates invalid.

Table 214: StarFire Beam Indicator

Network	Code (XX)	Designation	Satellite ID	Longitude	Uplink Site
Net 1	00	N/A	N/A	Unknown	Unknown
	01	4F3	402	98W	Laurentides
	02	4F2	525	25E	Burum
	03	4F1	643	143.5E	Auckland
Net 2	04	3F3	678	178E	Santa Paula, CA
	05	3F4	446	54W	Southbury
	06	3F1	564	64E	Perth
	09	N/A	N/A	Manual Override	Unknown

2.71.2 Current StarFire signal status

This value indicates the tracking status of the StarFire Channel. If the channel is not in use the value will be 1. When the signal is locked and data bits are being produced the value will be 9. Table 215 shows StarFire tracking status values.

Table 215: StarFire Tracking Status

Code	Description
0	Wait for power
1	Processing is disabled
2	Wait for AGC to settle
3	Start of processing
4	Signal detection
5	Signal detection failed
6	Frequency verify
7	Signal Acquisition with AFC and code pull-in
8	AFC plus Costas pull-in
9	Locked creating data bits

2.71.3 Current StarFire signal strength (Eb/NØ)

This field represents the signal to noise ratio for the StarFire channel in db/Hz. The LSB represents 0.25 db/Hz.

- Es/N0 = Eb/N0 – 3(dB)

  C/N0 = Eb/N0 + 27.8(dB)

2.71.4 Good packet counts (percentage)

This field displays the percentage of good packets in received StarFire data. It is updated every 20 seconds.

2.71.5 Idle packet counts (percentage)

This field displays the percentage of idle packets in received StarFire data. It is updated every 20 seconds.

2.71.6 Re-synchronization counts

This field represents the StarFire parser packet framing re-synchronization count.

2.71.7 StarFire Hub ID's and license status

B0 = 1 indicates StarFire option is licensed and enabled, otherwise 0.

B1 = invalid hub ID's

B4-B2: Hub ID– for StarFire GPS corrections

B7-B5: Hub ID– for StarFire GNSS corrections

B7-B5 StarFire GNSS	B4-B2 StarFire GPS HUB ID	B1 0 = valid ID's 1 = invalid ID's	B0 – SF license

If the hub ID's are invalid the ID's will be set to 7. However, 7 is a valid HubID so B1 needs to be also verified to make sure it is invalid. The primary StarFire satellite's hub ID is the primary Hub ID. Also, if the hub ID of another StarFire satellite matches the Hub ID of the primary satellite's Hub ID then all satellites that match will be used in the navigation solution.

2.71.8 External Hub ID

This is an 8-bit field that reports the Hub ID acquired by the receiver from a Starfire correction message received via NTRIP, Ethernet, or Serial connection. The default value for this External Hub ID, if not altered, is 255.

This field differs from the OTA Hub ID and is updated by the last received Hub ID from an external StarFire Correction message.

2.72 STARFIREALM1B

☒SF-5050 ☒Onyx

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

The TOW and GPS time represented in the header of the message represents the time (system time) at which a full StarFire OTA almanac (verified complete and valid) is committed to the receiver. This time is saved into NVRAM. This time is only updated upon the receipt of a NEW full valid set of StarFire OTA almanac and committed/applied to the receiver.

Number of entries included in STARFIREALM1B is fixed to 16 in older code.

Table 216: STARFIREALM1B binary message data

Data Item	Data Type
Almanac set number (0-15)	U08
Number of valid data in almanac table (0-15) = N	U08
N entries of packed almanac data	

Most up-to-date details of the packed almanac data can be found in the StarFire Over-the-air messaging ICD.

All values are big-endian byte ordering. Low order bit 0 is LSB and high order bit is MSB. Bit 0 is LSB and bit 7 is MSB.

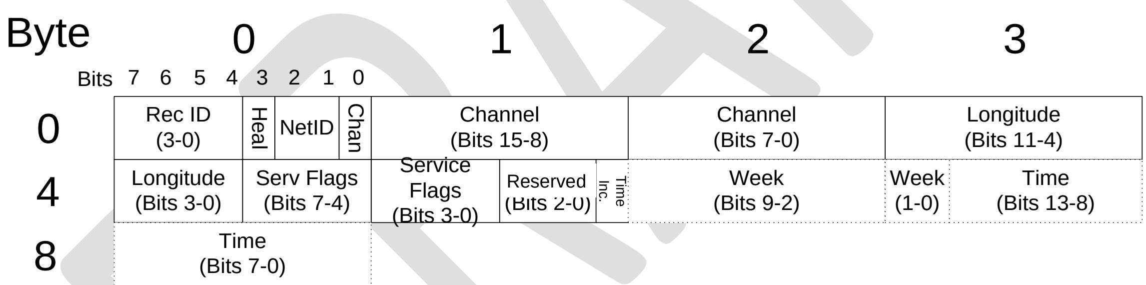


Figure 4: OTA StarFire Almanac Satellite Record

Table 217: OTA Almanac Satellite Record

Byte Position	Bit Position	Name	Valid Range	Description
0	4-7	Record ID	0-15	Satellite record identifier number. Describes the ordering of the records in a set. Records with the same record ID imply no particular order. *Note: Currently, receivers do not use this field.* *Note: May be assigned another purpose in the future*.
	3	Health	0 or 1	0 – Unhealthy 1 – Healthy
	1-2	Network ID	0 – 3	0 – Net 1 1 – Net 2 2 to 3 – Reserved
	0	Channel (bit 16 – MSB)	0-70000	Channel number Bit 0 is LSB and bit 15 is MSB
1	0-7	Channel (bits 8-15)	-	-
2	0-7	Channel (bits 0-7)	-	-
3	0-7	Longitude (bits 4-11)	-1800 to 1800	Satellite longitude in degrees Scale = (0.1)
4	4-7	Longitude (bits 0-3)	-	-
	0-3	Service Flags (bits 4-7)	-	Bit index and meaning 0 – StarFire GNSS 1 to 7 – Reserved
5	4-7	Service Flags (bits 0-3)	-	-
	1-3	Reserved (bits 0-2)		
	0	Time Included	0 – 1	0 – No week or time information included 1 – Week and time included and will be in the next three bytes
6	0-7	Week (bits 2-9)	0 – 1023	GPS week number Optional – present just prior to a change
7	6-7	Week (bits 0-1)		-
	0-5	TOW (in minutes) (bits 8-13)	0 – 10079	Scale = (86400/60*7) Optional – present just prior to a change
8	0-7	TOW (in minutes) (bits 0-7)		-

2.73 TXRXINFOA (ASCII)

☒SF-5050 ☒Onyx

This message contains UART throughput information.

Table 218: TXRXINFOA Message Output Format – SF-5050

Field #	Field Name	Description
F1	Port 1 TX percent	Port 1 TX usage percentage during last second
F2	Port 1 TX overflow count	Accumulated Port 1 TX overflow count since system starts[1]
F3	Port 1 RX percent	Port 1 RX usage percentage during last second
F4	Port 1 RX overflow count	Accumulated Port 1 RX overflow count since system starts[1]
F5	PORT 3 TX percent	Port 3 TX usage percentage during last second
F6	PORT 3 TX overflow count	Accumulated Port 3 TX overflow count since system starts[1]
F7	PORT 3 RX percent	Port 3 RX usage percentage during last second
F8	PORT 3 RX overflow count	Accumulated Port 3 RX overflow count since system starts[1]
F9	Reserved	
F10	Reserved	
F11	Reserved	
F12	Reserved	
F13	Reserved	
F14	Reserved	
F15	Reserved	
F16	Reserved	
F17	Reserved	
F18	Reserved	
F19	Reserved	
F20	Reserved	
F21	PIO board 2 TX percent	PIO board port 2 TX usage percentage during last second
F22	PIO board port 2 TX overflow count	Accumulated PIO board port 2 TX overflow count since system starts[1]
F23	PIO board port 2 RX percent	PIO board port 2 RX usage percentage during last second
F24	PIO board port 2 RX overflow count	Accumulated PIO board port 2 RX overflow count since system starts[1]
F25	PIO board 4 TX percent	PIO board port 4 TX usage percentage during last second

Field #	Field Name	Description
F26	PIO board port 4 TX overflow count	Accumulated PIO board port 4 TX overflow count since system starts[1]
F27	PIO board port 4 RX percent	PIO board port 4 RX usage percentage during last second
F28	PIO board port 4 RX overflow count	Accumulated PIO board port 4 RX overflow count since system starts[1]
F29	PIO board BLUETOOTH® port TX percent	PIO board BLUETOOTH® port TX usage percentage during last second
F30	PIO board BLUETOOTH® port TX overflow count	Accumulated PIO board BLUETOOTH® port TX overflow count since system starts[1]
F31	PIO board BLUETOOTH® port RX percent	PIO board BLUETOOTH® port RX usage percentage during last second
F32	PIO board BLUETOOTH® port RX overflow count	Accumulated PIO board BLUETOOTH® port RX overflow count since system starts[1]
F33	PIO board USB port TX percent	PIO board USB port TX usage percentage during last second
F34	PIO board USB port TX overflow count	Accumulated PIO board USB port TX overflow count since system starts[1]
F35	PIO board USB port RX percent	PIO board USB port RX usage percentage during last second
F36	PIO board USB port RX overflow count	Accumulated PIO board USB port RX overflow count since system starts[1]
F37	PIO board ETHERNET1 port TX percent	PIO board ETHERNET1 port TX usage percentage during last second
F38	PIO board ETHERNET1 port TX overflow count	Accumulated PIO board ETHERNET1 port TX overflow count since system starts[1]
F39	PIO board ETHERNET1 port RX percent	PIO board ETHERNET1 port RX usage percentage during last second
F40	PIO board ETHERNET1 port RX overflow count	Accumulated PIO board ETHERNET1 port RX overflow count since system starts[1]
F41	PIO board ETHERNET2 port TX percent	PIO board ETHERNET2 port TX usage percentage during last second
F42	PIO board ETHERNET2 port TX overflow count	Accumulated PIO board ETHERNET2 port TX overflow count since system starts[1]
F43	PIO board ETHERNET2 port RX percent	PIO board ETHERNET2 port RX usage percentage during last second
F44	PIO board ETHERNET2 port RX overflow count	Accumulated PIO board ETHERNET2 port RX overflow count since system starts[1]
F45	PIO board ETHERNET3 port TX percent	PIO board ETHERNET3 port TX usage percentage during last second
F46	PIO board ETHERNET3 port TX overflow count	Accumulated PIO board ETHERNET3 port TX overflow count since system starts[1]
F47	PIO board ETHERNET3 port RX percent	PIO board ETHERNET3 port RX usage percentage during last second

Field #	Field Name	Description
F48	PIO board ETHERNET3 port RX overflow count	Accumulated PIO board ETHERNET3 port RX overflow count since system starts[1]
F49	PIO board ETHERNET4 port TX percent	PIO board ETHERNET4 port TX usage percentage during last second
F50	PIO board ETHERNET4 port TX overflow count	Accumulated PIO board ETHERNET4 port TX overflow count since system starts[1]
F51	PIO board ETHERNET4 port RX percent	PIO board ETHERNET4 port RX usage percentage during last second
F52	PIO board ETHERNET4 port RX overflow count	Accumulated PIO board ETHERNET4 port RX overflow count since system starts[1]
F53	PIO board ETHERNET5 port TX percent	PIO board ETHERNET5 port TX usage percentage during last second
F54	PIO board ETHERNET5 port TX overflow count	Accumulated PIO board ETHERNET5 port TX overflow count since system starts[1]
F55	PIO board ETHERNET5 port RX percent	PIO board ETHERNET5 port RX usage percentage during last second
F56	PIO board ETHERNET5 port RX overflow count	Accumulated PIO board ETHERNET5 port RX overflow count since system starts[1]
F57	PIO board ETHERNET6 port TX percent	PIO board ETHERNET6 port TX usage percentage during last second
F58	PIO board ETHERNET6 port TX overflow count	Accumulated PIO board ETHERNET6 port TX overflow count since system starts[1]
F59	PIO board ETHERNET6 port RX percent	PIO board ETHERNET6 port RX usage percentage during last second
F60	PIO board ETHERNET6 port RX overflow count	Accumulated PIO board ETHERNET6 port RX overflow count since system starts[1]
F61	PIO board ETHERNET7 port TX percent	PIO board ETHERNET7 port TX usage percentage during last second
F62	PIO board ETHERNET7 port TX overflow count	Accumulated PIO board ETHERNET7 port TX overflow count since system starts[1]
F63	PIO board ETHERNET7 port RX percent	PIO board ETHERNET7 port RX usage percentage during last second
F64	PIO board ETHERNET8 port RX overflow count	Accumulated PIO board ETHERNET8 port RX overflow count since system starts[1]
F65	PIO board ETHERNET8 port TX percent	PIO board ETHERNET8 port TX usage percentage during last second
F66	PIO board ETHERNET8 port TX overflow count	Accumulated PIO board ETHERNET8 port TX overflow count since system starts[1]
F67	PIO board ETHERNET8 port RX percent	PIO board ETHERNET8 port RX usage percentage during last second
F68	PIO board ETHERNET8 port RX overflow count	Accumulated PIO board ETHERNET8 port RX overflow count since system starts[1]
F69	Reserved	

Field #	Field Name	Description
F70	Reserved	
F71	Reserved	
F72	Reserved	
f73	Reserved	
f74	Reserved	
f75	Reserved	
f76	Reserved	

[1]The overflow count is the number of times that software detects overflow occurs. It is not the number of bytes that overflows.

