Technical Reference Manual

Sapphire

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As used in this publication, “Solaris” refers to the project name of the SF-3050.

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Revision History

Rev O (Sep 2020)	Release, specifically relates to ICD, version 7.52 (s/w ver. 4.0.5.0)
LOGFILEA	Update SF-3040 entries
MEAS1B	Added Version 2 definitions
RADIOTYPE	Added command for Deere Shared Base feature

Rev N (July 2017)	Release, specifically relates to ICD, version 7.45 (s/w ver. 3.6.11.0)
DATUM	Update all referenced to ITRF
NMEAPNCTDTM	Update ITRF datums for F1 and F8
PVT1B	Table 178 – Updated ITRF references

Rev M (July 2016)	Initial release; specifically relates to ICD, version 7.41 (s/w ver. 3.6.9.0)
3RDPARTYRTKX	Update description with regard to RTK-X
ANTLIST	Added command
ANTENNAHEIGHT	Added note to Phase Center Adjustment
ANTENNAINFO	Updated notes
ANTREMOTE	Added command
DATUM, PVT1B, & RTGQUICKSTART	Update the datum of StarFire GPS from ITRF2005 to ITRF 2008.
NTRIPCONFIG	Updated 30 second mountpoint and IP address for StarFire Over IP in Appendix H
STARFIREMODE	Update description with regard to RTK-X
USERANTTYPE	Added command
USERANTTYPEB	Added command and response
WEBLOADB	Update description to indicate that web pages can only be loaded via a PIOB port.

Rev L (June 2015)	Initial release; specifically relates to ICD, version 7.25 (s/w ver. 3.5.8.0)
WEBUSERS	Expanded command description at end
RADIO	Updated Network ID keyword
GGAMODE	Added keyword to Quality
ALM1B (output)	Added Table 181: Navigation Mode: SBAS Health and Status Byte
NTRIPCONFIG	Added NTRIP Version argument

Rev K (Aug 2014)	Initial release; specifically relates to ICD, version 7.08 (s/w ver. 3.4.11.0)
3RDPARTYRTKX	Added command information.
ALM1B	Table 14: deleted reference to Galileo Table 105: deleted reference to Galileo Section 2.3.3 changed to “Reserved.”
CHNLSTATUS1B	Deleted all references to Galileo
DEFINESFSAT	Added keyword NONE
DNSOVERRIDE	Added command information
EPHEM1B	Table 120: deleted reference to Galileo; 2.19.3: changed to Reserved.

Rev K (Aug 2014)	Initial release; specifically relates to ICD, version 7.08 (s/w ver. 3.4.11.0)
LOGFILE	Revised file naming convention in Note 16.
NMEAGST	Added note for use of [STDDEVMODE] command.
NMEAPNCTGGA	Added StarFire LP mode to Table 166
NMEAPNCTGST	Added note for use of [STDDEVMODE] command.
MBRTK1B	Added note defining baseline velocity in Table 126.
MEAS1B	Deleted all references to Galileo
MODEM	Deleted command
MODEMCONFIG	Deleted command.
NAVCONFIG1B	Table 140: changed Galileo to Reserved.
NAVMEASUSE	Added note specifying that receiver cannot operate on GLONASS signals alone.
PVT1B (Ver. 1 & Ver .2)	Corrected the FOM description. Table 179: Added RTK WL note and updated NavMode for StarFire LP Table 181: Added RTCM note
RADIO	Added keyword FEC for Satel modes
RAPIDRECOVERY	Added default setting and note specifying that the feature is available in GPS mode only. Added FOM_LIMIT and note specifying access time limits and FOM constraints.
REFSTNPOS	Added note specifying maximum position offset.
RTKDEFAULTS	Table 82: Switched value of RTK navigation elevation mask with value of RTK search elevation mask.
RTKMODE	Table 83: Removed reference to Galileo and COMPASS from note2. Added Type 31 and 34 to RTCM list.
STDDEVMODE	Added command information.
STARFIREEXTEND	Deleted command.
Section 4	Table 209: Added RTCM outputs Table 210: Added RTCM inputs Table 212: Added CMR input.
Appendix E	Added note regarding support for RTCM messages.
Appendix H	Updated StarFire Over IP caster information and URL
Table 10	Moved Panica entry and revised explanation below table.

Rev J (May 2013)	Initial release; specifically relates to ICD, version 6.79 (s/w ver. 3.3.10)
3RDPARTYRTKGLONASS	Updated description and added examples
ALM1B	Update command description and SBAS Almanac description.
AUTOSCHEDULEDTM	Added command information
INCLINECONSTR	Corrected angle limits
NEWSFALMREADY	Added output message description
NTRIPCONFIG	Added Authentication parameter.
RAPIDRECOVERY	Added command information
RTGQUICKSTART	Updated parameters and added new examples

Rev J (May 2013)	Initial release; specifically relates to ICD, version 6.79 (s/w ver. 3.3.10)
RTKMODE	Changed port to all available ports.
RTKTIMEOUT	Corrected timeout limits.
SELFSURVEY	Added note regarding the need to save the profile.
SETSFALMSWITCHMODE	Added command information.
SFALMENABLENEW	Added command information
UPTIME	Added command information
WEBCONTROL	Added command information
WEBUSERS	Added command information
WEBLOADB	Added command information
Appendix I	Added instructions for Web Server function.

Rev I (December 2012)	Initial release; specifically relates to ICD, version 6.57 (s/w ver. 3.2.11.0)
NMEATTM	Added note regarding use of TTM message.

Rev H (October 2012)	Initial release; specifically relates to ICD, version 6.57 (s/w ver. 3.2.11.0)
Appendix H	Added instructions for StarFire Over IP function.
Table 150: Beam Selection ID	Added Satellite 484 information.
DEFINESFSAT	Added max frequency and changed example.
INPUTSFLICENSE	Added to OUTPUT command.
MPAUTOCONNECT	Added command information
MEAS1B	Signal block definition changed
NCTCB/CD/CE	Added command. Updated option term for all
NMEAGNS	Corrected values in Table 134. Added note explaining F13 field.
NTRIPCLIENT	Added notes.
NTRIPCONFIG	Added AuthType Arg, Note 2 and Note 3.
NTRIPSTAT	Added message information
PACKB	Corrected code.
PRDGPSMODE	Added SF-Source information. Updated tables 76 and 77.
PROFILE	Added Note.
PVT1B	Added note about StarFire transitioning from ITRF2005 to ITRF2008.
RADIOSTAT	Updated warning message.
RTGQUICKSTART	Added note about StarFire transitioning from ITRF2005 to ITRF2008.
RTKMODE	Added optional parameter (X_ON/X_OFF) to enable or disable RTK-X.
RTKMULTIPATH	Changed default to SURVEYENVIRON.
RTKTIMEOUT	Corrected to indicate that the value is a float not an integer.
SBAS ALM1B	Updated binary message data in Table 94.
SELFSURVEY	Added command.
SELFSURVEYSTATUS1A	Updated time reference in fields F6 and F7. Added height value range in field F4.

Rev H (October 2012)	Initial release; specifically relates to ICD, version 6.57 (s/w ver. 3.2.11.0)
SFSTATUS1B	Added External Hub information.
WRAPPEDRTK	Added command.

Rev G (Sep 2012)	Initial release; specifically relates to ICD, version 6.52 (s/w ver. 3.0.16.0)
CONFIGGFA	Added command
DATUM	Added note about StarFire transitioning from ITRF2005 to ITRF2008.
MSGSTANDARD	Added command
NMEADTM	Updated output rate information.
NMEAGBS	Updated format to NMEA v4.1
NMEAGFA	Added message
NMEAGGA	Updated output rate information.
NMEAGLL	Updated output rate information.
NMEAGNS	Added message
NMEAGRS	Updated format to NMEA v4.1
NMEAGSA	Updated format to NMEA v4.1
NMEAGSV	Updated format to NMEA v4.1
NMEARMC	Updated format to NMEA v4.1 and output rate information.
NMEAVTG	Updated format to NMEA v4.1
NMEAPCTDTM	Added note about StarFire transitioning from ITRF2005 to ITRF2008. Updated output rate information.
NMEAPCTGGA	Added output rate information.
NMEATTM	Added message information

Rev F (Jan 2012)	Initial release; specifically relates to ICD, version 6.06 (s/w ver. 3.0.9.0)
Table 7: Standard Sapphire Binary Header Format	Corrected Time Confidence and Version byte count
1PPS	Corrected width and interval parameters Corrected example Added SF-3050 port support description
ANTALIGN	Added User Angle capability
BASEINFOA	Added output message
DATUM	Added WGS84 keyword
FIXBASELINE	Added formula and statement for estimating heading accuracy
GLONASSCORRECTION	Changed the default setting to Off and added a note with regard use with third party base stations
LOGFILE	Added *[LOGFILE]A: Responses* table Added more examples
LOGFILEAUTOSTART	Added support for the SF-3050 internal SD flash memory
MBRTK1B	Added formula and statement for estimating heading accuracy

Rev F (Jan 2012)	Initial release; specifically relates to ICD, version 6.06 (s/w ver. 3.0.9.0)
MSGPRODUCTINFO	Added a note regarding future product additions
NAVCONFIG1B	Changed data type in “2D Manual Height” from U08, to R64
NAVMEASUSE	Changed default setting from ALL, ON to L1,ON,L2,ON,L2C,OFF,L5,OFF,WAASEGNOS,OFF,GLONASS,ON
NMEA Messages	Added an NMEA Messages Overview Added output interval data for each supported NMEA message
NMEADTM	Added output message
NMEAPNCTDTM	Added output message
PACKB	Added update to support the SF-3050
PNCTGGA	Updated Satellite Beam Selection Table
PVT1B	Added byte count example Added an example for coverting Latitude from binary to degrees Added Mean Sea Level description to paragraph 2.79.2 Added a new bit mask to Additional Navigation Solution Status for SBAS geofencing
RADIO	Added channel width and protocol keywords Changed the default Network ID and Channel Bandwidth
RADIOSTAT	Added channel width and protocol keywords
REFNAME	Changed the number of characters Name field from a maximum of 30 to 10
ENABLERTCM2.3	Added command to allow switching between RTCM 2.2 and RTCM 2.3 data formats
RTKMODE	Added note to Dynamics: The SF-3040 does not support the Dynamic keword.
RTGQUICKSTART	Added statement indicating single frequency mode is not supported
SBASLIST	Updated change in number of supported PRN’s
SERIALMODE	Changed “This command selects either the RS232 or RS422 mode for the Sapphire COM2 serial interface” to “This command selects either the RS232 or RS422 mode for the SF-3050 COM2 serial interface.”
SFSATLIST1B	Update Note 1 with regard to number of satellites supported
STARFIREALM1B	Added output message
USBMODE	Corrected SF-3040 keywords from “comport” or “com port” to “com_port”, and “massstorage” or “mass storage” to “mass_storage”

Rev E (June 2011) Specifically relates to ICD, v. 5.62 (s/w ver. Sapphire/SF-3050 v. 2.2.8.0; SF-3040 v. 2.1.6.0)	
Message ID	**Revision Description**
2DNAVMODE	Updated the definition of ALWAYS in Table 13.
BATSTAT	Updated message
BER	Deleted message
CHNLSTATUS1B (Version 2)	Updated command. Table 114 was updated as follows: Changed “Constellation type and channel block count for this PRN” to “Number of channel blocks for this PRN”; added Note re definition matching Version 1, with certain exceptions
DATUM	Added valid ranges to Table 1: Parameter List for User-Defined Datum Added an example to the 14-parameter list to transform from ITR-05 (StarFire) to ITRF-00 (WGS-84, G1150); updated description of the DEFAULT parameter
EVENTLATCH	Deleted Port “B” from keyword definition for this command

Rev E (June 2011) Specifically relates to ICD, v. 5.62 (s/w ver. Sapphire/SF-3050 v. 2.2.8.0; SF-3040 v. 2.1.6.0)	
FSFORMAT	Updated command to include information about SD flash mounting progress and mounting errors
LOGFILE	Added new features for the SF-3040
LOGFILEAUTOSTART	Added command
L1FALLBACK	Added Note re usage of this command for challenging operating environments
MBRTK1B	Updated message label from “ASCII” to “Binary”
MSGPRODUCTINFO	Added SF-3040 to list
MULTISATTRACK	Added command
NCTBD & NCTBE	Added messages
NMEA Messages Overview	Updated the statement “$GPxxx, describes data generated from Galileo satellites only” to…”$GAxxx, describes data generated from Galileo satellites only”
NMEAGGA	Added a note regarding the GGA invalid flag operation
OUTPUT	Added RADIO to the list of ports
PACKB	Added command
PHASENAVSTATUS2B	Added message
PNCTGGA	Added four new field 14 values to support StarFire GNSS
PORT	Added keyword Flow Control
PVT1B	Updated Table 182, Table 178, and Table 179 Removed Table 154, mode 8 description
PWALARMLVL	Added command
RADIO	Updated command parameters; added Network ID parameter; Default changed from ON to OFF; updated the Notes; added new examples; added data related to the SF-3040
RADIOSTAT	Added message for the SF-3040
RTGQUICKSTART	Corrected Height from MSL to Ellipsoidal and added Solid Earth Tide reference
RTKMODE	Added the following note and renumbered all notes: “The SF-3040 does not support MBRTK mode”
SDCARD	Added message
SFLICENSEB	Added data item “Status” to Table 195; added Region Selection to end of command description
SFSTATUS1B	In section 2.94.1, added headings for Version 1 and Version 2 and added a description of the Current StarFire Satellite ID field for Version 2; in section 2.94.10, added heading for Version 1 and Version 3 and added a description of the StarFire License Status field for Version 3
SHUTDOWN	Updated command: added new logic for ungraceful shutdown detection
STARFIREMODE	Added command
TXRXINFOA	Updated the description and added new tables
USBMODE	Updated the Note; added warning Note about how to correctly remove the USB cable; updated warning Note about changing USB mode from COM port to other modes when the USB port is in an open state
APPENDIX E	Updated the factory default profile
APPENDIX F	Added Table 217, Port-Loading Requirement
Entire manual	Updated numbers of commands and messages throughout document, as necessary, to

Rev E (June 2011) Specifically relates to ICD, v. 5.62 (s/w ver. Sapphire/SF-3050 v. 2.2.8.0; SF-3040 v. 2.1.6.0)	
	maintain sequential numbering; updated all table and figure numbering; changed "This command will be used for the SF-3040" to "This command is used for the SF-3040."

Rev D (November 2010) Specifically relates to ICD, ver. 4.84 (s/w ver. 2.0.22.0)	
Message ID	**Revision Description**
ANTENNAHEIGHT	Added Default value
BATSTAT	Added message
BER	Added message
BTSET	Added a note that the Bluetooth DISCONNECT command can only be issued from non-Bluetooth ports; added CLEARMAP keyword (slated for use in a SF-3040)
BUZZER	Added this command and added statement that it is to be used with a SF-3040.
CANCELSFLICENSE	Added the following note: This command requires the receiver to be tracking GPS satellites at the moment the command is entered.
DATUM	Added the following note: Only one user datum can be stored at one time. Entering a new user datum overwrites the currently stored datum
ERASEALM	Added Default value
ETHVCOM	Added Default values
EXTRAPBASE	Changed example [EXTRAPBASE]OFF from "Sets receiver to MBRTK base" to "Turns off base-motion extrapolation mode"
FORCETALKERID	Added command
INPUTSFLICENSE	This command was not in alphabetical order in previous release. It has been re-sequenced: *was* 1.73; is: *1.75*
INPUTSWOPTION	This command was not in alphabetical order in previous release. It has been re-sequenced: *was* 1.72; is: *1.77*
LOGFILE	Added Note telling user what to do if this error occurs after entering the CHKDSK:A command: "Signature file not found"
MODEMCONFIG	Added "This command will be used in the SF-3040…" to the description of this command.
NMEA Messages, Overview	Updated Table 11: Supported NMEA Messages
NMEAHDT	Added message
NMEAROT	Added message
PASSTHRU	Added Default value
PING	Updated this command to refer user to Table 72, Output Command Mnemonics; added Default value
PVT1B	Updated StarFire Source Type – "Reserved" numbers revised from 0, 1, 3-15 to 0, 1, 4-15
RADIO	Added command
SBASLIST	Added Default value
SETUTCOFFSET	Added Default values
USBMODE	Added new section 1.167.1 On-the-Go (OTG), functionality that is slated for a SF-3040
APPENDIX C	Added Note telling user what to do if this error occurs after entering the CHKDSK:A command: "Signature file not found"

Rev D (November 2010) Specifically relates to ICD, ver. 4.84 (s/w ver. 2.0.22.0)	
Entire Manual	Updated numbers of commands and messages throughout document as necessary to maintain sequential numbering

Rev C (August 2010) Specifically relates to ICD, ver. 4.61 (s/w ver. 2.0.11.0)	
Message ID	**Revision Description**
ALM1B (Binary) (Command)	Updated command to include "OnTime" almanac data output
ALMB1B (Binary) (Output)	Updated Section reference in Table 105; added software version number for tracking
ANTALIGN	Added command
ANTENNAINFO	Added command
ARLENGTHCONSTR	Added command
ASCII Output Message Organization	Deleted heading
BTSET	Added command
CANCELSFLICENSE	Added a warning that this action cancels the subscription to StarFire signal service; users need to contact their dealer or NavCom to replace the license; added a sentence that the receiver time at the time of cancellation is used as the cancellation date
CHNLSTATUS1B	Updated command: Combined versions 1 and 2; updated Table 110, CHNLSTATUS1B Binary Message Data – data types and corresponding sections to data items; updated Table 114, CHNLSTATUS1B Satellite Block – referenced Constellation Type section; added software version for tracking
CMR Output Messages	Added GLONASS Observations (Type 3) to Table 213
CODENAVSTATUS1B	Deleted message
COLDSTART	Updated the command description; added the parameter DEFAULTALM; added a note re using the command with no parameters; added a note re the hard-coded almanac remaining in the receiver after the almanac in NVRAM is erased
DATUM	Added command
DYNAMICS	Deleted the RTKDYNAMIC and VELSMOOTH commands and combined them in this new command
ENABLEGEOFENCE	Added command
EPHEM1B	Added bit mapping of GLONASS String 1 table Updated section 2.19.4 to indicate that the SBAS message type 9 can now be scheduled OnTime; added software version for tracking; added note about EPHEM1B message being a special case; added caution about not polling the receiver for messages more often than every 60 sec.; added examples
ETHCONFIG	Updated this command to include the dynamic IP mode (AUTO) and the new DHCP and DNS parameters; updated the notes; updated examples
ETHVCOM	Command extensively updated: added description of IP packets; added description of four logical ports (ETH1 – ETH4); updated description of local port to range 0-65535 (from 0-65534), noting that ports 0-1023 are reserved by IANA; added Table 63, ETHVCOM Task Transport Protocol; added notes; added section on establishing an EVCOM session; added section on configuring an Ethernet connection; added/updated examples
EVENTLATCHA	Added a caution that this message should only be scheduled as ONCHANGE
EXTRAPBASE	Added command
FIXBASELINE	Added command

Rev C (August 2010) Specifically relates to ICD, ver. 4.61 (s/w ver. 2.0.11.0)	
Message ID	**Revision Description**
FSCD	Added command
FSCWD	Added command
FSDELETE	Added command
FSDIR	Added command
FSDRIVE	Added command
FSFORMAT	Added command
FSMKDIR	Added command
GLONASSCORRECTION	Added command
GREETING	Added command
INCLINECONSTR	Added command
INPUTSFLICENSE	Added input string example
INPUTSWOPTION	Added input string example; changed [INPUTSWOPTION]licensestring to [INPUTSWOPTION]optionstring
LOGFILE	Command extensively updated to include USB thumb drive functionality; defined keywords: start, stop, pause, resume; added running, ready, stopped, and paused to file logging status; added warnings re avoiding file system corruption, logging dating on drive A and drive B simultaneously, and logging data at too high a data rate
MEAS1B	Added software version for tracking
Message Query, pg 23	Changed [OUTPUT]VERSION,ONCE to [OUTPUT]MSGVERSION,ONCE
MBRTK1B	Added message
MODEM	Added command
MODEMCONFIG	Added command
NAVMEASUSE	Updated note about WAASEGNOS not being supported in Sapphire – added version 2.0; added warning about never using WAAS set to ON outside of the American WAAS iono grid footprint
NMEA Messages Overview, pg 30	Updated NMEA sentences naming conventions: added one that describes data generated from Galileo satellites only
NMEAALM	Updated command to include ontime almanac data output; updated Table 144, Message Output Format
NMEAMLA	Added note that this message can now be scheduled ontime; corrected typo “ciculing” (to “circling”) for output F7 in Table 157; added example
NMEAGGA	Added warning re messages exceeding maximum allowable length; added a paragraph after the examples re SF-3050 output messages w/ talker ID based on current navigation mode ($GP, $GL, and $GA)
NMEAPNCTGGA	Updated message: Updated Table 167 to reflect reassignment of satellites 609 and 643. Satellite 609, which was in Net1, is now in Net2; Satellite 643, which was in Net2, is now in Net1; for ID 01, RTCM Type1, added GLONASS correction message Types 31 and 34 to Table 136
NTRIPCONFIG	Added command
NTRIPCLIENT	Added command

Rev C (August 2010) Specifically relates to ICD, ver. 4.61 (s/w ver. 2.0.10.0) (Continued)

Message ID	Revision Description
OUTPUT	Updated command: Updated “port” identification keyword to include -1 to mean “all ports”; added warning regarding the use of -1; updated command port mnemonics table; updated the note to include statement that time intervals are limited to purchased option or are predefined based on message type; updated command mnemonics and Table 73 and Table 73; updated port number; added note about EPHEM1B message being a special case; added caution about not polling the receiver for messages more often than every 60 sec.; added examples; updated definition of “interval” parameter to include PRN numbers for EPHEM1B, RTCM3_1019, and RTCM3_1020
PASSTHRU	Updated the caution statement to include user ability to turn off pass-through session; added a comment that Sapphire ports F1 and F2 do not support this command; deleted Pass Through Command Port Mnemonics table.
PORT	Updated Sapphire serial port numbers
POWERMODE	Deleted this command – no longer supported in the software
PROCESSRATE	Switched the order of this command in this manual so that it precedes the PROFILE command
PROFILE	Updated to include MSAS SBAS system; switched the order of this command in this manual so that it now follows the PROCESSRATE command
PSEUDORANGESTATS B	Updated message heading number from 2.83 to 2.63
PVT1B (Version 1 and Version 2)	Removed UOM from DOP description in Table 178 and paragraph 2.92.4 Corrected the comment in the source code snippet (second to last line) from "// convert S24 to R32” to "// convert S32 to R32” Updated height description in section 0. Updated Solution Status Codes Table 179 in section 0 re user-specified datum flag Updated section 2.92.4 Added bit mask 0x02 in section 2.92.15 to indicate MBRTK mode (if set, navigation mode of 3-7 indicates moving base RTK) Removed meter unit in reference to PDOP
PVT3B	Added message
REFNAME	Updated command default from NAVCOM REF1 to REF1
RTCM 3.0 Output Messages	Added new messages; added paragraph re RTCM3_1019 and RTCM3_1020, that they can be scheduled OnTime
RTGQUICKSTART	Included a statement that best performance is achieved from a previously fully converged position and updated the Caution at end; updated Table 81
RTKMODE	Added Table 80, Base Modes, and updated the notes following the table; updated Table 84 and Table 85; added a paragraph after Table 80 about automatically scheduled messages; added dynamic_static parameters and examples; added moving base RTK examples; added Scheduling Type parameters (Auto and Manual) and an example of Manual
RTKMULTIPATH	Updated command: Resolved discrepancy in default value. The default is OPENSKY.
RTKSTNID	Deleted command
SBASLIST	Added command
SELFSURVEY	Updated the command, adding the parameter “time” and the commands start, stop, quick-start, quick-survey, and cancel and examples of these; added note re a waiting period for the RTG readings to “settle”; added a note re synonymity of quick-survey and quick-start and how receiver generates its best results

SETL1RTK	Added command

Rev C (August 2010) Specifically relates to ICD, ver. 4.61 (s/w ver. 2.0.10.0) (Continued)	
Message ID	**Revision Description**
SFLICENSEB	Corrected the description from Sapphire License to StarFire license; added definitions for the issue date and start/end dates.
SFNETPRIORITY	Added command
SHUTDOWN	Added description of graceful and ungraceful shutdown detection logic
SIMULATORSTART	Updated command: added an example
SOLIDEARTHTIDE	Updated command: updated the note (correction automatically applied to single and dual position solution, but not applied to non-differential and SBAS mode solutions, etc.)
STARFIREALTSAT	Updated command: "This command can be used to override selection of the default channel for StarFire" changed to "This command can be used to override selection of the default satellite ID for StarFire"; "Override the default channel selection with an alternate value" changed to "Override the default satellite ID selection with an alternate value".
TRACKELEVMASK	Updated command description to point out that satellites below this mask angle will not be tracked or used by the receiver
TRACKINGMODE	Updated the notes, updated Table 88, and added a warning
TXRXINFOA	Updated Table 205, the TXRXINFOA Message Output Format table: added Eth 2 – Eth 4 port fields and added Note 3 to the table
USBMODE	Updated command: added two optional Device parameters: ComPort and MassStorage and examples of these; added the Default: ComPort device mode
USEPROFILE	Updated warning re saving changed profile settings
WARMSTART	Updated command: added an example
APPENDIX C	Added Logging Data to Internal Memory
APPENDIX D	Added Uploading Unified Files
APPENDIX E	Added MBRTK Commands and Responses
APPENDIX F	Added Network RTK
APPENDIX G	Added details re uploading unified firmware without using StarUtil 3000

Rev B (October 2009) Specifically relates to ICD, version 3.37 (s/w ver. 1.0.1.5)	
Message ID	**Revision Description**
	Added the Software License Agreement section to Notices, and added Appendix B Software License Agreement
BOOTLOADB	Added note about PC baud rate requirements for download of GNSS firmware on COM1 and COM2 of the SF-3050 via a Serial connection
BOOTLOADPIOB	Added note about PC baud rate requirements for download of PIO firmware on COM1 and COM2 of the SF-3050 via a Serial connection
EPHEM1B	Added SBAS Ephemeris section
GEOIDALMODEL	Added the keyword, DEFAULT, and also identified it as the default setting for this command. Added a note explaining the use of the keyword, DEFAULT. Added a section describing the GEOIDAL99 Format.
GGAMODE	Added message
INPUTSFLICENSE	Updated StarFire License file extension to *.lic. Added an example of the file contents.

INPUTSWOPTION	Updated Software Options file extension to *.opt. Added an example of the file contents.
L1FALLBACK	Added default value
MSGCANCELCODESB	Updated as an encrypted message
MSGPRODUCTINFO	Deleted “SF-3050B” as a product type string. Added “SF-3050” as a product type string.
NAVMEASUSE	Revised note about the disabling of L1. It is now: “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.” Added note describing what the tracking of newer navigation satellite signals (L2C, L5, E1, and E5A) is contingent upon.
NCTBB	Added message
NMEAGGA	Added the high precision format to F2 (Lat), F4 (Lon), and F9 (Alt), and added an example of a high precision message string. Added a reference to the GGAMODE command, and NMEAPNCTGGA.
NMEAPNCTGGA	Added information about high precision string resolution of this message with references to NMEAGGA and GGAMODE. Changed PAC-W Satellite ID to 643 in the StarFire Beam Indicator table.
NVCLEAR	Removed message. Executing this command renders the receiver inoperable.
OUTPUT	Added this example: [OUTPUT] NONE,,,-1
PASSTHRU	Added these ports to the Pass Through Command Port Mnemonics Table: Bluetooth, USB Virtual COM port, USB Thumb Drive, Ethernet Virtual COM port
RTKMODE	Added and described Base5E2 mode. Added note that 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.
SFSTATUS1B (Versions 1 and 2)	Changed PAC-W Satellite ID to 643 in the StarFire Beam Indicator table. Added note to the section, “Current StarFire Signal Strength (Eb/No)”. Defined and added text to the section, “StarFire License Status”.
TRACKINGMODE	Added note describing what the tracking of newer navigation satellite signals (L2C, L5, E1, and E5A) is contingent upon. Added note on disabling tracking SBAS signals in areas where the receiver can track SBAS signals for regions other than where the receiver is located.
VELSMOOTH	Added default value

Rev A (Aug 2009)	Initial release; specifically relates to ICD, version 3.15 (s/w ver. 1.0.0.4)

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

Sapphire Integration Guide
P/N 96-310028-3001

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

StarUtil 3000 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 96-312001-3001

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 Sapphire Message Block Formats

Message Application

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

Refer to these sections for basic format information:

- ✓ *Sapphire ASCII Input Commands*
- ✓ *Sapphire 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.)

- ✓ *Sapphire Input Commands Detailed Formats*
- ✓ *Sapphire Output Messages Detailed Formats*

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 [OUTPUT] 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 OUTPUT in this manual for more information about the OUTPUT command.

Sapphire ASCII Input Commands

ASCII input commands are used to set parameters which control the operation of the Sapphire 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 Sapphire 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 Sapphire 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 Sapphire 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 Sapphire 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 Sapphire 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 Sapphire 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

Sapphire Output Messages

The Sapphire 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 Sapphire 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.

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

Both ASCII and binary Sapphire 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

Sapphire 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 Sapphire binary output messages.

Table 6: General Format of Sapphire 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 Sapphire binary messages use the standard binary message header. The simplified binary header is used only in some special cases; e.g., bootloading. The Sapphire 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 Sapphire 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 Sapphire 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

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
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 *Sapphire Input Commands Detailed Formats* and 2 *Sapphire Output Messages Detailed Formats*.

Several different navigation solutions may be computed at a 1 Hz rate. Refer to *Section 2.92*, PVT1B, for detailed information. The navigation rate sets the measurement rate, which must be purchased. 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 when the data changes at the highest purchased rate the system can output. 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 3000, 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 Sapphire 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 3000, 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.

The command mnemonic [USEPROFILE] 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.

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

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 or up to v.3.0.13 of the software. Subsequent software versions support NMEA 0183, v.4.1. A software "switch" is available to return NMEA data to the former standard version. 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.

These messages are output messages *only*. The receiver does not process NMEA-0183 input data.

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.

Table 11: Supported Standard NMEA Output Messages

NMEA Message	Description
ALM	GPS Almanac Data
DTM	Datum Reference
GBS	GNSS Satellite Fault Detection
GFA	GNSS Fix Accuracy and Integrity (v.4.1)
GGA	Global Positioning System Fix Data
GLL	Geographic Position – Latitude/Longitude

GNS	GNSS Fix Data (v.4.1)
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
TTM	Tracked Target Message
VTG	Course over Ground and Ground Speed
ZDA	Time and Data

Table 12: Supported Non-Standard NMEA Output Messages

NMEA Message	Description
PNCTDTM	Datum Reference
PNCTGGA	Global Positioning System Fix Data, with additional station ID information
PNCTGST	Scaled Pseudorange Noise Statistics
PNCTMDE	Marginally Detectable Error
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 detailed formats for

- ✓ Sapphire Input Commands (in alphabetical order according to their identifying mnemonics)
- ✓ Sapphire Output Messages (in alphabetical order according to their identifying mnemonics)
- ✓ Legacy Starlight 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 Sapphire Input Commands Detailed Formats

This section provides Sapphire 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-3050 ☒Sapphire ☐SF-3040

This command is used to set up and control the output of the programmable PPS signal. 1PPS is available on COM1 pin 3 and Power pin 1 of the SF-3050. They are physically from the same 1PPS driver.

Command:	[1PPS] polarity, width, interval, delayMS, delayNS
Parameter	Definition
polarity	Keyword that defines the polarity of the PPS pulse (NEGATIVE, POSITIVE)
width	Sets the width of the PPS pulse (integer, nano-seconds) (25-1600000)
interval	Sets the interval in between pulses (integer, milli-seconds) (1-32768)
delayMS	Sets the delay of the PPS pulse from GPS time (integer, milli-seconds) (0-32768)
delayNS	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-3050 ☒Sapphire ☒SF-3040

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	2D navigation mode, keyword (NEVER, ALWAYS, AUTO) defined in Table 13.
height	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.

mode *Default*: *NEVER*

height *Default*: *0.0 meters*

Table 13: 2D Navigation Mode Settings

Keyword Mnemonic	2D Mode of Operation
NEVER	Never generate a 2D solution. Always generate a 3D solution or no solution at all.
ALWAYS	Always generate a 2D solution, with the height fixed at the valued entered via the height parameter. If this keyword is entered, the height parameter must be entered by the user or the command will be rejected.
AUTO	Generate a 3D solution whenever possible. Otherwise, automatically try to generate a 2D solution, with the height fixed at the entered height value, or at the previous height value if no height is entered.

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 Reserved

1.4 Reserved

1.5 3RDPARTYRTKGLONASS

☒SF-3050 ☒Sapphire ☒SF-3040

For software version 3.4.2 or later.

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
AUTO, ON,OFF	Keyword: {AUTO,ON,OFF} AUTO: Sets the source which can change by the unit depending on the 1033 message (or any other similar message ON: Sets the source and will not be changed by the unit regardless of the 1033 message (or any other similar message) OFF: Turns off this feature.
Receiver Type	NAV, NOV, TRI, JVD, TOP, LEI, UNKNOWN, MANUAL
Bias	Floating Point bias value for MANUAL mode

Default: *AUTO, UNKNOWN*

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

LEI: Leica

Behavior Summary:

Mode	Source	Use in L1PNav Float	Fix Glonass Ambiguity
OFF	-	NO	NO
ON or AUTO	UNKNOWN	YES	NO
ON or AUTO	Not UNKNOWN	YES	YES

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] AUTO, NOV
Receiver will use Glonass RTK corrections from a Novatel receiver. If a Navcom Base transmits 1007, 1008 or 1033 message, then this will change to AUTO, NAV

[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.

For software version 3.2.7 or earlier:

This command is used to turn on or off 3rd party GLONASS RTK corrections usage in RTK.

Command:	[3RDPARYRTKGLONASS] {ON, OFF}
Parameter	Definition
ON,OFF	Keyword: {ON,OFF} *Default*: *OFF*

Examples:

[3RDPARTYRTKGLONASS] ON
Receiver will use GLONASS RTK corrections in RTK.

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

1.6 3RDPARTYRTKX

☒SF-3050 ☒Sapphire ☒SF-3040

This command enables a “FallBack” feature for 3rd party corrections in order to improve the RTK-X performance. Enabling this will turn off the Starfire Backup Engine (SF GPS) and will use that engine to calculate the bias vector for the RTK-X solution. Use only if SF GNSS is the primary positioning mode and not SF GPS. If operating on SF GPS, this feature must be turned OFF. 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.

This command will be saved in the user profile. If this command is disabled, it must be saved in the profile for the changes to take effect.

1.7 Reserved

1.8 ALM1B (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This is a binary command used to enter different types of almanac data manually. Refer to section 2.3, ALM1B (Version 1; v1.0.0.4) (Binary) for details on the binary format.

Table 14: ALM1B Binary Command

Data Item	Data Type	Section
Satellite type (-1=NONE, 0=GPS, 1=Reserved, 2=SBAS, 3=GLONASS)	U08	
Almanac data		2.3.1 to 2.3.3

To output [ALM1B] data, use an [OUTPUT] command to schedule the message “onchange”, “once”, or “ontime”. The command does not differentiate which type of almanac types to output. If the message is scheduled “once”, all types of almanac will be output. If it is scheduled “onchange”, only what’s updated will be output. If it is scheduled “ontime”, the minimum interval is 60 seconds.

Only GPS and GLONASS almanac data can be entered manually.

1.9 ANTALIGN (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

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

Command:	[ANTALIGN] mode, <user_angle>
Parameter	Definition
Mode	LAT: Indicates two fixed antennae are laterally installed. The antennae are mounted in a ‘left-to-right’ alignment perpendicular to the center line of the vehicle. On an aircraft, this is known as the ‘axis of pitch’. LON: Indicates two fixed antennae are longitudinally installed. The antennae are mounted in a ‘front-to-rear’ alignment along the center line of the vehicle. On an aircraft, this is known as the ‘axis of roll’. USER: Assume longitudinally installation with additional user_angle rotation. The user_angle must be between 0-360 degrees relative to the center line of the platform
User Angle	0-360 degrees relative to the center line of the platform; referenced from the rover

Default: *LON*

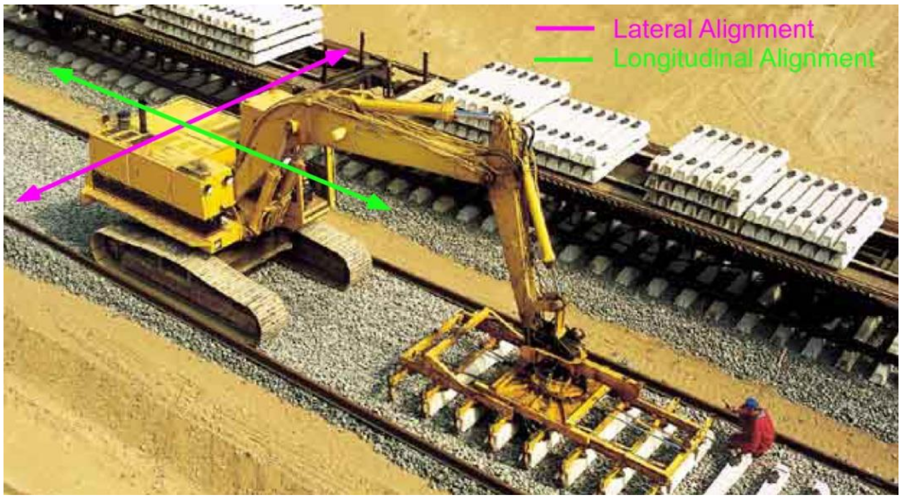

Figure 1: Antennae Alignment – Lateral and Longitudinal

Examples: [ANTALIGN] LAT
Two fixed antennas are laterally installed.

[ANTALIGN] LON
Two fixed antennas are longitudinally installed.

[ANTALIGN] USER, 352

User defined angle of 352 degrees clockwise (or 8 degrees counterclockwise)

[ANTALIGN]
Status is displayed.

1.10 ANTENNAHEIGHT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[ANTENNAHEIGHT] {mode}, antenna phase center adjustment, slant range of antenna body, radius of antenna body
Parameter	Definition
Mode	Keyword (ON, OFF) to enable/disable the antenna height adjustment. If this argument is empty, the receiver returns the current setting of the enable flag.
Phase Center Adjustment	Antenna height adjustment within -128 - +127 millimeters. It will be ignored if the mode is set to OFF. (Integer, millimeters); For firmware version 3.6.3 or later, this field is replaced with "Reserved", since no other source of Antenna compensation is supported other than the Antenna Database included in the firmware. In firmware v3.6.6 and later, this value is always set to 0. Use [ANTENNAINFO] for Phase Center Adjustment.
Slant range of Antenna Body	-32768 - +32767 (Integer, millimeters)
Radius of Antenna Body	-32768 - +32767 (Integer, millimeters)

Default: OFF

Examples: [ANTENNAHEIGHT]ON,5.5,5000,3000
Command to set antenna height, slant range, and radius of antenna body

[ANTENNAHEIGHT]ON,0,5000,3000
Firmware v3.6.6 command to set antenna height, slant range, & antenna body radius

OK [ANTENNAHEIGHT]
Response from the receiver

[ANTENNAHEIGHT]
Request for antenna height settings

[ANTENNAHEIGHT]ON,5.5,5000,3000
Response shows antenna height adjustment setting parameters

[ANTENNAHEIGHT]OFF
Command to disable antenna height adjustment

OK [ANTENNAHEIGHT]
Response from the receiver

[ANTENNAHEIGHT]
Request for antenna height adjustment enable status

[ANTENNAHEIGHT]OFF
Response shows antenna height adjustment is disabled

1.11 ANTENNAINFO (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command allows the user to modify and retrieve antenna information, including the IGS name, serial number, and setup ID.

Command:	[ANTENNAINFO] name, serial number, setup ID
Parameter	Definition
Name	IGS name of antenna (alphanumeric string of 0 – 32 bytes); must begin and end with quotation marks (“”); must be the exact spelling, case, and spacing of the IGS name.
Serial Number	Serial number on the antenna (alphanumeric string of 0 – 32 bytes); must begin and end with quotation marks (“”)
Setup ID	User-assigned antenna number of one unsigned byte (string of 0 – 255)

Any combination of parameters can be made by inserting nothing between the commas.

The user may submit a string value of "" to zero-out a value.

If an antenna name that doesn’t follow the IGS convention is entered, or more or fewer than 20 characters are typed inside of the quote marks for the antenna name, or the name is not listed in the receiver antenna database, the return value of [ANTENNAINFO] is “UNKNOWN”. Type [ANTENNAINFO] after setting the parameters to check its return value after changing the antenna name to confirm the change is applied. This applies to the [ANTREMOTE] command as well.

There is one exception which applies to the user-defined antenna names. For the two user-defined antenna names, the IGS convention is not a required format; the user can enter a preferred name, as long as it has no more than 20 characters inside of the quote mark.

Using an antenna from the database will provide position at Antenna Reference Point (ARP) in NCT RTK, RTCMv3, RTKX, and StarFire navigation modes. RTCMv2, SBAS, and nondifferential navigation modes are measured in Antenna Reference Point (APC), which can adjusted using the ANTENNAHIEGHT command.

Default: SF-3050 & Sapphire is "NAV_ANT3001R   NONE"
SF-3040 is “NAVSF3040   NONE”

Examples: [ANTENNAINFO] "NAV_ANT3001R   NONE", "7497", 48
Specifies all three parameters

[ANTENNAINFO] "NAV_ANT3001R   NONE"
Specifies the name only

ANTENNAINFO]”ANT-1”, “100300”, 48
Specifies all three parameters

[ANTENNAINFO]”ANT-1”
Specifies the name only

[ANTENNAINFO], “100300”
Specifies the serial number only

[ANTENNAINFO], , 48
Specifies the setup ID only

[ANTENNAINFO] "NAV_ANT3001R   NONE", "7497"
Specifies the name and serial number

[ANTENNAINFO] "NAV_ANT3001R   NONE",, 48
Specifies the name and setup ID

[ANTENNAINFO],"7497"*, 48*
Response from the receiver

[ANTENNAINFO]
Requests the current settings

OK [ANTENNAINFO]
Response from the receiver

1.12 Reserved

1.13 Reserved

1.14 ANTLIST

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to list the names of all the antennas in the PCO/PCV database.

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

Examples [ANTLIST]
List Antennas 1-200

[ANTLIST] LAST200
List Antennas 201-399

1.15 ANTREMOTE

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used by a rover to set the base antenna type.

Command:	[ANTREMOTE] mode {, antenna type}
Parameter	Definition
mode	Keyword AUTO specifies to accept RTCM message 1007, 1008, or 1033 content; or MANUAL specifies to use a user entered antenna type
antenna type	2-20 character string matching an antenna in the database. The database utilizes the IGS antenna naming convention.

Default: *AUTO*

If an antenna name that doesn't follow the IGS convention is entered, or more or fewer than 20 characters are typed inside of the quote marks for the antenna name, or the name is not listed in the receiver antenna database, the return value of [ANTREMOTE] is "UNKNOWN". Type [ANTREMOTE] after setting the parameters to check its return value after changing the antenna name to confirm the change is applied. This applies to the [ANTENNAINFO] command as well.

There is one exception which applies to the user-defined antenna names. For the two user-defined antenna names, the IGS convention is not a required format; the user can enter a preferred name, as long as it has no more than 20 characters inside of the quote mark.

Examples: [ANTREMOTE] AUTO

Uses the antenna type transferred by the the rover.

[ANTREMOTE]MANUAL, "NAVANT5001R   NONE"

1.16 ARLENGTHCONSTR (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

Use this command 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.

Command:	[ARLENGTHCONSTR] ON, OFF
Parameter	Definition
ON	Keyword ON specifies baseline length used as constraint
OFF	Keyword OFF specifies baseline length not used as constraint

Default: *OFF*

⚠ This constraint is fairly sensitive. Apply this constraint if you can supply a baseline length within 1 cm of accuracy. If your baseline length is not accurate within 1 cm, do not apply this constraint.

Examples: [ARLENGTHCONSTR] ON
Use length as constraint

[ARLENGTHCONSTR] OFF
Do not use length as constraint

[ARLENGTHCONSTR]
Displays length constraint status

1.17 Reserved

1.18 Reserved

1.19 Reserved

1.20 AUTOSCHEDULEDTM

☒SF-3050 ☒Sapphire ☒SF-3040

This command controls the automatic scheduling of the 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, NMEAGNS, or NMEARMC.
    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	Keyword ON: NMEADTM will be scheduled automaticall ONCHANGE whenever the user schedules either NMEAGGA, NMEAGLL, or NMEARMC. NMEAPNCTDTM will be scheduled automatically ONCHANGE whenever the user schedules NMEAPNCTGGA.
OFF	Keyword OFF: NMEADTM will NOT be scheduled automatically. NMEAPNCTDTM will NOT be scheduled automatically.

Default: *ON*

1.21 Reserved

1.22 Reserved

1.23 BOOTLOADA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 [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	What action the bootloader is to take (see Table 15 and Table 16).

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

The SF-3050 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-3050 does not support bootloading through the Bluetooth interface.

Example: [BOOTLOADA] PING, BOOT2, LOADSERIALBOOT2

Table 15: 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-3050, bootloader1 only supports loading through COM1.

Table 16: BOOTLOADA Bootloader2 Actions

Bootloader2 Action	Description
LOADSERIALBOOT2	Bootload through the serial port using bootloader2. For the SF-3050, 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.

For information on loading firmware without using StarUtil 3000, see Appendix G.

1.24 BOOTLOADB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

GNSS Bootloader1 and Bootloader2 monitor the serial ports for the download of SF-3050 binary software messages. [BOOTLOADB] is the message ID for the software that is being downloaded. BOOTLOADB uses the simplified Sapphire binary header format described in Table 9.

On COM1 of the SF-3050, the maximum PC baud rate to download PIO firmware via a Serial Connection is 115200 (see Table 24).

On COM2 of the SF-3050, the required PC baud rate to download PIO firmware via a Serial Connection is 57600.

These requirements do not apply to a USB 2.0 Device or Ethernet connection.

1.24.1 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 Solaris.

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

For Solaris (Sapphire), the input file for the PowerIO board bootload process could be one of the following: PIO bootloader and application.