2.74 USERANTTYPEB

☒SF-5050 ☒Onyx

This message displayes the two user-defined custom antenna types. The format of the message is described in the table below. Scheduling USERANTTYPEB actually results in two messages being output: USERANTTYPE0B and USERANTTYPE1B. Their format is identical except for the mnemonics.

Table 219: USERANTTYPE0B Content

Data Item	Data Type	Description
Antenna number	U08	Which user-defined antenna (0 or 1)
Name	ASCIIZ	The antenna name (2 – 21 characters, including the NULL terminator)
Number of frequency records	U08	The number of frequency records contained in this message (1 – 8)
Frequency record 0	23-S16's	PCO and PCV values for this frequency.
…	…	…
Frequency record n		PCO and PCV values for this frequency

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3 Legacy Proprietary RTK Correction Messages

☒SF-5050 ☒Onyx

The Onyx receiver can produce and accept some former NavCom Proprietary RTK correction formats supported by the previous generation of NavCom receivers.

Table 220 shows the output streams associated with each correction type. Table 221 lists the supported correction types.

Table 220: NavCom Proprietary Correction Output Streams

Products	Onyx Output Stream	NavCom Proprietary Message Type
NCT-2000, NCT-2001, NCT-2030, SF-2040, SF-2050	NCT5B	RTK Correction Message (0x5B)
NCT-2000, NCT-2001, NCT-2030, SF-2040, SF-2050, Sapphire, SF-3040, SF-3050	NCT5C	RTK Base Position (0x5C)
NCT-2000, NCT-2001, NCT-2030, SF-2040, SF-2050	NCT5D	Base Station StarFire/RTK Position Vector Delta (0x5D)

The NCT5E Raw measurements from RTK base site produced by the Sapphire, SF-3040, and SF-3050 are no longer supported. Update these receivers to the most recent firmware and use the NCT61 and NCT62 proprietary correction formats instead.

Table 221: Supported NavCom Proprietary Correction Inputs

Products	Correction Inputs	NavCom Proprietary Message Type
NCT-2000, NCT-2001, NCT-2030, SF-2040, SF-2050	0x5B	RTK Correction Message
NCT-2000, NCT-2001, NCT-2030, SF-2040, SF-2050, Sapphire, SF-3040, SF-3050	0x5C	RTK Base Position
NCT-2000, NCT-2001, NCT-2030, SF-2040, SF-2050, Sapphire, SF-3040, SF-3050	0x5E	L-RTK Correction

0x5b - RTK Correction Message - 4+12+(n*18) bytes

☒SF-5050 ☒Onyx

Use with all NCT-2000D and NCT-2100D-based products.

If Survey position is greater than 1 km from navigation solution, the RTK correction blocks (0x5b/0x5e) will not be output. Furthermore, the message 0x5c, the RTK reference position block, will be output with an unhealthy indication and a site id of 0xffff.

0x5c - RTK Base Position - 25 bytes

☒SF-5050 ☒Onyx

Message 0x5c, the NCT Proprietary RTK base position block, is extended to provide additional precision and new information to support certain survey applications. W7 and W8 are added to this block. The length of the block indicates the availability of W7 and W8.

On the rover side:

- ✓ NCT-2000D Products: If W1, B4 is set to “1”, the message is computed to W6. This shorter message provides for backward compatibility.
- ✓ Onyx, Sapphire, and NCT-2100D Products: If W1, B4 is set to “0”, the message is computed to W8.

NCT-2000D Products: Software v3.2.10 and earlier will receive the older message where W7 does not exist.

0x5e – RTK Base Raw Measurements - 4+12+(n*18) bytes

☒SF-5050 ☒Onyx

RTK base raw measurements block, 0x5e, can only be received by Onyx and the SF-5050. If Onyx or the SF-5050 are used as base stations with Sapphire, the SF-3040, or the SF-3050, then these older products must be updated to current firmware in order to accept the NCT62 proprietary correction format from Onyx or the SF-5050.

4 Other Correction Output and Input Message Types

4.1 RTCM 2.3 Output Messages

☒SF-5050 ☒Onyx ☒

The Onyx receiver can produce RTCM corrections (refer to the section, *Related Standards*). Table 222 shows the supported RTCM correction messages along with the corresponding Onyx output stream.

Table 222: RTCM 2.3 Correction Output Streams

Onyx Output Stream	RTCM Message Type
RTCM1	Differential GPS Corrections (Type 1); Differential GLONASS corrections set (Type 31);
RTCM2	Delta Differential GPS Corrections (Type 2)
RTCM3	GPS Reference Station Parameters (Type 3)
RTCM9	GPS Partial Correction Set (Type 9); GLONASS Partial corrections set (Type 34)
RTCM16	GPS Special Message (Type 16)
RTCM18	RTK Uncorrected Carrier Phases (Type 18)
RTCM19	RTK Uncorrected Pseudoranges (Type 19)
RTCM20	RTK Carrier Phase Corrections (Type 20)
RTCM21	High-Accuracy Pseudorange Corrections (Type 21)
RTCM22	Extended Reference Station Parameters (Type 22)

RTCM Code corrections can be produced by enabling either RTCM1 and RTCM3 output streams or RTCM9 and RTCM3 output streams.

RTCM RTK corrections can be produced by enabling RTCM3, RTCM18, RTCM19, and RTCM22 output streams or by enabling RTCM3, RTCM20, RTCM21, and RTCM22 output streams.

4.2 RTCM 2.3 Input Messages

☒SF-5050 ☒Onyx ☒

The Onyx receiver accepts RTCM corrections (refer to the section, *Related Standards*). Table 223 lists the supported RTCM Correction messages.

Table 223: Supported RTCM Correction Inputs

RTCM Message Type
Differential GLONASS Corrections (Type 31)
Differential GPS Corrections (Type 1)
GLONASS Partial Correction Set (Type 34)
GPS Partial Correction Set (Type 9)

Table continued on next page…

RTCM Message Type
GPS Reference Station Parameters (Type 3)
GPS Special Message (Type 16)
RTK Uncorrected Carrier Phases (Type 18)
RTK Uncorrected Pseudoranges (Type 19)
RTK Carrier Phase Corrections (Type 20)
High-Accuracy Pseudorange Corrections (Type 21)
Extended Reference Station Parameters (Type 22)

4.3 RTCM 3.0 Output Messages

☒SF-5050 ☒Onyx ☒

The Onyx receiver can produce RTCM 3.0 corrections (refer to the section, *Related Standards*). Table 224 shows the supported RTCM 3.0 correction messages along with the corresponding Onyx output streams.

Table 224: RTCM 3.0 Correction Output Streams

Onyx Output Stream	RTCM 3.0 Message Type
RTCM 1001	GPS basic RTK, L1 only Corrections (1001)
RTCM 1002	GPS Extended RTK, L1 only Corrections (1002)
RTCM 1003	GPS basic RTK, L1, L2 only Corrections (1003)
RTCM 1004	GPS Extended RTK, L1 only Corrections (1004)
RTCM 1005	Stationary antenna reference point, No Height (1005)
RTCM 1006	Stationary antenna reference point (1006)
RTCM 1007	Antenna description (1007)
RTCM 1008	Antenna description (1008)
RTCM 1009	GLONASS basic RTK, L1 only Corrections (1009)
RTCM 1010	GLONASS Extended RTK, L1 only Corrections (1010)
RTCM 1011	GLONASS basic RTK, L1, L2 Corrections (1011)
RTCM 1012	GLONASS Extended RTK, L1, L2 Corrections (1012)
RTCM 1019	GPS ephemeris data (1019)
RTCM 1020	GLONASS ephemeris data (1020)
RTCM 1033	Antenna and receiver description (1033)

RTCM L1 only corrections can be produced by enabling RTCM 1001 or RTCM 1002 and 1005/1006 output streams.

RTCM RTK L1 and L2 corrections can be produced by enabling either RTCM 1003 or RTCM 1004 and RTCM 1005/1006 output streams.

RTCM3_1019 and RTCM3_1020 can be scheduled OnTime with minimum interval of 60 seconds. When scheduled OnTime, the whole set of messages, which consists of multiple messages each containing the ephemeris for one satellite, are output at specified intervals. Within the set, each ephemeris message is output at one second at a time.

4.4 RTCM 3.0 Input Messages

☒SF-5050 ☒Onyx ☒

The Onyx receiver accepts RTCM 3.0 corrections (refer to the section *Related Standards*). Table 225 lists the supported RTCM 3.0 Correction messages.

Table 225: Supported RTCM 3.0 Correction Inputs

RTCM 3.0 Message Type
GPS basic RTK, L1 L2 Corrections (1003)
GPS Extended RTK, L1 L2 Corrections (1004)
Stationary antenna reference point, No Height (1005)
Stationary antenna reference point (1006)

A.. CRC Function/Data Parsing and Decoding

```
/*****************************************************************************
**  CCITT 16-bit CRC Function
**
**  $Workfile: CCITTcrc.c $
**  $Revision: 3 $
**  $Date: 1/10/06 2:13p $
**
*****************************************************************************/

typedef unsigned char       U08;
typedef unsigned short      U16;

static const U16 CrcTable[256] =
{
   0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50a5, 0x60c6, 0x70e7,
   0x8108, 0x9129, 0xa14a, 0xb16b, 0xc18c, 0xd1ad, 0xe1ce, 0xf1ef,
   0x1231, 0x0210, 0x3273, 0x2252, 0x52b5, 0x4294, 0x72f7, 0x62d6,
   0x9339, 0x8318, 0xb37b, 0xa35a, 0xd3bd, 0xc39c, 0xf3ff, 0xe3de,
   0x2462, 0x3443, 0x0420, 0x1401, 0x64e6, 0x74c7, 0x44a4, 0x5485,
   0xa56a, 0xb54b, 0x8528, 0x9509, 0xe5ee, 0xf5cf, 0xc5ac, 0xd58d,
   0x3653, 0x2672, 0x1611, 0x0630, 0x76d7, 0x66f6, 0x5695, 0x46b4,
   0xb75b, 0xa77a, 0x9719, 0x8738, 0xf7df, 0xe7fe, 0xd79d, 0xc7bc,
   0x48c4, 0x58e5, 0x6886, 0x78a7, 0x0840, 0x1861, 0x2802, 0x3823,
   0xc9cc, 0xd9ed, 0xe98e, 0xf9af, 0x8948, 0x9969, 0xa90a, 0xb92b,
   0x5af5, 0x4ad4, 0x7ab7, 0x6a96, 0x1a71, 0x0a50, 0x3a33, 0x2a12,
   0xdbfd, 0xcbdc, 0xfbbf, 0xeb9e, 0x9b79, 0x8b58, 0xbb3b, 0xab1a,
   0x6ca6, 0x7c87, 0x4ce4, 0x5cc5, 0x2c22, 0x3c03, 0x0c60, 0x1c41,
   0xedae, 0xfd8f, 0xcdec, 0xddcd, 0xad2a, 0xbd0b, 0x8d68, 0x9d49,
   0x7e97, 0x6eb6, 0x5ed5, 0x4ef4, 0x3e13, 0x2e32, 0x1e51, 0x0e70,
   0xff9f, 0xefbe, 0xdfdd, 0xcffc, 0xbf1b, 0xaf3a, 0x9f59, 0x8f78,
   0x9188, 0x81a9, 0xb1ca, 0xa1eb, 0xd10c, 0xc12d, 0xf14e, 0xe16f,
   0x1080, 0x00a1, 0x30c2, 0x20e3, 0x5004, 0x4025, 0x7046, 0x6067,
   0x83b9, 0x9398, 0xa3fb, 0xb3da, 0xc33d, 0xd31c, 0xe37f, 0xf35e,
```

```
  0x02b1, 0x1290, 0x22f3, 0x32d2, 0x4235, 0x5214, 0x6277, 0x7256,
  0xb5ea, 0xa5cb, 0x95a8, 0x8589, 0xf56e, 0xe54f, 0xd52c, 0xc50d,
  0x34e2, 0x24c3, 0x14a0, 0x0481, 0x7466, 0x6447, 0x5424, 0x4405,
  0xa7db, 0xb7fa, 0x8799, 0x97b8, 0xe75f, 0xf77e, 0xc71d, 0xd73c,
  0x26d3, 0x36f2, 0x0691, 0x16b0, 0x6657, 0x7676, 0x4615, 0x5634,
  0xd94c, 0xc96d, 0xf90e, 0xe92f, 0x99c8, 0x89e9, 0xb98a, 0xa9ab,
  0x5844, 0x4865, 0x7806, 0x6827, 0x18c0, 0x08e1, 0x3882, 0x28a3,
  0xcb7d, 0xdb5c, 0xeb3f, 0xfb1e, 0x8bf9, 0x9bd8, 0xabbb, 0xbb9a,
  0x4a75, 0x5a54, 0x6a37, 0x7a16, 0x0af1, 0x1ad0, 0x2ab3, 0x3a92,
  0xfd2e, 0xed0f, 0xdd6c, 0xcd4d, 0xbdaa, 0xad8b, 0x9de8, 0x8dc9,
  0x7c26, 0x6c07, 0x5c64, 0x4c45, 0x3ca2, 0x2c83, 0x1ce0, 0x0cc1,
  0xef1f, 0xff3e, 0xcf5d, 0xdf7c, 0xaf9b, 0xbfba, 0x8fd9, 0x9ff8,
  0x6e17, 0x7e36, 0x4e55, 0x5e74, 0x2e93, 0x3eb2, 0x0ed1, 0x1ef0
};

U16 crc_CCITT(U08 *buf, int length)
{
   U16 accum;

   for ( accum = 0; length != 0; length--, buf++)
      accum = (U16)((accum << 8) ^ CrcTable[(accum >> 8) ^ *buf]);
   return ( accum );
}
```

Onyx Pseudocode Message Parser

This source code is an example of basic message parsing:

```
typedef enum {
        GET_LEFT_BRACE=1,
        GET_MNEMONIC,
        GET_LEN1,        // For binary message
        GET_LEN2,        // For binary message
        GET_MSG_BODY,    // For binary message
        GET_CRC16_START, // For binary message
        GET_CRC16,
} ParseState;

  char mnemonic[MAX_MNEMONIC_LEN];
  char msg_body[MAX_MSG_BODY_LEN];
  char crc_str[4];

#define CARRIAGE_RETURN 0x0D
```

```
#define BACK_SPACE 0x08

 ParseState parser;
 char ch;
 int mnemonic_len;
 int msg_len;
 int expected_msg_len;
 int crc_count;

 parser = GET_LEFT_BRACE; // initial state, look for "["

 LOOP
 {
   ch = retrieve one byte from receiving port

   // Process the next input character based on the current state
  switch( parser )
  {
  case GET_LEFT_BRACE:
    if( ch == '[' )
    {
      parser = GET_MNEMONIC;
      mnemonic_len = 0;
      msg_len = 0;
    }

    break;

  case GET_MNEMONIC:
    if( ch == ']' )
    {
      // Got a right brace, try to match mnemonic string
      if(  mnemonic matches "PVT1B" )
      {
        msg_body will hold PVT1B message
        will process later
      }

      parser = GET_LEN1;
    }
    else if( ch is not ascii_char )
    {
      Error handling here
    }
    else if( mnemonic_len >= MAX_MNEMONIC_LEN-1 )
    {
      // Too many characters in the mnemonic
      Error handling;
    }
    else
    {
      // Save this character on the end of the mnemonic string and
      // add null terminator after it.
      mnemonic[mnemonic_len] = ch;
      mnemonic_len++;
      mnemonic[mnemonic_len] = 0;
    }
    break;
```

```
case GET_LEN1:
  msg_body[0] = ch;
  msg_len = 1;
  parser = GET_LEN2;
  break;

case GET_LEN2:
  msg_body[1] = ch;
  msg_len = 2;

  expected_msg_len = (int)(msg_body[0] | ((unsigned int)ch<<8));

  if ( expected_msg_len > MAX_INPUT_MSG_BODY_LEN)
  {
    Error handling;
  }
  // Message length includes the 2 length field, so minimum value is 2
  else if (expected_msg_len < 3)
  {
    parser = GET_CRC16_START;
  }
  else
  {
    parser = GET_MSG_BODY;
  }
  break;

case GET_MSG_BODY:
  msg_body[msg_len] = ch;
  msg_len++;
  if (msg_len >= expected_msg_len)
    parser = GET_CRC16_START;
  break;

case GET_CRC16_START:
  if (ch == '*')
  {
    parser = GET_CRC16;

    crc_count = 0;
  }
  break;
case GET_CRC16:
  if( ch == CARRIAGE_RETURN && crc_count == 4)
  {
   // check crc

   Set flag "PARSE_COMPLETED_OK" if crc is correct
  }
  else if( ch == BACK_SPACE )
  {
   // Got a backspace, delete last arg string character
   if( crc_count > 0 )
   {
    crc_count--;
    crc_str[crc_count] = 0;
```

```
    }
  }
  else if(  ch is not ascii_char )
  {
    // Got a 'non-ASCII' character, parse fails
    Error handling;
  }
  else if( crc_count >= 4 )
  {
    // CRC string is too long
    Error handling;
  }
  else
  {
    // Save this character on the end of the crc string and
    // add null terminator after it.
    crc_str[crc_count] = ch;
    crc_count++;
    crc_str[crc_count] = 0;
  }
  break;
}// end switch on parse state

// Input character has been processed.
// Check if initial parse has completed or failed.

if( flag PARSE_COMPLETED_OK is set )
{
  if(  mnemonic matches "PVT1B" )
  {// msg_body holds binary data for PVT1B
   Decode msg_body using [PVT1B] format definition
  }
}
} // end of LOOP
```

Onyx Pseudocode for Coordinate Conversions

This is example source code for properly parsing the LAT|LON|HGHT from the PVT1B message:

```
if ( msg.IsNavValid())
            {
               double latitude = msg.GetLatitude();
               double longitude = msg.GetLongitude();
               double height = msg.GetHeight();
            }

// convert from S32 in arc-seconds scaled to 2^-11
// to R64 as degrees.minutes <with seconds embedded>
R64 CNovaPVT1B::GetLatitude()
{
   if (IsPvtRevision1OrPvtRevision2())
   {
      R64 xTmp = rev1_latitude;  // convert S32 to R64
      xTmp = xTmp / 2048.0;        // convert to arc-seconds

      // pull the latitude correction
```

```
      latlonResidual latCor;
      latCor.latlon = rev1_latlonlsb;  // convert bitfield to U08
      R64 rLatX= latCor.extended.lat;  // convert the lat corr to float
      rLatX /= 32768.0;             // convert to arc-seconds

      // add the correction, yielding arc-seconds
      xTmp += rLatX;

      // convert the sum to degrees
      xTmp = xTmp / 3600.0;

      return xTmp;
   }
   return latitude;
}

// convert from S32 in arc-seconds scaled to 2^-11
// to R64 as degrees.minutes <with seconds embedded>
R64 CNovaPVT1B::GetLongitude()   // see above for lat
{
   if (IsPvtRevision1OrPvtRevision2())
   {
      R64 xTmp = rev1_longitude;  // convert S32 to R64
      xTmp = xTmp / 2048.0;        // convert to arc-seconds

      // pull the longitude correction
      latlonResidual lonCor;
      lonCor.latlon = rev1_latlonlsb;  // convert bitfield to U08
      R64 rLatX= lonCor.extended.lon;  // convert the lat corr to float
      rLatX /= 32768.0;             // convert to arc-seconds

      // add the correction, yielding arc-seconds
      xTmp += rLatX;

      // convert the sum to degrees
      xTmp = xTmp / 3600.0;
      return xTmp;

   }
   return longitude;
}

R32 CNovaPVT1B::GetHeight()   // see above for lat,long
{
   if (IsPvtRevision1OrPvtRevision2())
   {
      R32 xTmp = (R32) rev1_ell_height;  // convert S32 to R32
      xTmp = xTmp / 1000;       // convert to meters
      return xTmp;
   }
   return height;
}
```

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<tr><td>North America</td><td rowspan="5">Deere & Company
ATTN: GNSS Receiver Customer Support
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C .... Logging Data to the SF-5050 SD Card

This appendix provides instructions on how to log scheduled messages to the SF-5050 removable SD card and download those messages to a PC. StarUtil 5000 provides limited parsing capability.

NavCom has tested the following SD card with the SF-5050:

Panasonic
P Series
RP-SDPC16
Speed Class 4

The receiver supports SD cards of this quality from 4 to 16 GB.

The SF-5050 receiver has *Card* detection and *Write* protection detection.

Log data to port SDCARD.

Use the [LOGFILE] command, *C:* refers to the SD memory card location.

The following commands are associated with data logging:

- [LOGFILE] START|STOP, Delay hrs(0-23), Delay min(0-59), Duration hrs(0-23), Duration Min(0-59)
- [LOGFILEAUTOSTART] ON,OFF
- [LOGFILEDRIVE] C:
- [LOGFILENAME] Log file string
- [LOGFILETIME] Duration minutes, Rollover period minutes
- [SDCARD] – output message to report events associated with SD card
- [OUTPUT]SDCARD,ONCHANGE,,PORT
- File system related commands FSCWD, FSCD, FSDIR, FSRMDIR, FSMKDIR, FSCOPY, FSRENAME,FSSPACE, FSFORMAT, FSDELETE AND FSDRIVE

SD CARD Formatting

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 simplify this process, a profile can be configured to begin and end data logging. For detailed information, refer to the [PROFILE] command in this manual. Also refer to Chapter 6 of the *StarUtil 5000 User Guide*.

Internal data logging is limited to a 25Hz maximum data rate for a multi-hertz message (i.e., MEAS1B, PVT1B, etc.).

As indicated below, this process takes some time (~30 seconds) to complete. Please be patient until the process finishes before executing additional commands for data logging.

Figure 5: Input Terminal – Creating Logging File

⚠ The [LOGFILE] command requires that at least 10% of the drive be free before it begins logging. It will also automatically stop logging when free space drops below 1 MByte.

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D.........................Uploading Unified Firmware Files Using StarUtil 5000

StarUtil 5000 provides a method for uploading multiple firmware files at once.