1.24.1.1 Solaris (Sapphire) S0 Record Format

For Solaris, 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 17: 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 22
Data	U08[12]	ANSI C standard software build date string. Example: Mar 13 2009
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 22 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
S01900003A32313A33380000000003000001534F4C415249532063
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
```

1.24.2 BOOTLOADB Message Body General Format

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

Table 18: 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

1.24.2.1 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 19: 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

1.24.2.2 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.

1.24.2.3 Valid Count

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

1.24.2.4 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 20. This field has other meanings under different circumstances.

Table 20: 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

1.24.2.5 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.

1.24.3 BootloadB SubID Message Format

1.24.3.1 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 21.

Table 21: 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 22. For this command, the valid value is ST_Bootblock1 or ST_Bootblock2. For the SF-3050, 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 22: Software Type Enum

Value	Enum	Description	Product String (in Software Info Structure)
0	ST_Boot1	GNSS board Bootloader1 software	SOLARIS GNSS BOOT1
1	ST_Boot2	GNSS board Bootloader2 software	SOLARIS GNSS BOOT2
2	ST_NavProg	GNSS board Navigation software	SOLARIS GNSS APP
3	Reserved	Reserved	Reserved
4	Reserved	Reserved	Reserved
4	ST_PioBoot	PIO board bootloader (Solaris only)	SOLARIS PIO BOOT
5	ST_PioApp	PIO board application (Solaris only)	SOLARIS PIO APP

1.24.3.2 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 23.

Table 23: 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*.

1.24.3.3 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. Its message format is defined in Table 24.

For the SF-3050, 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 24: 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

1.24.3.4 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 25.

Table 25: 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.

1.24.3.5 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. Its message format is defined in Table 26.

Table 26: 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

1.24.3.6 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 27: 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*.

1.24.3.7 SubID NB_LoadDataCmd Message Format

SubID NB_LoadDataCmd is used for sending software image data from PC to receiver. Its format is defined in Table 28.

Table 28: SubID NB_LoadDataCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum NB_LoadDataCmd.
Pass or Fail	U08	For Solaris GNSS bootloader1, this field is not used. Value should be 0. For Solaris 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 Solaris 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 Solaris 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 Solaris bootloader1 doesn't implement this mechanism. (This field is not used in Solaris 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

1.24.3.8 SubID NB_LoadDataRep Message Format

SubID NB_LoadDataRep is sent from receiver to PC. It is the reply message for NB_LoadDataCmd. Its format is defined in Table 29.

Table 29: 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-3050 bootloader1. 1 for SF-3050 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-3050 bootloader2. It contains the data frame number of the received command that generates this reply.

1.24.3.9 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 30.

Table 30: 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

1.24.3.10 SubID NB_ChkCrcRep Message Format

SubID NB_ChkCrcRep is sent from receiver to PC. It is the reply message for NB_ChkCrcCmd. Its format is defined in Table 31.

Table 31: 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.

1.24.3.11 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. Its format is defined in Table 32.

Table 32: 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

1.24.3.12 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. Its format is defined in Table 33.

Table 33: 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.

1.24.3.13 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. Its format is defined in Table 34.

Table 34: 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.

1.24.3.14 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. Its format is defined in Table 35.

Table 35: 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

1.24.3.15 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. Its format is defined in Table 36.

Table 36: 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

1.24.3.16 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 37.

Table 37: 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

1.24.4GNSS 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".

Table continued on next page…

PC	Receiver Navigation Software
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 1.24.3.3 for more details.	7. Send "[BOOTLOADB]NB_BaudRep" and start to change receiver baud rate.
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.

For information on loading firmware without using StarUtil 3000, see Appendix G.

1.25 BOOTLOADPIOB (Binary)

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used for downloading new Solaris (Sapphire) Power I/O cold bootloader and application software images. The binary software message that is downloading has the message ID [BOOTLOADPIOB]. BOOTLOADPIOB uses the simplified Sapphire binary header format described in Table 9.

The input file format of the PIO bootload process is the same as described in section 1.24.1.

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.

On COM2 of the SF-3050, the maximum PC baud rate to download PIO firmware via a Serial Connection is 115200 (see Table 42).

On COM1 of the SF-3050, the required PC baud rate to download PIO firmware via a Serial Connection is 57600.

These requirements do not apply to a USB 2.0 Device or Ethernet connection.

1.25.1 Message General Format

The message general format is defined in Table 38.

Table 38: BOOTLOADPIOB 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[]

1.25.1.1 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 the PC to the receiver. Enums ending with “Rep” are replies sent from the receiver to the PC).

Table 39: BOOTLOADPIOB 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

1.25.1.2 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 has another meaning (defined below).

1.25.1.3 Valid Count

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

1.25.1.4 Address

When downloading data, this field indicates the destination address of the data. In response messages, if the pass/fail field is fail, this field indicates the error code. Error codes are defined in Table 20. This field has other meanings under different circumstances (defined below).

1.25.1.5 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.

1.25.2 BOOTLOADPIOB SubID Message Format

1.25.2.1 SubID NB_PingCmd Message Format

SubID NB_PingCmd is sent from PC to 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 40.

Table 40: 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.

1.25.2.2 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. Its format is defined in Table 41.

Table 41: 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.

1.25.2.3 SubID NB_BaudCmd Message Format

SubID NB_BaudCmd is sent from PC to 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 (see Table 42 for the message format).

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

Table 42: 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	Baud rate PC commands the receiver to change to. The supported baud rates are: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

1.25.2.4 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 43.

Table 43: 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, 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. It is recommended that the PC wait for 10 to100ms before it sends the next command to allow both the receiver and PC to finish changing baud rate.

1.25.2.5 SubID NB_SetupCmd Message Format

SubID NB_SetupCmd is sent from PC to receiver. It is used for the PC to specify the minimum and maximum address of the data to be loaded (see Table 44 for the message format).

Table 44: 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

1.25.2.6 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 45.

Table 45: 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.

1.25.2.7 SubID NB_LoadDataCmd Message Format

SubID NB_LoadDataCmd is used for sending software image data from PC to receiver. Its format is defined in Table 46.

Table 46: 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 subsequent data message, this number increments by 1. When it reaches 255, the next message has the value 1. The Solaris 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 Solaris (Sapphire) 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

1.25.2.8 SubID NB_LoadDataRep Message Format

SubID NB_LoadDataRep is sent from receiver to PC. It is the reply message for NB_LoadDataCmd. Its format is defined in Table 47.

Table 47: 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 the Solaris (Sapphire) bootloader1. 1 for Solaris (Sapphire) 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 contains the data frame number of the received command that generates this reply.

1.25.2.9 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 48.

Table 48: SubID NB_ChkCrcCmd Message 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. The value should be 0.
Valid count	U16	0
Address	U32	0

1.25.2.10 SubID NB_ChkCrcRep Message Format

SubID NB_ChkCrcRep is sent from receiver to PC. It is the reply message for NB_ChkCrcCmd. Its format is defined in Table 49.

Table 49: SubID NB_ChkCrcRep Message 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, 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.

1.25.2.11 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.

The cold bootloader sends the NB_EraseRep, NB_WorkingRep and NB_WriteRep messages (described below) while programming, then waits for additional commands. The warm bootloader responds with an NB_WriteFRep response, then automatically reboots after programming is complete.

The NB_ ProgCmd format is defined in Table 50.

Table 50: SubID NB_ProgCmd Message 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. The value should be 0.
Valid count	U16	0
Address	U32	0

1.25.2.12 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. Its format is defined in Table 51. This reply is sent by the PIO cold bootloader, but not the warm bootloader.

Table 51: SubID NB_EraseRep Message 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.

1.25.2.13 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. Its format is defined in Table 52.

Table 52: SubID NB_WriteFRep Message 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.

1.25.2.14 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 could take up to 20 seconds. Its format is defined in Table 53. This message is sent by the PIO cold bootloader but not the warm bootloader.

Table 53: SubID NB_Working Message 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

1.25.2.15 SubID NB_ResetCmd Message Format

The SubID NB_ResetCmd is sent from PC to receiver. It is used to command 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. Its format is defined in Table 54.

Table 54: SubID NB_ResetCmd Message Format

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

1.25.2.16 SubID NB_ResetRep Message Format

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. The format of this message is defined in Table 55.

Table 55: SubID NB_ResetRep Message 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

1.25.3PIO Software Loading Sequence

The PIO software loading sequence is similar to the GNSS board software loading described in section 0. Figure 2 shows the message protocol.

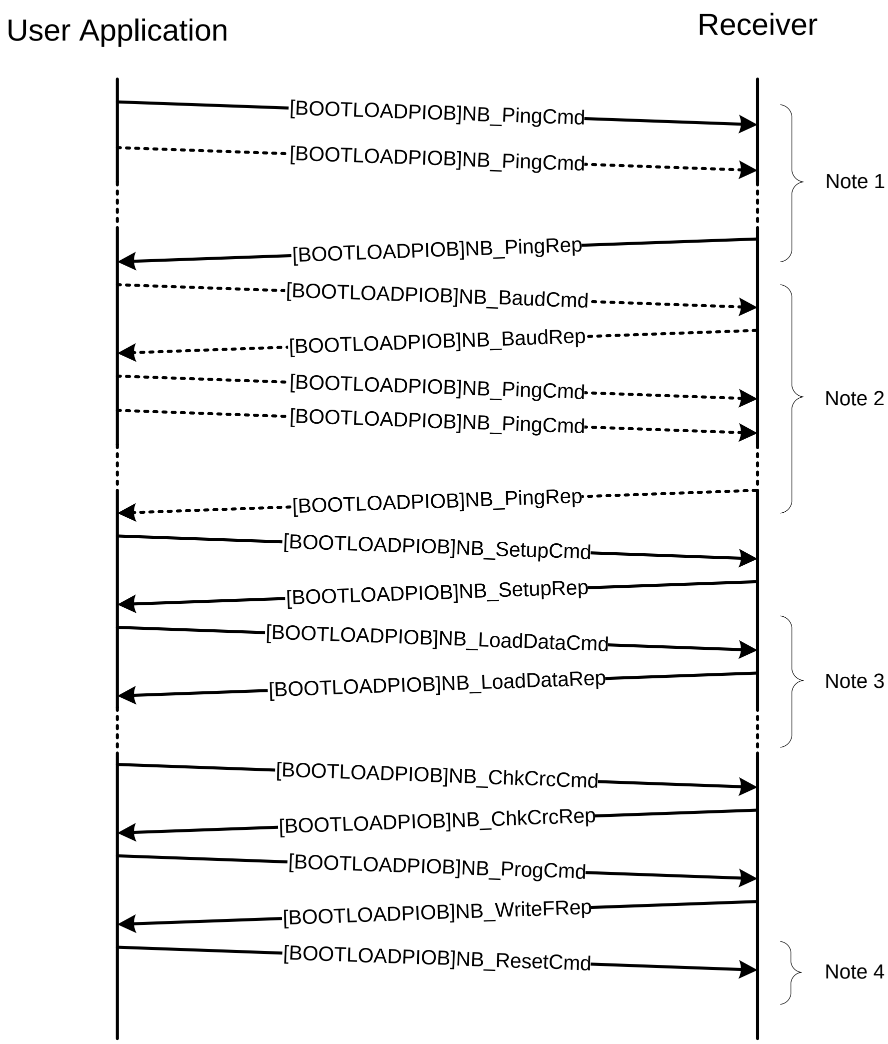

Figure 2: BOOTLOADPIOB Message Protocol

The 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 chooses to use it. If a NB_LoadDataCmd is not acknowledged, 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_ResetRep 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.

1.26 Reserved

1.27 Reserved

1.28 BTSET (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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 56: [BTSET] Command Action Keywords (Subcommands)

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

1.29 BUZZER

☐SF-3050 ☐Sapphire ☒SF-3040

This command is used in the SF-3040 to set the buzzer mode.

Command:	[BUZZER] (mode), Volume
Parameter	Definition
ON	Keyword that enables the buzzer (see note below)
OFF	Keyword that disables the buzzer (see note below)
AUTO	Keyword that specifies the default mode
Volume	Parameter that functions only with the ON keyword

Default: AUTO

Upon power-up, the buzzer is in AUTO mode. In this mode, the buzzer is controlled by a power management code. The buzzer turns on and off to indicate the state of the SF-3040 batteries. The threshold for the buzzer being turned on can be adjusted using the [PWALARMLVL] command.

The keywords ON and OFF are used to overwrite power management and set the buzzer state according to user preferences.

1.30 CANCELSFLICENSE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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.

1.31 Reserved

1.32 Reserved

1.33 Reserved

1.34 COLDSTART (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[COLDSTART] {DEFAULTALM}
Parameter	Definition
Defaultalm	Keyword that commands the system to use the default hard-coded almanac after reset

Using the [COLDSTART] command without any parameters means the system does not use the hard-coded almanac after reset.

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

1.35 CONFIGGFA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to change those parameters used in NMEA GFA message: K_H, K_V, Selected Accuracy Level, HAL. This is a User Command; it can be included in a user's profile.

Command:	[CONFIGGFA] float(K_H), float(K_V), float(HAL for), float(Selected Accuracy Level)
Parameter	Definition
K_H	Horizontal Protection Level; default = 4.0
K_V	Vertical Protection Level; default = 3.5
HAL	Horizontal Alert Level; default = 10

Default: [CONFIGGFA]4.0,3.5,10

The following algorithm applies:

HPL = K_{H_NPA} * d_{major}

HPL = K_{H_PA} * d_{major}

VPL = K_V * d_U

Where d_{major} is the error uncertainty along the semimajor axis of the error ellipse, d_U is the error uncertainty along the vertical axis.

.

1.36 Reserved

1.37 DATUM (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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.

1.37.1 Reference 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, or ITRF. Refer to Table 179 for the datum used in the solution.

The StarFire network updates the ITRF reference frame every few years. Information on the current reference frame in use and the transition dates are locoated on NavCom's FAQ website under the *StarFire* category and *To Which Datum Are StarFire Corrections Referrenced?* title.

1.37.2 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 (G1150)	WGS84 to User-Specified	User-Specified
ITRF2005 (v2.0.22.0 to v2.2.9 for StarFire GPS and GNSS modes; and v3.0.9.0 and to v3.6.5.0 when in StarFire GPS mode); discontinued for all modes in v3.6.6.0 and later	1. ITRF2005 to WGS84 2. WGS84 to User-Specified	
ITRF2008 (v3.0.9.0 or later for StarFire GNSS mode); for all StarFire modes in v3.6.6.0 and later	1. ITRF2008 to ITRF2005 2. ITRF2005 to WGS84 3. WGS84 to User-Specified	

1.37.3 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 relative to the base position. The reference frame used in solutions from the rover is reconciled with the data it receives from the base. That is, the base receiver dictates the solution type it outputs as well as the solution type in the rover receivers that receive the correction from the base.

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.

1.37.4 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] DEFAULT, GDA94, USERDATUM
Parameter	Definition
DEFAULT	Default datum of the system (ITRF, or WGS84_G1150); no [PARAMETER_LIST] fields
WGS84	Transform StarFire ITRF datum to WGS84 G1150. 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] See Note 1, below.

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

Command:	[DATUM] [PARAMETER_LIST] (the parameter list for user-defined datum)

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

Ellipsoid model

3-parameter model

7-parameter model

14-parameter model

Table 57: 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	

* double = decimal number (R64 data type)

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 list of parameters – 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.

1.37.5 Ellipsoid Model

Table 58: 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.

1.37.6 Transformation Models

1.37.6.1 Three-Parameter Transformation

Table 59: 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

1.37.6.2 Seven-Parameter Transformation

Table 60: 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

1.37.6.3 Fourteen-Parameter Transformation

Table 61: 14-Parameter Model Transformation (with Sample Values)

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

Example: [DATUM]USERDATUM,6378137.0,298.2572220972,2000,0,0,0

Sets the datum to ITRF-00 (WGS-84; G1150). This may be used when operating in StarFire mode to have the receiver convert the native ITRF2005 or ITRF2008 data to ITRF-00 which is commonly used by many data collectors.

1.38 Reserved

1.39 Reserved

1.40 Reserved

1.41 DEFINESFSAT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to define/delete a user-defined StarFire satellite. Entering this command with no arguments displays the current user-defined satellite. The keyword NONE behaves the same as DELETE since there can only be one entry saved at a time.

Command:	[DEFINESFSAT] define_delete, {satellite_id}, {frequency}
Parameter	Definition
Define_delete	Keyword (DEFINE, DELETE, NONE)
Satellite_id	Satellite ID number (integer) (320 to 680)
Frequency	Satellite frequency in kHz (min. = 1525000 kHz, max.= 1560000 kHz)

Examples: [DEFINESFSAT] define, 680, 1556000

Defines a user-defined StarFire satellite

1.42 Reserved

1.43 Reserved

1.44 DNSOVERRIDE

☒SF-3050 ☐Sapphire ☐SF-3040

This command is used to allow 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 ENS 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	Turns this functionality ON or OFF
DNS1	DNS Server IP in xx.xx.xx.xx format
DNS2	DNS Server IP in xx.xx.xx.xx format

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

1.45 Reserved

1.46 DYNAMICS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used for specifying receiver dynamics. The setting affects the RTK rover dynamic, the RTG (StarFire) dynamic, and the velocity smoothing settings. Refer to Table 62 for guidance on the various settings.

Command:	[DYNAMICS] dynamic_mode, {rtk_dynamic_mode}, {rtg_dynamic_mode}, {velocity_smoothing}
Parameter	Definition
Static	Keyword that configures RTK rover and RTG mode to use static dynamic constraints in navigation
Low	Keyword that configures RTK rover and RTG 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 RTG 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 RTG mode to use high dynamic model in navigation. It achieves the best navigation performance when the platform experiences high accelerations.
User	Keyword that configures additional user parameters: the RTK rover dynamic, the RTG dynamic, and the velocity smoothing settings

Default: Medium

Dynamic_mode is the receiver overall dynamic setting. When a user specifies dynamic_mode as STATIC, LOW, MEDIUM, or HIGH, the receiver uses the built-in settings in Table 62 for the RTK rover, the RTG dynamic, and velocity smoothing. No additional parameters are needed. However, when a user specifies dynamic mode as USER, the user can add specific parameters to configure the RTK rover, the RTG dynamic, and the velocity smoothing settings.

Table 62: Dynamic Modes Mapping and Applications

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

The settings in Table 62 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 RTG dynamic unchanged.

[DYNAMICS]USER, LOW, LOW, ON

Sets RTK rover dynamics to low, the RTG dynamic to low, and velocity smoothing to on

1.47 ENABLEALL (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	Keyword (SAT, CH); SAT for enabling all satellites, CH for enabling all channels

Example: [ENABLEALL] SAT

Enables all satellites

1.48 Reserved

1.49 ENABLEGEOFENCE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to enable or disable the use of the geofence during WAAS processing. The geofence defines the geographical boundaries which define where the SBAS corrections will be applied to the position solution.

Command:	[ENABLEGEOFENCE] ON, OFF
Parameter	Definition
ON	Keyword that enables geofence
OFF	Keyword that disables geofence

Default: ON

Examples: [ENABLEGEOFENCE] ON

Enables geofencing

1.50 Reserved

1.51 ENABLERTCM2.3

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[ENABLERTCM2.3] ON, OFF
Parameter	Definition
ON	Keyword that enables RTCM 2.3
OFF	Keyword that enables RTCM 2.2

[ENABLERTCM2.3] keyword(ON,OFF)

Default: ON

Examples: [ENABLERTCM2.3] on

This configures Rover to accept RTCM2.3 corrections.

[ENABLERTCM2.3] off

This configures Rover to accept RTCM2.2 corrections.

1.52 Reserved

1.53 ERASEALM (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to clear almanac data stored in non-volatile memory.

The Sapphire engine hardware provides non-volatile memory, which is capable of retaining stored values in memory when all power is removed from the unit. Information stored in non-volatile memory includes almanac data.

Command:	[ERASEALM] {type}
Parameter	Definition
type	Satellite type (keyword) (ALL, GPS, SBAS, STARFIRE, 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 almanac data to be discarded from non-volatile memory. It will take the receiver 12.5 minutes to collect full almanac information data again.

1.54 ERASEEPH (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to clear ephemeris data stored in non-volatile memory.

The Sapphire Engine hardware provides non-volatile memory, which is capable of retaining stored values in memory when all power is removed from the unit. Information stored in non-volatile memory includes ephemeris data.

Command:	[ERASEEPH] {type}
Parameter	Definition
type	Satellite type (keyword) (ALL, GPS, WAASEGNOS, STARFIRE, GLONASS, GALILEO,). If empty, it defaults to “ALL”.

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

1.55 Reserved

1.56 Reserved

1.57 ETHCONFIG (ASCII)

☒SF-3050 ☐Sapphire ☐SF-3040

This command specifies the Ethernet port IP settings (Internet IP address, network mask, default gateway, and DNS servers).The command can be received from any of the input ports.

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	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	Specifies the local IP address of the unit.
Network mask	Identifies the network part of the IP address, as a.b.c.d (range: 1-255 for each)
Gateway address	Identifies the IP address of the default Internet Gateway (or router). The gateway IP (if any) must be on the local network. For example, if the unit IP address is 192.168.0.2, and the network mask is 255.255.255.0, then the first 3 bytes of the gateway IP must be 192.168.0.x (i.e., 192.168.0.1). A special case (the default) is 0.0.0.0, meaning there is no gateway device.
DNS1	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. (Absent a default gateway, the DNS query will fail.)
DNS2	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

1.58 ETHVCOM (ASCII)

☒SF-3050 ☐Sapphire ☐SF-3040

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 – ETH4) 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.

Command:	[ETHVCOM] on_off, remote IP address, remote UDP/TCP port, mode, local UDP/TCP port, logical port
Parameter	Definition
on_off	Keyword that enables (ON) or disables (OFF) the virtual COM port functionality on the logical port
Remote IP address	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	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.
Local port	If non-zero, specifies the local UDP/TCP port number the ETHVCOM task will listen on (range: 0 – 65535). The IANA has reserved ports 0 – 1023 for specific purposes (e.g., FTP, telnet, Web servers) and these ports should be avoided.
Logical port	ETH1, ETH2, ETH3, or ETH4. This is the logical port to be used by ETHVCOM for requesting or scheduling messages.
Mode	Identifies the ETHVCOM task transport protocol (see Table 63)

Defaults:

If NVRAM is clear, the defaults are the following:

[ETHVCOM] ON, 0.0.0.0, 0, UDP2, 4361, ETH1

[ETHVCOM] OFF, 0.0.0.0, 0, UDP2, 4362, ETH2

[ETHVCOM] OFF, 0.0.0.0, 0, TCP1, 4363, ETH3

[ETHVCOM] OFF, 0.0.0.0, 0, TCP1, 4364, ETH4

If the command is typed without specifying the port, it defaults to ETH1. Any other parameter not specified is not changed.

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

Table 63: ETHVCOM Task Transport Protocol

Protocol Mode	Description
UDP1	UDP with no "connection"; any input 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 with "pseudo session" (See the "UDP pseudo session") description.)
TCP1	This connection operates as a normal TCP session with this exception: If there is a Send error other than a re-transmission of a lost packet, the connection will be terminated and the logical port will enter listen mode for a new connection. This can occur if the remote client experiences a power or network interruption.
TCP2	TCP session with keep-alive timeout

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

An active UDP session will be automatically re-established if the Sapphire unit is reset due to power interruption. However, 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.

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 – ETH4) 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. If an ETHVCOM command is issued with no parameters, the status of all ETHVCOM ports is displayed.
2. If the only argument entered is the ETHVCOM port number, the status of that port is displayed.
3. 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.
4. The current values are used for any parameters not entered.
5. Changing any of the EVCOM port settings causes a connected port to disconnect and begin listening for a new connection.

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 Sapphire 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)

Table 64 lists the default settings (when no parameters are specified).

Table 64: Default Settings for Unspecified Parameters

EVCOM Port	Mode	Local IP Port
ETH1	UDP2	4361
ETH2	UDP1	4362
ETH3	TCP1	4363
ETH4	TCP1	4364

To configure the receiver for an Ethernet connection, first log on to another port, such as USB, and open the StarUtil 3000 *View Raw Data* tab (so you can view all response data). See Figure

Enter [ETHVCOM] with no parameters to view the current settings. It might look like this if port ETH1 has been busy:

[ETHVCOM] ON, 204.54.86.67, 4116, UDP2, 4361, ETH1

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

[ETHVCOM] OFF, 0.0.0.0, 0, TCP1, 4363, ETH3

[ETHVCOM] OFF, 0.0.0.0, 0, TCP1, 4364, ETH4

These values may have been assigned dynamically and therefore may not be usable. To create operative parameters, enter the Virtual COM port command:

[ETHVCOM] ON, 0.0.0.0,0 UDP2, 4361, ETH1, where:

ON – sets the virtual port ON

"0.0.0.0" – puts the virtual port into a mode to accept the next caller (you)

"0" – clears the internal port

"UDP2" – names the protocol, from UDP1, UDP2, TCP1

"4361" – names the port (note: 4361 is NavCom-specific)

"ETH1" – names the port, from ETH1/2/3/4

Verify the EVCOM settings by entering [ETHVCOM] with no parameters:

[ETHVCOM] ON, 0.0.0.0, 0, UDP2, 4361, ETH1

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

[ETHVCOM] OFF, 0.0.0.0, 0, TCP1, 4363, ETH3

[ETHVCOM] OFF, 0.0.0.0, 0, TCP1, 4364, ETH4

Enter [ETHCONFIG] with no parameters to view the current Ethernet Port IP settings to use for the connections dialog:

[ETHCONFIG]AUTO,204.54.86.4,255.255.254.0,204.54.87.1,204.54.87.20,204.54.87.39, where

“204.54.86.4” – your IP address; *make a note of this*

“255.255.254.0” – network address mask

“204.54.87.1” – gateway address

“204.54.87.20” – primary DNS server

“204.54.87.39” – secondary DNS server

⚠ The [ETHCONFIG] command can also be entered with MANUAL; AUTO means use DHCP and MANUAL means assign a fixed IP. You can use AUTO, but keep in mind that if the receiver drops offline, it may be difficult to retrieve the IP address. If you specify MANUAL, the IP address does not change if the receiver drops offline for power cycle, downline load of new firmware, etc.

Example:

[ETHCONFIG]MANUAL,204.54.86.4,255.255.254.0,204.54.87.1,204.54.87.20,204.54.87.39

To make the change to MANUAL permanent, enter [PROFILE]SAVEAS “PROFILENAME” and power cycle the receiver.

For further information, refer to the ETHCONFIG and PROFILE commands in this manual. For help getting online, refer to Chapter 2 of the *StarUtil 3000 User Guide*.

1.59 EVENTLATCH (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

This command is used to enable the operation of the event latch feature in the available port 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	Keyword that selects port A
on_off	Keyword that enables (ON) or disables (OFF) the event latch port
trigger	Keyword that sets the trigger edge of the pulse (RISING, FALLING)

Default: *Latch A = OFF, RISING*

1.60 EXTRAPBASE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	Runs MBRTK rover in base-motion extrapolation mode
OFF	Turns off base-motion extrapolation mode

Default: ON

Examples: [EXTRAPBASE] ON

Sets MBRTK rover in base-motion extrapolation mode

[EXTRAPBASE] OFF

Turns off base-motion extrapolation mode

[EXTRAPBASE]

Returns base-motion extrapolation status

1.61 FIXBASELINE (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

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

Command:	[FIXBASELINE] on_off {, length, length_rms}
Parameter	Definition
ON	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).
OFF	When set to OFF, the baseline is not fixed (i.e., leader follower application).
length	Baseline length in meters, between 1 and 250
length_rms	Baseline length tolerance, rms in meters, between 0.001 and 0.2

Default: OFF

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.

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 on baseline mode

[FIXBASELINE]
Displays status

1.62 Reserved

1.63 FORCETALKERID (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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] off, GP, GL
Parameter	Definition
OFF	Talker ID not forced
GP	Talker ID forced to GP
GL	Talker ID forced to GL

Default: OFF

Examples: [FORCETALKERID] GP
Forces talker ID to GP

[FORCETALKERID]OFF
Talker ID not forced

1.64 Reserved

1.65 Reserved

1.66 FSCD (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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

Command:	[FSCD] directory_name

Examples: [FSCD]
Returns the current working directory

[FSCD] "my_directory"
Changes the working directory to "my_directory". If this directory does not exist, the following message will be output:

[FSCD]UNKNOWN DIRECTORY

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

[FSCD] "/"

[FSCD] "\"

Changes the working directory to the root directory

[FSCD] "/directory_1/directory_2/directory_3"

[FSCD] "\directory_1\directory_2\directory_3"

Changes 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"

Changes the working directory to the current_directory\directory_1\directory_2\directory_3

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSCD]"ACCESS DENIED: USB IS IN MASS STORAGE MODE"

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.67 FSCWD (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to query the current working directory.

Command:	[FSCWD]

Examples: [FSCWD]

Returns the current working directory

[FSCWD]A:datalog

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSCWD]"ACCESS DENIED: USB IS IN MASS STORAGE MODE".

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.68 FSDELETE (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSDELETE]"ACCESS DENIED: USB IS IN MASS STORAGE MODE".

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.69 FSDIR (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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, B}
A	Keyword that returns the directory on drive A (internal 2G memory)
B	Keyword that returns the directory on drive B (thumb drive)

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)

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSDIR]"ACCESS DENIED: USB IS IN MASS STORAGE MODE".

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.70 FSDRIVE (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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]{A:,B:}
Parameter	Definition
A	Keyword that selects the internal 2G memory
B	Keyword that selects the USB thumb drive

Examples: [FSDRIVE]

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

[FSDRIVE]A: FAT32; TOTAL BYTES: 2050662400; FREE BYTES: 191737856

[FSDRIVE]A:
Selects the internal SD flash as the current drive

When using this command to change to drive B, the USB must be in Host mode and a USB thumb drive must be attached to the port; otherwise, the following message is output:

[FSDRIVE]B:
[FSDRIVE]B: DRIVE (USB THUMB DRIVE) NOT CONFIGURED

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSDRIVE]"ACCESS DENIED: USB IS IN MASS STORAGE MODE".

If the current drive is A, the USB mode is changed to Mass Storage Device mode, and a command with no parameters is sent querying the current drive, the following message is output:

[FSDRIVE]
[FSDRIVE]ACCESS DENIED: USB IS IN MASS STORAGE MODE

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.71 FSFORMAT (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to format the internal SD flash and the USB thumb drive (with USB HOST mode enabled).

Command:	[FSFORMAT]{A:,B:,}{DEFAULT, FAT, FAT32}
Parameter	Definition
A	Keyword that selects the internal SD flash
B	Keyword that selects the USB thumb drive
DEFAULT	Optional keyword that formats drive A as default (receiver-selected) FAT
FAT	Optional keyword that forces FAT12 or FAT16
FAT32	Optional keyword that forces FAT32

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

Examples: [FSFORMAT]

Returns the current FAT information for drives “A” and “B”

[FSFORMAT]A: FAT 16; B: UNKNOWN

[FSFORMAT]A:

Returns current FAT information for drive A

[FSFORMAT]A: FAT 16

[FSFORMAT]A:,DEFAULT

Formats drive A as the default FAT (receiver chooses a better FAT)

[FSFORMAT]A:,FAT

Formats drive A as FAT12 or FAT16

[FSFORMAT]A:,FAT12

[FSFORMAT]A:,FAT32

Formats drive A as FAT32

[FSFORMAT]A:,FAT32

When a user enters [FSFORMAT]A:,DEFAULT to start formatting the internal SD flash, the following message is output if mounting failed:

[FSFORMAT] ERROR ON MOUNTING SD FLASH

When a user enters [FSFORMAT]A:,DEFAULT to start formatting the internal SD flash, the following message is output if the SD flash is still being mounted:

[FSFORMAT] SD FLASH IS BEING MOUNTED, PLEASE WAIT

While formatting, the following messages are output:

[OK] FSFORMAT

[FSFORMAT]A: FORMATTING 1 SECONDS

[FSFORMAT]A: FORMATTING 2 SECONDS

…………………..

[FSFORMAT]A: FORMATTING 53 SECONDS

[FSFORMAT]A: FORMATTING DONE - FAT32

[FSFORMAT] may take up to 1 minute for [FSFORMAT] to be completed. Once formatting is done, the following message will be output:

[FSFORMAT]A: FORMATTING DONE – FAT type

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSFORMAT]"ACCESS DENIED: USB IS IN MASS STORAGE MODE".

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.72 FSMKDIR (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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

Once USB mode is changed to Mass Storage Device mode, the onboard file system commands cannot access the SD flash. The following message is output:

[FSMKDIR]"ACCESS DENIED: USB IS IN MASS STORAGE MODE".

When changing the USB from Mass Storage Device mode to other modes, please allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing the onboard file system commands.

1.73 GEOIDALMODEL (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[GEOIDALMODEL] {NONE, GGM02, GEOIDAL99, DEFAULT}
Parameter	Definition
NONE	Deselect geoidal database
GGM02	Select GGM02 geoidal database
GEOIDAL99	Select GEOIDAL99 (user-defined) database
DEFAULT	Select geoidal database according to the default priority list

Default: DEFAULT

Only two types of Geoidal models may be loaded in the SF-3050: GGM02 and GEOIDAL99. The GGM02 geoidal database is factory loaded. The user may define a GEOIDAL99 database and load it into the receiver. The GEOIDAL99 model is typically more precise than the GGM02 model. If loaded, it is typically preferred.

When the DEFAULT keyword is used, the receiver automatically selects the Geoidal model according to this default priority list: GEOIDAL99, GGM02, NONE. The model listed first, GEOIDAL99 is used if it is loaded in the receiver; otherwise, the next model, GGM02, is used if it is loaded. If neither Geoidal model is loaded, NONE is selected. The sequential order of the priority list cannot be changed by the user. The GEOIDAL99 model is listed first because it typically provides the highest precision.

If the user does not desire the automatic selection of the loaded Geoidal model(s), based on his geographic position, he can input a specific model. This supersedes the DEFAULT keyword, which then must be input when automatic selection is desired.

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
Selects GGM02 geoidal database

[GEOIDALMODEL]
Returns the currently selected geoidal database

1.73.1 GEOIDAL99 Format

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

Table 65: 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 66 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 65 defines NLAT and NLON.)

Table 66: 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 66, 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.

1.74 GGAMODE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to select the low precision mode (keyword LP) or the high precision mode (keyword HP) for the NMEAGGA output sentence.

The low precision mode is the standard NMEAGGA output stream in compliance with NMEA-0183 Standards version 3.0. It is limited to a maximum of 80 characters.

The high precision mode is an extended mode for the NMEAGGA output sentence. It is not in compliance with the NMEA-0183 Standards version 3.0 in terms of message length. The high precision mode adds two digits of precision for the latitude, longitude, and altitude parameters.

In the high precision mode, the GGA sentence outputs latitude as dd.mmmmmm and longitude as ddd.mmmmmm, as opposed to the low precision mode, which is dd.mmmm and dd.mmmm. Also, in the high precision mode, the GGA sentences show altitude as mm.mmm as opposed to mm.m in the low precision mode.

Refer to NMEAGGA in this manual for the GGA message output format.

The NavCom proprietary NMEA type message, NMEAPNCTGGA, also provides high precision. Refer to NMEAPNCTGGA in this manual for the PNCTGGA message output format.

Command:	[GGAMODE] MODE
Parameter	Definition
Precision	Keywords LP or HP specify the precision for the NMEAGGA output sentence.
Quality	Keyworkds: SF or RTK; refer to Table 181: Navigation Mode

Default: 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

Specifies high precision mode

[GGAMODE] LP

Specifies low precision mode

[GGAMODE]

Requests output of current setting, "HP" or "LP"

[USEPROFILE] "NONE"

Sets the default to [GGAMODE] LP

1.75 GGM02STATUS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to query the GGM02 database status in the receiver. The GGM02 database is factory installed. 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 section *1.91 LOADBULKB (Binary)* 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

1.76 GREETING

☒SF-3050 ☒Sapphire ☒SF-3040

This command turns the greeting message on or off on COM1 that sounds when the receiver starts. This command has no effect on Sapphire COM2. Greeting messages on COM2 are always on.

Command:	[GREETING] {on_off}
Parameter	Definition
on	Keyword that turns on the receiver-startup greeting
off	Keyword that turns off the receiver-startup greeting

Default: ON

Example: [GREETING] on

Turns on the receiver startup greeting

Example output from COM1:

Starting NOVA bootloader1!

Bootloader1 CRC32 good

Invalid boot command

[VERSION]BOOT1,"SOLARIS, 02.00.00, Apr 1 2010 11:35:03"

NavSW Start, MPC 5200! port0.

[VERSION] NAV,"SOLARIS, 02.00.01, scn0,, Apr 1 2010 11:03:25"

[CPUPOWER]HIGH

1.77 Reserved

1.78 Reserved

1.79 Reserved

1.80 Reserved

1.81 Reserved

1.82 Reserved

1.83 Reserved

1.84 Reserved

1.85 INCLINECONSTR (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 (greater than 5 and less than 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 set to off

[INCLINECONSTR]

Status will be displayed

1.86 INPUTSFLICENSE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to input a StarFire license. The format for the license string is the same as the license .lic file. The license code file is an ASCII text message that can be opened with any common text editor to view the settings and the code.

Command:	[INPUTSFLICENSE]licensecode

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: RTG Precise
Regions: All
Authorized Net: All Nets
Actions: Cancel Current License & Load New License
License Code: 4A2A6C82-F2EB1CEE-8D682E3C-95B83A16

Figure 3: Example of StarFire License File Contents

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

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

1.87 Reserved

1.88 INPUTSWOPTION (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to input Software options. The format for the software options string is the same as the software_options.opt file. This command prompts a response with the same name, with a list of all SW options and the status of the SW options. The option code file is an ASCII text message that can be opened with any common text editor to view the settings and the code.

Command:	[INPUTSWOPTION]optionstring