1. In StarUtil 5000, click *Firmware Update* on the lefthand column (see Figure 6).

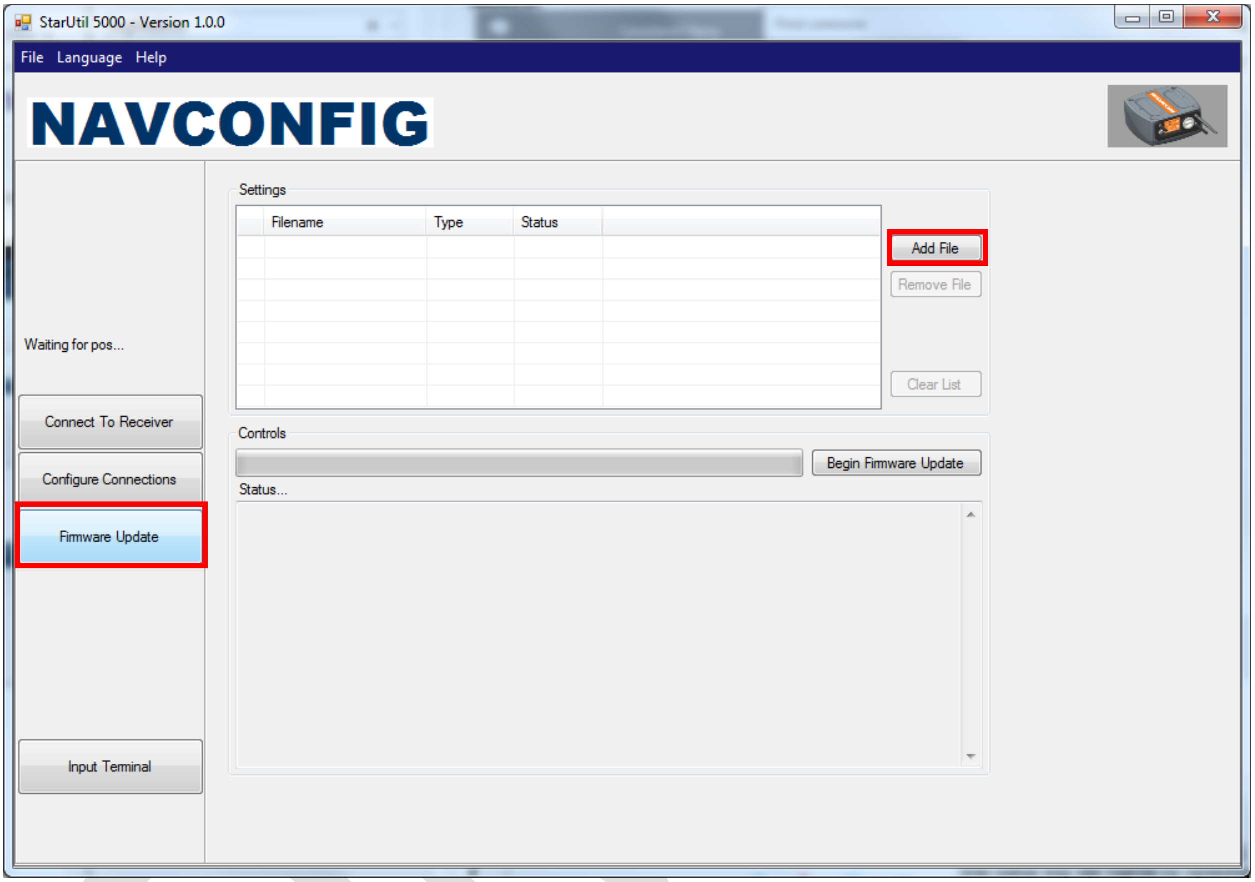

Figure 6: Receiver Options Tab

Select the appropriate *".s19"* to upload (see Figure 7). Files are loaded one at a time. Upload files in the following order:

- Onyx_Boot1
- Onyx_Boot2
- Onyx
- 5050_PWRIOboot1
- 5050_PWRIOboot2
- 5050_PWRIO

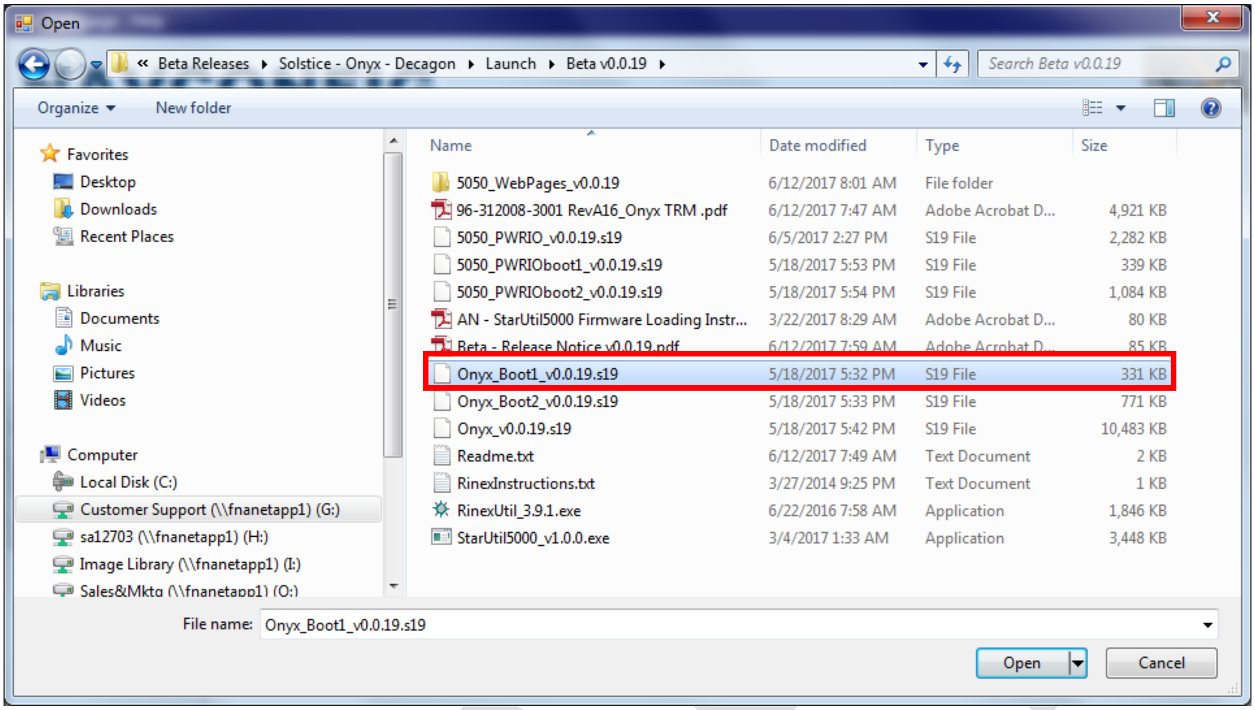

Figure 7: File Upload

3. Add all the files to upload list. (see Figure 8).

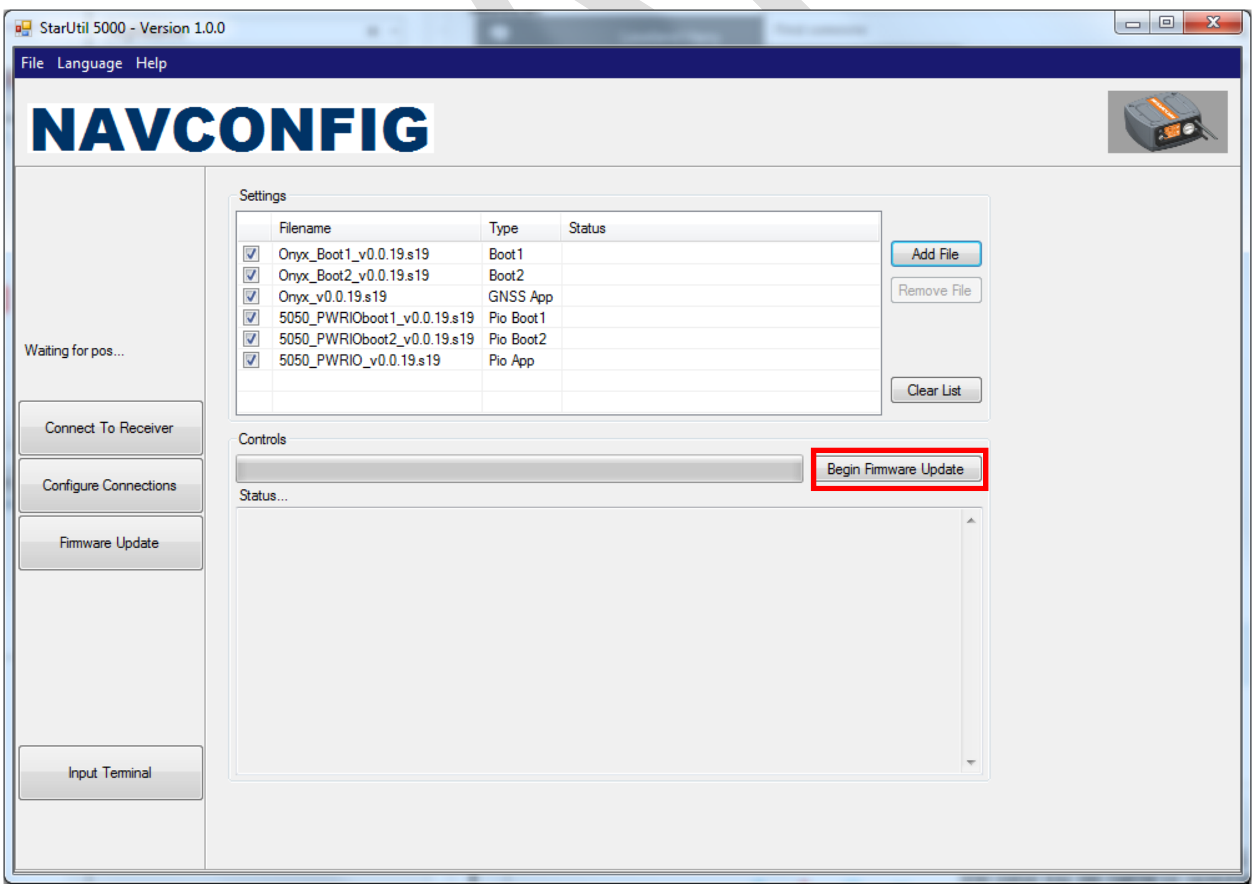

Figure 8: Firmware Update List

4. Click Begin *Firware Update* (see Figure 8).
5. Once the firmware files have been uploaded, the *Finished with All Downline Loads* dialog box is displayed (see Figure 9).

Figure 9: Finished All Downline Loads

For information on loading firmware without using StarUtil 5000, see Appendix G.

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E .... Base RTK Configuration

Overview

This will step you through setting up and using the SF-5050 in a RTK Base Station for outputting multiple correction formats to support traditional message structures (NCT, RTCM v2.3, RTCM v3.0, and RTCM v3.2) via various ports by using NavCom's configuration software. This section describes connection via Ethernet to a cell-modem (i.e., Cybertech, as used by SmartNetAus or Geo++) for streaming data to RTK networks.

This instruction requires that the receiver is optioned for RTK Base/Rover.

Hardware Requirements

The following hardware is required for this interface. Cabling may vary depending on application needs

- ✓ SF-5050 receiver
- ✓ Rover antenna PN PH98229974
- ✓ Power Cable PN 82-020007-3001LF with 73-200002-0001LF, or 94-310274-3010LF
- ✓ Com 1 connection: RS-232 and Ethernet interface cable P/N 94-310272-3006LF
- ✓ Com 2 connection: RS-232 and USB Device interface cable P/N PH96229299 or PH96229301
- ✓ Low-loss coaxial cable (requirements are detailed later in this document)
- ✓ Ethernet connection (either/or)
    - Cellular modem (i.e., Cybertech; customer supplied)
    - Router for a hardwire interface (secure connection preferred; customer supplied)
- ✓ Radio modem (internal (Premium SF-5050 model) or external) for local RTK data (optional) and connecting cables
    - Cable requirements are based on the radio modem in use and are not detailed in this document

Hardware Configuration

The below diagram (see Figure 10) depicts a typical installation:

- ✓ Com 1 – used for NCT formated correction output; baud rate is 19200 bps
- ✓ Eth1 – Ethernet 1 is assigned port ID of 4361 and is used for command and control with StarUtil. The user has an option to change the port ID as needed.
- ✓ Eth2 and Eth3 – Ethernet 2 and 3; both are unassigned. The user has an option to change the port ID as needed.
- ✓ Eth4 – Ethernet 4 is assigned port ID of 4364 and is used for output of RTK (RTCM v3.1) network corrections to SmartNet, Geo++, eGPS, etc.. The user has an option to change the port ID as needed.
    - SmartNetAus indicates that every SF-5050 in the network can maintain the settings above and be uniquely identified by the radio modem router. This eases installation, as no changes are needed to the default network RTK profile for connectivity.
- ✓ Com 2 – used for command and control with StarUtil; default baud rate is 57600 bps
    - As an option Com 2 can be connected to output RTCM, CMR, or CMR+ correctors and StarUtil can be connected to a different port (USB, Ethernet, or Bluetooth®)
- ✓ USB – used for command and control with StarUtil

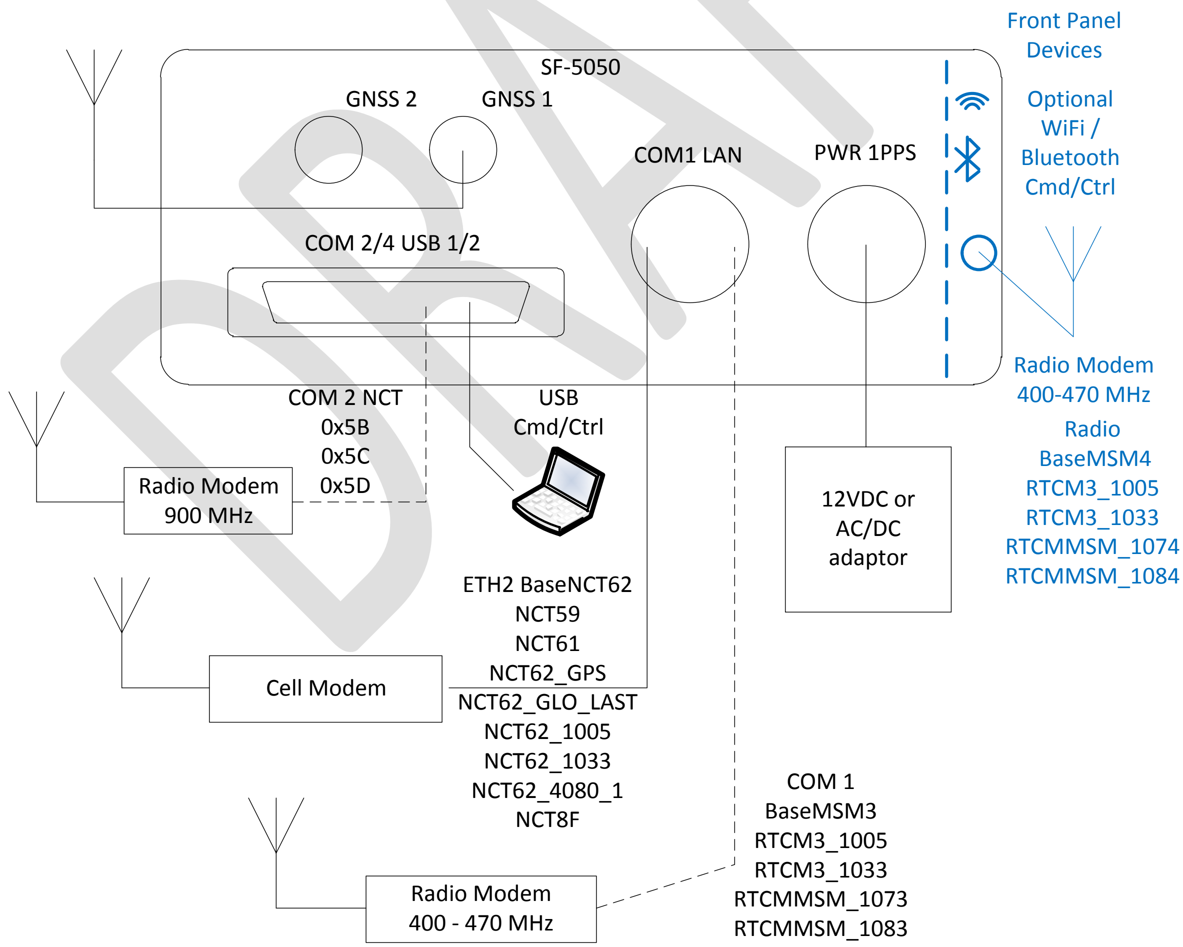

Figure 10: Typical RTK Base Installation

Antenna Installation

Refer to the SF-5050 Product User Guide, Chapter 4, for antenna installation considerations. Table 226 describes the maximum cable length between the antenna and the SF-5050 based on cable type without an external LNA.

Table 226: 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

Longer cable lengths are possible with the appropriate use of a LNA. Please contact your NavCom dealer or NavCom Product Support for additional guidance.

Update Profile (with Ethernet Port Base Station and Radio Settings)

The default SF-5050 profile sets the receiver up in a Rover application. Therefore, the end-user will need to make a number of setting changes to meet the needs of the base application.

1. Copy the settings below to Note Pad and label the file as Network Base – <site name>.npt.
    - Leave the file open for editing.
    - For ease of demonstrating what is needed, this profile is: *Network Base - Sample.npt*

Here is an example of a configured base station for Ethernet. The messages highlighted in Red should not be changed or experimented with by the user. These are not documented in the TRM and are for engineering/factory use only; however, when the profile is retrieved from the SF-5050, these will appear, and setting them correctly here reduces the likelihood of errors.

The messages highlighted in Gray should not be changed or experimented with by the user. These are documented in the TRM; however, when these are set inappropriately, the base and client rover performance can be profoundly affected.

The messages highlighted in Yellow must be changed, based on local information appropriate for that field, in order for the SF-5050 to operate as a base station. Additional messages are also needed to support additional output formats.

The messages highlighted in Blue are the local Ethernet information.

Each installation is unique and may require fewer or additional data turned off or on. Once the equipment is operating as desired, be sure to update the profile as appropriate. This ensures that the receiver starts up in the correct configuration should the site suffer a power outage and allows a replacement receiver to be programmed in like fashion with ease.

```
[NAVELEVMASK]7.00
[TRACKELEVMASK]3
[DISABLESAT]
[DISABLECHANNEL]
[STARFIREALTSAT]OFF
[DEFINESFSAT]NOUSER-DEFINEDSATELLITE.
[TRACKINGMODE]L2,ON,L2C,ON,L5,OFF,WAASEGNOS,ON,STARFIRE,ON,G1,ON,G2,ON
[NAVMEASUSE]L1,ON,L2,ON,L2C,ON,L5,OFF,WAASEGNOS,OFF,GLONASS,ON
[REFNAME]"NAVCOMREF1"
[DEBUG]OFF,RXP,CORENAV,NVRAM,I2C,TR,OSC,BB,CMR,WAAS,SF,TIME,MISC,USB,RTKRADIO
,SPI,ALM,GLONASS,GPS
[DEBUG]ON,NONE
[OUTPUT]NONE,,,-1
[OUTPUT]??,ONCHANGE,,1
[OUTPUT]OK,ONCHANGE,,1
[OUTPUT]PVT1B,ONTIME,1,1
[OUTPUT]MEAS1B,ONTIME,1,1
[OUTPUT]EPHEM1B,ONCHANGE,,1
[OUTPUT]ALM1B,ONCHANGE,,1
[OUTPUT]PANICA,ONCHANGE,,1
[OUTPUT]CHNLSTATUS1B,ONTIME,1,1
[OUTPUT]MSGVERSION,ONTIME,600,1
[OUTPUT]MSGPRODUCTINFO,ONTIME,600,1
[OUTPUT]??,ONCHANGE,,3
[OUTPUT]OK,ONCHANGE,,3
[OUTPUT]PANICA,ONCHANGE,,3
[OUTPUT]??,ONCHANGE,,BT
[OUTPUT]OK,ONCHANGE,,BT
[OUTPUT]PANICA,ONCHANGE,,BT
[OUTPUT]??,ONCHANGE,,2
[OUTPUT]OK,ONCHANGE,,2
[OUTPUT]PANICA,ONCHANGE,,2
[OUTPUT]??,ONCHANGE,,4
[OUTPUT]OK,ONCHANGE,,4
[OUTPUT]PANICA,ONCHANGE,,4
[OUTPUT]??,ONCHANGE,,USB1
[OUTPUT]OK,ONCHANGE,,USB1
[OUTPUT]PVT1B,ONTIME,1,USB1
[OUTPUT]MEAS1B,ONTIME,1,USB1
[OUTPUT]EPHEM1B,ONCHANGE,,USB1
[OUTPUT]ALM1B,ONCHANGE,,USB1
[OUTPUT]PANICA,ONCHANGE,,USB1
[OUTPUT]CHNLSTATUS1B,ONTIME,1,USB1
[OUTPUT]MSGVERSION,ONTIME,600,USB1
[OUTPUT]MSGPRODUCTINFO,ONTIME,600,USB1
[OUTPUT]??,ONCHANGE,,USB2
[OUTPUT]OK,ONCHANGE,,USB2
[OUTPUT]PANICA,ONCHANGE,,USB2
[OUTPUT]??,ONCHANGE,,FH1
[OUTPUT]OK,ONCHANGE,,FH1
[OUTPUT]PANICA,ONCHANGE,,FH1
[OUTPUT]??,ONCHANGE,,FH2
[OUTPUT]OK,ONCHANGE,,FH2
[OUTPUT]PANICA,ONCHANGE,,FH2
[OUTPUT]??,ONCHANGE,,ETH1
[OUTPUT]OK,ONCHANGE,,ETH1
[OUTPUT]PANICA,ONCHANGE,,ETH1
[OUTPUT]??,ONCHANGE,,ETH2
[OUTPUT]OK,ONCHANGE,,ETH2
```

```
[OUTPUT]PANICA,ONCHANGE,,ETH2
[PORT]1,57600,8,1,NONE
[PORT]3,57600,8,1,NONE
[PORT]2,57600,8,1,NONE
[PORT]4,57600,8,1,NONE
[2DNAVMODE]NEVER,0.0000
[CASINTERVAL]150
[IFSINTERVAL]20000
[PDOPLIMIT]10.0
[RTKTIMEOUT]15.0
[RTKFLOATTIMEOUT]300
[PRDGPSMODE]RTCM1,ON
[PRDGPSMODE]WAASEGNOS,ON
[PRDGPSMODE]SF,ON
[PRDGPSTIMEOUT]RTCM1,300
[PRDGPSTIMEOUT]WAASEGNOS,300
[PRDGPSTIMEOUT]SF,1200
[REFSTNPOS]0,0,0.000000,0,0,0.000000,0.000000
[MULTIPATH]W1
[MULTISATTRACK]OFF,20
[L1FALLBACK]OFF
[VELSMOOTH]ON
[RTKDYNAMIC]MEDIUM
[RTKMULTIPATH]OPENSKY
[RTKSYNCMODE]LOWLATENCY
[RTKFIXMODE]FIXED
[GEOIDALMODEL]DEFAULT
[SETUTCOFFSET]0,0
[RTKMODE]ROVER,CMR,0,
[GGAMODE]LP
[ETHCONFIG]192.168.0.2,255.255.255.0,192.168.0.10
[SERIALMODE]RS232
[USBMODE]DEVICE
```

2. After saving the changes to the above profile, load them to the receiver, and click *View/Edit Profile* on the taskbar.

Figure 11: View/Edit Profile Button

3. Click Refresh Profile in Use on the lower right-hand corner. The receiver will return either the current loaded profile or 'None'.