```
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
```

Figure 4: Example of Software Options File Contents

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

1.89 Reserved

1.90 L1FALLBACK (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to enable/disable the 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_off	Keyword (ON, OFF)

Default: OFF (the recommended setting)

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.

1.91 LOADBULKB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

The LOADBULKB message is used to install any bulk message/data through serial port into NVRAM. The message format is defined as below and it is different from the regular binary message format.

Table 67: LOADBULKB Message Format

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	

1.92 Reserved

1.93 Reserved

1.94 LOGFILE (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to start, stop, pause, or resume file logging on the SD flash or the USB thumb drive for the SF-3050, or the removable SD card for the SF-3040.

Command:	[LOGFILE] {A:,B:}{START,STOP,PAUSE,RESUME,FORCESTART}
Parameter	Definition
A	SD flash drive (internal memory)
B	Thumb drive (removable device)
Start	Starts file logging
Stop	Stops file logging
Pause	Pauses file logging
Resume	Resumes file logging
Forcestart	Forces file logging to start

Table 68 [LOGFILE]A: Responses

Keyword	ASCII String	Description
STOPPED	SD FLASH IS GOOD (SF-3050) SD CARD IS GOOD (SF-3040)	SD flash/card is good for logging data This message is output when [LOGFILE] is issued to query, and file logging is not started yet, and the following statements are true: • A SD card is present (SF-3040) • The SD is unlocked (SF-3040) • The SD flash/card is mounted successfully • The SD flash/card passes integrity check (The file “CHKDSK.SD” is present and signature “PASS” is found in this file) This message is output when [LOGFILE] is issued to query, and file logging is not started yet, and the following statements are true for the SF-3040: • A SD card is present • The SD is unlocked • The SD card is mounted successfully • The file “CHKDSK.SD” is not present, and this file is created successfully upon insertion of a SD card This message is output when [LOGFILE] is issued to query, and file logging is stopped gracefully This message is output when [LOGFILE] is issued to query, and formatting of SD flash/card using [FSFORMAT] is just finished successfully

Keyword	ASCII String	Description
	FILE IS CLOSED PROPERLY	This message is output when file logging is stopped by issuing [LOGFILE]A:,STOP command, or a graceful shutown of the receiver Once this message is output, SD flash/card state is changed to “SD FLASH IS GOOD” for Solaris and “SD CARD IS GOOD” for the SF-3040
STARTING	RETRIEVING FREE SPACE… n	This message shows the receiver is retrieving free space on SD flash/card “n” means time passes in seconds since retrieving free space has been started. This message is output when [LOGFILE]A:,START is issued, and SD flash/card is good for logging data
	OPENING LOGGING DIRECTORY	This message shows the receiver is opening the logging directory The message is output when retrieving free space is finished and free space on SD flash/card is greater than 1Mbytes
	CREATING LOGGING FILE	This message shows the reciver is creating the logging file The message is output after a successful opening of the logging directory
	READY TO LOG DATA	This message shows the receiver is ready to log data The message is output after a successful creation of the logging file
	SD FLASH IS BEING MOUNTED, PLEASE WAIT (SF-3050) SD CARD IS BEING MOUNTED, PLEASE WAIT (SF-3040)	This message is output when [LOGFILE]A:,START is issued, and mounting of SD flash/card is not finished yet Upon completion of a successful SD flash/card mounting, file logging will proceed
	SD FLASH IS BEING FORMATTED, PLEASE WAIT (SF-3050) SD CARD IS BEING FORMATTED, PLEASE WAIT (SF-3040)	This message is output when [LOGFILE]A:,START is issued, and formatting of SD flash/card is not finished yet Upon completion of a successful SD flash/card formatting, file logging will proceed
RUNNING	nnn BYTES LOGGED	This message shows the receiver is logging data on SD flash/card, and how many bytes of data have been logged so far This message is output when [LOGFILE] is issued, and the receiver is logging data on SD flash/card
PAUSED	nnn BYTES LOGGED	This message shows file logging is paused, and how many bytes of data have been logged so far

Keyword	ASCII String	Description
		This message is output when [LOGFILE] is issued, and file logging is paused
ERROR	SD CARD IS NOT PRESENT (SF-3040 only)	This message is output when SD card is not present, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued
	SD CARD IS LOCKED (SF-3040 only)	This message is output when SD card is present and locked, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued
	SD FLASH IS BEING MOUNTED (SF-3050) SD CARD IS BEING MOUNTED (SF-3040)	This message is output when SD card is unlocked for the SF-3040, and mounting of SD flash/card is not finished yet, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued
	ERROR ON MOUNTING SD FLASH (SF-3050) ERROR ON MOUNTING SD CARD (SF-3040)	This message is output when SD card is unlocked for the SF-3040, and mounting of SD flash/card fails, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued
	SD FLASH IS BEING FORMATTED (SF-3050) SD CARD IS BEING FORMATTED (SF-3040)	This message is output when SD card is unlocked for the SF-3040 and formatting of SD flash/card is not finished yet, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued
	ERROR ON FORMATTING SD FLASH (SF-3050) ERROR ON FORMATTING SD CARD (SF-3040)	This message is output when SD card is unlocked for the SF-3040, and formatting of SD flash/card fails, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued
	SIGNATURE FILE IS NOT PRESENT	This message is output when file “CHKDSK.SD” is not present on SD flash/card, and [LOGFILE]A:,START is issued. It can be corrected by sending command “[LOGFILE]A:,FORCESTART”

Keyword	ASCII String	Description
	INVALID SIGNATURE	When receiver is powered on, if a SD card is present and unlocked for SF-3040, and file “CHKDSK.SD” is present, the file will be checked to see if signature “PASS” is in it For the SF-3040 when a SD card is inserted and file “CHKDSK.SD” is present, the file will be checked to see if signature “PASS” is in it This message will be output when signature “PASS” is not found in file “CHKDSK.SD”, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued This message suggests a ungraceful shutdown occurred while doing file logging
	ERROR ON ACCESSING SIGNATURE FILE	This message is output when opening, reading or deleting file “CHKDSK.SD” fails, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued This message suggests the SD flash/card is corrupted. [FSFORMAT] command can be used to format the SD flash/card
	ERROR ON CREATING SIGNATURE FILE	When receiver is powered on, if a SD card is present and unlocked for SF-3040, and file “CHKDSK.SD” is not present, this file will be created automatically For the SF-3040 when a SD card is inserted and file “CHKDSK.SD” is not present, this file will be created automatically. This message is output when creation of file “CHKDSK.SD” fails, and one of the following action occurred: • [LOGFILE] is issued • [LOGFILE]A: is issued • [LOGFILE]A:,START is issued This message suggests the SD flash/card is corrupted. [FSFORMAT] command can be used to format the SD card
	TASK CAN NOT BE STARTED	Once SD flash/card passes integrity check, a task will be created for file logging when [LOGFILE]A:,START is issued This message will be output when creation of file

Keyword	ASCII String	Description
		logging task fails Once this message is output, SD flash/card state is changed to “SD FLASH IS GOOD” for the SF-3050, and “SD CARD IS GOOD” for the SF-3040
	INSUFFICIENT SPACE	This message is output after retrieving free space is finished and free space on SD flash/card is less than 1Mbytes [FSDELETE] command can be used to delete some file on SD flash/card to reclaim more bytes for free space
	ERROR ON OPENING LOGGING DIRECTORY	This message is output when opening logging directory fails This message suggests the SD flash/card is corrupted. [FSFORMAT] command can be used to format the SD flash/card
	ERROR ON CREATING LOGGING FILE	This message is output when creating logging file fails This message suggests the SD flash/card is corrupted. [FSFORMAT] command can be used to format the SD flash/card
	WRITING FILE ERROR, FORCE TO STOP	This message is output when writing data to file fails. The file logging is stopped once this message is sent

Examples:

[LOGFILE]
Returns the current file logging status for drives A or B, including READY, RUNNING, STOPPED, PAUSED, or ERROR
[LOGFILE]A:,STOPPED,”SD FLASH IS GOOD”, B: STOPPED
[LOGFILE]A:,ERROR,”ERROR ON ACCESSING SIGNATURE FILE”, B: STOPPED

When the status is RUNNING or PAUSED, the logged bytes are displayed.
[LOGFILE]A: RUNNING 5245989 BYTES LOGGED; B: STOPPED

[LOGFILE]A:
Returns the current file logging status for drive A (internal memory)

[LOGFILE]A:,START
Starts file logging on drive A (internal memory) if it has not been started (see detailed Examples and Essential Notes, below)

> [OK] LOGFILE
> [LOGFILE]A:,STARTING,”RETRIEVING FREE SPACE”
> [LOGFILE]A:,STARTING,”RETRIEVING FREE SPACE… 1”
> [LOGFILE]A:,STARTING,”RETRIEVING FREE SPACE… 2”
> …………….

[LOGFILE]A:,STARTING,”RETRIEVING FREE SPACE… 21”
[LOGFILE]A:,STARTING,”OPENING LOGGING DIRECTORY”
[LOGFILE]A:,STARTING,”CREATING LOGGING FILE”
[LOGFILE]A:,STARTING,”READY TO LOG DATA”
[LOGFILE]A:,RUNNING,”RUNNING 0 BYTES LOGGED”

Essential Notes:

1. When the receiver is first turned on, or the USB mode is changed from Mass Storage device mode to COM port mode for the SF-3040, and the USB mode is changed from Mass Storage device mode to COM port mode or Host mode for Sapphire, the SD removable card or the SD flash internal memory is reconfigured. If the user sends the command [LOGFILE]A:,START before the reconfiguration is finished, the following message is output:

   For SF-3050 [LOGFILE]A: SD FLASH IS BEING MOUNTED, PLEASE WAIT

   For SF-3040: [LOGFILE]A: SD CARD IS BEING MOUNTED, PLEASE WAIT

   If the SDCARD message is turned on for this port, the following [SDCARD] message is output:

   [SDCARD] MOUNTING… 5

   [SDCARD] MOUNTING… 6

   [SDCARD] MOUNTING… 7

   [SDCARD] MOUNTING…8

   The numeral represents the SD card mounting time in seconds. Upon successful completion of mounting, data logging starts.

   If mounting fails, the following message is output:

   For the SF3050:

   [LOGFILE]A: ERROR ON MOUNTING SD FLASH

   For the SF-3040:

   [LOGFILE]A: ERROR ON MOUNTING SD CARD

   For the SF-3040:

   If the SD card is not present and the user sends the command [LOGFILE]A:,START, the following message is output:

   [LOGFILE]A: SD CARD IS NOT PRESENT

   If the SD card is present and locked and the user sends the command [LOGFILE[A:,START, the following message is output:

   [*LOGFILE]A: SD CARD IS LOCKED*

2. When the USB mode is changed to Host mode, the USB thumb drive (external device) needs to be enumerated (enumeration takes up to 1 minute; log data on drive B only after enumeration is finished). If the user sends the command [LOGFILE]B:,START before enumeration is complete, this message is output:

[LOGFILE]B: USB HOST NOT ENUMERATED YET, TRY AGAIN LATER

3. If the USB mode is in Mass Storage device mode and the user sends the command [LOGFILE]A:,START, logging will not start and this message will be output:

   [LOGFILE] REQUEST DENIED: USB IS IN MASS STORAGE MODE

4. If the user sends the command [LOGFILE]B:,START before the USB is in Host mode, logging will not start on the external device and this message will be output:

   [LOGFILE] REQUEST DENIED – USB IS IN MASS STORAGE MODE

5. When changing the USB from Mass Storage Device mode or other modes, refrain from logging data on drive A (internal memory) until the onboard file system is reinitialized. This takes about 1 minute.

6. The command START begins a new file in the datalog folder (the system creates the datalog folder if one does not exist). The logging file uses GPS time information as its name: datalog_Year_Month_Day_Hour_Minute.dat, and the file creation and modification times will be added to the file attributes. Logging may take several seconds to begin ("RUNNING" status). Once logging has started, another START command is ignored, and the following message is output:

   [LOGFILE] REQUEST DENIED – LOGGING ALREADY STARTED

7. If the user sends the USBMODE command to switch from USB to Mass Storage when data logging is running on drive B, data logging will automatically terminate.

8. If the USB is currently in Mass Storage mode, starting data logging on drive A will fail. Before logging data on drive B, use [USBMODE] HOST to set the USB to Host mode, and attach a thumb drive.

9. Once data logging has started on drive A (internal SD flash for SF-3050; SD card for the SF-3040), if the user enters a [USBMODE] command to switch from USB to Mass Storage mode, logging will be automatically terminated.

10. If the USB is currently in Mass Storage mode, starting data logging on drive A will fail. Before logging data on drive B, use [USBMODE] HOST to set the USB to Host mode, and attach a thumb drive.

11. Use the [OUTPUT] command to schedule messages to be logged on drive A or B (e.g., [OUTPUT]PVT1B,ONTIME,1,FH1 schedules 1 Hz PVT1B messages to be logged on drive A and [OUTPUT]PVT1B,ONTIME,1,FH2 schedules 1 Hz PVT1B messages to be logged on drive B).

12. Logging data using the [LOGFILE] command requires at least 1 Mbyte free space; logging stops when free space drops below 1 Mbyte.

13. When the USB is not in Host mode and the user sends the command [LOGFILE]B:,START, logging will not be started and the following message is output:

    [LOGFILE]REQUEST DENIED – USB IS NOT IN HOST MODE

14. Logic1 is implemented to detect if the logging file was not properly closed: When the user sends the command [LOGFILE]A:,START, a CHKDSK.SD file is created in the root directory of the SD flash or the SD card, and a PASS signature is identified with this file. This CHKDSK.SD is then deleted and replaced with another CHKDSK.SD file, to which a PENDING signature is written. If a CHKDSK.SD file cannot be found or the PASS signature cannot be found, the first CHKDSK.SD file is not deleted and a new file with PENDING written to it cannot be created. In this case, file logging cannot start, and the receiver outputs the following message:

    For Sapphire: *[LOGFILE]A: POTENTIAL SD FLASH CORRUPTION, PLEASE CHECK DISK*

    For the SF-3040: *[LOGFILE]A: POTENTIAL SD CARD CORRUPTION, PLEASE CHECK DISK*

If the above scenario occurs, connect the receiver to a PC using a USB device cable and use the [USBMODE]DEVICE,MASSTORAGE command to switch to mass storage device mode. Approximately 1 minute after receiving this command, the internal SD flash appears as a removable drive in Windows Explorer. Use the Windows CHKDSK utility to check the SD flash for corruption. If the SD flash is corrupted, it can be reformatted from the PC.

For the SF-3040: Remove the SD card and use an SD card reader to check whether or not the SD card is corrupted. If the SD card is corrupted, it can be reformatted from the PC. Once it has been determined that the SD card is not corrupted, use the [USBMODE]DEVICE or the [USBMODE]HOST commands to go out of mass storage device mode. Use the [LOGFILE]A:,FORCESTART command to force logging data on the SD card. A CHKDSK.SD file is created and another forcestart is not necessary. A simple START command is sufficient.

If the error message “SIGNATURE FILE NOT FOUND” occurs after a [CHKDSK]A: command is input, the file CHKDSK.SD is not present on the SD flash. Enter the following command to create it:

[CHKDSK]A:,CREATE

Once it has been determined that the SD flash is not corrupted, use the [USBMODE]DEVICE or [USBMODE]HOST command to change the USB from mass storage mode. Use the [LOGFILE]A:,FORCESTART command to force file logging on the SD flash. A CHKDSK.SD file is then created, so a forced start will not be necessary the next time.

The SD flash can be formatted using the [FSFORMAT command. Then use the [USBMODE]DEVICE or the [USBMODE]HOST command to change the USB from mass storage mode. Use [FORMAT]A:,DEFAULT to format the SD flash. Upon completion of formatting, the CHKDSK.SD file is created automatically. Use the [LOGFILE]A:,START command to begin file logging on the SD flash.

When the log file is closed properly, the signature PENDING in the file CHKDSK.SD on drive A or file CHKDSK.USB on drive B will be replaced by the signature PASS.

---

[1] The same logic is applicable to file logging on the USB thumb drive, except that the file name is CHKDSK.USB in the root directory of the USB thumb drive.

⚠ To avoid file system corruption on the media, always stop file logging before turning off power. For the SF-3040, to avoid file system corruption on the removable SD card, always stop file logging prior to removing the card. After power cycle, file logging is in STOPPED status. To avoid file system corruption once file logging is started on drive B (the USB thumb drive), stop file logging prior to removing the thumb drive. For a graceful shutdown, file log file is automatically closed.

⚠ Prior to logging data, use the PC utility CHKDSK to check the drive for corruption. Use the [USBMODE]Device MassStorage command to switch from USB mode to Mass Storage mode. The SD flash appears as a removable drive on the PC, and CHKDSK can then be used to check for corruption[1]. (The FSFORMAT command can be used to format drives A and B.)

[1] If the internal flash drive is formatted by a PC, use the command [CHKDSK]A:,CREATE to create the CHKDSK.SD file. Or use the command [FSFORMAT]A:, DEFAULT to format the internal flash and the CHKDSK.SD file will be created automatically once formatting is complete.

⚠ Refrain from logging data on drive A and drive B simultaneously.

Examples: [LOGFILE]A:,START
Starts file logging on drive A if it has not already started, and the following message will be output:

[OK]LOGFILE
[LOGFILE]A: RETRIEVING FREE SPACE
[LOGFILE]A: RETRIEVING FREE SPACE 1 SECONDS

………..

[LOGFILE]A: RETRIEVING FREE SPACE 21 SECONDS
[LOGFILE]A: OPENING LOGGING DIRECTORY
[LOGFILE]A: CREATING LOGGING FILE
[LOGFILE]A: READY
[LOGFILE]A: RUNNING 0 BYTES LOGGED

[LOGFILE]A:, FORCESTART
Forces file logging on drive A.

[LOGFILE]A:,STOP
Stops file logging on drive A if it is running or paused

[LOGFILE]A:,PAUSE
Pauses file logging on drive A if it is running

[LOGFILE]A:,RESUME
Resumes file logging on drive A if it is paused

15. The command START begins a new file in the folder “datalog.” The datalog folder is created if it does not exist.
16. The log file uses the time the file was created as its name. The log file must have unique characters for the first four characters to provide tracability from the finished work back to the original input file. The input file naming convention reflects that of the RINEX format to provide this traceability.

    The NavCom file naming convention is as follows:

    04490111.dat, where:
    04 represents the hour (in GPS time)
    49 represents the minute
    011 is the Julian calendar day of the year (number of days since January 1)
    1 is the sequence number of the files processed for this day
    .dat is the file type (in this case, an NCT raw data file).
17. Another START” command is ignored if logging has already started and the following message is output:

    [LOGFILE]REQUEST DENIED – LOGGING ALREADY STARTED

Do not log data on drive A at a higher data rate than that of these combined messages:

[OUTPUT]PVT1B,ONTIME,0.01,FH1
[OUTPUT]MEAS1B,ONTIME,0.02,FH1
[OUTPUT]EPHEM1B,ONCHANGE,,FH1
[OUTPUT]ALM1B,ONCHANGE,,FH1
[OUTPUT]CHNLSTATUS1B,ONTIME,1,FH1

⚠ Do not log data on drive B at a higher data rate than that of these combined messages:

[OUTPUT]PVT1B,ONTIME,0.01,FH2
[OUTPUT]MEAS1B,ONTIME,0.02,FH2
[OUTPUT]EPHEM1B,ONCHANGE,,FH2
[OUTPUT]ALM1B,ONCHANGE,,FH2
[OUTPUT]CHNLSTATUS1B,ONTIME,1,FH2

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

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

This command requires that at least 10% of the drive be free before logging begins. Also, it will automatically stop logging when free space drops below 1 MByte.

After power cycle, file logging is in STOPPED status. To avoid file system corruption on the USB flash drive, always stop file logging before removing the flash drive.

1.95 LOGFILEAUTOSTART (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to start data logging automatically on the SD card/SD flash after power cycling the receiver.

Command:	[LOGFILEAUTOSTART] {ON,OFF}
Parameter	Definition
ON	Enables auto start of data logging, but data logging does not start until after power-cycling the receiver
OFF	Disables auto start of data logging; stops data logging if data logging is currently running

Detault: OFF

When auto start for data logging is ON, data logging will start automatically on the SD device after power cycling the receiver.

A new file is created in the "\datalog" directory when data logging starts automatically. The file name is datalog_Year_Month_Day_Hour_Minute.dat.

When doing a graceful down (pressing the power button to turn off power or entering a [SHUTDOWN] command), the file is closed automatically.

The [LOGFILE] command is used to query data logging status.

Examples:

[LOGFILEAUTOSTART]
Returns the current settings for auto start of data logging

[LOGFILEAUTOSTART]ON
Enables auto start of data logging, but does not start data logging immediately; the user must power-cycle the receiver if data logging was previously OFF

[LOGFILEAUTOSTART]OFF
Disables auto start of data logging; stops data logging if data logging is currently running

The ON setting can generate an error condition during receiver power-up, depending on the state of the SD device.

Error message(s) are generated via the [SDCARD] output stream. The [SDCARD] output stream has to be enabled for the user to see an error message. The following list is a collection of possible error messages:

Examples:

[SDCARD] FILE LOG AUTOSTART IS ON
ERROR: SD CARD IS NOT PRESENT

[SDCARD] FILE LOG AUTOSTART IS ON
ERROR: SD CARD IS LOCKED

[SDCARD] FILE LOG AUTOSTART IS ON
ERROR: ERROR ON MOUNTING SD CARD

[SDCARD] FILE LOG AUTOSTART IS ON
ERROR: INVALID SIGNATURE

[SDCARD] FILE LOG AUTOSTART IS ON
ERROR: ERROR ON CREATING SIGNATURE FILE

[SDCARD] FILE LOG AUTOSTART IS ON
ERROR: ERROR ON ACCESSING SIGNATURE FILE

1.96 Reserved

1.97 Reserved

1.98 Reserved

1.99 Reserved

1.100 Reserved

1.101 MPAUTOCONNECT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[MPAUTOCONNECT] mode,"mp1","mp2","mp3",..."mp10"
Parameter	Definition
Mode	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	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.

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.

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

1.102 MSGSTANDARD

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[MSGSTANDARD] <standardtype>, <version>
Parameter	Definition
Standardtype	IEC61162 - Standard type for the NMEA messages. Requires a version number. DEFAULT - Configures the NMEA messages to correspond to the default setting, which is currently IEC61162, Version 4
Version	3 – Sets the following messages to NMEA 0183 version 3.0: GRS, GSA, GSV, RMC and VTG 4 – Sets all NMEA 0183 messages to version 4.10 (default setting)

Default: DEFAULT

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

1.103 Reserved

1.104 MULTISATTRACK

This command is used to enable or disable multi-satellite tracking. It also enables or disables automatic bandwidth reduction and can set the fixed bandwidth or the minimum bandwidth when in automatic bandwidth mode.

Command:	[MULTISATTRACK] multi_enable, max_bandwidth_hz, min_bandwidth_hz
Parameter	Definition
multi_enable	Enables multi-satellite tracking (keyword ON,OFF)
max_bandwidth_hz	This is the fixed bandwidth the receiver uses when multi-satellite tracking is OFF and the maximum bandwidth the receiver uses when multi-satellite tracking is ON. Float(2.5,5,10,20)
min_bandwidth_hz	This is the minimum bandwidth the receiver uses when multi-satellite tracking is ON. It must be less than or equal to the maximum bandwidth. When multi-satellite tracking is OFF, this parameter is not used. Float(2.5,5,10,20)

Default : mutli_enable = ON; bandwidth = 20

Examples:

[MULTISATTRACK] on,10,5

Enables multi-satellite tracking with a maximum bandwidth of 10 and minimum bandwidth of 5 Hz

[MULTISATTRACK]off,10

Sets tracking mode to fixed bandwidth of 10Hz

[MULTISATTRACK] on,10,10

Enables multi-satellite tracking with fixed bandwidth of 10 Hz

1.105 NAVELEVMASK (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	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.

Example: [NAVELEVMASK] 8.0

Sets the elevation mask angle at 8 degrees

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.

1.106 NAVMEASUSE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	Keyword, defined in Table 88 (TRACKINGMODE command), which specifies the signal or frequency to be enabled or disabled.
on_off	Keyword (ON or OFF)

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

Sapphire-based GNSSreceivers are designed to always operate with at least L1 GPS enabled. The receiver may not be operated on GLONASS signals alone.

Table 69: 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[1]	WAAS or EGNOS SBAS systems
GLONASS	GLONASS G1 and G2

[1] WAASEGNOS is not supported in versions 1.0 and 2.0 of Sapphire. Entering this keyword will not result in an error message, but this measurement will remain disabled.

Multiple signals can be set to ON or OFF in one command string (see example on next page).

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.

L5 and G2 tracking are mutually exclusive due to hardware resource sharing. The NAVMEASUSE command allows both L5 and GLONASS to be enabled for navigation; however, due to the tracking limitations, only one of the two signals will be available.

Tracking of newer navigation satellite signals (L2C, L5, E1, and E5A) is subject to the availability of the signals from newer satellites, the "health bit" set to "healthy", and the SF-3050 navigation software updated to a version compatible with the signals.

⚠ 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

1.107 Reserved

1.108 NTRIPCLIENT (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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

Command:	[NTRIPCLIENT] {NONE} {CONNECT} {DISCONNECT} {SRCTBL} {NEWSRCTBL} {DEBUG}
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[1] 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

[1] The source table is the list that each NTRIP caster maintains of all of the NTRIP servers ("sources" or "base stations") that are connected to mountpoints on the caster. Each entry in the table has details about the server, such as its location, what type of corrections it sends, and what GPS receiver brand it uses. The source table is not used by the receiver itself; it is only used by a user to select which mountpoint to connect to. The source table in the receiver is always cleared at power-on.

The NTRIP client and server cannot 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.

NEWSRCTBL and SRCTBL can only be executed when the NTRIP client is idle because the source table must be requested upon initial handshake with the caster. The caster will then download the source table to the receiver and disconnect. If the NTRIP client is not idle, an error message will be displayed.

NMEA messages may be scheduled for output on the NTRIP port (NP1). If they are scheduled, they will be sent to the NTRIP server on the mountpoint to which the client is connected.

Any message other than NMEAGGA on the NTRIP port should not be scheduled 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.

1.108.1 NTRIP Client Status Messages

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 70 for details.

Table 70: 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

1.109 NTRIPCONFIG (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command specifies the information the NTRIP client or server needs to connect to an NTRIP caster. If no configuration information is specified, the current settings will be displayed. The majority of the data which follows is supplied by the NTRIP hosting agent.

Command:	[NTRIPCONFIG] {Caster name} {Caster port} {Mountpoint} {Username} {Password} {NMEA GGA} {Autoconnect} {Correction port} {Authentication}
Parameter	Definition
Caster name	Keyword that specifies the 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 (e.g., “rtgpsout.unavco.org”).
Caster port	Keyword that specifies the caster port number to connect to
Mountpoint	Keyword that specifies the name of the mount point to connect to
Username	Username, if required for authentication
Password	Password, if required for authentication
NMEA GGA	Whether or not the NTRIP server requires the transmission of the GNSS receiver NMEA GGA sentence as part of the NTRIP handshake
Autoconnect	Keyword that indicates whether or not the NTRIP should try to automatically connect to a caster at power-on or when idle. The unit can be configured to not connect, to connect as a client, or to connect as a server.
Correction port	Keyword that indicates whether to use an Ethernet port or a mobile cellular modem to connect to the caster.
Authentication	Keyword that indicates whether to use BASIC or DIGEST authentication, or let the unit select AUTO. Prior to software version 3.0.9.0, only BASIC authentication was possible. To fully support NTRIP2.0, the unit will handle DIGEST authentication. If the user selects either AUTO or DIGEST, the unit will determine which method the server will use. If the server returns 401 with “WWW-Authenticate: <AuthType>” where <AuthType> is either DIGEST or BASIC, the unit will connect using the appropriate Authentication method. If BASIC is selected, the unit will only attempt to connect to BASIC.
Version	Which NTRIP protocol version to use for the NTRIP connection (SF-3050 only)

The modem must be connected to COM2.

Table 71 provides the NTRIP client configuration data.

Table 71: NTRIP Client Configuration Data

Name	Description	Values
Caster name	Name of the NTRIP caster to connect to (see note next page)	string (128 character max; must be captured within quotation marks “”)
Caster port	Caster port number to connect to (see note next page)	int (0 – 65535)
Mountpoint	Name of the mount point to connect to	string (128 character max; must be captured within quotation marks “”)
Username	Username for authentication	string (128 character max; must be captured within quotation marks “”)
Password	Password for authentication	string (128 character max; must be captured within quotation marks “”)
NMEA GGA	Whether transmission of NMEA GGA is required	Keywords: OFF, ON
Autoconnect	Whether or not NTRIP should try to connect automatically to a caster at power-on or at idle	Keywords: OFF, CLIENT, SERVER
Correction port	The local port to use for NTRIP connection (SF-3050 only)	Keywords: ETH, MOBILE
Authentication	The authentication method to use for NTRIP connection (SF-3050 only).	Keywords: AUTO, BASIC, DIGEST
Version	Which NTRIP version to use for the NTRIP connection (SF-3050 only)	Keyword: AUTO, 1.0, 2.0

Examples: [NTRIPCONFIG] “69.44.86.66”, 2101, “LASC_RTCM3”,,,ON, MOBILE
Configures the caster at IP address 69.44.86.66, on port 2101, and obtains corrections from the server connected to mount point LASC_RTCM3. Uses the mobile cellular modem to connect to the Internet and sends an NMEA GGA sentence as part of the handshake.

[NTRIPCONFIG]

[NTRIPCONFIG] "69.44.86.68", 2101, "LASC_RTCM3", "", "", OFF, ETH

Displays 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. 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 this 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 to connect to the Starfire Mountpoint.

1.110 NTRIPSERVER (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

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

Command:	[NTRIPSERVER] {NONE} {CONNECT} {DISCONNECT}
Parameter	Definition
None	Keyword that displays the 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

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.

1.110.1 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 72 for details.

Table 72: 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 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.

State	Action	Message	Description
		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.

1.111 Reserved

1.112 Reserved

1.113 Reserved

1.114 OUTPUT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to control which data the Sapphire engine outputs on its data ports. The Sapphire engine output data are organized into different types of output messages, also called output streams. Section 2 discusses the Sapphire Output Messages and provides detailed descriptions of their formats. Each Sapphire 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	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	Keyword that identifies scheduling or timing method (see Table 73)
interval[1]	Time interval between outputs, truncated to the nearest 0.01 second (float, seconds) (0.01 to 9999.9)
port	Keyword that identifies the data port to use for the output stream, or -1 to mean "all ports" (see Table 74). 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	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.

⚠ Use "-1" judiciously because it can turn off a potentially large number of messages.

[1]This field is also used to indicate PRN number when the Timing field is ONCE for the following mnemonics:

- 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)

⚠ 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

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, except for PANICA, which is turned on for ONCHANGE*

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 73: 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
ONEVENT	Output the message whenever an event is detected on the event latch input circuitry. (This is not currently supported.)
ONCE	Outputs the message once as soon as the [OUTPUT] command is received
OFF	Stops output of this message for the specified port

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 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."

Table 74: Output Command Port Mnemonics

Keyword Mnemonic	Data Port
1	RS232 Serial port 1 (COM1)
2	RS232/RS422 Serial port 2 (COM2)
3	Sapphire board only
4	Sapphire board only
5	RS232 serial port 5 (Sapphire)
6	RS232 serial port 6 (Sapphire)
BT	Bluetooth
USB1	USB port 1
USB2	USB port 2 (not yet available)
FH1	Internal 2GB SD flash memory
FH2	USB flash drive 2 (SF-3050)
ETH1	Ethernet port 1 (SF-3050)
ETH2	Ethernet port 2 (SF-3050)
ETH3	Ethernet port 3 (SF-3050)
ETH4	Ethernet port 4 (SF-3050)
RADIO	PIO radio port (SF-3040)

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

[OUTPUT]EPHEM1B,ONCE,,ETH4
[OUTPUT]EPHEM1B,ONCHANGE,,ETH4
Schedules the entire list to output Once and future changes to output as they occur on Ethernet port 4

[OUTPUT]EPHEM1B,ONCE,32,ETH4
[OUTPUT]EPHEM1B,ONCE,54,ETH4
Schedules PRN 32 and PRN 54 to output Once on Ethernet port 4

1.115 PACKB

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to pack navigation corrections into the Sapphire command format. The message follows standard binary format, with more header format descriptions provided in paragraph 1.115.5.1. Issue the message whenever the sender accumulates 512 bytes of data or when the time from the last transfer exceeds 500 ms.

Table 75: PackB Command Format

Data Item	Data Type	Section
Format	U08	1.115.1
Port	U08	1.115.1
Correction Data	U08[]	1.115.3

1.115.1 Format

Table 76: PackB Command Format Field Mnemonics

Format Field Value	Meaning
0	Unknown
1	NCT proprietary
2	RTCM 2.3
3	RTCM 3.0
4	CMR/CMR+

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.

1.115.2 Port

This value is reserved; it is always 0.

1.115.3 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 Sapphire parsers are highly adaptable. If correction data are not encoded, the Sapphire parsers may become confused and start switching between correction mode and Sapphire 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++;
            }
      }
```

1.115.4 Theory of Operation

This command is used when both Sapphire commands and corrections are transmitted to the Sapphire via one communication port. This command is primarily used with the Bluetooth port; however, there is no limitation on the port for this command.

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 Sapphire 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.

1.115.5 Limitations and Points of Interest

1.115.5.1 Header Format

PACKB should be formatted as a standard binary message, in standard Sapphire 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 standard header field is used in a non-standard way: It is used to verify the integrity of the length field. The version field should be 0 for the current version.

1.115.5.2 Correction Data/Sapphire Command Sequence

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

1.115.6 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 PACK

1.116 PASSTHRU (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	Keyword that turns pass through mode on and off
port_dst	Keyword that identifies the destination data port to be used for the output stream (refer to Table 74)
port_src	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-3050 ports FH1 and FH2 do not support PASSTHRU (refer to Table 74). 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 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]OFF command, which allows a user to turn off the pass through session.

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.

[PASSTHRU] OFF

Turns off pass through mode

1.117 PDOPLIMIT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	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.

1.118 PING (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 Sapphire 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	Keyword that identifies the data port to send a response to (see Table 72 for keyword mnemonics).

Default: If no port is specified, the port number defaults to the port where the ping command was issued.

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

1.119 Reserved

1.120 PORT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

Command:	[PORT] {port#}, {baud}, {data_bits}, {stop_bits}, {parity}, {flow control}
Parameter	Definition
port#	Serial port number (integer) (1 to 4) – for SF-3050 (ports 2, 4 are Atmel ports) Serial port number (integer) (1, 3, 5, 6) – for Sapphire
baud	Baud rate (integer) (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200)
data_bits	Number of data bits (integer) (7 or 8)
stop_bits	Number of stop bits (integer) (1 or 2)
parity	Parity (keyword) (NONE, ODD, EVEN)
flow control	Flow Control (keyword) (NONE, ODD, EVEN)

Default: At startup, all available serial ports are set to baud rate = 57600, data bits = 8, 1 stop bit, no parity. After start up, if USEPROFILE is different from NONE, the profile settings for the ports are applied.

Example: [PORT], 9600

Sets the baud rate of the current active serial port to 9600

1.121 Reserved

1.122 PRDGPSMODE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	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	Keyword to enable (ON) or disable (OFF) dGPS mode
SF_Source	Keyword to select which StarFire source to use. See Table 78 for more information. This source only works with SFRTG.

Defaults: All code-based differential modes are defaulted to ON.
SF_Source is defaulted to 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
SFRTG	StarFire™	1200

Table 78: SF_Source Controlled by the PRDGPSMODE Command (SFRTG Only)

Keyword Mnemonic	Description
INTERNAL	Default – Uses 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.

Examples: [PRDGPSMODE] WAASEGNOS, OFF

Disables navigation using dGPS corrections from WAAS, EGNOS, or MSAS

1.123 PRDGPSTIMEOUT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	Keyword which specifies the code-based, dGPS mode as defined in Table 77.
timeout	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 Table 77.

Examples: [PRDGPSTIMEOUT] WAASEGNOS, 300

Sets the dGPS correction age limit for WAAS, EGNOS, or MSAS to 300 seconds

1.124 PROCESSRATE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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, and PVT1B, and the NMEA messages GBS, GGA, GLL, GRS, GST, RMC, RRE, VTG, ZDA, PNCTGGA, GSA, and PNCTSET. The message that changes the data rate is MEAS1B.

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.

1.125 Reserved

1.126 PROFILE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire 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	Keyword that specifies the action to be performed on the user profile, as described in Table 79.
name	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 Sapphire 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 section 1.199.2 USEPROFILE.

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

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 the [OUTPUT] command. This will guarantee that the desired settings are preserved if [OUTPUT] is ever changed to modify the automatically scheduled messages.

> If [RTKMODE] is changed in the profile text, the corrections will not be scheduled unless they are written into the [OUTPUT] list in the profile. Another method would be to put the modified [RTKMODE] after [OUTPUT] in the edited profile.

1.127 PWALARMLVL (ASCII)

☐SF-3050 ☐Sapphire ☒SF-3040

This command is used with the SF-3040 to configure the receiver for the type of batteries installed and the proper voltage levels that determine when a battery is near the end of its useful charge. There are three specified voltages, each corresponding to a different temperature range due to the changing characteristics of the batteries at different temperatures: The LOW range is anything less than 12°C, NORM is 12 – 33°C, and HIGH is anything greater than 33°C. This command is used with the SF-3040 only when factory supplied batteries are not used. This command allows the end user to configure the receiver for the type of batteries installed and the proper voltage levels that determine when a battery is near the end of its useful charge.

Command:	[PWALARMLVL] type_num, min_low_v,min_norm_v, min_high_v
Parameter	Definition
TYPE_NUM	A number assigned during the battery qualification process, it identifies the battery model for informational purposes only
MIN_LOW_V	The threshold voltage for the low temperature range
MIN_NORM_V	The threshold voltage for the normal temperature range
MIN_HIGH_V	The threshold voltage for the high temperature range

When a battery's voltage drops below the specified value for the current temperature, it is considered to be at the end of its useful charge and the receiver switches to the other battery for power. The voltage levels are determined as part of the qualification process and are fixed for each battery type.

When entered without parameters, this command generates a response message with the currently configured parameters.

Example: [PWALARMLVL]1,6.2,6.5,6.8

Sets the battery type to 1, the minimum allowed battery voltage for the low temperature range to 6.2V, the minimum allowed battery voltage for the normal temperature range to 6.5V, and the minimum allowed battery voltage for the high temperature range to 6.8V

The threshold voltage for each temperature range is the voltage which, if the battery falls below this value, the battery status will change from BAT_GOOD to BAT_LOW, and its LED will change from GREEN to RED. The current temperature is the ambient temperature *inside* the unit. If the current temperature is, for example, 30°C and a battery voltage falls below 6.5 V, then its status will change from BAT_GOOD to BAT_LOW, its LED will change from GREEN to RED, a one-second alarm will sound to alert the operator of the change, and, if the battery was the currently selected battery (if it was the current power source), the software will switch to the other battery (assuming the status of the other battery is BAT_GOOD).

The minimum allowed battery voltage is the threshold where the battery status will change from BAT_GOOD to BAT_LOW and its LED will change from GREEN to RED (assuming its status was BAT_GOOD before falling below the threshold voltage specified in the [PWALARMLVL]).

1.128 RADIO (ASCII)

☐SF-3050 ☐Sapphire ☒SF-3040

This command controls the plug-in radio module for the SF-3040.

Command:	[RADIO] {on_off}, {TX frequency}, {TX power}, {RX threshold}, {network ID}, {channel width}, {protocol}, {FEC}
Parameter	Definition
ON	Turns on power to the radio (default)
OFF	Turns off power to the radio
TX FREQUENCY	Commands radio to transmit frequency in MHz (403.0 to 473.0 MHz)
TX POWER	Commands radio to transmit power in milliwatts (100, 200, 500, or 1000 mW)
RX THRESHOLD	Commands the radio to receive the signal threshold in dBm (-118 to -80 dBm)
NETWORK ID	Displays network ID (1 to 4090 decimal for Satel, -1 – 255 for Pacific Crest, which is converted to a 4-digit hex value to send to the radio, -1 = disable addressing))
CHANNEL WIDTH	Transmit channel bandwidth in kHz, 25 or 12.5 (default)
PROTOCOL	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	Enables or disables REC for Satel modes (ON/OFF).

Default: OFF, 464.75, 100, -117, 0, 12.5, 0, OFF

This is a user profile command, meaning the values of on/off, frequency, and power will be saved in NVRAM to allow them to survive a power cycle.

If command parameters are not specified, the current settings are maintained.

This command specifies the values for the radio and returns the last values set.

Use the command [OUTPUT]RADIOSTAT to query values of the receiver. It may take a few seconds for the radio values to update, so allow for a short delay before following a [RADIO] command with an [OUTPUT]RADIOSTAT command.

Examples:

[RADIO]ON 464.75000, 1000, -100, 0, 12.5, 0

Turns on the radio with TX frequency = 464.75 MHz, TX power = 1000 mW, RX threshold = -100 dBm, and network ID = 0, Channel width of 12.5KHz, Satel Protocol

[RADIO]

[RADIO] ON, 464.950, 100, -117, 0000, 12.5, 0
Queries current radio settings

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.

1.129 Reserved

1.130 Reserved

1.131 RADIOTYPE

☒SF-3050 ☐Sapphire ☐SF-3040

This command is used with an SF-3050 configured with the Deere Shared Base option. This command is used to indicate what type of Deere radio is attached, what channel it is using and whether repeaters are there in the network.

Command:	[RADIOTYPE] Type, Channel, Repeater
Parameter	Definition
Type	Keyword: either “Unknown”, “Freewave900”, “Freewave450”, or “Satel869”
Channel	An Integer; Radio channel number.
Repeater	“ON” if network includes repeaters, otherwise “OFF”. Default is to leave value unchanged. Ignored if unit is not an RTK base. Ignored if type is not Freewave450.

Default: Unknown, 0, OFF

The SF-3050 receiver boots up with unknown radio type. This must be user-specified before the radio can be used correctly with the Deere RTK Rover. “Unknown” is the default setting and should be set for all non-radio RTK connections, including Serial-to-Serial RTK.

Examples:

[RADIOTYPE] Freewave900, 4
Freewave 900 radio set to channel 4. Repeater in network is ignored

[RADIOTYPE] Freewave450, 4, ON
Freewave 450 radio set to channel 4. Repeater is present in the network.

[RADIOTYPE] Freewave450, 4, OFF
Freewave 450 radio set to channel 4. Repeater is not present in the network.

1.132 Reserved

1.133 RAPIDRECOVERY

☒SF-3050 ☒Sapphire ☒SF-3040

The Rapid Recovery feature provides a way to more quickly recover from the loss of StarFire corrected positioning after loss and recovery of navigation and StarFire Correction. The receiver starts to secure Rapid Recovery corrections after FOM (Figure of Merit – FOM, representing the best-guess accuracy of the horizontal position) becomes lower than a specified limit. The receiver uses these corrections when the link to the navigation satellites has been lost, or has degraded (Figure of Merit – FOM, representing the best-guess accuracy of the horizontal position).

Command:	[RAPIDRECOVERY] command, <FOM_LIMIT>
Parameter	Definition
Command	Keyword: either (“ENABLE” or “DISABLE”) ENABLE may optionally include a new value for FOM_LIMIT(Default:10), but DISABLE may not.
FOM_LIMIT	An Integer; value from 1 to 255, representing horizontal accuracy in cm. NavCom recommends using a FOM_LIMIT value less than 20. If “DISABLE” is specified, an error return will generate indicating invalid input.

Default: ENABLE

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.

Examples:

[RAPIDRECOVERY]
views current state of Rapid Recovery and the FOM:
>[RAPIDRECOVERY]ENABLE,4 … or,
>[RAPIDRECOVERY]DISABLE

[RAPIDRECOVERY]Enable
Enables use of Rapid Recovery using the existing FOM

[RAPIDRECOVERY]Disable
Disables use of Rapid Recovery

[RAPIDRECOVERY]Enable,10
Enables use of Rapid Recovery, and uses a FOM of 10

1.134 REFNAME (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to define the reference station name for base station mode of operation. When the Sapphire engine 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	Reference station name (string) (1 to 10 characters; must be captured within quotation marks “”)

Default: REF1

The stored reference station name will be used while composing the following messages:

CMR Type 2 (long station ID field)

CMR Type 4 (long station ID, subframe 3)

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
- RECEIVERNAME is the product name
- REFNAME is the string set by the [REFNAME] command

Examples: [REFNAME] “HELLYER”
Sets reference name to HELLYER, which might be a location for RF Tower 59

Query stored value:

[REFNAME]
[REFNAME]”HELLYER”

1.135 REFSTNPOS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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
Parameter	Definition
Lat-deg	Degree portion of latitude (integer) (-90 to 90, positive North)
Lat-min	Minute portion of latitude (integer) (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	Second portion of latitude (float) (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	Degree portion of longitude, (integer) (-180 to 180, positive East)
Lon-min	Minute portion of longitude (integer) (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	Second portion of longitude (float) (0 to <60, assumed to be in same direction as Lon-deg)
Height	Mean sea level (MSL) height (float, meters) (-1000 to 18,000)

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.

1.136 Reserved

1.137 Reserved

1.138 RTGQUICKSTART (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

The StarFire™ RTG 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 RTG QuickStart. This command is used to manually set the QuickStart position for RTG. Single frequency StarFire mode is not supported.