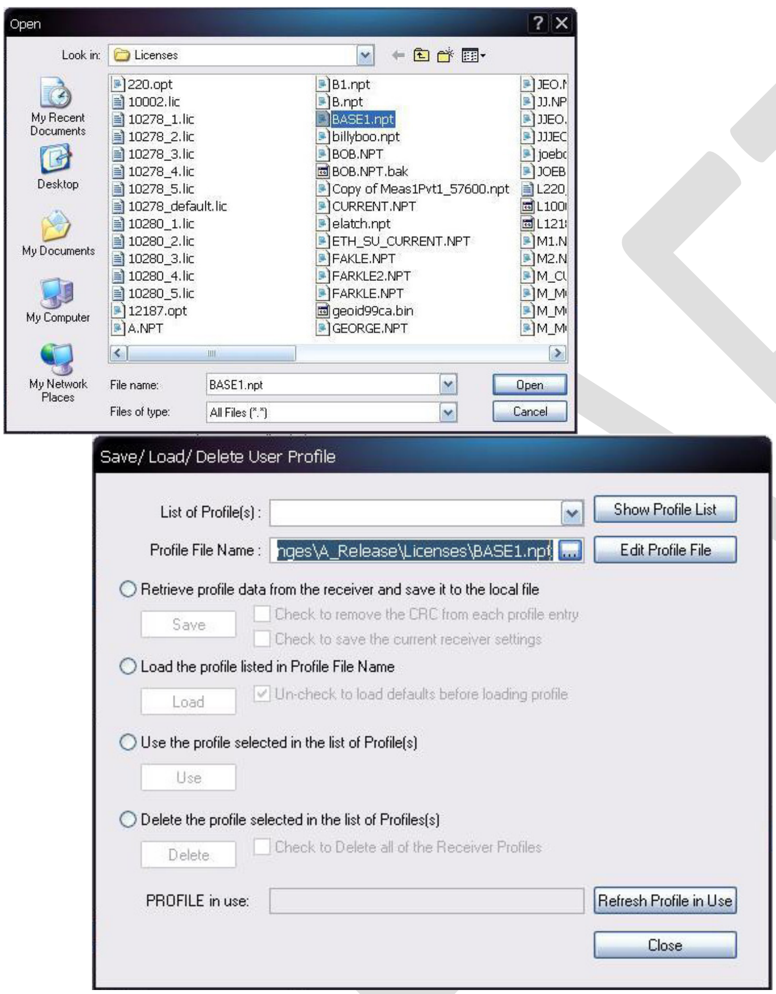

Figure 12: Network Base – Sample.npt Upload

4. Click ... and locate the *Network Base* profile just saved.
5. Select *Load the profile listed in Profile File Name;* make sure the *Un-check to load defaults before loading profile* is checked *(*as in Figure 12*).*
6. Click Load to load the profile.
7. Review the *Input Terminal* window after the profile loads to ensure none of the command was rejected.
8. Click Refresh Profile in Use and the receiver will return the current loaded profile.

Additional Information

Automatic Ethernet Connection

The [ETHVCOM] command configures the Ethernet virtual COM port server application. It can also be used to establish an EVCOM connection with a specific remote user or to terminate an existing connection.

An Ethernet Virtual Com port (EVCOM) is similar to an ASYNC serial com port and supports the same set of commands/responses as a serial COM port. It operates as a server to provide this service to remote clients in a network environment such as a LAN or the Internet.

The data stream is encapsulated in IP packets and can be configured to use either the UDP or TCP transport protocol. An IP packet may contain one or more complete message(s) or response(s), a fragment of a message, or any combination. It is simply a stream of data that is arbitrarily segmented into one or more UDP or TCP packets.

There are four logical ports that may be used by the EVCOM application (ETH1 – ETH4) for scheduling messages or sending responses to received Nova commands. Each of the logical ports can be individually configured for operation mode (TCP or UDP), IP port number, scheduled messages, and remote endpoints (client applications) providing four independent data streams.

[ETHVCOM] is a system command, and the settings will be stored in system NVRAM.

An active UDP session will automatically be re-established if the SF-5050 is reset due to power interruption.

This is not possible for a TCP mode connection except under special conditions where the remote will be listening on the configured remote port. This essentially reverses the server/client roles.

Entering this command without any arguments displays the current settings for all four logical ports.

[ETHVCOM] Syntax

[ETHVCOM]on/off, remote IP address, remote UDP/TCP port, mode, local UDP/TCP port, logical port

- On/off — Keyword that enables (ON) or disables (OFF) the virtual COM port functionality on this logical port.
- Remote IP — If the logical port is enabled (ON), and IP address & port are non-zero, a connection is established to a remote user having this IP address and port. If the IP address is 0.0.0.0 then the unit breaks any current connection, and listens for a new connection from any remote user.
- Remote Port — If non-zero, specifies the remote UDP/TCP port number the ETHVCOM task will connect to. If the remote IP address is non-zero, the remote port must be non-zero also.
- mode — Keyword identifying ETHVCOM task transport protocol:

UDP1	UDP with no “connection”. Any Nova command responses, or any sched output messages will be sent to the IP address and port of the sender of last received UDP datagram.

UDP2	This with pseudo session. (See notes for description of a UDP "pseudo session")
TCP1	The connection operates as a normal TCP session with the exception tha there is a send error, other than a re-transmission of a lost packet, then t connection will be terminated, and the logical port will enter listen mode f new connection. This may happen if the remote client experiences a pov interruption, or some sort of network interruption.
TCP2	TCP session with keep-alive timeout. (Future implementation)

- Local Port   If non-zero, specifies the local UDP/TCP port number the ETHVCOM task will listen on (range : 4100 – 65534).
- Logical Port   ETH1, ETH2, ETH3, or ETH4. This is the logical port that will be used by ETHVCOM task for requesting, or scheduling, messages.

[ETHVCOM] Examples

[ETHVCOM] ON, 192.168.0.2, 4361

Establish a virtual COM port connection with a remote user having an IP address of 192.168.0.2 and port number 4361

[ETHVCOM] ON,0.0.0.0,0

Break current connection (if any), and enable the unit to listen for a connection from the next remote unit that sends a packet to this unit. This is the proper way for a remote user to terminate a UDP connection when in UDP2 mode. It will cause the unit to stop sending data, and listen for a new connection from another user. The mode will remain the same (UDP or TCP) as the previous session.

[ETHVCOM] ON,0.0.0.0,0,UDP1

Break the current connection (if any) and listen for a UDP1 connection. Any scheduled messages for this logical port will be silently discarded

[ETHVCOM] OFF

Terminate any current connection, and disable new EVCOM connections on this logical port (ETH1…ETH4).

[ETHVCOM]

[ETHVCOM] ON, 192.168.0.100, 5042, TCP1, 4361, ETH1

[ETHVCOM] ON, 0.0.0.0, 0, TCP1, 4362, ETH2

[ETHVCOM] OFF, 0.0.0.0, 0, UDP1, 4363, ETH3

[ETHVCOM] ON, 46.153.12.73, 12345, UDP2, 4364, ETH4

Display EVCOM logical port settings (in this case, ETH1 has an active TCP1 mode connection with remote user at IP 192.168.0.100 port 5042, to local TCP port 4361. EVCOM logical port ETH2 is listening for a TCP1 mode connection from any remote client. ETH3 is disabled. ETH4 has an active UDP2 mode connection with a remote client at IP address 46.153.12.73 port 12345 on the SF-5050 UDP port 4364).

[ETHVCOM],,,,,ETH3

[ETHVCOM] ON,0.0.0.0,0,CTRL,4363,ETH3

Display current settings for "ETH3" (Ethernet Virtual COM port enabled, no active connection, listening on UDP port 4363 for a CTRL mode connection from any remote client).

Defaults: Default settings for unspecified parameters.

Local UDP/TCP port	4361
Mode	UDP1

ETHVCOM Application Notes

An EVCOM session may be established for several reasons, such as a StarUtil connection, high speed data logging, or an OEM application interface.

If client applications schedule messages on an ONTIME basis using the [OUTPUT] command, they should take care to un-schedule those messages before closing the connection. If not, then next user that opens a connection to that logical port (ETH1 – ETH4) will receive those messages even if they are unwanted and not requested. Additionally, it will cause unnecessary overhead on the GNSS board to generate those messages, and be discarded until the next EVCOM connection is established.

The best practice is for an EVCOM client application to cancel all output messages on the SF-5050 when the connection is first established, then schedule just the messages it needs.

UDP1 mode operates in a connectionless manner. There is no authentication, and the port never establishes a “connection”. A remote client will not know if that port is already being used by another remote client. A connection attempt by a second client will divert any output stream set up by a previous client to the second remote client. If a remote client wishes to prevent this, it should not use UDP1 mode.

A UDP “Pseudo Session” (UDP2 mode) may be established when the ETHVCOM task is in the ‘listening’ mode (remote IP is 0.0.0.0 port 0). While in the ‘listening’ mode, any messages previously scheduled to be sent to its logical port will be silently discarded.

Once a UDP2 mode “Pseudo Session” is established in this way, any datagrams received from any other UDP IP address/port will be silently discarded. The session is terminated by the remote client sending an [ETHVCOM]ON,0.0.0.0,0 command, but can also be terminated by entering that command on any other port (e.g. a serial COM port, or a different EVCOM port) on the SF-5050. The ETHVCOM task will then terminate the current “session”, and enter its ‘listen’ mode.

Although this server is labeled “Ethernet”, it is possible to have this functionality over any interface that supports TCP/IP, such as Bluetooth®, USB, or a GSM modem via a serial COM port using PPP.

Exercise

The Ethernet port can be set to auto-connect to a host site by setting the SF-5050 in a listener mode.

1. Use the Input Terminal to issue the following commands (Figure 13).

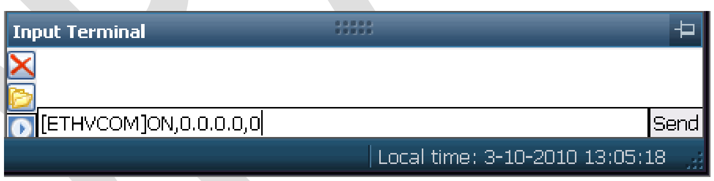

Figure 13: Input Terminal

2. Enter the [ETHVCOM]ON,0.0.0.0,0 command. This allows the SF-5050 to be called by a remote device.
3. The remote device should then call the SF-5050 address and port assigned in Exercise 2: 192.168.0.2, 4361

Resetting the Ethernet Virtual Com Connection

If the SF-5050 displays "CUDPSocket::OnReceive Receive error code: 10054":

This error means that the receiver has already been connected and it is rejecting further connection. Set [ETHVCOM] to [ETHVCOM]ON,0.0.0.0,0 and try to connect again. Enter [ETHCONFIG] to find out what port the SF-5050 thinks it is connected to.

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F ....MBRTK Commands and Responses

Setting Up the Moving Base Position

The position of the moving base is set up via the [RTKMODE] command.

[RTKMODE]

Examples:

[RTKMODE] BASENCT62,,,1,DYNAMIC,AUTO

Configures the receiver as an NCT moving base RTK base and output corrections on port 1

[RTKMODE] ROVER,NCT,,,DYNAMIC,,X_OFF

Configures the receiver as an NCT moving base RTK rover

⚠ Do not use the following configurations:

BaseRTCM1001 Receiver operates as an RTCM 3.0 type 1001 base station

BaseRTCM1002 Receiver operates as an RTCM 3.0 type 1002 base station

BaseRTCM1003 Receiver operates as an RTCM 3.0 type 1003 base station

BaseRTCM1004 Receiver operates as an RTCM 3.0 type 1004 base station

Bit mask 0x02 indicates moving base RTK mode (if set, navigation mode of 11 – 7 indicates moving base RTK).

Table 227: Base Modes

Mode	Description	
Rover	Receiver operates as a rover; all ports accept corrections	
BaseRTCM1	Receiver operates as an RTCM type 1 and type 31 base station	Do not use
BaseRTCM9	Receiver operates as an RTCM type 9 and type 34 base station	Do not use
BaseRTCM1819	Receiver operates as an RTCM type 18/19 base station.	
BaseRTCM2021	Receiver operates as an RTCM type 20/21 base station	
Base5B	Receiver operates as a proprietary 5B base station	
BaseRTCM1001	Receiver operates as an RTCM 3.0 type 1001 base station	
BaseRTCM1002	Receiver operates as an RTCM 3.0 type 1002 base station	
BaseRTCM1003	Receiver operates as an RTCM 3.0 type 1003 base station	
BaseRTCM1004	Receiver operates as an RTCM 3.0 type 1004 base station	
BaseNCT62	Receiver operates as a proprietary 62 base station. (Default; also supports Sapphire, SF-3040, and SF-3050 with most current firmware)	
BaseMSM3	Receiver operates as a proprietary MSM3 base station	
BaseMSM4	Receiver operates as a proprietary MSM4 base station	

Mode	Description	
BaseMSM5	Receiver operates as a proprietary MSM5 base station	
BaseMSM6	Receiver operates as a proprietary MSM6 base station	
BaseMSM7	Receiver operates as a proprietary MSM7 base station	

The following commands are supported; refer to the individual commands in the section *Onyx Input Commands Detailed Formats* in this manual for details, as necessary:

[EXTRAPBASE]

This command is used to enable the MBRTK rover to extrapolate base motion or lack thereof. The receiver must be running in MBRTK rover mode for this command to take effect. This feature is defaulted to Off and generally provides the best performance in this mode.