Command:	[RTGQUICKSTART] Action, {Lat-deg, Lat-min, Lat-sec, Lon-deg, Lon-min, Lon-sec, Height, Datum}
Parameter	Definition
Action	Keyword defined in Table 80 that specifies QuickStart actions. The following arguments are required only when "START" is specified as action.
Lat-deg	Degree portion of latitude (integer) (-90 to 90, positive North; ITRF-08)
Lat-min	Minute portion of latitude (integer) (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	Second portion of latitude (float) (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	Degree portion of longitude (integer) (-180 to 180, positive East; ITRF-08)
Lon-min	Minute portion of longitude (integer) (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	Second portion of longitude (float) (0 to <60, assumed to be in same direction as Lon-deg)
Height	Ellipsoidal height (float, meters;-1000 to no upper limit; without Solid Earth Tide compensation)
Datum	ITRF: The coordinates are displayed in the latest ITRF format unless otherwise specified. *Default:* The coordinates are in the latest ITRF format. WGS84: The coordinates given are in WGS84 format. This parameter is only supported in v3.3.6.0 or later firmware.

Minus sign for South or West must precede only the Lat-deg and Lon-deg fields.

Table 80: [RTG QUICKSTART] Action Keywords

Keyword Mnemonic	RTG 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 RTG navigation

Examples:

[RTGQUICKSTART] START, 33, 50, 28.5506, -118, 20, 37.4839, 9.03
OR
RTGQUICKSTART] START, 33, 50, 28.5506, -118, 20, 37.4839, 9.03, ITRF

Sets RTG 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.

[RTGQUICKSTART] START, 33, 50, 28.5506, -118, 20, 37.4839, 9.03, WGS84

Sets RTG 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.

The QuickStart process requires 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:

[RTG QUICKSTART] mode, total_time, current_time, lat, lon, ht

mode	quick start mode described in Table 81
total_time	total time required for quick start (seconds)
current_time	the length of time that quick start has running (seconds)
lat	latitude in degrees
lon	longitude in degrees
ht	ellipsoidal height in meters

Table 81: [RTGQUICKSTART] QuickStart Mode in Response

Mode	Description
0	Idle
1	QuickStart initiated
2	QuickStart in progress
3	QuickStart completed
4	QuickStart failed due to nav proximity

The QuickStart position should be accurate to better than 30 cm; however, best performance is achieved from a previously fully converged position (i.e., 7 cm), and is referenced to ITRF. Refer to NavCom’s website FAQ’s for ITRF realization transition dates, which evolve over time. For optimal performance, use ITRF to initiate QuickStart.

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 the gross check is different from the current navigation position by more than 25 meters, QuickStart aborts and QuickStart status reports FAILED.

Any error biases contained in the input position cause the output to be biased by an equal amount, plus any error in the StarFire™ RTG navigation solution. For example, an error of 25 centimeters in the input position plus a 7 centimeter error in the RTG navigation solution, biases the output by 32 centimeters.

1.139 RTKDEFAULTS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to return all the RTK settings to default values. See table below.

Command:	[RTKDEFAULTS]

Table 82: RTK Default Values

RTK Control Parameter	Default Value
RTK navigation elevation mask	10.0 degrees
RTK search elevation mask	7.0 degrees
RTK carrier phase correction time out	15 seconds

1.140 RTKFIXMODE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to set RTK fix mode.

Command:	[RTKFIXMODE] mode
Parameter	Definition
Mode	Keywords (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

1.141 RTKFLOATTIMEOUT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

1.142 Reserved

1.143 RTKMODE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	See Table 83 for keywords. This is a required field.
type	Keywords (CMR,CMR+,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	Refer to the tables below for the id range for the rover site id request and for the base station. 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]	Keyword: (all available ports). This field must be empty for rover mode.
Dynamics[2]	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. The moving base RTK is only supported in NCT format. See the Examples for the configuration of moving base RTK base and rover. The SF-3040 does not support the *Dynamic* keword.
scheduling type	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 Examples.
X_ON/X_OFF	This is an optional field specifying whether or not the user would like the receiver to transition into RTK-X mode. If the user does not specify this keyword, nothing changes and the receiver will stay in the current mode. X_ON – RTK-X is enabled. This is the default mode. X_OFF – RTK is disabled. Will enable the receiver to go from RTK Dual Fixed to StarFire. However, this mode is less accurate than the mode in which RTK-X is enabled.

[1] 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 using the OUTPUT command).

[2] The SF-3040 does not support MBRTK mode, so the DYNAMIC keyword is not applicable to the SF-3040 when configured as a base.

Table 83: 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
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
BaseCMR	Receiver operates as a CMR base station
BaseCMRPLUS	Receiver operates as a CMR+ base station
Base5B[1]	Receiver operates as a proprietary 5B (10 km) base station; supports legacy products
Base5E[2]	Receiver operates as a proprietary new 5E (40 km) base station (to support multi-GNSS RTK)
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

[1]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 and the legacy version of x5E message to support this older generation of products.

[2]Base5E supports all GNSS RTK corrections, including GLONASS and WAAS.

Table 84: Rover Site ID Request

dGPS Correction Type	Station ID Range
CMR	0 – 31
CMR+	0 – 255
RTCM (Includes RTCM1, RTCM9, RTCM1819, RTCM2021)	0 – 1023
RTCMv3 (Includes RTCM1001, RTCM1002, RTCM1003, RTCM1004)	0 – 4095
NCT (Includes 5B, 5E)	0 – 1023

Table 85: Base Station ID

dGPS Correction Type	Station ID Range
CMR	1-31
CMR+	1-255
RTCM (Includes RTCM1, RTCM9, RTCM1819)	1-1023
RTCMv3 (Includes RTCM1001, RTCM1002, RTCM1003, RTCM1004)	0-4095
NCT (Includes 5B, 5E)	1-1023

Examples:

[RTKMODE]ROVER, CMR, 2,
Configures the receiver to be a rover. The rover will accept dGPS corrections from site id 2; the site id range will be checked against the CMR correction type.

[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. Schedule the desired individual RTK correction messages using the [OUTPUT] command.

[RTKMODE]BASE5E,,,1,DYNAMIC
Configures the receiver to be an NCT moving base and to output corrections on port 1

[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 or CMR).

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 (not supported in Sapphire v1.0.1.5)

1002 – GPS L1 Observations (expanded set) (not supported in Sapphire v1.0.1.5)

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. (supported in Sapphire v3.6.3.0 or later)

1007 – Antenna Descriptor (supports NGS antenna model designations) (supported in Sapphire v3.6.3.0 or later)

1008 – Antenna Descriptor & Serial Number (Supports NGS antenna model designations) (supported in Sapphire v3.6.3.0 or later)

1009 – GLONASS G1 Observations (not supported in Sapphire v1.0.1.5)

1010 – GLONASS G1 Observations (expanded set) (not supported in Sapphire v1.0.1.5)

1011 – GLONASS G1/G2 Observations

1012 – GLONASS G1/G2 Observations (expanded set)

1019 – GPS Satellite ephemeris data (not supported in Sapphire v1.0.1.5)

1020 – GLONASS satellite ephemeris data (not supported in Sapphire v1.0.1.5)

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 with the [OUTPUT] command.

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
```

1.144 RTKMULTIPATH (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to set the multipath environment the RTK rover receiver experiences.

Command:	[RTKMULTIPATH] keyword (OPENSKY, SURVEYENVIRON, HIGHMULTIPATH, URBANCANYON) (see Table 86)

Default: SURVEYENVIRON

Table 86: 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

1.145 RTKNAVRESET (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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.

1.146 RTKSYNCMODE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to configure the RTK measurement synchronization mode.

Command:	[RTKSYNCMODE] keyword (LOWLATENCY, TIMESYNC) (see Table 87)

Default: LOWLATENCY

Table 87: RTK Measurement Synchronization Mode Keywords

Keyword Mnemonic	Description
LOWLATENCY	This configures the RTK rover receiver to use the latest RTK corrections from the base receiver in RTK mode.
TIMESYNC	This configures the RTK rover receiver to synchronize its measurements with RTK corrections and then process in RTK mode.

1.147 RTKTIMEOUT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	RTK correction age limit (positive float) (0.0 to no upper limit)

Default: 15 seconds

Examples: [RTKTIMEOUT]30

Sets correction age limit to 30 seconds

1.148 Reserved

1.149 SBASLIST (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	Keyword that tells the receiver to rebuild the list
User	Keyword that allows the user to build a list of satellites that overwrites the default list (prn1 – prn4 include numbers ranging from 120 – 138) Software v2.2.9.0 (Sapphire and SF-3050) and earlier, and Software v2.1.7.0 (SF-3040) support up to 4 PRN's. Software v3.0.x.x and later support up to 2 PRN's

Default: DEFAULT

Examples:

[SBASLIST]DEFAULT
Returns the default configuration of SBAS satellites

[SBASLIST]USER, 120, 135, 138
Creates configuration of SBAS satellites that includes prn 120, prn 135, and prn 138

[SBASLIST]?
[SBASLIST][DEFAULT][USER prn, prn, prn, prn: (1-4, each 120-138)

The user may save the list of SBAS satellites as part of the default profile using the [PROFILE]SAVEAS command. Also, the command [PROFILE]NONE clears the list of SBAS satellites and causes the receiver to reconfigure the list to the system default. This re-setting occurs immediately, to minimize SBAS downtime.

1.150 Reserved

1.151 Reserved

1.152 SELFSURVEY (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command performs a self survey operation by averaging the GNSS receiver position over time and then applying that averaged position as the reference station position. The command supports the following parameters:

Command:	[SELFSURVEY] {start, stop, quick-start, quick-survey, cancel}, time
Parameter	Definition
start	Begins a survey for the specified time, and writes the results to the current surveyed position in REFSTNPOS. The TIME keyword defaults to 1440 if not specified. The survey continues for the specified time, or until the user enters STOP or CANCEL.
stop	Stops the self survey; if the user issues the STOP command before the survey time has elapsed, the results will be saved to an internal location from which [REFSTNPOS] draws its data. If the user issues the CANCEL command before the survey time has elapsed, the results will be discarded.
quick-start	The QUICK-START command begins a survey for up to 86400 seconds (24 hours) and automatically stops and writes after either of the following: • after 86400 seconds have passed • after the STOP command is entered *only if* it has collected four survey points; if fewer than four have been collected, it will discard any results The surveyed position will be applied at [REFSTNPOS].
quick-survey	See second note, below.
cancel	Cancels the self survey in progress; if the user issues a [SELFSURVEY] CANCEL command, any survey in progress is aborted and the receiver discards the surveyed position without changing [REFSTNPOS] (no change to the reference station position or base station table will occur).
time	The length of the self-survey in minutes (1-10080); the default is 1440 (24 hours)

Default: 1440

The receiver waits for a period of time (nominally 3600 seconds) to allow the RTG readings to "settle." This means there will be no valid survey results until this time has passed. However, if the user specifies less than this value as the time limit, the survey will continue until complete.

QUICK-SURVEY is synonymous with QUICK-START. This command starts an open-ended survey. Regardless of the solution quality, the survey runs for one day or until the user enters the STOP or CANCEL command. The receiver generates its best results when it has an hour to collect position fixes before it starts averaging them to create a solution, and will continue to average data for an additional 24 hours. If the user specifies a runtime of less than an hour, the receiver will do its best to average the current results until the time expires. The purpose of specifying a runtime of less than an hour is to quickly diagnose a problem and is not typical.

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

Examples:

[SELFSURVEY] {no parameters}

Returns the status of the current survey

[SELFSURVEY] QUICK-START

Initiates a survey

[SELFSURVEY] START,{TIME}

Begins a survey for the specified time and writes the results to the current surveyed position in REFSTNPOS.

[SELFSURVEY] START,180

1.153 SERIALMODE (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command selects either the RS232 or RS422 mode for the SF-3050 COM2 serial interface.

Command:	[SERIALMODE] {mode}
Parameter	Definition
Mode	Keyword (RS232 or R2422) specifying the interface mode

Default: Displays RS-232 serial mode

Examples: [SERIALMODE] RS422
Sets the serial mode to RS422

[SERIALMODE]
Displays the current serial mode
[SERIALMODE]RS232

1.154 Reserved

1.155 Reserved

1.156 Reserved

1.157 Reserved

1.158 SETL1RTK (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

The [SETL1RTK] command is used to turn on/off the single-frequency RTK feature.

Command:	[SETL1RTK] {on_off}

Default: OFF

Examples:

[SETL1RTK]ON
Turns on single-frequency RTK feature

[SETL1RTK]OFF
Turns off single-frequency RTK feature

1.159 SETPOSITION (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to set the approximate position in the receiver.

If the receiver is already generating navigation solution from tracking live signals, this command does not take effect.

This command is typically used, in conjunction with the [SETTIME] command, to aid the receiver with startup.

Command:	[SETPOSITION] Lat-deg, Lat-min, Lat-sec, Lon-deg, Lon-min, Lon-sec, Height
Parameter	Definition
Lat-deg	Degree portion of latitude (integer) (-90 to 90, positive North)
Lat-min	Minute portion of latitude (integer) (0 to 59, assumed to be in same direction as Lat-deg)
Lat-sec	Second portion of latitude (float) (0 to <60, assumed to be in same direction as Lat-deg)
Lon-deg	Degree portion of longitude, (integer) (-180 to 180, positive East)
Lon-min	Minute portion of longitude (integer) (0 to 59, assumed to be in same direction as Lon-deg)
Lon-sec	Second portion of longitude (float) (0 to <60, assumed to be in same direction as Lon-deg)
Height	Mean sea level (MSL) height (float, meters) (-1000 to 18,000)

Minus sign for South or West must only precede the Lat-deg and Lon-deg fields.

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.

If this command is given without any argument, it responds with the current system position.

1.160 SETSFALMSWITCHMODE

☒SF-3050 ☒Sapphire ☒SF-3040

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	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	Number of hours (integer) (0 to 24) to wait in AUTO mode
MINS	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.

1.161 SETTIME (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to set the approximate time and date in the receiver.

If the receiver already has the accurate time and date from tracking a live GNSS signal, then this command does not take effect.

This command is typically used in conjunction with the [SET POSITION] 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.

Command:	[SETTIME] year, month, {day}, {hour}, {minute}, {second}, {offset hr}, {offset min}
Parameter	Definition
year	full calendar year (integer) (1901 to 2999)
month	calendar month (integer) (1 to 12)
day	calendar day (integer) (1 to 31)
hour	hour portion of the time of the day (integer) (0 to 23)
minute	minute portion of the time of the day (integer) (0 to 59)
second	second portion of the time of the day (integer) (0 to 59)
offset hr	difference between UTC and time zone of time entered, in hours (integer) (-13 to +13)
offset min	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

Example: [SETTIME] 2006, 07, 13, 11, 30

Set the date and time to 2006/7/13, 11:30:00

1.162 SETUTCOFFSET (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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	hour portion of the offset (integer) (-13 to 13)
minutes	minute portion of the offset (integer) (0 to 59)

Default: offset hr = 0; offset min = 0

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.

1.163 Reserved

1.164 Reserved

1.165 Reserved

1.166 Reserved

1.167 Reserved

1.168 SFALMENABLENEW

☒SF-3050 ☒Sapphire ☒SF-3040

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.

This command is issued with no parameters.

Example:

[SFALMENABLENEW]

1.169 Reserved

1.170 Reserved

1.171 Reserved

1.172 Reserved

1.173 Reserved

1.174 SFNETPRIORITY (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to set a StarFire™ priority net.

Command:	[SFNETPRIORITY] {default, net1, net2}
Parameter	Definition
default	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	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	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.

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

1.175 Reserved

1.176 Reserved

1.177 SHUTDOWN (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command shuts down the Sapphire and Power I/O boards.

Command:	[SHUTDOWN] {action} {delay}
Parameter	Definition
Action	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	A value in seconds defining how long to wait before shutting down (default = 0 seconds)

If no arguments are entered, the command is treated as a query and will respond with the most recent action request and remaining time until it is implemented.

The response to the [SHUTDOWN] command depends on how the unit is powered, rather than on the HALT or REBOOT keywords. If it is powered from the front panel ON/OFF switch, the unit always halts (powers down). If it is powered from the ignition pin, it always reboots (powers up).

Logic is implemented to detect if the receiver shut down gracefully. The GNSS board monitors the PIO heartbeat message age. When the GNSS board receives a shutdown command, it saves this PIO heartbeat message age as a missing heartbeat count in NVRAM.

When the receiver is powered on, the GNSS board retrieves the missing heartbeat count from NVRAM and sends it to the PowerIO board. Once the GNSS board sends this missing heartbeat count to the PowerIO board, it invalidates this missing heartbeat count to (-2) and saves it in NVRAM.

When the receiver is powered on, if the GNSS board is unable to retrieve the missing heartbeat count from NVRAM, the GNSS sends an invalid missing heartbeat count (-1) to the PowerIO board. Once the GNSS board sends this missing heartbeat count to the PowerIO board, it invalidates this missing heartbeat count to (-2) and saves it in NVRAM.

When the PIO heartbeat message is greater than 1 and is modulo 60, the GNSS automatically saves it as a missing heartbeat count in NVRAM. Values that may be written in NVRAM are 60, 120, 180, and 240.

Based on this missing heartbeat count, the PowerIO determines whether the receiver experienced an ungraceful shutdown.

If the missing heartbeat count is equal to or greater than 0 and less than 60, the receiver experienced a previous graceful shutdown.

If the missing heartbeat count is equal to or greater than 60, the receiver experienced a previous ungraceful shutdown, and the following message is output:

[PANICA]0,0.0,0, PREVIOUSLY UNGRACEFUL SHUTDOWN IS DETECTED: code (12)

Code 12 indicates that this ungraceful shutdown was triggered by the watchdog time reset on the PowerIO board.

If the missing heartbeat count is (-2), the receiver experienced a previous ungraceful shutdown, and the following message is output:

[PANICA]0,0.0,0, PREVIOUSLY UNGRACEFUL SHUTDOWN IS DETECTED: code (11)

If the missing heartbeat count is (-1), a previous ungraceful shutdown cannot be determined, and the following message is output:

[PANICA]0,0.0,0, UNDETERMINED PREVIOUSLY UNGRACEFUL SHUTDOWN: code (-1)

For example, when a GNSS board with firmware that does not have the capability of detecting an ungraceful shutdown is first upgraded to firmware with this capability, the GNSS board cannot retrieve a missing heartbeat count, so it will send an invalid heartbeat missing count (-1) to the PowerIO board.

If the PowerIO board does not receive a missing heartbeat count from the GNNS board within 1 minute of powering on, a previous ungraceful shutdown cannot be determined, and the following message is output:

[PANICA]0,0.0,0, UNDETERMINED PREVIOUSLY UNGRACEFUL SHUTDOWN: code (-3)

For example, if the GNSS board firmware does not have the capability of detecting an ungraceful shutdown, it won't send this missing heartbeat count to the PowerIO board.

For all other situations in which a previous ungraceful shutdown cannot be determined, the following message is output:

[PANICA]0,0.0,0, UNDETERMINED PREVIOUSLY UNGRACEFUL SHUTDOWN: code (-2)

This ungraceful shutdown detection mechanism also detects occurrences of GNSS reset. When more than one missing heartbeat count is received from the GNSS board, the GNSS was reset, and the following message is output:

[PANICA]0,0.0,0, GNSS RESET IS DETECTED

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

1.178 Reserved

1.179 SIMULATORSTART (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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

1.180 Reserved

1.181 SOLIDEARTHTIDE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to enable or disable the correction of solid earth tide. This command causes a response, which includes the *[SOLIDEARTHTIDE]* mnemonic followed by the *ON/OFF* setting.

Command:	[SOLIDEARTHTIDE] {mode}
Parameter	Definition
Mode	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.

Examples: [SOLIDEARTHTIDE]ON
Request to enable solid earth tide correction

OK [SOLIDEARTHTIDE]
Response from the receiver

[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

OK [SOLIDEARTHTIDE]
Response from the receiver

[SOLIDEARTHTIDE]
Request for solid earth tide correction enable status

[SOLIDEARTHTIDE]OFF
Response shows solid earth tide correction is disabled

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.

1.182 Reserved

1.183 STARFIREALTSAT (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver has one channel 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. 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 IDs for the selection to be successful. The valid ID numbers are 358, 402, 484, 525, 609 and 643.

⚠ This command is used only in rare circumstances when temporary channel assignments are made to support satellite vehicle maintenance or changes.

Command:	[STARFIREALTSAT] on_off, {satellite_id}
Parameter	Definition
on_off	Keyword (ON, OFF)
satellite_id	Satellite ID number (integer)

Example: [STARFIREALTSAT] ON, 358

Override the default StarFire™ satellite ID selection with an alternate value.

1.184 STARFIREMODE (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

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 the GPS and the GLONASS satellite corrections contained in the current 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.

Command:	[STARFIREMODE] gps_gnss
Parameter	Definition
GPS	Keyword that directs the receiver to use the StarFire GPS service. [3RDPARTYRTKX] shall be turned OFF in order for this command to work as expected.
GNSS	Keyword that directs the receiver to use the StarFire GNSS service
BOTH	Keyword that directs the receiver to use both the GPS and the GNSS service

This command is not supported in the SF-3040 in this release.

If the receiver operates in single-frequency mode and uses the BOTH keyword, the position output in Starfire mode will use the StarFire GPS service only from the legacy message.

Examples:

[STARFIREMODE] GPS
Use only GPS satellites. [3RDPARTYRTKX] shall be turned OFF in order for this command to work as expected.

[STARFIREMODE] GNSS
Use GPS and GLONASS satellites

[STARFIREMODE] BOTH
Use GPS and GLONASS satellites unless there is a data error, in which case use GPS satellites

1.185 Reserved

1.186 Reserved

1.187 Reserved

1.188 STDDEVMODE

☒SF-3050 ☒Sapphire ☒SF-3040

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	standard deviation mode configuration Keyword: (FIX, SMOOTH)

Default: FIX

Receiver will default to this mode and perform exactly as earlier firmware builds without this configurable command.

Examples:

[STDDEVMODE] FIX
Receiver performs standard code to phase transition.

[STDDEVMODE] SMOOTH
Receiver performs transition from code to phase only after a defined threshold comparison is triggered.

This is a user command that is saved in the profile

1.189 Reserved

1.190 Reserved

1.191 Reserved

1.192 Reserved

1.193 Reserved

1.194 TRACKELEVMASK (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to manually set the 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	tracking elevation mask (float, degrees) (0.0 to 60.0)

Default: 0.0 degrees

Example: [TRACKELEVMASK] 5

Sets the tracking elevation mask angle to 5.0 degrees

1.195 TRACKINGMODE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to enable or disable the receiver's tracking of various signals or frequencies. When a GPS signal or frequency is enabled or disabled, it applies to all GPS 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	Keyword, defined in Table 88, which specifies the signal or frequency to be enabled or disabled.
on_off	Keyword (ON or OFF)

Default: ALL, ON

Table 88: Signals and/or Frequencies Keywords for TRACKINGMODE Command

Keyword Mnemonic	Signal or Frequency
ALL	Used to specify all signals and frequencies (see notes)
L2	GPS L2/P2(Y)
L2C	GPS L2C
L5	GPS L5
WAASEGNOS	WAAS, EGNOS, or MSAS SBAS systems
STARFIRE	StarFire™ global dGPS correction signals
G1	GLONASS G1
G2	GLONASS G2

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.

L2C requires L2. If L2 is turned off, it will force L2C off. Trying to turn L2C on when L2 is turned off will have no effect.

G2 requires G1. If G1 is turned off, it will force G2 off. Trying to turn G2 on when G1 is turned off will have no effect.

Notes continued on next page…

L5 and G2 tracking are mutually exclusive due to hardware resource sharing. Turning on G2 tracking automatically turns off L5 tracking, and vice versa. The command "[TRACKINGMODE] ALL, ON" turns on all signal tracking except L5. The command "[TRACKINGMODE] ALL,OFF" turns off all signal tracking, including L5 and G2.

⚠ Do not try to turn on L5 and G2 tracking at the same time. If one command tries to turn on L5 and G2 at the same time, the later pair in the command will overwrite the earlier pair.

⚠ Issuing the command [TRACKINGMODE]WAASEGNOS disables the satellite.

Examples: [TRACKINGMODE] L2C, OFF
Disables tracking of L2C for all satellites broadcasting it

[TRACKINGMODE] ALL, ON
Enables tracking for all signals and frequencies except L5

[TRACKINGMODE] G1, ON, L2, OFF, L2C, OFF
Enables tracking of G1, but disables L2 and L2C

1.196 Reserved

1.197 Reserved

1.198 UPTIME

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.

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

1.199 USBMODE (ASCII)

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used to check the current USB mode, or to set a specific USB mode.

1.199.1 USB Mode for SF-3050 Only

Command:	[USBMODE]{mode, option}
Parameter	Definition
Mode Keywords	
Host	USB Host mode
Device	USB Device mode
Option Keywords (Device mode only)	
ComPort	USB virtual com port mode (default)
MassStorage	USB mass storage mode

Default: If no Device mode option keyword is specified, the USB defaults to ComPort.

Examples: [USBMODE]
Returns current USB mode.

[USBMODE]Host

Sets USB to host if its current mode is not host; otherwise, the USB remains in host mode.

[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,

Mass Storge Device mode allows a user to connect to a USB host (e.g., a laptop) to operate with programs like StarUtil 3000 and to download data from the internal 2GB memory device. The SF-3050 2GB internal memory chip shows in Windows Explorer as an additional (removable) drive, similar to a camera when connected to the USB port. The desired files can then be located on the 2GB drive. Copy and paste (or drag and drop) them to the desired directory on the laptop.

⚠ 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 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 3000 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 3000 restarted, to recover the connection. The best practice is to close the USB port from StarUtil 3000 first, and then remove the USB cable.

⚠ Changing the USB mode from COM port to other modes when the USB port is in an open state in StarUtil 3000 results in connection difficulty when the USB mode is switched back to COM port mode. If this happens, power-cycle the receiver or restart StarUtil 3000. The best practice is to first close the USB port from StarUtil 3000 and then use the [USBMODE] command to switch to USB mode.

1.199.2 USB Mode for SF-3040 Only

On-the-Go (OTG) works by detecting whether the USB_ID pin is grounded or high. Special USB cables are required for the OTG feature. When the USB device cable is plugged in, Device Mode is engaged. When the USB host cable is plugged in, Host Mode is engaged.

Command:	[USBMODE]{mode, option}
Parameter	Definition
Mode Keywords	
Host	USB Host mode
Device	USB Device mode
Option Keywords (Device mode only)	
Com_Port	USB virtual com port mode (default)
Mass_Storage	USB mass storage mode

Default: If no Device mode option keyword is specified, the USB defaults to Com_Port.

- When the USB is in OTG HOST mode and the user enters the command [USBMODE] without any parameters, the receiver returns the current mode: OTG HOST.
- When the USB is in OTG HOST mode and the user enters the command “[USBMODE] device”, the receiver returns the current mode: OTG HOST.
- When the USB is in OTG HOST mode and the user enters the command “[USBMODE] host”, the receiver returns the current mode: OTG HOST.
- When the USB is in OTG DEVICE mode and the user enters the command [USBMODE] without any parameters, the receiver returns the current mode: OTG DEVICE : xx, where “xx” is either “COM_PORT” or “MASS_STORAGE”.
- When the USB is in OTG DEVICE mode and the user enters the command “[USBMODE] device”, the receiver returns the current mode: OTG DEVICE : xx, where “xx” is either “COM_PORT” or “MASS_STORAGE”.

- When the USB is in OTG DEVICE mode and the user enters the command “[USBMODE] host”, the receiver returns the current mode: OTG DEVICE : xx, where “xx” is either “COM_PORT” or “MASS_STORAGE”.
- When the USB is in OTG DEVICE:COM_PORT mode and the user enters the command “[USBMODE] device, mass_storage”, the receiver changes the current mode to mass storage device mode.
- When USB is in OTG DEVICE:MASS_STORAGE mode, user enters command “[USBMODE] device, com_port”, the receiver will change current mode to virtual com port mode.
- When USB is in OTG HOST mode, user enters command “[USBMODE] device, mass_storage”, the receiver will remember the mass storage for the device mode. Once user changes USB cable to device cable, the mass storage device mode will be engaged.
- When the USB is in OTG HOST mode and the user enters the command “[USBMODE] device, com_port”, the receiver remembers the com port for the device mode. Once the user changes USB cable to Device cable, the virtual com port mode is engaged.

Only the following [USBMODE] commands can be saved in a user profile:

[USBMODE]device,com_port

[USBMODE]device,mass_storage

Issuing a “[USBMODE] DEVICE, MASS_STORAGE” command through the USB port will result in a COMMAND FAILED error message, since executing the command would result in disconnecting the USB port.

Changing the USB mode from COM port to mass storage device mode when the USB port is open in StarUtil 3000 will result in connection difficulty when the USB mode is changed back to COM port mode. If this happens, the receiver has to be power cycled, or StarUtil 3000 restarted to recover. The best practice is to first close the USB port from StarUtil 3000 and then use the [USBMODE] command to change to USB mode.

1.200 USEPROFILE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire 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.

<table>
<tr><td>Command:</td><td>[USEPROFILE] {“name”}</td></tr>
<tr><td>Parameter</td><td>Definition</td></tr>
<tr><td>name</td><td>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 arguments in Sapphire 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 section 1.124).
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.</td></tr>
</table>

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

⚠ 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

1.201 USERANTTYPE

☒SF-3050 ☐Sapphire ☒SF-3040

This ASCII system command allows the user to enter up to two user-defined custom antenna types, one at a time.

Each of the 8 (possible maximum) frequency records must be added one-at-a-time for each of the two user-defined customer antenna types.

Command:	[USERANTTYPEB] {User Antenna Type Slot}, {Antenna Name}, {Total Number of Frequency Records}, {Frequency Record Index}, {PCO/PCV value1 for this Frequency Record}…{PCO/PCV value22 for this Frequency Record}
Parameter	Definition
User Antenna Type Slot	Indicates which user antenna is being defined (1 or 2) [Note that this correspond to 0 | 1 in software]
Antenna Name	The antenna name. (2 – 21 characters)
Total Number of Frequency Records	The number of frequency records contained in the message. (1 – 8)
Frequency Record Index	The frequency record being set (0 – 7)
Frequency record PCO/PCV value 1	1st PCO and PCV value for this frequency record
. . .	
Frequency record PCO/PCV value 22	22nd PCO and PCV value for this frequency record

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.

Note: 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
```

Note: 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:

Note: 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
```

User Defined Antenna Type 1 is now ready to be used.

1.202 USERANTTYPEB

☒SF-3050 ☒Sapphire ☒SF-3040

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}
Parameter	Definition

Default: not applicable

The format of the binary data is defined in the table below.

Data Item	Data Type	Description
Antenna Number	U08	Indicates which user antenna is being defined (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 the message. (1 – 8)
Frequency record 0	23 S16	PCO and PCV values for this frequency.
. . .		
Frequency record n	23 S16	PCO and PCV values for this frequency.

Note: This command does not produce a status message if entered without an argument. To output the current user-defined antenna types schedule the USERANTTYPEB message.

1.203 Reserved

1.204 VERSION (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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.

Use MSGVERSION to schedule the data on a recurring basis.

Command:	[VERSION] {component}
Parameter	Definition
component	Keyword, defined in Table 89, that specifies the firmware component for which version of information is being requested

Default: Displays BOOT1, BOOT2, NAV, PIOBOOT, PIOAPP, and BLUETOOTH

Table 89: VERSION Keywords for Software Components

Keyword Mnemonic	Firmware Component
NAV	Navigation (5200), CoreNav, LBAND DSP
BOOT1	Boot loader part 1 (5200)
BOOT2	Boot loader part 2 (5200)
PIOBOOT	PIO cold bootloader
PIOAPP	PIO application
BLUETOOTH	Bluetooth

1.205 WARMSTART (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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.

1.206 WEBCONTROL

☒SF-3050 ☒Sapphire ☒SF-3040

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 the SF-3040 and the Sapphire unit, it only affects the performance of the SF-3050 unit.

Command:	[WEBCONTROL] mode,source
Parameter	Definition
Mode	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	Keyword: (NCT/OEM) The webpages are stored in the internal storage of the SF-3050 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

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*

1.207 WEBLOADB

☒SF-3050 ☐Sapphire ☒SF-3040

This command is used for downloading new SF-3050 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 **50000** bytes.
    a. The maximum filename + filepath length is **96**
    b. 96 including A:\WEB\NCT\ or A:\WEB\OEM\
    c. 85 not including A:\WEB\NCT\ or A:\WEB\OEM\

It uses the simplified Nova binary header format described in *Table 9: Simplified Sapphire Binary Header Format*.

WEBLOADB] can only be used to update web pages via a PIOB Port: COM2, Ethernet, or USB.

1.207.1 Message General Format

The message general format is defined in the following table:

Table 90: WEBLOADB Binary Message

Data Item (8 Bytes + data)	DataType
Function Type SubID (enum)	U08
Pass or Fail (1 = pass, 0 = fail)	U08
Valid count	U16
Address (reserved)	U32
Data	U08[ ]

1.207.1.1 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 the PC to the receiver. Enums ending with “Rep” are replies sent from the receiver to the PC).

Table 91: WEBLOADB Message Function SubID Enum Definition

Value	Enum Name
1	WB_PingCmd
2	WB_PingRep
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_EnumLast

1.207.1.2 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.

1.207.1.3 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.

1.207.1.4 Address

Not used, reserved for future use.

1.207.1.5 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.

1.207.2 WEBLOADB SubID Message Format

1.207.2.1 SubID WB_PingCmd Message Format

SubID WB_PingCmd is sent from PC to receiver. It is used for PC to ping receiver webloadb software and to start the webloadb initialization process. 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 92: SubID WB_PingCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_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, reserved
Data	U08[ ]	0

1.207.2.2 SubID WB_PingRep Message Format

SubID WB_PingRep is sent from receiver to 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 93: SubID WB_PingRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_PingRep*.
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

1.207.2.3 SubID WB_SetupCmd Message Format

SubID WB_SetupCmd is sent from PC to receiver. It is used for 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 94: SubID WB_SetupCmd Message Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_SetupCmd*.
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.

1.207.2.4 SubID WB_SetupRep Message Format

SubID WB_SetupRep is sent from receiver to PC. It is the reply message for WB_ SetupCmd. It could fail if the file size exceeds the maximum filesize allowed by the receiver (50000 bytes) or if the filename is too long (96 bytes including “A:\WEB\NCT\” or “A:\WEB\OEM”). Its format is defined in the table below.

Table 95: SubID WB_SetupRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_ BaudRep.*
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

1.207.2.5 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 96: SubID WB_LoadDataCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_LoadDataCmd*.
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

1.207.2.6 SubID WB_LoadDataRep Message Format

SubID WB_LoadDataRep is sent from receiver to PC. It is the reply message for WB_LoadDataCmd. It could fail if the number if bytes transmitted in this process exceed the number of total bytes promised to be transmitted. Its format is defined in the table below.

Table 97: SubID WB_LoadDataRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_LoadDataRep.*
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

1.207.2.7 SubID WB_ ChkCrcCmd Message Format

SubID WB_ ChkCrcCmd is sent from PC to receiver. It is used to tell 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 98: SubID WB_ChkCrcCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_ChkCrcCmd*.
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

1.207.2.8 SubID WB_ChkCrcRep Message Format

SubID WB_ChkCrcRep is sent from receiver to 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 99: SubID WB_ChkCrcRep Message Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_ChkCrcRep.*
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

1.207.2.9 SubID WB_WriteCmd Message Format

SubID WB_WriteCmd is sent from PC to 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 100: SubID WB_WriteCmd Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_WriteCmd.*
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

1.207.2.10 SubID WB_WriteRep Message Format

SubID WB_WriteFRep is sent from receiver to 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 101: SubID WB_WriteRep Format

Field	DataType	Value and Description
Function Type SubID	U08	Enum *WB_WriteRep.*
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

1.207.3 PIO Webpage Loading Sequence

Table 102: WEBLOADB message protocol

PC	WB_PingCmd →	Receiver
	← WB_PingRep	
	WB_SetupCmd →	
	← WB_SetupRep	
	WB_LoadCmd →	Repeat for N files
	← 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.

1.208 WEBPAGES

This command indicates that the webpages can be properly installed and allows the user to format and remove current webpages on the system.

Command:	[WEBPAGES] function
Parameter	Definition
function	Keyword: (FORMAT) FORMAT will erase and initialize the filetable of both the NCT and OEM webpages on the receiver and get the system to a known state, this will only work if the file system has been already initialized at least once via FSFORMAT after upgrading to v3.3.x.0 or later.

Querying this command without any parameters will inform the user if the file system is ready to accept and install the webpages. If not, the user will need to run the [FSFORMAT] command to format the drive.

Examples:

Before running FSFORMAT in SB4+

[WEBPAGES]

[WEBPAGES] The storage is ready for the Web Pages.

[WEBPAGES] FORMAT

[??] The Internal Storage has not been formatted!

After running FSFORMAT in SB4+

[WEBPAGES]

[WEBPAGES] The storage is NOT ready for the Web Pages.
use [FSFORMAT] to format the drive.

[WEBPAGES] FORMAT

[OK] WEBPAGES

The webpages will be erased and the system will be ready to install new webpages.

1.209 WEBUSERS

☒SF-3050 ☒Sapphire ☒SF-3040

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 and Manage Accounts
TECH: Same as USER but is able to view Input Terminal
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,accessLvl
Parameter	Definition
Function	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	(string) The username of the user, case sensitive. Cannot be null, must always be specified.
Password	(string) The password of the user. Cannot be an empty password, case sensitive. Cannot be null while adding a new user
AccessLvl	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”, “IsCool”, TECH

Will add a new user with username: Sheldon, password: IsCool, and access: TECH

[WEBUSERS] ADD, “Dsharp”

Error, need password

[WEBUSERS] ADD, “Dsharp”, “Sharpness OverWhelming”

Error, need access level

[WEBUSERS] ADD, “Dsharp”, “uncool”, USER

Will add a new user with username: Dsharp, password: uncool, and access: USER

[WEBUSERS] REMOVE, “Dsharp”

Will remove Dsharp from the user list

[WEBUSERS] UPDATE, “Sheldon”, “Super Special Awesome”

Will change Sheldon’s password to Super Special Awesome

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.

1.210 WRAPPEDRTK (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This command is used to configure the receiver to output wrapped RTK corrections of different modes (CMR, 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	SET/OFF This is a required field. If SET is selected, the unit will output the wrapped corrections based on the current RTKMo see Table 6-81. If OFF is selected, all wrapped messages will be de-scheduled on all ports.
Port	Keyword (0 – 3, RADIO, BT, USB1)

Default: OFF

Examples:

[RTKMODE]BaseRTCM1819,,1,1

[WRAPPEDRTK] SET, 2

Schedules the necessary BaseRTCM1819 messages wrapped with the PackB wrapper on port 2

[RTKMODE]BaseCMR,,1,1

CMR corrections are scheduled on Port 1

Wrapped RTCM1819 corrections are scheduled on Port 2

[WRAPPEDRTK]SET

CMR corrections are scheduled on Port 1

Wrapped CMR corrections are scheduled on Port 2

[RTKMODE]Rover,NCT

Receiver configured as rover

Wrapped CMR corrections are scheduled on Port 2

[WRAPPEDRTK]OFF,2

No wrapped corrections are scheduled

[OUTPUT] WRAPPED_RTCM22,ontime,1,2

User can still schedule individual wrapped messages

[WRAPPEDRTK]OFF

Disables all wrapped messages on the previously set port

1.210.1 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:

Command:	[PACKB] L_0L_1 ~L_0~L_1 $T_0T_1T_2T_3$ T_V C_t P _MSG_ *$C_0C_1C_2C_3$	
Keyword	Description	Size (byte)
[PACKB]	PackB Header	7
L_0L_1	Length of msg (not including [PACKB])	2
~L_0~L_1	Inverse of length	2
$T_0T_1T_2T_3$	TOW (ms)	4
T_V	Time version (unused)	1
C_t	Correction Type 0=unknown, 1=NCT, 2=RTCM2, 3=RTCM3, 4=CMR	1
P	Logical Port (unused)	1
MSG	RTK Message	??
*$C_0C_1C_2C_3$	CRC	5

Table 103: 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`

Base5E	Receiver outputs the following corrections:
	`WRAPPED_NCT5C,ONTIME,10`
	`WRAPPED_NCT5D,ONTIME,1`
	`WRAPPED_NCT5E,ONTIME,1`
	`WRAPPED_NCT61,ONTIME,1`

BaseRTCM1001	Receiver outputs the following corrections:
	`WRAPPED_RTCM3_1001,ONTIME,1`
	`WRAPPED_RTCM3_1005,ONTIME,5`
	`WRAPPED_RTCM3_1009,ONTIME,1`
	`WRAPPED_RTCM3_1033,ONTIME,60`

BaseRTCM1002	Receiver outputs the following corrections:
	`WRAPPED_RTCM3_1002,ONTIME,1`
	`WRAPPED_RTCM3_1005,ONTIME,5`
	`WRAPPED_RTCM3_1010,ONTIME,1`
	`WRAPPED_RTCM3_1033,ONTIME,60`

BaseRTCM1003	Receiver outputs the following corrections:
	`WRAPPED_RTCM3_1003,ONTIME,1`
	`WRAPPED_RTCM3_1005,ONTIME,5`
	`WRAPPED_RTCM3_1011,ONTIME,1`
	`WRAPPED_RTCM3_1033,ONTIME,60`

BaseRTCM1004	Receiver outputs the following corrections:
	`WRAPPED_RTCM3_1004,ONTIME,1`
	`WRAPPED_RTCM3_1005,ONTIME,5`
	`WRAPPED_RTCM3_1012,ONTIME,1`
	`WRAPPED_RTCM3_1033,ONTIME,60`

2 Sapphire Output Messages Detailed Formats

This section provides the Sapphire 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 Sapphire receiver.

2.1 1PPSA (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

This output message reports UTC time that the next PPS will occur. The 1PPSA message is sent out approximately 10ms 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 (see Table 104)

Examples: [1PPSA]1411,503312.0730,5*8DB6

Table 104: 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

2.2 Reserved

2.3 ALM1B (Version 1; v1.0.0.4) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

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 GPS, SBAS and GLONASS are available to be output and each satellite type has its own data format.

The format of this binary message is defined in Table 105.

Table 105: ALM1B Binary Message Data

Data Item	Data Type	Section
Satellite type (-1=NONE, 0=GPS, 1=Reserved, 2=SBAS, 3=GLONASS)	U08	
Almanac data		2.3.1 to 2.3.4

2.3.1 GPS Almanac

Table 106 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 106: 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

2.3.2 GLONASS Almanac

This record contains the packed almanac data for 24 GLONASS satellites. The almanac for each satellite contains two strings. Table 107 lists the message structure.

Table 107: 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.

2.3.3 Reserved

2.3.4 SBAS Almanac

Table 108: SBAS ALM1B Binary Message Data

Data Item (N * 34 Bytes)		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)	U32
	Number of seconds since the start of the week	R64
	GPS week number	U16
Satellite 2 Almanac		
…		
Satellite N Almanac		

Table 109: SBAS Health and Status Byte

Bit 0 (lsb)	Ranging On (0), Off (1)	
Bit 1	Corrections On (0), Off (1)	
Bit 2	Broadcast Integrity On (0), Off (1)	
Bit 3	Reserved	
Bits 4-7	Service Provider ID	
	0	WAAS
	1	EGNOS
	2	MSAS
	3-13	Not Yet Assigned
	14-15	Reserved

2.4 Reserved

2.5 BASEINFOA

☒SF-3050 ☒Sapphire ☒SF-3040

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

CMR_x1

RTCM1005

RTCM1006

x5c

It 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;

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 Output:

[BASEINFOA]33.841179,N,118.343621,W,8.9

2.6 Reserved

2.7 BATSTAT (ASCII)

☐SF-3050 ☐Sapphire ☒SF-3040

For the SF-3040, this message outputs the current power source (EXT, BAT1, BAT2), the selected battery (BAT1 or BAT2), the current measured voltage of the external power input, and the current measured voltage, temperature, and status of the connected batteries.

Example Output:
[BATSTAT] {SRC} {BAT_SEL} {REG_VOLT} {BAT1_VOLT} {BAT1_TEMP} {BAT1_STATUS} {BAT2_VOLT} {BAT2_TEMP} {BAT2_STATUS}

Where:
{SRC} – the current power source (EXT, BAT1, or BAT2)
{BAT_SEL} – battery online (BAT1 or BAT2)
{REG_VOLT} – measured internal regulator input voltage
{BAT1_VOLT} – measured battery 1 voltage
{BAT1_TEMP} – measured battery 1 temperature
{BAT1_STATUS} – battery 1 status (GOOD, LOW, NONE, SWITCHED)
{BAT2_VOLT} – measured battery 2 voltage
{BAT2_TEMP} – measured battery 1 temperature
{BAT2_STATUS} – battery 2 status (GOOD, LOW, NONE, SWITCHED)

Code	Description
GOOD	The measured battery voltage is greater or equal to the threshold set with the [PWALARMLVL] command.
LOW	The measured battery voltage is greater than 0 V, but less than the threshold voltage set with the [PWALARMLVL] command. This indicates that the battery should be replaced or recharged.
NONE	The measured battery voltage is less than 0.9V. This indicates there is no battery installed in this (BAT1 or BAT2) position.
SWITCHED	The measured battery voltage is greater than 0 V and was previously the active selected battery, but has fallen below the acceptable threshold and has been switched to Standby mode. Once it is in Standby mode, it must be removed (status = NONE) and replaced with a battery having a voltage above the threshold for the status to be changed back to GOOD. This may require that the battery be removed for at least 2 seconds to ensure the firmware recognizes the battery has been removed.

The regulator input voltage (REG_VOLT) will usually be the higher than the EXT power input, or the selected internal battery. Normally, the EXT power input will either be vehicle ignition or vehicle battery and will be either > 9V or 0V. However, there may be a case in which the EXT power input voltage is close to the selected internal battery voltage. In this case, the regulator power input may be a combination of power from both the EXT power input and the selected internal battery.

External (EXT) voltage is not directly measured at the input. If the REG_VOLT is greater than 9 V, then it may be assumed it is the measured EXT input voltage.

2.8 Reserved

2.9 Reserved

2.10 Reserved

2.11 Reserved

2.12 Reserved

2.13 Reserved

2.14 Reserved

2.15 CHNLSTATUS1B (Version 2; v0.3.0.3) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

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 in Table 110, with descriptions of the fields in the sections indicated.

Table 110: CHNLSTATUS1B Binary Message Data

Data Item (9 + (4 + 6 * M) * N Bytes)	Data Type	Section
Cooperative tracking setting and StarFire CNØ	U08	2.6.1
StarFire tracking status	U08	2.6.2
StarFire satellite ID	U32	2.6.3
Start type and number of visible satellites	U08	2.6.4
Position status and number of satellites tracked	U08	2.6.5
Almanac available	U08	2.6.6
Start here with one Block per PRN		2.6.7

2.15.1 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.

2.15.2 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. StarFire tracking status values are shown in Table 111.

Table 111: 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

2.15.3 StarFire Satellite ID

The StarFire satellite IDs range from 320 to 680.

2.15.4 Start Type and Number of Satellites Visible

The start type resides in the two MSB (7:6) and represents one of the conditions described in Table 112.

Table 112: 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).

2.15.5 Position Status and Number of Satellites Tracked

The position status occupies the two MSB, as described in Table 113, and the number of satellites tracked occupies the six LSB.

Table 113: Position Status

Number	Data Item
0	Position is invalid
1	Position is old
2	Position from normal navigation
3	Reserved

2.15.6 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.

2.15.7 Block per PRN

This section of the CHNLSTATUS1B binary message data displays a block containing the information for one satellite.

Table 114 shows the values contained in this block, with descriptions of the fields in the sections indicated. The definition is the same as [CHNLSTATUS1B] (Version 1), excep that in Table 97 the number of channels dedicated to a single PRN is expanded to 255. The PRN number is redefined to allow determining the constellation type from the PRN number (1-37 for GPS, 120-138 for WAAS\EGNOS, 38-61 for GLONASS).

Table 114: CHNLSTATUS1B Satellite Block, One per PRN

Data Item (4 + 6 * M Bytes)	Data Type	Section

PRN (1-37 for GPS, 120-138 for WAAS/EGNOS, 38-61 for GLONASS)	U08	2.15.7.1
Number of channel blocks for this PRN	U08	2.15.7.2
Satellite azimuth and elevation (azimuth 9 MSB, elevation 7 LSB)	U16	2.15.7.3
Blocks per channel assigned to this PRN (see Table 116)		2.15.8

2.15.7.1 PRN

This field displays the PRN number of the satellite being tracked. This field is coded using native PRN numbers (1-32 for GPS, 120-138 for WAAS\EGNOS, 1-24 for GLONASS). Use this field in conjunction with the constellation type field (next) to determine which constellation the PRN is associated with.

2.15.7.2 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 Table 115. The 5 LSB (bits 4:0) count the number of channel blocks that follow for this PRN.

Table 115: Constellation Type

Number	Data Item
0	GPS
1	Reserved
2	SBAS
3	GLONASS

2.15.7.3 Satellite Azimuth and Elevation

The upper 9 MSB (bits 15:7) describe the azimuth in units of 1 degree, ranging from 0 to 359 degrees. The lower 7 MSB (bits 6:0) describe the satellite elevation in units of 1 degree, ranging from 0 to 90 degrees.

2.15.8 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 116 shows the values contained in this block; descriptions of the fields can be found in the sections indicated.

Table 116: CHNLSTATUS1B Blocks per Channel

Data Item (6 Bytes)	Data Type	Section
Channel number	U08	2.15.8.1
Code type and allocation mode	U08	2.15.8.2
Tracking status and loop bandwidth	U08	2.15.8.3
CN_0	U08	2.15.8.4
Reserved	U08	
Reserved	U08	

2.15.8.1 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.

2.15.8.2 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) and are shown in Table 117. The allocation mode is represented by the two LSB (1:0), per Table 118.

Table 117: Code Type Values

Code	Description	GUI 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) acquisition on L2 x L1 on Y channel	YL2A
15	P(Y) acquisition 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	Reserved	E5AI
19	Reserved	E5AQ
20	Reserved	E5BI
21	Reserved	E5BQ
22	Reserved	E1B
23	Reserved	E1C
24	Reserved	E6B
25	Reserved	E6C
26	BCG - GLONASS Civil G1 code (data messages)	G1C
27	BCG - GLONASS Civil G2 code (no data messages)	G2C

Table 118: 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.

2.15.8.3 Tracking Status and Loop Bandwidth

Tracking status is in the 5 MSB (7:3) and represents one of the data items in Table 119.

Table 119: 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 120.

Keep in mind that these values start at 2 instead of 0.

Table 120: Loop Bandwidth

Code	Description
2	Bandwidth 20 Hz
3	Bandwidth 10 Hz
4	Bandwidth 5 Hz
5	Bandwidth 2.5 Hz

2.15.8.4 C/No

This field displays the signal-to-noise ratio for the channel listed above, in db/Hz. This field will only have a value if the tracking status field is greater than 18. The LSB represents 0.25 db/Hz.

2.16 Reserved

2.17 Reserved

2.18 Reserved

2.19 EPHEM1B (Version 1; v1.0.0.4) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This record contains the packed ephemeris data for a satellite. Table 121 lists the message structure; descriptions of the fields can be found in the sections indicated.

Table 121: EPHEM1B Binary Message Header

Data Item	Data Type	Section
Satellite type (-1=NONE, 0=GPS, 1=Reserved, 2=SBAS, 3=GLONASS)	U08	
Ephemeris data		2.19.1 to **Error! Reference source not found.**

2.19.1 GPS Ephemeris

Table 122: 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

2.19.2 GLONASS Ephemeris

This record contains the packed ephemeris data for a GLONASS satellite (string 1, 2 and 3, 4). Table 123 lists the message structure.

Table 123: GLONASS EPHEM1B Binary Message

Data Item (49 Bytes)	Data Type
PRN (1-24)	U08
string 1 (3 words * 4 bytes)	12 bytes
string 2 (3 words * 4 bytes)	12 bytes
string 3 (3 words * 4 bytes)	12 bytes
string 4 (3 words * 4 bytes)	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 124.

Table 124: 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							

2.19.3 Reserved

2.19.4 SBAS Ephemeris

Table 125: 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 SBAS type 9 message is 250 bits long. The MSB of the SBAS type 9 message is transmitted first. It is saved in the MSB of WORD 1. The last bit of the type 9 message is saved in the LSB of WORD 8. Eight WORDs can hold 256 bits, so 6 bits of WORD 8 are not used. These 6 bits are in the MSB positions of WORD 8.

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.

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."

Examples: [OUTPUT]EPHEM1B,ONCE,,ETH4
[OUTPUT]EPHEM1B,ONCHANGE,,ETH4
Schedules the entire list to output Once and future changes to output as they occur on Ethernet port 4

[OUTPUT]EPHEM1B,ONCE,32,ETH4
[OUTPUT]EPHEM1B,ONCE,54,ETH4
Schedules PRN 32 and PRN 54 to output Once on Ethernet port 4

2.20 EVENTLATCHA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This output message reports the time of events that are captured by either of the two event latch ports.

Command:	[EVENTLATCHA]latch,week,time,fom*CRC
Parameter	Definition
Latch	Latch that event occurred on. (Sapphire 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 126)

⚠ Use only the 'ONCHANGE' mode of the [OUTPUT] command to schedule this message. (Refer to Table 73.)

Example: [EVENTLATCHA]A,1411,241740.535058372,5*0259

Table 126: 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

2.21 Reserved

2.22 Reserved

2.23 Reserved

2.24 Reserved

2.25 Reserved

2.26 INPUTSFLICENSE

☒SF-3050 ☒Sapphire ☒SF-3040

The INPUTSFLICENSE output stream contains the Over-The-Air Starfire license key information that will be sent the same way the INPUTSFLICENSE nova command will be sent. This can be scheduled ONCHANGE or ONCE.

If if the unit is displaying RTK or RTG 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

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

2.27 Reserved

2.28 Reserved

2.29 Reserved

2.30 Reserved

2.31 MBRTK1B (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This message is used to output the moving base RTK solution. Some of the data are analogous to PVT1B data.

When the rover is operating in MBRTK, PVT1B is not impacted. PVT1B operates in the mode based on the input correction format. In other words, if StarFire corrections are being received, PVT1B will be in StarFire (5cm) operation and MBRTK1B (with corrections from a moving base) will be at RTK levels.

Table 127 lists the MBRTK1B message body data items and their data types.

Table 127: MBRTK1B Binary Message Body

Data Item (53 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[2] 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.

2.31.1 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; (see Table 128)
U08 nav_mode:3; (see Table 129)
U08 amb_fixed:1;

Table 128 lists the codes and code descriptions for MBRTK mode.

Table 128: MBRTK 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 129 lists the codes and code descriptions for navigation mode.

Table 129: Navigation Mode

Code	Description
0	Non-diff
1	dGPS code
2	WAAS
3	WCT
4	RTG
5	RTK
6	Not known

See Appendix F for further details.

2.32 MEAS1B (Version 1 and 2) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

The MEAS1B output stream contains raw measurement data collected from the Sapphire 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 130: MEAS1B

Data Item (1 + number of satellites * length of satellite clock)	Data Type
Number of satellites	U08
Satellite block…	

2.32.1 Satellite Block

Table 131: Satellite Block

Data Item (5 bytes + 8 bytes * number of code types)	Data Type	Units	Scale	Bytes
PRN/Slot number	U08		1	1
Number of code type	U04		1	4
Coarse range	U19	meter	100	
Coarse Doppler	S09[1]	meter/sec	10	
Signal block				

[1] The value must be two's complement, with the sign bit occupying the MSB. Most MSB are signed.

2.32.2 Signal Block

Table 132: Version 1 Signal Block

Data Item (8 bytes)	Data Type	Units	Scale	Bytes
Frequency number	U03		1	2
Code type	U03		1	
CN0	U06	dB-Hz	1	
Cycle slip count	U04		1	
Delta range[1]	S16	meter	0.01	2
Delta phase[2]	S20	cycle	1/256	4
Delta_doppler[3]	S12	meter/sec	0.005	

[1] Delta range = code range – coarse range

[2] Delta phase = carrier phase – code range

[3] Delta Doppler = doppler – coarse doppler

Firmware version 4.0.5 and beyond – Meas1B revision version 2 – only difference in version 2 is Signal Block definition total length = 8 byte

Table 133: Version 2 Signal Block

<table>
<tr><th>Data Item (8 bytes)</th><th>Data Type</th><th>Units</th><th>Scale</th><th>Bytes</th></tr>
<tr><td>Half-cycle Adjust</td><td>U01</td><td></td><td>1</td><td></td></tr>
<tr><td>Frequency number</td><td>U02</td><td></td><td>1</td><td rowspan="5">2</td></tr>
<tr><td>CPH Quality</td><td>U01</td><td></td><td>1</td></tr>
<tr><td>Code type</td><td>U02</td><td></td><td>1</td></tr>
<tr><td>CN0</td><td>U06</td><td>dB-Hz</td><td>1</td></tr>
<tr><td>Cycle slip count</td><td>U04</td><td></td><td>1</td></tr>
<tr><td>Delta range[1]</td><td>S16</td><td>meter</td><td>0.01</td><td>2</td></tr>
<tr><td>Delta phase[2]</td><td>S20</td><td>cycle</td><td>1/256</td><td rowspan="2">4</td></tr>
<tr><td>Delta_doppler[3]</td><td>S12</td><td>meter/sec</td><td>0.005</td></tr>
</table>

[1] Delta range = code range – coarse range

[2] Delta phase = carrier phase – code range

[3] Delta Doppler = doppler – coarse doppler

2.32.3 PRN Slot Number

Table 134: PRN Slot Number

PRN Number	Constellation
1-37	GPS
38-61	GLONASS
120–138	SBAS
---	Reserved
---	Reserved

2.32.4 Frequency Number

Table 135: Frequency Number

Number	GPS Frequency Type
0	L1
1	L2
2	L5
3-7	Reserved

Number	GLONASS Frequency Type
0	G1
1	G2
2-7	Reserved
Number	SBAS Frequency Type
0	L1
2	L5
1, 3-7	Reserved

2.32.5 Code Type

Table 136: Code Type

Number	GPS Code Type
0	C[1]
1	P[2]
2-7	Reserved

[1]CA measurement from L1, L2CL measurement from L2, L5 Q measurement from L5
[2]P1 measurement from L1, P2 measurement from L2

Number	GLONASS Code Type
0	C/A
1	P
2-7	Reserved
Number	SBAS Code Type
0	C/A
1-7	Reserved

2.32.6 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.

2.32.7 Bit alignment

The alignment of each field starts from the MSB. For example, In 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><td colspan="4">No. of code type</td><td colspan="19">Coarse range</td><td colspan="9">Coarse Doppler</td></tr>
<tr><td colspan="4">4 Bits</td><td colspan="19">19 Bits</td><td colspan="9">9 Bits</td></tr>
</table>

2.33 Reserved

2.34 Reserved

2.35 MSGCANCELCODESB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This message reports the number of cancel code and the content of cancel codes (see Table 137). The content of the cancel code information is encrypted, and a special decryption algorithm is needed to decode it.

Table 137: MSGCANCELCODESB

Data Item	Data Type
Number of Cancel Codes (0, 1 or 2)	U08

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

2.36 MSGCANCELHISTORYB

☒SF-3050 ☒Sapphire ☒SF-3040

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 138: MSGCANCELHISTORYB Part 1

Data Item	Data Type	Section
Reserved	U08	
Number of Cancel Histories	U08	2.36.1

2.36.1 Number of Cancel Histories

This field counts the number of instances in Table 139. The value is 0, 1 or 2.

The second part of the message consists of the ‘Number’ of instances in Table 139.

Table 139: MSGCANCELHISTORYB Part 2

Data Item	Data Type	Section
License Issue Date	U32	2.36.2
License End Date	U16	2.36.3
Date of Cancellation	U32	2.36.4
Days Left (Unused Days)	U32	2.36.5
Cancel Reason	U08	2.36.6
Cancellation Source	U08	2.36.7

2.36.2 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.

2.36.3 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.

2.36.4 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.

2.36.5 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.

2.36.6 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.

2.36.7 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 140: MSGCANCELHISTORYB Cancellation Source

Port #	Port Name
0	COM 1
4	Over The Air (OTA) StarFire Licensing
8	Bluetooth
9	COM 2
13	USB
17	Ethernet
31	Expired

2.37 MSGPRODUCTINFO (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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]

Example: [MSGPRODUCTINFO]

Request for product type, digital serial number, and system revision number

[MSGPRODUCTINFO]SF-3050M,12345,1
Response shows the product type, digital serial number, and system revision number

These product type strings are supported:

SolarisNone

SolarisProduction

SF-3040

SF-3050

SF-3050A

SF-3050G

SF-3050S

SF-3050M

CNAV3050A

CNAV3050G

CNAV3050M

Sapphire

Dragon

VueStarII

2.38 MSGVERSION

☒SF-5050 ☒Solstice ☒SF-5040

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 141, that specifies the firmware component for which version of information is being requested

Default: Displays BOOT1, BOOT2, NAV, PIOBOOT, PIOAPP, and BLUETOOTH

Table 141: MSGVERSION Keywords for Software Components

Keyword Mnemonic	Firmware Component
NAV	Navigation (5200), CoreNav, LBAND DSP
BOOT1	Boot loader part 1 (5200)
BOOT2	Boot loader part 2 (5200)
PIOBOOT	PIO cold bootloader
PIOAPP	PIO application
BLUETOOTH	Bluetooth

2.39 NAVCONFIG1B

☒SF-3050 ☒Sapphire ☒SF-3040

This message reports the current configuration of the core navigation module.

Table 142: 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 RTG	U08
DGPS Output No WAAS	U08
DGPS Output No CMR	U08
DGPS Output No RTK	U08
DGPS Output No RTK RTG	U08
DGPS RTCM Code Max Age Seconds	S32
DGPS RTG 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 RTG Static Site	U08
Phase Filter Option RTG Option Enable	U08
Phase Filter Option Used Avg Code Phase	U08
Phase Filter Option RTG Report All Sats	U08
Phase Filter Option RTG Dual Only	U08
RTK Nav Option Pos Model	U16
RTK Nav Option Time Synchronized	U08
RTK Nav Option Multipath	U16

2.40 Reserved

2.41 Reserved

2.42 NCT5B (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This output message is used to send the RTK corrections from the RTK base site to the rover receiver. Refer to *Chapter* 3 *Legacy Starlight 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 Sapphire as a base and a NCT 2100D product (e.g., SF-2050) as rover, configure Sapphire to output the NCT5B message. The NCT5B message provides the same navigation performance as the Starlight 0x5B or 0x5E message, based on the hardware configuration (NCT-2000D or NCT-2100D respectively).

Additional information may be available for key channel partners and will require a Non-Disclosure Agreement with NavCom. Contact NavCom Customer Support at *customersupport@NavComtech.com* for further details.

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.

2.43 NCT5C (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This output message is used to send the base coordinates from an RTK base site to the rover receiver. Refer to *Chapter* 3, *Legacy Starlight Proprietary RTK Correction Messages*, for the description of legacy Starlight message 0x5C.

2.44 NCT5E (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This output message is used to send the raw measurements from a RTK base site to the rover receiver.

When a receiver is configured as a RTK rover, Sapphire and the SF-3050 support both the Sapphire NCT5E message (GPS+GLONASS) and the legacy Starlight 0x5E message (GPS only). When the receiver is configured as a RTK base, Sapphire and the SF-3050 do not support the Starlight 0x5E message with this message.

> To use Sapphire as base and a NCT 2100D product (e.g., SF-2050) as rover, configure Sapphire to output the NCT5B message. The NCT5B message provides the same navigation performance as the Starlight 0x5B or 0x5E message, based on the hardware configuration (NCT-2000D or NCT-2100D respectively).

Additional information may be available for key channel partners and will require a Non-Disclosure Agreement with NavCom. Contact NavCom Customer Support at *customersupport@NavComtech.com* for further details.

2.45 Reserved

2.46 Reserved

2.47 Reserved

2.48 Reserved

2.49 NCTBB (Binary)

☒SF-3050 ☒Sapphire ☐SF-3040

This output message is scheduled via the [OUTPUT] command.

This command requires the BB option.

Examples: [OUTPUT]NCTBB, ONCHANGE, , 1
Outputs NCTBB when the data is available on port 1

[OUTPUT]NCTBB, ONTIME,1,2
Outputs NCTBB once per second on port 2

2.50 NCTBD (Binary) and NCTBE (Binary)

☒SF-3050 ☒Sapphire ☐SF-3040

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

2.51 Reserved

2.52 NCTCB (Binary)

☒SF-3050 ☐Sapphire ☒SF-3040

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.

2.53 NCTCD (Binary) and NCTCE (Binary)

☒SF-3050 ☐Sapphire ☒SF-3040

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.

2.54 Reserved

2.55 NEWSFALMREADY

☒SF-3050 ☒Sapphire ☒SF-3040

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 143: 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

2.56 NMEA Messages Overview

☒SF-3050 ☒Sapphire ☒SF-3040

Selected sentences included in the ensuing sections are defined in the National Marine Electronics Association (NMEA) document 0183 “Standard For Interfacing Marine Electronic Devices”, Version 3.01, January 1, 2002 or up to v.3.0.13 of the software. Subsequent software versions support NMEA 0183, v.4.1. A software “switch” is available to return NMEA data to the former standard version.

These messages are all prefixed with the string value “NMEA”, and can be viewed as a common set of sentences describing navigation data.

The 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 satellites

2.57 NMEAALM (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 and is in compliance with NMEA-0183 Standards version 3.0.

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.

The output format for this message is described in Table 144.

Table 144: ALM Message Output Format

Output Format:	$GPALM,total,message,prn,week,health,eccentricity,reftime,inclination,ascension,axis,perigee,node,anomaly,F0clock,F1clock,*checksum	
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

2.58 NMEADTM (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

ONCE = output immediately once upon initiation of system

OnChange = same rate as the most frequently scheduled NAV Message (NMEAGGA, NMEAGLL or NMEARMC)

OnTime = highest rate licensed

This output stream reports the local geodetic datum and datum offsets from a reference datum. It is in compliance with NMEA 0183 Standards version 3.0.

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.

If the user is running an earlier version of the software (v3.0.13 and earlier), the NMEADTM must be manually scheduled to display at the same rate as the NMEAGGA, the NMEAGLL or the NMEARMC to meet IMO and MED certification requirements.

The output format for this message is described in the following table.

When datum code is unknown (e.g. RTK mode), the output will be empty.

Table 145 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 146 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 which NMEAGGA, NMEAGLL, or NMEARMC is output. This applies to all ports except for the NTRIP port.

Examples:

[OUTPUT]NMEAGGA,ontime,1,1

[OUTPUT],,,1

[OUTPUT]NMEAGGA,ONTIME,1,1

[OUTPUT]NMEADTM,ONCHANGE,,1

*NMEADTM will display immediately before NMEAGGA once a second

[OUTPUT]NMEAGLL,ONTIME,0.1,1

*NMEADTM will display immediately before NMEAGLL ten times a second

2.59 NMEAGBS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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, in compliance with NMEA 0183 Standards version 3.0. The addition of Fields F9 and F10 bring this message in compliance with version 4.1 of the NMEA standard.

Table 147: GBS Message Output Format

Output Format:	$GPGBS,UTC,Lat,Long,Alt,SVID,Det,Bias,StdDev,*checksum	
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 (NMEA v4.1 only)
F10	Signal ID	Specific frequency likely failed for the given satellite (See Note 1) (NMEA v4.1 only)
F11	*CRC	Checksum

Example: $GPGBS,161816.00,0.0,-0.0,-.0,13,0.8,0.0,0.0*6C

[1]The Signal ID is designed to show which Signal failed for that particular satellite. NavCom receivers show satellites in the GPS constellation using 0, 1, 2, and 4. GLONASS constellation uses 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. See the graphic on the next page.

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

2.60 NMEAGFA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 148: GFA Message Output Format

Output Format:	$GPGBS,UTC,Lat,Long,Alt,SVID,Det,Bias,StdDev,*checksum	
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.

2.61 NMEAGGA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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. The NMEAGGA output stream is in compliance with NMEA 0183 Standards version 3.0.

The NMEAGGA output can be scheduled to change at a set frequency that reflects any changes in position. The changed NMEAGGA output will automatically be preceeded by a changed NMEADTM output.

The [GGAMODE] command is used to select the standard NMEAGGA output stream or high precision for NMEAGGA output. Refer to the [GGAMODE] command to understand how to add two digits of precision for the latitude, longitude, and altitude parameters. The NavCom proprietary NMEA type message, NMEAPNCTGGA, also provides high precision.

⚠ 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

The output format for this message is described in Table 149.

Table 149: GGA Message Output Format

Output Format:	$GPGGA,time,lat,N/S,lon,E/W,quality,used,hdop,alt,M,separation,M,age,id*checksum	
Field#	Field Name	Description
F1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	Lat	NMEAGGA: 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	NMEAGGA: 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	Quality of the position fix (0 to 8) 0 = fix not available, or invalid 1 = GPS SPS Mode, fix valid 2 = Differential GPS, SPS Mode, fix valid 3 = GPS PPS Mode, fix valid 4 = Real Time Kinematic, fixed integers 5 = Float RTK, floating integers 6 = estimated (dead reckoning) Mode 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, 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. NMEAGGA: 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 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	Reference station ID number (0000 – 1023). In RTG mode this is the StarFire satellite ID.
F15	*CRC	Checksum

Examples: NMEAGGA:

$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-3050 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.

'$GA' = Galileo and requires the receiver to only track and use Galileo satellites; all other navigation satellite tracking and modes must be disabled.

In the current software release, 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 3000 to constrain the mode to GPS only using the following commands:

[TRACKINGMODE]L1,ON,L2,ON,L2C,ON,L5,ON,WAASEGNOS,ON,STARFIRE,ON,G1,OFF,G2,OFF

[NAVMEASUSE]L1,ON,L2,ON,L2C,ON,L5,ON,WAASEGNOS,OFF,GLONASS,OFF

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.

2.62 NMEAGLL (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 and is in compliance with NMEA-0183 Standards version 3.0.

The NMEAGLL output can be scheduled to change at a set frequency which reflects any changes in geographic position. The changed NMEAGLL output will automatically be preceeded by a changed NMEADTM output.

Table 150: GLL Message Output Format

Output Format:	$GPGLL,lat,N/S,lon,E/W,time,status*checksum	
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

2.63 NMEAGNS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 for single or combined satellite navigation systems and is in compliance with NMEA-0183 Standards version 3.0.

Refer to the [GGAMODE] command to understand how to add two digits of precision for the latitude and longitude parameters.

Table 151: GNS Message Output Format

Output Format:	$GPGNS,time,lat,N/S,lon,E/W,mode,used,HDOP,alt,separation,age,ID,status*checksum	
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.
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).

Example:

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

2.64 NMEAGRS (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 in compliance with NMEA 0183 Standards version 3.0. NMEA 0183 v4.1 are given by the addition of fields F9 and F10.

Table 152: GRS Message Output Format

Output Format:	$GPGRS,UTC,Mode,Res…,Res,*checksum	
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 (NMEA v4.1 only)
F10	Signal ID	1 for Single Mode, and 0 for Dual Mode (see note 3) (NMEA v4.1 only)
F11	*CRC	Checksum

Example: $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*4F

[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* means that the navigation solutionis using L1C/A and L2 P(Y) signals. Refer to the graphic on the next page.

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

2.65 NMEAGSA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

This output message reports 2D/3D solution mode, DOP values, and active satellite information, and is in compliance with NMEA-0183 Standards version 3.0. Field F7 is added to comply with v4.1 of the NMEA standard.

Table 153: GSA Message Output Format

Output Format:	$GPGSA,mode,solution,used,pdop,hdop,vdop*checksum	
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	Dilution of position
F5	hdop	Horizontal dilution of position
F6	vdop	Vertical dilution of position
F7	System ID	1 for GPS, 2 for GLONASS (NMEA v4.1 only)
F8	*CRC	Checksum

Example: $GPGSA,A,3,03,08,13,16,20,23,25,27,,,,,2.4,1.4,1.9*36

2.66 NMEAGST (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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, and is in compliance with NMEA-0183 Standards version 3.0.

The [STDDEVMODE] command will allow the user to control the reporting and navigation transition method for this data.

Table 154: GST Message Output Format

Output Format:	$GPGST,time,rms,majoraxis,minoraxis,orientation,laterr,lonerr,alterr*checksum	
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

2.67 NMEAGSV (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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. Note that one GSV sentence can only provide data for up to 4 satellites, so several sentences may be required for full “satellite in view” information. The format for this message is in compliance with NMEA-0183 Standards version 3.0. The addition of Field 8 brings this message compliant to NMEA v4.1.

Table 155: GSV Message Output Format

Output Format:	$GPGSV,total,message,totalsv,prn1,elev1,azim1,snr1,…..,prn4,elev4,azim4,snr4*checksum	
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) (NMEA v4.1 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

[1] : To meet the new Signal ID requirements for IEC61162 4th Edition, the GSV sentence is output in two groups, one group with Signal ID 1, which are the Satellites that are being tracked with L1CA or G1C only. The second group is 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. A signal ID 0 is given to a group of sats once they have LOCKED on an L2 signal.

Example of NMEA v4.1 format :

$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

2.68 NMEAHDT (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

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.

The output format for this message is described in Table 156.

Table 156: HDT Message Output Format

Field #	Field Name	Description
F1	Heading	Degrees true

Example:

$GNHDT,73.4,T*1B

2.69 NMEAMLA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 and is in compliance with NMEA-0183 Standards, version 3.0.

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.

The output for this message is described in Table 157.

Table 157: MLA Message Output Format

Output Format	$GLMLA,T.T,S.S,sID,N.N,CH,EEEE,Tn,pppp,tMSB,dtnaco,tascmd,lllll,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,T.T,S.S,sID,N.N,CH,EEEE,Tn,pppp,tMSB,dtnaco,tascmd,lllll,iaiaia,tLS,tss*hh<CR><LF>

2.70 NMEARMC (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output message reports minimum recommended GPS information, including position, velocity, and time information, and is in compliance with NMEA-0183 Standards version 3.0. The update of Field 12 and the addition of Field 13 comply with NMEA v4.1.

The NMEARMC output can be scheduled to change at a set frequency which reflects any changes in position, velocity and time. The changed NMEARMC output will automatically be preceeded by a changed NMEADTM output.

Table 158: RMC Message Output Format

Output Format:	$GPRMC,time,status,lat,N/S,lon,E/W,speed,course,date,variation,E/W,mode*checksum	
Field#	Field Name	Description
F1	time	UTC time for position fix in hours, minutes, seconds (hhmmss.ss) (000000.00 to 235959.99)
F2	status	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 (the product puts no upper limit on this value, reporting the actual data, which itself is likely limited to an extreme upper limit of mach 3 or so)
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 (0-359.99)
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 (NMEA v4.1 only) (see note 1) R = RTK (NMEA v4.1 only) (see note 1)

		F = Float (NMEA v4.1 only) (see note 1)
F13	Nav Status	Navigational Status Indicator (NMEA v4.1 only) 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

[1] The IEC 61162 4th Edition adds a new mode indicator field: P for Precise, R for RTK, and F for RTK Float.

- P is used for all Dual Frequency StarFire related solutions
- D is used for all other DGPS solutions including: WAAS, RTCM Code, and StarFire Single.
- R is used for all RTK related solutions except RTK Float, these solutions include RTK Single, RTK Dual, and RTK-Extend.
- F is used for RTK Float solution.

2.71 NMEAROT (ASCII)

☒SF-3050 ☒Sapphire ☐SF-3040

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.

The output format for this message is described in the Table 159.

Table 159: ROT Message Output Format

Field #	Field Name	Description
F1	Rate of return	Degrees per minute, negative = bow turns to port
F2	Status	A = data valid, V = data invalid

Example:

$GNROT,488.2,A*29

2.72 NMEARRE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 3.0.

Table 160: 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

2.73 NMEATTM (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 based on NMEA 0183 Standards version 4.0.

Table 161: 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	Units of measurements used: 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.

2.74 NMEAVTG (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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, and is in compliance with NMEA-0183 Standards version 3.0.

Table 162: VTG Message Output Format

Output Format:	$GPVTG,track,T,track,M,speed,N,speed,K,mode*checksum	
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 P = Precise (NMEA v4.1 only) (see note 1)
F10	*CRC	Checksum

Example: $GPVTG,0.0,T,,M,0.03,N,0.06,K,D*0D

[1] The IEC 61162 4th Edition adds a new mode indicator field, P for Precise, in order to distinguish Precise solution from DGPS solution.

- P is used for all Dual Frequency StarFire and RTK related solutions
- D is used for all other DGPS solutions including: WAAS, RTCM Code, and StarFire Single.

2.75 NMEAZDA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = based on [PROCESSRATE]

OnTime = highest rate licensed

This output message reports date and time information, and is in compliance with NMEA-0183 Standards version 3.0.

Table 163: ZDA Message Output Format

Output Format:	$GPZDA,time,day,month,year,offset_hour,offset_min*checksum	
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

Example: $GPZDA,035751.00,18,04,2007,00,00*6B

2.76 NMEAPNCTDTM (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

ONCE = output immediately once upon initiation of system

OnChange = same rate as the fastest NAV Message (e.g. PNCTGGA).

OnTime = highest rate licensed

This output stream reports local geodetic datum and datum offsets from a reference datum. It is in compliance with NMEA 0183 Standards version 3.0.

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.

If the user is running an earlier version of the software (v3.0.12 and earlier), the NMEAPNCTDTM must be manually scheduled to display at the same rate as the NMEAPNCTGGA.

The output format for this message is described in the following table.

The difference between NMEADTM and NMEAPNCTDTM is the added datum codes for ITRF and GDA94. When the datum code is unknown (e.g. RTK mode), the output will be empty.

Table 164 PNCTDTM 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 ITR = ITRF 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	Reference Datum Code W84 = WGS84 W72 = WGS72 S85 = SGS85 PE90 = P90 ITR = ITRF 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 165 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	ITR	ITR	0
	WGS84	W84	W84	0
	GDA94	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 which NMEAPNCTGGA is displayed. This applies to all ports except for the NTRIP port.

2.77 NMEAPNCTGGA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 in compliance with NMEA-0183 Standards version 3.0. (version 4.0 is now available)The high precision mode is an extended mode for the NMEAGGA output sentence. It is not in compliance with the NMEA-0183 Standards version 3.0 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 166: PNCTGGA Message Output Format

Output Format:	$PNCTGGA,time,lat,N/S,lon,E/W,quality,used,hdop,alt,M,separation,M,age,id* checksum	
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
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 167), and YY is the GPS correction signal type being used (see Table 168).
F15	*CRC	Checksum

Example:

$PNCTGGA,160023.00,3350.475212,N,11820.623211,W,2,17,0.7,44.486,M,-35.989,M,5.0,0107*5D

Table 167: Beam Selection ID

Network	Code (XX)	Designation	Satellite ID	Longitude	Uplink Site
Net 1	00	N/A	N/A	Unknown	Unknown
	01	4F3	402	97.65W	Laurentides
	02	4F2	525	25E	Burum
	03	4F1	643	143.5E	Auckland
Net 2	04	3F3	678	178E	Santa Paula
	05	3F4	446	54W	Southbury
	06	3F1	564	64E	Perth
	07	3F2	484	15.5W	Southbury
	09	N/A	N/A	Manual Override	

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

Table 168: Navigation Mode

ID (YY)	GPS Correction Signal
00	Non dGPS
01	dGPS, RTCM type 1 (GPS – code); and type 31 (GLONASS – code) or type 9 (GPS – code); and type 34 (GLONASS partial correction set – code), Single Freq. and Dual Freq.
02	WAAS/EGNOS, Single Freq., (see 2.65 NMEAGSA, Field F3 for SBAS ID in use) (GPS)
03	WAAS/EGNOS Dual Freq., (see 2.65 NMEAGSA, Field F3 for SBAS ID in use) (GPS)
04	Reserved
05	Reserved
06	StarFire RTG, Single Freq. (no 'Tide' Adjustment) (GPS)
07	StarFire LP
08	Reserved
09	Reserved
10	dGPS/dGLONASS, RTCM type 1 or 9 and 31 or 34, Dual Freq.
11	StarFire RTG Dual Freq. (no 'Tide' Adjustment)
12	Code base Nav, Single Freq., NCT Proprietary Format
13	Code base Nav, Single Freq., RTCM 18/19 (GPS and GLONASS)
14	Code base Nav, Single Freq., RTCM 20/21 (GPS and GLONASS)
15	Code base Nav, Single Freq., CMR (GPS and GLONASS)
16	Code base Nav, Dual Freq., NCT Proprietary Format (GPS and GLONASS)
17	Code base Nav, Dual Freq., RTCM 18/19 (GPS and GLONASS)
18	Code base Nav, Dual Freq., RTCM 20/21(GPS and GLONASS)
19	Code base Nav, Dual Freq., CMR (GPS and GLONASS)
20	RTK Mode, NCT Proprietary Format 5e/5c (GPS and GLONASS) or 5b/5c (GPS)
21	RTK Mode, RTCM 18/19 (GPS and GLONASS)
22	RTK Mode, RTCM 20/21(GPS and GLONASS)
23	RTK Mode, CMR (GPS and GLONASS)
24	StarFire RTG, Single Freq., Adjusted for "Tides" (GPS)
25	StarFire RTG, Dual Freq., Adjusted for "Tides" (GPS)
26	RTK Extend Active (StarFire RTG filling in for missing RTK epochs) (GPS)
33	GNSS, single freq., No "Tides" (Not supported in the SF-3040)
34	GNSS, dual freq., No "Tides" (Not supported in the SF-3040)
35	GNSS, single freq., Adjusted for "Tides" (Not supported in the SF-3040)
36	GNSS, dual freq., Adjusted for "Tides" (Not supported in the SF-3040)

2.78 NMEAPNCTGST (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

Supported Output Rate: ☒OFF ☒ONCE ☒OnChange ☒OnTime

OnChange = when slow nav is completed (1Hz)

OnTime = minimum 1Hz

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.

The [STDDEVMODE] command will allow the user to control the reporting and navigation transition method for this data.

Table 169: PNCTGST Message Output Format

Output Format:	$PNCTGST,time,rms,majoraxis,minoraxis,orientation,laterr,lonerr,alterr,fisher*checksum	
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, and is in compliance with NMEA 0183 Standards version 3.0.

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

2.79 NMEAPNCTMDE (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 170: MDE 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

2.80 NMEAPNCTSET (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

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 171: 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*checksum	
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) (range TBD)
F5	PT dN	Polar Tides, delta North (meters) (range TBD)
F6	PT dE	Polar Tides, delta East (meters) (range TBD)
F7	PT dU	Polar Tides, delta Up (meters) (range TBD)
F8	Ocean Loading dN	Ocean Loading, delta North (meters) (range TBD)
F9	Ocean Loading dE	Ocean Loading, delta East (meters) (range TBD)
F10	Ocean Loading dU	Ocean Loading, delta Up (meters) (range TBD)
F11	*CRC	Checksum

Example: $PNCTSET,214040.00,-0.060,-0.018,0.110,,,,,,*47

2.81 NTRIPSTAT

☒SF-3050 ☐Sapphire ☒SF-3040

This message is used to report events associated with the NTRIPCLIENT command. It can be scheduled as OnChange output message for a specific port, and turned off by using the command [OUTPUT].

The following examples were output on week 1690 and TOW 486398.

Table 172: 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 …

2.82 Reserved

2.83 Reserved

2.84 Reserved

2.85 Reserved

2.86 PHASENAVSTATUS1B (Version 1; v1.0.0.4) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This is a message for reporting Phase Nav Status information.

Table 173: 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…

Quick Start Mode (enum)	U16	
Start Status (enum)	U16	
RTG Delay Time (milliseconds)	U16	
Number of Satellite Blocks	U08	
Satellite Block		See Table 148

Table 174: PHASENAVSTATUS1B Satellite Block

Data Item	Data Type	Section
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	

2.87 PHASENAVSTATUS2B (Version 1; v3.0.6) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

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.

2.88 Reserved

2.89 POINTRADIUSDATAB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This function fetches the latitude, longitude, and radius information defined in the Point Radius license entered prior to entering this command, as defined in Table 175.

Table 175: POINTRADIUSDATAB

Data Item	Data Type
Count of entries	U08
Reserved, reported as zero	U08
Radius LSB, kilometers	U08
Radius MSB, kilometers (0-3) bit 0x4 is also set if latitude is negative, bit 0x08 if longitude is negative	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

2.90 PSEUDORANGESTATSB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This output message reports pseudo-range noise statistical information.

Table 176: 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.

2.91 Reserved

2.92 PVT1B (Version 1; v0.3.0.3 and 2; v1.0.0.0) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

In the Sapphire 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 Sapphire 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.

When the rover is operating in MBRTK, PVT1B is not impacted. PVT1B operates in the mode based on the input correction format. In other words, if StarFire corrections are being received, PVT1B will be in StarFire (5cm) operation and MBRTK1B (with corrections from a moving base) will be at RTK levels.

This message is identical for version 1 (preproduction) and version 2 (production), except for a single byte of status flags, one of which is populated for version 2, a flag denoting "Doppler Used" in the solution. To minimize the change to the programs that read and format this message, that single byte has been added at the very end of the message. Also note that this adds 1 to the byte count previously known for version 1.

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 177: PVT1B Version Size Differences

Data Bits in Constellation Mask	Version 1 Message Size	Version 2 Message Size
None	59 bytes	60 bytes
One of GPS, GLONASS or SBAS	67 bytes	68 bytes
Two of GPS, GLONASS or SBAS	75 bytes	76 bytes
All	83 bytes	84 bytes

Table 178: 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 relative to ellipsoid (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
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) see Section 2.92.15	U08

2.92.1 Navigation Solution Status

This field displays a status code for the navigation solution, as shown in Table 179.

Table 179: Solution Status Codes

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.)
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 – RTG, non-differential, RTCM, etc.) See the [DATUM command.
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. Note: StarFire ITRF reference frames evolve over time. Refer to NavCom’s website for FAQ’s that describe transition dates.
0x40	Geoid99 (If set, GGM02 must be clear)
0x80	GGM02 (If set, Geoid99 must be clear)

2.92.2 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"

Example:

How to read latitude. Note, the length is 44 00 => 00 44 = 68 bytes.