[FIXBASELINE]

This command is used to enter baseline mode and length information for the MBRTK rover. Use the equation 0.6/L (whre L is length in meters) degree as a rough 1-sigma estimate of heading accuracy. The minimum antenna separation is 1m. For heading applications, no maximum is given. MBRTK operation is possible up to a 40km baseline length with the same degredation in positioning performance accuracy as normal RTK over the same baseline length.

[ANTALIGN]

This command is used to enter baseline installation information (orientation) for the MBRTK rover.

[ARLENGTHCONSTR]

This command is used to specify whether or not the baseline length is to be used as the ambiguity constraint and pseudo measurement. To obtain a valid setting, the receiver must be in MBRTK rover mode and the fixed baseline must be set.

[INCLINECONSTR]

This command is used to set the maximum allowed inclination angle for the MBRTK rover.

General Setup Commands

These commands are related to general setup, but are self-explanatory; refer to the individual commands in the section *Onyx Input Commands Detailed Formats* in this manual for details, as necessary:

[RTKTIMEOUT]

[RTKMULTIPATH]

[RTKFIXMODE]

[RTKSYNCMODE]

[RTKFLOATTIMEOUT]

[DYNAMICS]

This command is used for specifying receiver dynamics. The setting affects the RTK rover dynamic, the StarFire dynamic, and the velocity smoothing settings.

Dynamic_mode is the receiver overall dynamic setting. When a user specifies dynamic_mode as STATIC, LOW, MEDIUM, or HIGH, the receiver will use the built-in settings for the RTK rover, the StarFire dynamic, and velocity smoothing. No additional parameters are needed. When a user specifies dynamic mode as USER, additional parameters can be added to configure the RTK rover, the StarFire dynamic, and the velocity smoothing settings.

It is assumed that the receiver is navigating at a rate of 1 Hz. As a rule of thumb, the higher the rate at which the receiver navigates, the higher the dynamics the settings can accommodate.

MBRTK Output Streams

[MBRTK1B]

The message [MBRTK1B] is used to output the moving base RTK solution. Some of the data are analogous to PVT1B data.

[PVT1B]

[RTKSTATUS1B]

This output stream contains a variety of information about the RTK navigation process.

NMEA supported formats include:

NMEAHDT

NMEAROT(ASCII)

NMEATTM

MBRTK Port-Loading Requirement

Table 228 lists the port-loading requirement from the base to the rover.

Table 228: Port-Loading Requirements

Message ID	Max. Byte Count	Message Rate (Hz)	Total Byte Count	Bits Per Second
NCT23	29	10	280	
NCT5C	29	1	30	
NCT62	222 – GPS (Assuming 13sats, 2sig, 26cells) 164 – GLONASS (Assuming 9sats, 2sig, 18cells)	1	47	

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G...Loading Firmware Without StarUtil 5000

These instructions apply to both the unified file image and the individual file images.

BOOTLOADA (ASCII)

This command is used to initiate a GNSS board software download using GNSS Bootloader1 or Bootloader2.

Command:	[BOOTLOADA] command, target, action
Parameter	**Definition**
command	The only valid command is PING
target	For the [BOOTLOADA] command sent from the PC to the receiver, this is which bootloader to transfer control to (BOOT1, BOOT2) For [BOOTLOADA] reply sent from receiver to PC, this is the target software type that generates the reply. (NAV_PROG)
action	What action the bootloader is to take (see Table 229 and Table 230).

Bootloader1 can only perform Bootloader1 actions, and Bootloader2 can only perform Bootloader2 actions.

The SF-5050 Power I/O board uses a Virtual COM port interface for the USB and Ethernet ports, so all bootloading is done using the LOADSERIALBOOTx actions. The SF-5050 does not support bootloading through the Bluetooth® interface.

Example: [BOOTLOADA] PING, BOOT2, LOADSERIALBOOT2

Table 229: BOOTLOADA Bootloader1 Actions

Bootloader1 Action	Description
BOOT1	Remain in bootloader1. Do not try to start the navigation program automatically.
BOOT2	Start bootloader2.
NAV	Start the navigation program.
LOADSERIALBOOT1	Bootload through the serial port using bootloader1. For the SF-5050, bootloader1 only supports loading through COM1.

Table 230: BOOTLOADA Bootloader2 Actions

Bootloader2 Action	Description
LOADSERIALBOOT2	Bootload through the serial port using bootloader2. For the SF-5050, bootloader2 supports loading through COM1, COM2, USB, and Ethernet. Loading through COM2, USB, and Ethernet requires that the Power I/O board software is up and running.

BOOTLOADB (Binary)

GNSS Bootloader1 and Bootloader2 monitor the serial ports for the download of SF-5050 binary software messages. [BOOTLOADB] is the message ID for the software that is being downloaded.

Message General Format

The message general format is defined in Table 231.

Table 231: BOOTLOADB Binary Message

Data Item (8 Bytes + data)	Data Type
Function Type SubID (enum)	U08
Pass or Fail (1 = pass, 0 = fail)	U08
Valid count	U16
Address	U32
Data	U08

Function Type

Function Type provides a Function/SubID of the command. The following function type SubIDs are defined as enum: Enums ending with “Cmd” are commands sent from the PC tool to the receiver). Enums ending with “Rep” are replies sent from the receiver to the PC tool).

Table 232: BOOTLOADB Message Function SubID Enum Definition

Value	Enum Name
1	NB_PingCmd
2	NB_PingRep,
3	NB_BaudCmd,
4	NB_BaudRep,
5	NB_SetupCmd,
6	NB_SetupRep,
7	NB_LoadDataCmd,
8	NB_LoadDataRep,
9	NB_ChkCrcCmd,
10	NB_ChkCrcRep,
11	NB_ProgCmd,

Table continued on next page…

Value	Enum Name
12	NB_ProgRep,
13	NB_EraseCmd,
14	NB_EraseRep,
15	NB_WriteFCmd,
16	NB_WriteFRep,
17	NB_ResetCmd,
18	NB_ResetRep,
19	NB_Working,
20	NB_EnumLast

Pass or Fail

For a reply message, this field indicates if the previous command passed or failed. For a command message, this field either is not used or it has another meaning.

Valid Count

This field indicates how many bytes in the data field are valid.

Address

When downloading data, this field indicates the destination address of the data. In the response message, if the pass/fail field is fail, this field indicates the error code. Error codes are defined in Table 233.

This field has other meanings under different circumstances.

Table 233: BOOTLOADB Message Error Codes

Enum	Value	Description
Err_PingTarget	0	Ping Target Error. This could be caused by an invalid value in the *ping_target* (*address*) field in the NB_PingCmd command or by trying to ping bootloader2 when bootloader1 is running.
Err_InvalidBaud	1	Invalid baud rate in NB_BaudCmd command
Err_SetupRange	2	Address range error in NB_SetupCmd command
Err_LoadData	3	Error in NB_LoadDataCmd command
Err_MaxAddr	4	Maximum address error. This could be caused by the maximum address of the data received being inconsistent with the value specified in the NB_SetupCmd command.
Err_BadCrc	5	Software image CRC error detected in replying to NB_ChkCrcCmd command
Err_EraseFlash	6	Erase flash error
Err_WriteFlash	7	Write to flash error
Err_Reset	8	Receiver reset error
Err_SubID	100	Unknown SubID received in [BOOTLOADB] command

Data

In the NB_LoadDataCmd message, this field contains the data. It has other meanings in other subID messages. The maximum size of this field is 2048 bytes.

BootloadB SubID Message Format

SubID NB_PingCmd Message Format

SubID NB_PingCmd is sent from the PC to the receiver. It is used by the PC to ping the receiver bootloader software and to start the bootloading process. Its format is defined in Table 234.

Table 234: SubID NB_PingCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_PingCmd*
Pass or Fail	U08	0. This field is not used for this command
Valid count	U16	0. There is no data following the address field
Address	U32	*Ping_Target*. *Ping_Target* is the receiver software type that the PC program is trying to ping. The software type enum is defined in Table 235. For this command, the valid value is ST_Bootblock1 or ST_Bootblock2. For SF-5050, Bootloader1 can be used for loading any GNSS board software from COM1 except itself. Bootloader2 can be used for loading any GNSS board software from both COM1 and COM2. Use bootloader2 to load software whenever possible.

Table 235: Software Type Enum

Enum	Value	Description
ST_Boot1	0	Bootloader1 software
ST_Boot2	1	Bootloader2 software
ST_NavProg	2	Navigation software

SubID NB_PingRep Message Format

SubID NB_PingRep is sent from the receiver to the PC. It is the reply message to NB_PingCmd. Its format is defined in Table 236.

Table 236: SubID NB_PingRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_PingRep*

Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field.
Address	U32	If pass, this field contains the enum of the software type that generates this response. If fail, this field contains error code *Err_PingTarget*.

SubID NB_BaudCmd Message Format

SubID NB_BaudCmd is sent from the PC to the receiver. It is used by the PC to specify an alternative baud rate for bootloading. This message is not required if the baud rate doesn't need to be changed. Its message format is defined in Table 237.

For SF-5050, if the GNSS software bootloading port is USB or Ethernet, this command has no effect and should not be sent. Also, due to hardware architecture design, if the GNSS software bootloading port is COM2, this command is not sent.

Table 237: SubID NB_BaudCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_BaudCmd*
Pass or Fail	U08	0. This field is not used for this command.
Valid count	U16	0. There is no data following the address field.
Address	U32	The baud rate the PC commands the receiver to change to. The supported baud rates are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200

SubID NB_BaudRep Message Format

SubID NB_ BaudRep is sent from the receiver to the PC. It is the reply message to NB_BaudCmd. Its format is defined in Table 238.

Table 238: SubID NB_BaudRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ BaudRep*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field
Address	U32	If pass, this field is 0. If fail, this field contains error code *Err_InvalidBaud*.

The receiver sends out this reply at the original baud rate, and then changes the port baud rate to the value specified in the *NB_BaudCmd* command.

The PC changes its baud rate after it receives this reply from the receiver. Wait 10 to 100 ms before sending the next command to allow both the receiver and the PC to finish changing the baud rate.

SubID NB_SetupCmd Message Format

SubID NB_SetupCmd is sent from the PC to the receiver. It is used by the PC to specify the minimum and maximum address of the data to be loaded. Its message format is defined in Table 239.

Table 239: SubID NB_SetupCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_SetupCmd*
Pass or Fail	U08	0. This field is not used for this command.
Valid count	U16	4. This is the data size following the address field (in bytes)
Address	U32	Minimum address of the software image data to be loaded
Data	U32	Maximum address of the software image data to be loaded

SubID NB_SetupRep Message Format

SubID NB_SetupRep is sent from receiver to PC. It is the reply message for NB_ SetupCmd. Its format is defined in Table 240.

Table 240: SubID NB_SetupRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ BaudRep*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0. There is no data following the address field.
Address	U32	If pass, this field is 0. If fail, this field contains error code *Err_SetupRange*.

SubID NB_LoadDataCmd Message Format

SubID NB_LoadDataCmd is used for sending software image data from the PC to the receiver. Its format is defined in Table 241.

Table 241: SubID NB_LoadDataCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_LoadDataCmd*
Pass or Fail	U08	For the SF-5050 receiver, this field is the data frame number between 1 and 255 (inclusive). For each subsequent data message, this number shall increment by 1. When it reaches 255, the next message shall have a value of 1 again. If SF-5050 bootloader2 receives a data message out of order, it won't ack or nak, which should cause a timeout for the PC to resend the old data frame. The current version of SF-5050 bootloader1 doesn't

		implement this mechanism. (This field is not used in SF-5050 bootloader1.)
Valid count	U16	Number of data in the data field (in bytes)
Address	U32	Destination address of the first data byte in the data field
Data	U08[]	Array of software image data

SubID NB_LoadDataRep Message Format

SubID NB_LoadDataRep is sent from the receiver to the PC. It is the reply message to NB_LoadDataCmd. Its format is defined in Table 242.