```
00000e7ah: 5B 50 56 54 31 42 5D 44 00 6D 06 58 E3 BA 13 25    ; [PVT1B]D.m.Xãº.%
00000e8ah: 8D BC 25 DF 0E 81 54 FE CB 86 18 1D 00 00 0C 70    ; • ¼%ß.• TþË†.....p
00000e9ah: FF 25 0B CB 08 A2 11 09 07 0F 00 00 00 00 00 00    ; ÿ%.Ë.¢..........
00000eaah: 06 00 00 07 00 00 00 00 00 FF 01 ED FF 19 00 1B    ; .........ÿ.íÿ...
00000ebah: 00 01 D0 04 01 0A D0 04 01 0A 00 2A 34 37 45 35    ; ..Ð...Ð....*47E5
00000ecah: 0D 0A                                              ; ..
```

Latitude = **BC 25 DF 0E**
The receiver outputs in Little Endian; do a byte swap => 0E DF 25 BC => 249505212
(249505212 / 2048) / 3600 = 33.84131022135416666 degrees
Also, read this byte to get more precision.

Lat/Lon LSB (two four-bit fields, each LSB = 1/32768)	U08

In this case, (x86 & xF0) 10000110 >> Lat is the first four bits or 1000 = 08.
((249505212 / 2048) + (8 / 32768)) / 3600 = 33.841310289171005

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).

For the pseudocode for PVT1B coordinate conversions, refer to Sapphire Pseudocode for Coordinate Conversions in Appendix A.

2.92.3 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.

2.92.4 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.

2.92.5 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
```

2.92.6 Number of Satellites Tracked

This indicates the number of satellites used in the position solution. This corresponds to the count and bit mask of the GNSS satellites making of the solution. 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. This value presents as an 8-bit unsigned integer.

2.92.7 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 180: Navigation Mode and Source Type Fields

Bits (Starting from MSB)	Description
1-4	Navigation mode
5-8	Source type (DGPS, RTK, Starfire)

Table 181: Navigation Mode

Number	Navigation Mode
0	Non-differential
1	DGPS (WAAS, RTCM Code, StarFire single)
2	StarFire dual
3	RTK Float
4	RTK X

5	[1]RTK WL 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 182: 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 183: RTK Source Type

Number	RTK Source Type
0	Proprietary 5B
1	Proprietary 5E
2	RTCM18/19
3	RTCM20/21
4	CMR
5	CMR+
6	RTCM3-L1 Compact
7	RTCM3-L1 Full
8	RTCM3-Dual Compact
9	RTCM3-Dual Full
10	RTCM3.1
11-15	Reserved

2.92.8 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 (RTG) 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.

2.92.9 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.

2.92.10 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.

2.92.11 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 184: 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

2.92.12 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 receiver is operating in StarFire differential mode using global RTG 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 RTG, 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.

2.92.13 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 exists 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 185: GNSS Satellite Constellation Usage Bit Mask

Bit	Data Item
0	GPS
1	GLONASS
2	Galileo
3	COMPASS
4	SBAS

2.92.14 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.

2.92.15 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.

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) *WAAS and MSAS systems do not broadcast geofence tables. Thus bit 3 of SBAS geofence source is used for EGNOS only
0x08	AutoTrac Disengagement Flag
0x10	Rapid Recovery mode engaged
0x20	SF3 Mode success flag (true if single difference NL ambiguities are 'fixed'. If false, then we have SF2.5 mode)
0x04-0x80	Reserved

2.93 Reserved

2.94 Reserved

2.95 PVT3B

☒SF-3050 ☒Sapphire ☒SF-3040

This output stream is identical to PVT1B (Version 2) in Table 178, 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 the table below.

Refer to section 2.92 for details about the data fields in this table.

Table 186: 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 velocity solution (depends on Constellation bit set, may be zero)	U32

Data Item (76 Bytes)	Data Type
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 2.92.15	U08

2.96 RADIOSTAT (ASCII)

☐SF-3050 ☐Sapphire ☒SF-3040

This message reports the current radio status for the SF-3040. This is an ASCII message.

Table 187: 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. The GPS week and time of week were appended to the [RADIOSTAT] message in ver 3.2.7. SF-3040 v2.1.7 software did not report channel width and protocol in [RADIOSTAT], and only the first 6 characters of the 450MHz radio version were output (V06.16).

Example (v2.1.7):

[RADIOSTAT] -65 dBm, 464.95000 MHz, 100 mW, -117 dBm, 1, V06.16, 094942347

Examples (v3.0.12):

RADIOSTAT] -65 dBm, 464.95000 MHz, 100 mW, -117 dBm, 1, V06.16.3.45, 094942347, 25.0 kHz, 0

[RADIOSTAT] -65 dBm, 464.95000 MHz, 100 mW, -117 dBm, 1, V06.16.3.46.3, 094942347, 12.5 kHz, 0

Examples (v3.2.7):

[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. Poll this message 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.

2.97 Reserved

2.98 RTKSTATUS1B (Version 1; v1.0.0.4) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

The RTKSTATUS1B output stream contains a variety of information about the RTK navigation process. The data items included in this message are listed in Table 188.

This message can vary 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 bytes
One of GPS, GLONASS or SBAS	50 bytes
Two of GPS, GLONASS or SBAS	62 bytes
All	74 bytes

Table 188: RTKSTATUS1B binary message

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
RTK search duration (seconds)	U32
Bit mask of GNSS satellite constellation 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

Table continued on next page…

Data Item (38 – 74 Bytes)	Data Type
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

2.98.1 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; 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.

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

2.98.2 RTK Search Flag

Table 189: RTK Search Flag Enum

Code	Description
0	FIX_NOT_READY
1	FIX_TOO_FEW_SATS
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

2.98.3 RTK Search Flag

The bit mask for GNSS satellite constellation usage is the same as in Table 185.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.

2.99 Reserved

2.100 Reserved

2.101 SATSUSEDB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This message describes all the tracked PRN's and any reasons why a PRN is not used in the Code and RTG navigation. Table 190 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 190: 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 191 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 191: 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

Table continued on next page…

MSB	Failure Condition Enum	Failure Condition
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
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_RTG_BROKEN	RTG 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

Table continued on next page…

MSB	Failure Condition Enum	Failure Condition
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	
45	reserved	
46	reserved	
47	reserved	
48	reserved	

2.102 SDCARD (ASCII)

☐SF-3050 ☐Sapphire ☒SF-3040

This message is used to report events associated with the SF-3050 internal SD flash and the SF-3040 removable SD card. It can be scheduled as an OnChange output message for a specific port and turned off using the [OUTPUT] command.

Table 192: SDCARD Output Messages for the SF-3040

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
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 193: SD FLASH Output Messages for the SF-3050

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:

The following apply to the SF-3040 only:

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

The following apply to both the SF-3050 and the SF-3040:

If an SD card (internal SD flash for the SF-3050) 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-3050) 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-3050) is in progress:

[SDCARD] MOUNTING... 5

[SDCARD] MOUNTING... 6

[SDCARD] MOUNTING... 7

[SDCARD] MOUNTING... 8

The numeral indicates the mounting time in seconds.

Refer to the [LOGFILE] command for further information about the SD card or internal SD flash.

2.103 SELFSURVEYSTATUS1A (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This output message reports the current values of the averaged position available during self-survey mode.

Table 194: 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	Averaged value for latitude in degrees. (-90 to +90)
F3	lon	Averaged value for longitude in degrees. (-180 to +180)
F4	ht	Averaged value for height in meters. (-inf to inf)
F5	count	Number of position samples in average (0 to 4294967296)
F6	Duration	Length (seconds) of survey in progress set by the self survey command. If survey length is not specified duration is zero. (0-604800)
F7	Remaining	Time (seconds) remaining for the current survey. (0-604800)
F8	*CRC	Checksum

Example: [SELFSURVEYSTATUS1A] 513318.0000,33.8413,
-118.3437,20.0299,33,86400,5000*46AF

2.104 Reserved

2.105 Reserved

2.106 SFLICENSEB (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

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 195: 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	
Status	U08	
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	
Days Licensed	U16	
Days Left	U16	
Next license block, if applicable…		

Table 196: Net Authorization

Bit 1	Bit 0	Authorized Nets
0	0	All Nets
0	1	Net 1
1	0	Net 2
1	1	Undefined

Table 197: 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
4	OTA
8	Bluetooth
9	COM 2
13	USB
17	Ethernet

Region Selection

0x8000 – Global License

0x4000 – Land-only License

All other values are reserved.

2.107 Reserved

2.108 Reserved

2.109 SFSATLIST1B (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

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 198 with a description of the size of each file.

Table 198: SFSATLIST1B Binary Message Data

Data Item (1 + N * 12)	Data Type
Count of StarFire satellites	U08
Holding for the first 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.

2.110 SFSEARCHPOSB

☒*SF-3050* ☐*Sapphire* ☒*SF-3040 (v.3.2.x or later)*

This message is periodically used for the High Latitude StarFire Solution and is transmitted from the GNSS receiver to the StarFire receiver. It can be set ONCHANGE and ONTIME for any baud rate. However, the message will be 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. This option will employ the time information to verify if the SF License is valid. The position will be used to verify that the SF region is valid. Finally, it will calculate the lookup angle in order to search for SF Satellites.

If the Starfire receiver does not receive this message within 15 minutes, it will default to output corrections until the command is provided again. This message shall be encrypted to prevent any changes to the time information and position.

2.111 SFSTATUS1B (Ver. 1; v0.1.8 & 2; v1.0.0.4; Ver. 2 & 3; v2.2.0.1, Ver. 5, v3.2.9) (Binary)

☒SF-3050 ☒Sapphire ☒SF-3040

This record shows the status of StarFire signals. The body of the SFSTATUS1B message is listed in Table 199 with descriptions of the fields in the sections indicated.

Table 199: SFSTATUS1B Binary Message Data

Data Item (35 Bytes)	Data Type	Section
Reserved	U32	2.111.1
Current StarFire downlink beam indicator	U08	2.111.2
Current StarFire signal status	U08	2.111.3
Current StarFire signal strength (Eb/N0)	R32	2.111.4
Reserved	R32	2.111.5
Good packet counts (percentage)	R32	2.111.6
Idle packet counts (percentage)	R32	2.111.7
Re-synchronization counts	U32	2.111.8
Reserved	R32	2.111.9
StarFire license status (TBD)	U08	2.111.10
Reserved	U32	0
External HubID (ver 5)	U08	2.106.11

2.111.1 Current StarFire satellite ID

(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.

Bits	Description
31:22	StarFire satellite ID (range = 320 – 680)
21	ID valid (1 = valid; 0 = invalid)
20:0	Reserved

2.111.2 Current StarFire downlink beam indicator

This field represents the current StarFire downlink beam indicator. Table 200 shows the possible values for the StarFire beam indicator.

Table 200: 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
	07	3F2	484	15.5W	Southbury
	09	N/A	N/A	Manual Override	Unknown

2.111.3 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 201 shows StarFire tracking status values.

Table 201: 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

2.111.4 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)

2.111.5 Reserved

2.111.6 Good packet counts (percentage)

This field displays the percentage of good packets in received StarFire data. It is updated every 20 seconds.

2.111.7 Idle packet counts (percentage)

This field displays the percentage of idle packets in received StarFire data. It is updated every 20 seconds.

2.111.8 Re-synchronization counts

This field represents the StarFire parser packet framing re-synchronization count.