Table 242: SubID NB_LoadDataRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_LoadDataRep*
Pass or Fail	U08	1= pass, 0 = fail
Valid count	U16	This is the length for the data field (in bytes). 0 for SF-5050 bootloader1 1 for SF-5050 bootloader2
Address	U32	If pass, this field is the address in the received command. If fail, this field contains error code *Err_LoadData*.
Data	U08	This field only exists for SF-5050 bootloader2. It contains the data frame number of the received command that generates this reply.

SubID NB_ ChkCrcCmd Message Format

SubID NB_ ChkCrcCmd is sent from the PC to the receiver. It is used to tell the receiver that the data loading process is complete. After receiving this command, the receiver starts comparing the maximum address of the received data with the value in the NB_SetupCmd message and computing the CRC of all the received data. Its format is defined in Table 243.

Table 243: SubID NB_ChkCrcCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ChkCrcCmd*.
Pass or Fail	U08	This field is not used for this command. Value should be 0.
Valid count	U16	0
Address	U32	0

SubID NB_ChkCrcRep Message Format

SubID NB_ChkCrcRep is sent from the receiver to the PC. It is the reply message to NB_ChkCrcCmd. Its format is defined in Table 244.

Table 244: SubID NB_ChkCrcRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ChkCrcRe.*
Pass or Fail	U08	1= pass, 0 = fail
Valid count	U16	This is the length for the data field (in bytes). 4 if fail due to CRC error 0 otherwise
Address	U32	If pass, value is 0. If fail due to maximum address not equal to the value in NB_SetupCmd, value is error code *Err_MaxAddr*. If fail due to CRC error, value is error code *Err_BadCrc.*
Data	U32	This field only exists if fail due to CRC error. Its value is the computed CRC32 of the data image.

SubID NB_ProgCmd Message Format

SubID NB_ ProgCmd is sent from the PC to the receiver. It is used to tell the receiver to start programming the new data to Flash. After receiving this command, the receiver will start erasing the Flash and writing the new data to Flash. Its format is defined in Table 245.

Table 245: SubID NB_ProgCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ProgCmd*
Pass or Fail	U08	This field is not used for this command. Value should be 0.
Valid count	U16	0
Address	U32	0

SubID NB_EraseRep Message Format

SubID NB_EraseRep is sent from the receiver to the PC. It is one of the reply messages to NB_ProgCmd. The receiver sends out this message after it erases Flash, which typically takes 1 to 3 seconds. Its format is defined in Table 246.

Table 246: SubID NB_EraseRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_EraseRep*
Pass or Fail	U08	1= pass, 0 = fail
Valid count	U16	0
Address	U32	If pass, value is 0. If fail, value is error code *Err_EraseFlash*.

SubID NB_WriteFRep Message Format

SubID NB_WriteFRep is sent from the receiver to the PC. It is one of the reply messages to NB_ProgCmd. The receiver sends out this message after it writes new data to Flash, which can take up to 20 seconds, depending on program size. Its format is defined in Table 247.

Table 247: SubID NB_WriteFRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_WriteFRep*
Pass or Fail	U08	1= pass, 0 = fail
Valid count	U16	0
Address	U32	If pass, value is 0. If fail, value is error code *Err_WriteFlash*.

SubID NB_Working Message Format

SubID NB_Working is sent from the receiver to the PC. It is one of the reply messages to NB_ProgCmd. Receiver sends out this message at a rate of approximately 1 Hz when the receiver is erasing flash or writing data to Flash. It is used to keep the PC from timing out because erasing and writing data to flash could take up to 20 seconds. Its format is defined in Table 248.

Table 248: SubID NB_Working Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_Working*
Pass or Fail	U08	1
Valid count	U16	0
Address	U32	0

SubID NB_ResetCmd Message Format

SubID NB_ResetCmd is sent from the PC to the receiver. It is used to tell the GNSS board software to do a software reset after bootloading. After reset, the GNSS board runs navigation software, if software exists; otherwise, it will stay in bootloader1. Its format is defined in Table 249.

Table 249: SubID NB_ResetCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ResetCmd*
Pass or Fail	U08	0
Valid count	U16	0
Address	U32	0

SubID NB_ResetRep Message Format

SubID NB_ResetRep is sent from the receiver to the PC. It is the reply message to NB_ResetCmd. Its format is defined in Table 250.

Table 250: SubID NB_ResetRep Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_ResetRep.*
Pass or Fail	U08	1= pass, 0 = fail.
Valid count	U16	0
Address	U32	0

GNSS Software Loading Sequence

PC	Receiver Navigation Software
1. Send “[BOOTLOADA] PING, BOOT1, LOADSERIALBOOT1” or “[BOOTLOADA] PING, BOOT2, LOADSERIALBOOT2”	2. If GNSS board navigation software is running, it decodes the command and reply with “[BOOTLOADA]PING, NAV_PROG”. Then it runs bootloader1 or bootloader2. Bootloader1 and bootloader2 always run at default baud rate 57600. If GNSS board bootloader1 or bootloader2 is already running, it NAK this message.
PC	**Receiver Bootloader1 or Bootloader2**
3. If received [BOOTLOADA] reply, go to step 4. If received NAK, continue to send the [BOOTLOADA] command 2 more times, then go to step 4. 4. Change PC baud rate to 57600 and send out “[BOOTLOADB]NB_PingCmd” command. The ping_target field should be consistent with the one in [BOOTLOADA] command. “[BOOTLOADB]NB_PingCmd” may need to be sent out multiple times before a reply can be received due to receiver transitioning between navigation software and bootloader1 or bootloader2. It is suggested this command being sent out at 5 Hz rate until a reply is received. Normally when bootloader1 starts, there is a 0.5 seconds window that it listens to the bootload command. Sending this command at 5 Hz rate will improve the chance of bootloader1 catching the command within the window and help receiver recovery in some cases.	5. Bootloader1 or bootloader2 runs, receives the command and reply with “[BOOTLOADB]NB_PingRep”.
6. If PC wants to change baud rate, send “[BOOTLOADB]NB_BaudCmd”; otherwise, go to step 11. Note: This command shall not be sent under certain circumstances. Refer to 0 for more details.	7. Send “[BOOTLOADB]NB_BaudRep” and start to change receiver baud rate.

Table continued on next page…

PC	Receiver Bootloader1 or Bootloader2
8. After receiving “[BOOTLOADB]NB_BaudRep”, change PC baud rate. 9. Send “[BOOTLOADB]NB_PingCmd” again at new baud rate. This message may need to be sent multiple times before a reply is received, due to unsynchronization of changing baud rate between PC and receiver. It is suggested that this command be sent out at 1 Hz rate until a reply is received.	10. Reply “[BOOTLOADB]NB_PingRep”
11. Send “[BOOTLOADB]NB_SetupCmd”	12. Reply “[BOOTLOADB]NB_SetupRep”
13. Send “[BOOTLOADB]NB_LoadDataCmd”	14. Reply “[BOOTLOADB]NB_LoadDataRep”
15. Repeat step 13 and 14 until all the software image data are sent	
16. Send “[BOOTLOADB]NB_ChkCrcCmd”	17. Reply “[BOOTLOADB]NB_ChkCrcRep”
18. Send “[BOOTLOADB]NB_ProgCmd”	19. Start to erase Flash and send out “[BOOTLOADB]NB_Working” at 1 Hz rate 20. Reply “[BOOTLOADB]NB_EraseRep” when finished erasing the Flash 21. Start to write new data to Flash and send out “[BOOTLOADB]NB_Working” at 1 Hz rate 22. Reply “[BOOTLOADB]NB_WriteFRep” when finished writing new data to the Flash
23. Send “[BOOTLOADB]NB_ResetCmd”	24. Reply “[BOOTLOADB]NB_ResetRep” and do GNSS software reset.

H .... Web Server

☒SF-5050 ☐Onyx

Supported Browsers

- Firefox
- Chrome
- Safari
- Internet Explorer

Storage Location

1. Web pages are stored on the internal flash as part of the file system accessible via NavCom commands and FTP.
    a. The webpages need to be stored under A:\WEB\NCT or A:\WEB\OEM in order to be loaded.
    b. WEBCONTROL must be set to ENABLE mode in order for the unit to access the webpages.

Account information

1. The username and password are both case sensitive
2. There are 3 levels of access, refer to WEBUSERS cmd for more info:
    a. ADMIN
    b. TECH
    c. USER
3. The default account is:
    a. Username: admin
    b. Password: admin
    c. Access Level: ADMIN
4. There can be at least 1 and at most 9 accounts:
    a. At most and at least 1 ADMIN
    b. At most 8 and at least 0 USER or TECH
5. The admin account cannot be deleted or given a different access level
6. All accounts (with the exception of the admin) must only be modified via the web pages. They cannot be modified via StarUtil3000. Only the admin account can have its password updated via StarUtil3000.
7. There is a command that will wipe out all the user accounts except the admin account and return the admin account to its default password. Contact Customer Support for information on the command and its use.

How to Access

1. The unit must be connected to the internet or a Local Area Network
2. Use [ETHCONFIG] to configure the receiver's network connection
    a. Ensure that you are able to ping the receiver from the computer
3. The webpages must be enabled via WEBCONTROL (PPN default)
4. Open one of the supported browsers listed above and type in the IP Address returned by [ETHCONFIG] in the address bar
5. The receiver will prompt for a username and password, the default administractor account is:
    a. Username: admin
    b. Password: admin

How to Update

1. Open StarUtil3000 1.2.24+ and connect to the receiver via any port
2. Under Receiver Options, select Webpage Loader and hit Upload
3. Select the NCT or OEM directory provided which have all the web pages.
4. Hit Load
5. Wait for the receiver to reboot

Limitations

1. To avoid performance issues, only one user should access the receiver via the web pages at a time.
2. It takes about 30 – 60 seconds for the web server to be ready after boot up.
3. The NMEA page does not contain MLA and ALM due to the way they are output.
4. The page does not store any cookie information so the check boxes and text box inputs are cleared upon leaving the page.

Web and Ftp Commands

Command	Local port (e.g. Serial)	Web Browser	Ethernet Port
FtpControl	-Current state is readable. -Enable / Disable setting change is allowed.[1]	Input Terminal page: -Current state is readable. -Enable / Disable setting is blocked.[2]	-Current state is readable. -Enable / Disable setting is blocked.[2]
WebControl	-Current state is readable. -Enable / Disable setting change is allowed.[1]	Input Terminal page: -Current state is readable. -Enable / Disable setting is blocked.[2]	-Current state is readable. -Enable / Disable setting is blocked.[2]

Command	Local port (e.g. Serial)	Web Browser	Ethernet Port
FtpUsers	-Full control. -Passwords are displayed.	Input Terminal page: -Full control. -Passwords are displayed when logged on as TECH or ADMIN.[3] Manage FTP page:[6] - Full control. -Passwords for existing accounts are not displayed.	-Full control. -Passwords are displayed.
WebUsers	-Displays all users. -Passwords are displayed. -ADD, REMOVE and UPDATE are not supported for USER & TECH accounts. -UPDATE of an ADMIN account is allowed.	Input Terminal page: -Access Denied! is displayed.[4] Manage Web page:[5] -Displays all users. -Passwords for existing accounts are not displayed.[4] -ADD, REMOVE and UPDATE are supported for USER & TECH accounts. -UPDATE of an ADMIN account is allowed.	-Displays all users. -Passwords are displayed. -ADD, REMOVE and UPDATE are not supported for USER & TECH accounts. -UPDATE of an ADMIN account is allowed.

The above table shows behavior of the FTPCONTROL, WEBCONTROL, WEBUSERS, FTPUSERS commands. Some port access is restricted to alleviate security concerns.

[1] Local users are allowed to change these settings.

[2] FTPCONTROL and WEBCONTROL commands enable and disable network access. Remote, possibly malicious, users are not allowed to change these settings.

[3] Accounts with USER access level are blocked from the Input Terminal Page.

[4] Password readback is restricted.

[5] Must be logged on with an ADMIN level account

[6] Must be logged on with an ADMIN or TECH level account.