2.111.9 Reserved

2.111.10 StarFire license status

(Version 1)

B0; 1 = The StarFire License *and* the StarFire Software Option are licensed and enabled. Both a valid license and software option are required to enable the StarFire Subscription Service.

0 = The StarFire Subscription Service is not enabled.

(Version 3)

B0 = 1 indicates StarFire option is licensed and enabled, otherwise 0.

B1 = Reserved

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 Reserved	B0 – SF license

2.111.11 External Hub ID

(Version 5)

This is an 8bit 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 SF Correction message.

2.112 Reserved

2.113 STARFIREALM1B

☒SF-3050 ☐Sapphire ☒SF-3040

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.

When the StarFire almanac is updated in the receiver, the receiver automatically acts upon it immediately. The receiver will compare its current position against the new almanac and select the highest in-network satellite in the new list. Further, the table in SFSATLIST1B will be updated with the relevant new data from this almanac message.

Number of entries included in STARFIREALM1B is fixed to 16 in older code.

Table 202: 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	

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.

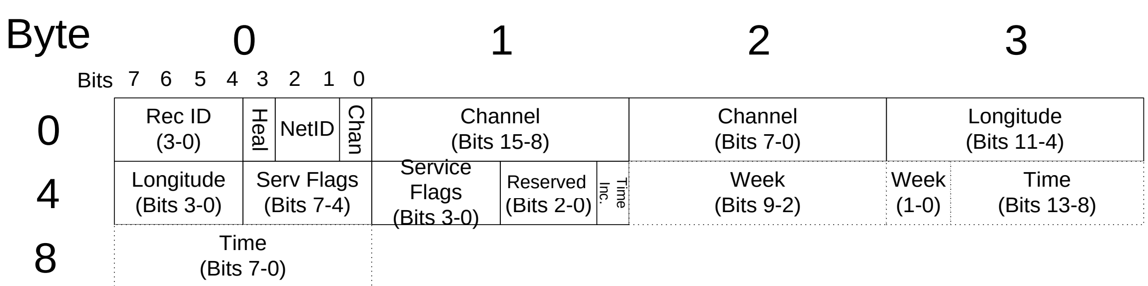

Figure 5: OTA StarFire Almanac Satellite Record

Table 203: 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	Value and meaning 0 – Unhealthy 1 – Healthy
	1-2	Network ID	0 – 3	Value and meaning 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 16 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)		-

2.114 Reserved

2.115 Reserved

2.116 Reserved

2.117 TXRXINFOA (ASCII)

☒SF-3050 ☒Sapphire ☒SF-3040

This message contains UART throughput information. Table 204 describes the output format for the SF-3040. Table 205 describes the output format for the Sapphire. Table 206 describes the output format for the SF-3050.

Table 204: TXRXINFOA Message Output Format – Sapphire

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	Port 5 TX percent	Port 5 TX usage percentage during last second
F10	Port 5 TX overflow count	Accumulated Port 5 TX overflow count since system starts[1]
F11	Port 5 RX percent	Port 5 RX usage percentage during last second
F12	Port 5 RX overflow count	Accumulated Port 5 RX overflow count since system starts
F13	Port 6 TX percent	Port 6 usage percentage during last second
F14	Port 6 TX overflow count	Accumulated Port 6 overflow count since system starts[1]
F15	Port 6 RX percent	Port 6 RX usage percentage during last second
F16	Reserved	
F17	Reserved	
F18	Reserved	
F19	Reserved	
F20	Reserved	

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

Table 205: TXRXINFOA Message Output Format – SF3050

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	Reserved	
F6	Reserved	
F7	Reserved	
F8	Reserved	
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	Reserved	
F26	Reserved	
F27	Reserved	

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

2. Fields 21 through 56 are supported only in Sapphire v1.1 and later.

Table continued on next page…

Field #	Field Name	Description
F28	Reserved	
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	Reserved	
F46	Reserved	
F47	Reserved	
F48	Reserved	

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

2. Fields 21 through 56 are supported only in Sapphire v1.1 and later.

Table continued on next page…

Field #	Field Name	Description
F49	Reserved	
F50	Reserved	
F51	Reserved	
F52	Reserved	
F53	Reserved	
F54	Reserved	
F55	Reserved	
F56	Reserved	
F57	Reserved	
F58	Reserved	
F59	Reserved	
F60	Reserved	

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

2. Fields 21 through 56 are supported only in Sapphire v1.1 and later.

Table 206: TXRXINFOA Message Output Format – SF-3040

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	Reserved	
F6	Reserved	
F7	Reserved	
F8	Reserved	
F9	Reserved	
F10	Reserved	
F11	Reserved	
F12	Reserved	

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

Table continued on next page…

Field #	Field Name	Description
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	Reserved	
F26	Reserved	
F27	Reserved	
F28	Reserved	
F29	Reserved	
F30	Reserved	
F31	Reserved	
F32	Reserved	
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	Reserved	
F38	Reserved	
F39	Reserved	

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

2. Fields 21 through 56 are supported only in Sapphire v1.1 and later.

Table continued on next page…

Field #	Field Name	Description
F40	Reserved	
F41	Reserved	
F42	Reserved	
F43	Reserved	
F44	Reserved	
F45	Reserved	
F46	Reserved	
F47	Reserved	
F48	Reserved	
F49	Reserved	
F50	Reserved	
F51	Reserved	
F52	Reserved	
F53	Reserved	
F54	Reserved	
F55	Reserved	
F56	Reserved	
F57	PIO board Bluetooth channel 0 TX rate	PIO board Bluetooth channel 0 TX rate in bytes per second
F58	PIO board Bluetooth channel 0 TX rate	PIO board Bluetooth channel 0 TX rate in bytes per second
F59	PIO board Bluetooth channel 1 TX rate	PIO board Bluetooth channel 1 TX rate in bytes per second
F60	PIO board Bluetooth channel 1 TX rate	PIO board Bluetooth channel 1TX rate in bytes per second

1. The overflow count is the number of times the software detects overflow. It is not the number of bytes that overflows.

2. Fields 21 through 56 are supported only in Sapphire v1.1 and later.

2.118 USERANTTYPEB

☒SF-3050 ☒Sapphire ☒SF-3040

This message displays the two user-defined custom antenna types. The format of the message is described in the table below. Scheduling USERANTTYPEB results in two messages being output: USERANTTYPE0B and USERANTTYPE1B. Their format is identical except for the mnemonics.

Command:	[USERANTTYPEB] {Binary data}
Parameter	Definition

Default: not applicable

The format of the binary data is defined in the table below.

Data Item	Data Type	Description
Antenna Number	U08	Indicates which user antenna is being defined (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 the message. (1 – 8)
Frequency record 0	23 S16	PCO and PCV values for this frequency.
. . .		
Frequency record n	23 S16	PCO and PCV values for this frequency.

2.119 Reserved

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3 Legacy Starlight Proprietary RTK Correction Messages

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver can produce and accept NavCom Proprietary RTK corrections supported by the previous generation of NavCom receivers.

Table 207 shows the output streams associated with each correction type. Table 208 lists the supported correction types.

Table 207: NavCom Proprietary Correction Output Streams

Sapphire Output Stream	NavCom Proprietary Message Type
NCT5B	RTK Correction Message (0x5B) and L-RTK Correction (0x5e)
NCT5C	RTK Base Position (0x5C)

Table 208: Supported NavCom Proprietary Correction Inputs

Correction Inputs	NavCom Proprietary Message Type
0x5B	RTK Correction Message
0x5C	RTK Base Position
0x5E	L-RTK Correction

0x5b - RTK Correction Message - 4+12+(n*18) bytes

☒SF-3050 ☒Sapphire ☒SF-3040

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-3050 ☒Sapphire ☒SF-3040

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.
- ✓ 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-3050 ☒Sapphire ☒SF-3040

RTK base raw measurements block, 0x5e.

4 Other Correction Output and Input Message Types

4.1 RTCM 2.3 Output Messages

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver can produce RTCM corrections (refer to the section, *Related Standards*). Table 209 shows the supported RTCM correction messages along with the corresponding Sapphire output stream.

Table 209: RTCM 2.3 Correction Output Streams

Sapphire 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-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver accepts RTCM corrections (refer to the section, *Related Standards*). Table 210 lists the supported RTCM Correction messages.

Table 210: 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)
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-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver can produce RTCM 3.0 corrections (refer to the section, *Related Standards*). Table 211 shows the supported RTCM 3.0 correction messages along with the corresponding Sapphire output streams.

Table 211: RTCM 3.0 Correction Output Streams

Sapphire Output Stream	RTCM 3.0 Message Type
RTCM1	Differential GPS Corrections (Type 1);
RTCM3	GPS Reference Station Parameters (Type 3)
RTCM9	GPS Partial Correction Set (Type 9);
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)
RCTM31	Differential GLONASS corrections set (Type 31)
RCTM34	GLONASS Partial corrections set (Type 34)
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-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver accepts RTCM 3.0 corrections (refer to the section *Related Standards*). Table 212 lists the supported RTCM 3.0 Correction messages.

Table 212: Supported RTCM 3.0 Correction Inputs

RTCM 3.0 Message Type
Differential GPS Corrections (Type 1);
GPS Reference Station Parameters (Type 3)
GPS Partial Correction Set (Type 9);
GPS Special Message (Type 16)
RTK Uncorrected Carrier Phases (Type 18)
High-Accuracy Pseudorange Corrections (Type 21)
Extended Reference Station Parameters (Type 22)
Differential GLONASS corrections set (Type 31)
GLONASS Partial corrections set (Type 34)
GPS basic RTK, L1 only Corrections (1001)
GPS Extended RTK, L1 only Corrections (1002)

GPS basic RTK, L1, L2 only Corrections (1003)
GPS Extended RTK, L1 only Corrections (1004)
Stationary antenna reference point, No Height (1005)
Stationary antenna reference point (1006)
Antenna description (1007)
Antenna description (1008)
GLONASS basic RTK, L1 only Corrections (1009)
GLONASS Extended RTK, L1 only Corrections (1010)
GLONASS basic RTK, L1, L2 Corrections (1011)
GLONASS Extended RTK, L1, L2 Corrections (1012)
GPS ephemeris data (1019)
GLONASS ephemeris data (1020)
Antenna and receiver description (1033)

4.5 CMR Output Messages

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver can produce CMR and CMR+ corrections (refer to the section, *Related Standards*). Table 213 shows the output streams associated with each correction type.

Table 213: CMR Output Streams

Sapphire Output Stream	CMR Message Type
CMROBSERVATIONS	Observables (Type 0)
CMRREFLOCATION	Reference Station Coordinates (Type 1)
CMRREFDESCRIPTION	Reference Station Description (Type 2)
GLNS_CMROBSERVATIONS	GLONASS Observations (Type 3)
CMRPLUSREFDESCRIPTION	Extended Reference Station Description (Type 5)

To enable CMR correction output, the CMROBSERVATIONS, CMRREFLOCATION, and CMRREFDESCRIPTION output streams must be enabled.

To enable CMR+ correction output, the CMROBSERVATIONS, CMRREFLOCATION, and CMRPLUSREFDESCRIPTION output streams must be enabled.

4.6 CMR Input Messages

☒SF-3050 ☒Sapphire ☒SF-3040

The Sapphire receiver accepts CMR and CMR+ corrections (refer to the section, *Related Standards*).

Table 214 lists the supported CMR correction input types.

Table 214: Supported CMR Correction Inputs

CMR Message Type
Observables (Type 0)
Reference Station Coordinates (Type 1)
Reference Station Description (Type 2)
GLONASS Observations (Type 3)
Extended Reference Station Description (Type 5)

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 );
}
```

Sapphire 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
```

Sapphire 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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C........................ Logging Data to the SF-3050 Internal Memory Device

This appendix provides instructions on how to log scheduled messages to the SF-3050 2G internal memory device and download those messages to a PC using an available input terminal. (If using StarUtil 3000, use that application's *Input Terminal* window).

There are two methods of data logging: the first is to internal memory (port FH1) and the second is to an external USB memory device (port FH2). Where unique features of each port require further explanation, they are identified by their port number for ease of reference.

Similarly, when using the [LOGFILE] command, *A:* refers to the internal memory location and *B:* refers to the external USB memory device.

Logging to FH2 requires an optional cable, PN 94-310271-3006LF.

Scheduling Messages

To log data to internal memory, the messages to be logged are first scheduled on a special port, *fh1*. The letters "fh" refer to "file handler." The [OUTPUT] command is used to schedule the messages (refer to [OUTPUT] in Section 1 for further details).

1. In the terminal window, type the appropriate Output message:
   [OUTPUT](message), (timing), (interval), fh1

   For example, to output PVT1B at 10Hz and send to the internal memory port, the command is
   [OUTPUT]PVT1B, ontime, 0.1, fh1
2. Click the *Send* button on the *Input Terminal*.
3. Repeat steps 1 and 2 to schedule all necessary messages.

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 3000 User Guide*.

Internal data logging is limited to a 25Hz maximum data rate for a multi-hertz message (i.e., MEAS1B, PVT1B, etc.).

Logging Data

4. Prior to logging data, type the command *[FSFORMAT]A:,DEFAULT* to check for corruption and to format the internal flash drive; a "CHKDSK.SD" file will be created automatically upon completion of formatting and stored in the "datalog" folder (see Figure 6).

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.

If the error message "SIGNATURE FILE NOT FOUND" occurs after a [CHKDSK]A: command is input, the file CHKDSK.SD is not present on the SD flash. Enter the following command to create it:

[CHKDSK]A:,CREATE

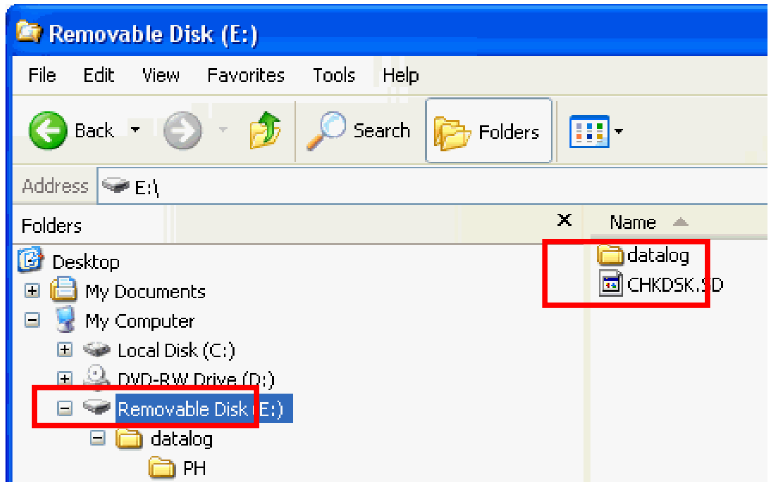

Figure 6: Datalog Folder and CHKDSK.SD File on Removable Disk

5. In the *Input Terminal* window, type the command *[LOGFILE]A:,start*, where "A:" is the internal memory. The system will retrieve the available free space for logging data and issue a READY message (see Figure 7). (Refer to the [LOGFILE] command in this manual for detailed instructions, including "Essential Notes").

   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.

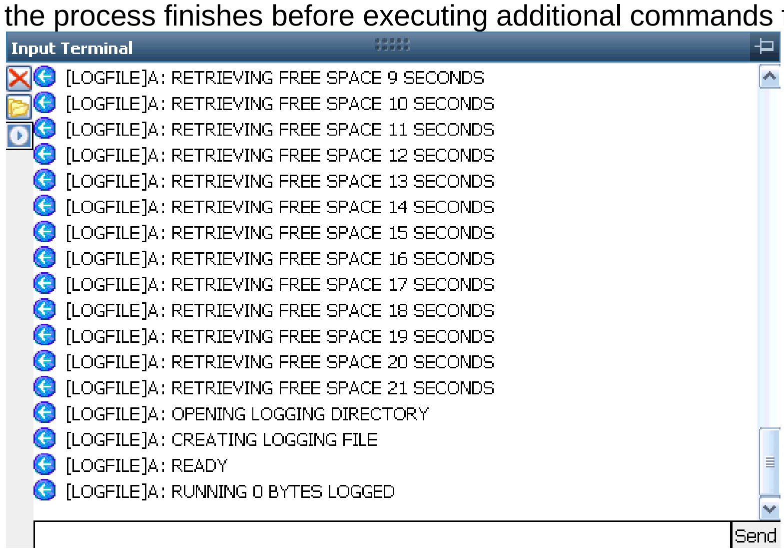

Figure 7: Input Terminal – Creating Logging File

⚠ 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.

On fh2, the [LOGFILE] command used in this procedure does not work with USB flash drives that have a write-protected primary partition. The partition will not mount properly. The most common examples of this are drives with U3 software installed. In order to log using these drives, this partition must be removed. Reformatting the drive is not sufficient. According to the U3 web site:

> *"Most U3 smart drives come with an uninstall utility that converts the U3 smart drive into a regular USB flash drive. This utility can be accessed from the U3 Launchpad. Open the U3*

Launchpad and click on Settings, then select U3 Launchpad Settings and click on the Uninstall tab. Some devices have a link to the Uninstall utility under Help and Support."

6. Create a directory in the current working directory for data logging: Type [FSMKDIR] followed by a directory name. (i.e. *[FSMKDIR] "Pt_Conception"*, Refer to the [FSMKDIR] command for details on creating directories.) Repeat to create multiple directories for data logging. The directories will be stored in the "datalog" folder (see Figure 6).

7. Type [LOGFILE]A:, START

8. Click the *Send* button to begin logging the scheduled messages into the specified directory (messages are logged in the *.dat format; see Notes below).

9. Type any of the following on the *Input Terminal* window, as necessary (updates can be a little slow; only issue the command once and allow 30 seconds for a response):

- *[LOGFILE]A:* – displays the current file logging status for the internal memory device
- *[LOGIFLE]A:,pause* – stops data logging on drive A until a resume command is issued
- *[LOGFILE]A:,resume* – resumes data logging on drive A
- *[LOGFILE]A:,stop* – stops data logging on drive A
- *[LOGFILE]* – displays the current file logging status for drives A and B, including READY, RUNNING, STOPPED, or PAUSED

When the status is RUNNING or PAUSED, the logged bytes are displayed.
[LOGFILE]A: RUNNING 5245989 BYTES LOGGED; B: STOPPED

After power cycle, file logging is in Stopped status. If DC power is removed from the receiver power input port prior to turning off the front panel switch, there is a risk of corrupting and losing the stored data. Always stop data logging before removing power. Similarly, there is a risk of corrupting and losing the stored data if DC power is removed from the receiver power input port while transferring data from the receiver to a PC.

Each time data logging is restarted, a new log file is created (see Figure 8). The log files are created in a datalog_YYYY_MM_DD_HH_MM.dat format.

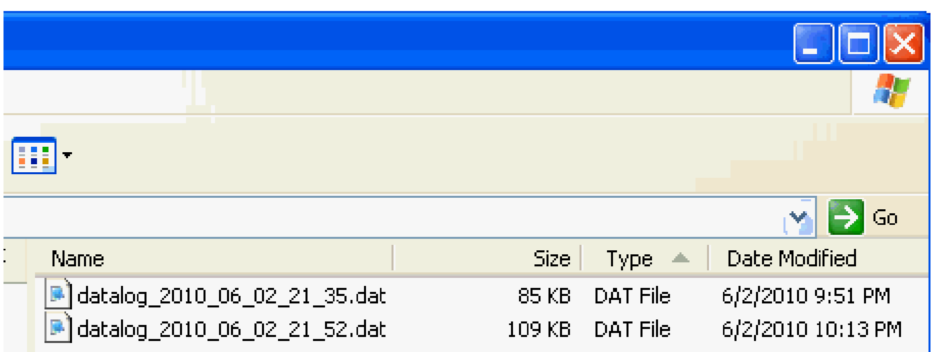

Figure 8: Automatically Generated Datalog Files

Managing Datalog Files

Use any of the following commands, as necessary, in the *Input Terminal* window to manage datalog directories and files on the SD internal memory:

- [FSCD] – to change to another directory, type this command followed by the directory name to change to (refer to [FSCD] for detailed instructions). If no directory name is specified, the current working directory is returned.

[FSCWD] – to display the current working directory, type this command (refer to [

- FSCWD] for detailed instructions).

- [FSDELETE] – to delete a file *or* a directory, type this command followed by the name of the directory or file to delete (refer to [FSDELETE] for detailed instructions).

- [FSDIR] – to display all contents of the currently selected drive, type this command (refer to [FSDIR for detailed instructions).

- [FSDRIVE] – to select a drive (A or B), type this command followed by the drive letter. If no letter is specified, the current drive, its FAT, and the total space and free space in sectors are displayed (refer to [FSDRIVE] for detailed instructions).

When using the [FSDRIVE] command to change to drive B, the USB must be in Host mode and a USB thumb drive must be attached to the port.

- [FSMKDIR] – to create a new directory for data logging, type this command followed by a new directory name (refer to [FSMKDIR] for detailed instructions).

Keep in mind that once *USB* mode is changed to *Mass Storage Device* mode, the above onboard file system commands cannot access the SD flash.

When changing the USB from Mass Storage mode to other modes, allow approximately 1 minute for the SD flash to be reconfigured and the onboard file system to be reinitialized before implementing onboard file system commands.

Downloading Data from the Internal Memory to a PC

Follow these steps to download data from the internal memory device to a PC:

1. Create a directory on the PC for storing the logged data.
2. On the *Input Terminal*, type [USBMODE]Device, MassStorage.The SF-3050 2GB internal memory chip will show in Windows Explorer as an additional “removable” drive (see Figure 6).
3. Open the datalog folder (see Figure 6) on the removable drive and select the folders or files to store on the PC (see Figure 8).
4. Drag and drop these folders or files into the designated folder on the PC.

Removing data from the internal memory is a slow process, so it is better to keep the files small and remove them soon after data logging is complete. In the current software, downloading 1GB of data requires approximately 1.5 hrs. File sizes are accumulated based on the number and frequency of messages scheduled to log. At 1Hz, a typical log file used for survey purposes will be about 20MB.

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D........................Uploading Unified Firmware Files Using StarUtil 3000

StarUtil 3000 provides a method for uploading multiple firmware files at once.

1. In StarUtil 3000, click *Receiver Options* on the *Detailed Views* menu to open the *Receiver Options* tab (see Figure 9).

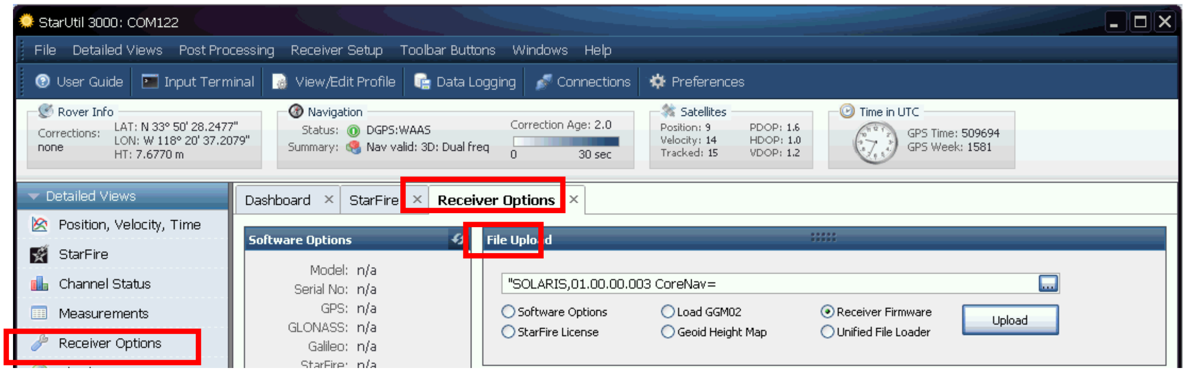


Figure 9: Receiver Options Tab

2. Select *Unified File Loader* on the *File Upload* dialog box (see Figure 10).

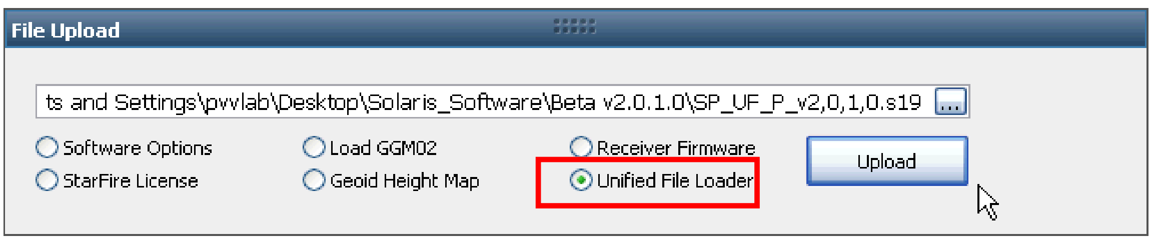


Figure 10: File Upload – Unified File Loader

3. Click .
4. Browse to NavCom\Firmware on the PC (see Figure 11).

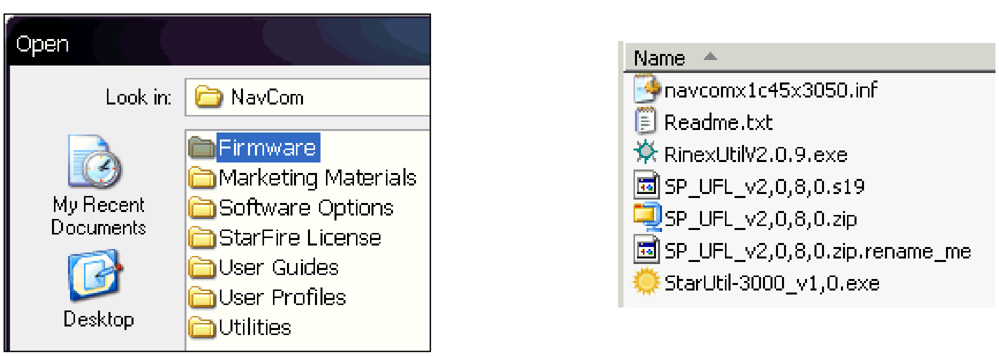


Figure 11: Firmware Folder

5. Select the appropriate *unified* file to upload and click  (see Figure 10).
6. The files to be uploaded are displayed on the *Ready to Downline Load File* dialog box with their corresponding check boxes selected (see Figure 12).

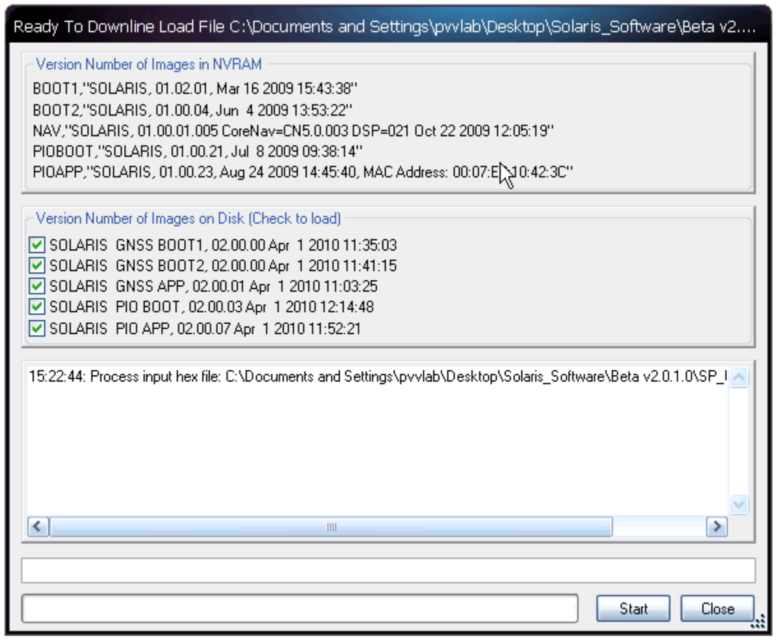
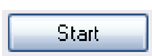


Figure 12: Ready to Downline Load File

7. Click  .
8. Once the firmware files have been uploaded, the *Finished with All Downline Loads* dialog box is displayed (see Figure 13).

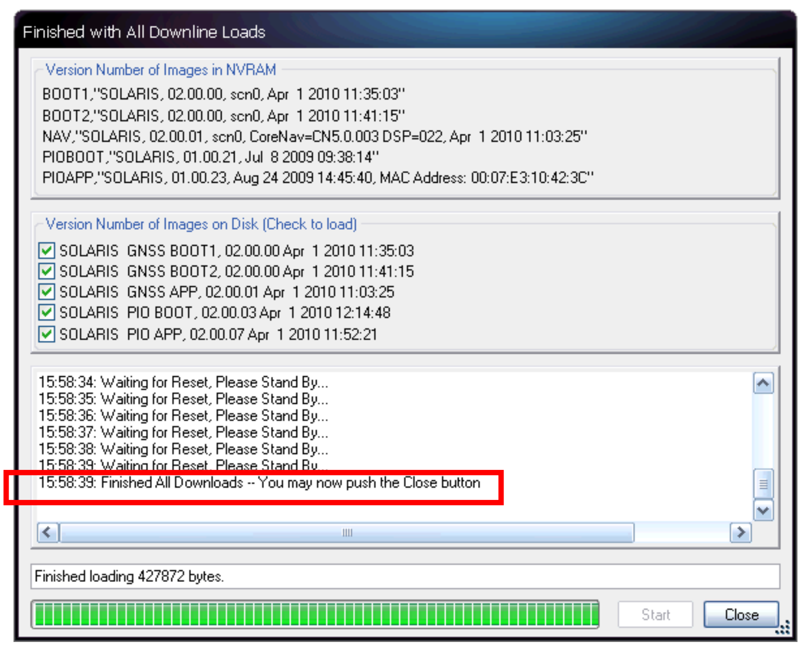


Figure 13: Finished All Downline Loads

9. If any file failed to load, go back to the Receiver Options screen and refresh the window. Identify which software modules did not load. Then follow steps 2 through 8 again, ensuring the successfully loaded software modules are deselected in step 6 the

10. Click 

.

Check  (refresh) on the *Firmware Info* window to view the current versions of all uploaded firmware (see Figure 14).

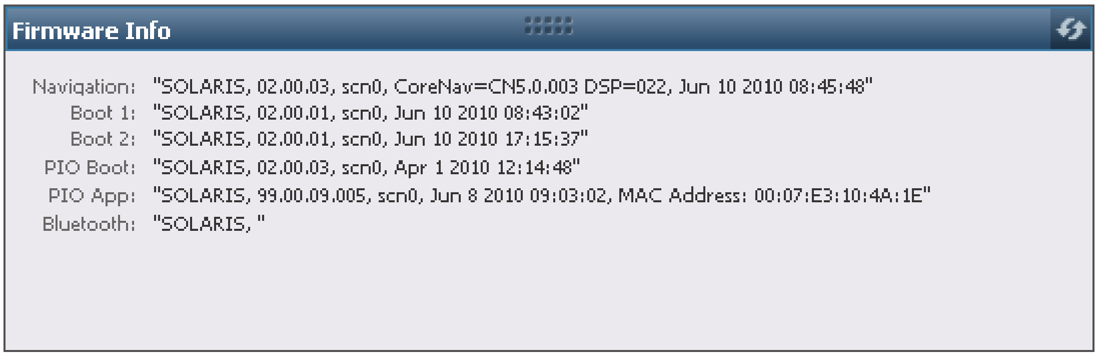


Figure 14: Firmware Window – Example of Installed Firmware

For information on loading firmware without using StarUtil 3000, see Appendix G.

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E .... Base Network RTK Configuration

Overview

This will step you through setting up and using the SF-3050 in a Network Base Station for outputting multiple correction formats to support traditional and VRS message structures (NCT, RTCM v2.3, RTCM v3.1 Network, CMR, and CMR+) via various ports by using NavCom's StarUtil 3000 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 applies to software version 2.0.10.0 and later.

This instruction requires that the receiver is optioned for RTK Network/Base/Rover.

Hardware Requirements

The following hardware is required for this interface:

- ✓ SF-3050 receiver
- ✓ Rover antenna PN 82-001020-3001LF
    - Choke ring antenna option: PN 82-001021-3001LF

- ✓ DC Power Cable (for battery power installations)
    - Choke ring antenna option: PN 82-001021-3001LF

- ✓ P/N 94-310274-3010LF is a 10 ft (3 m) unterminated power cable with a filter used to connect directly to a DC source.

- ✓ 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 94-310273-3006LF
- ✓ Low-loss coaxial cable (requirements are detailed later in this document)
- ✓ Ethernet connection (either/or)
    - Cellular modem (i.e., Cybertech)
    - Router for a hardwire interface (secure connection preferred)
- ✓ Radio modem 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 15) 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-3050 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

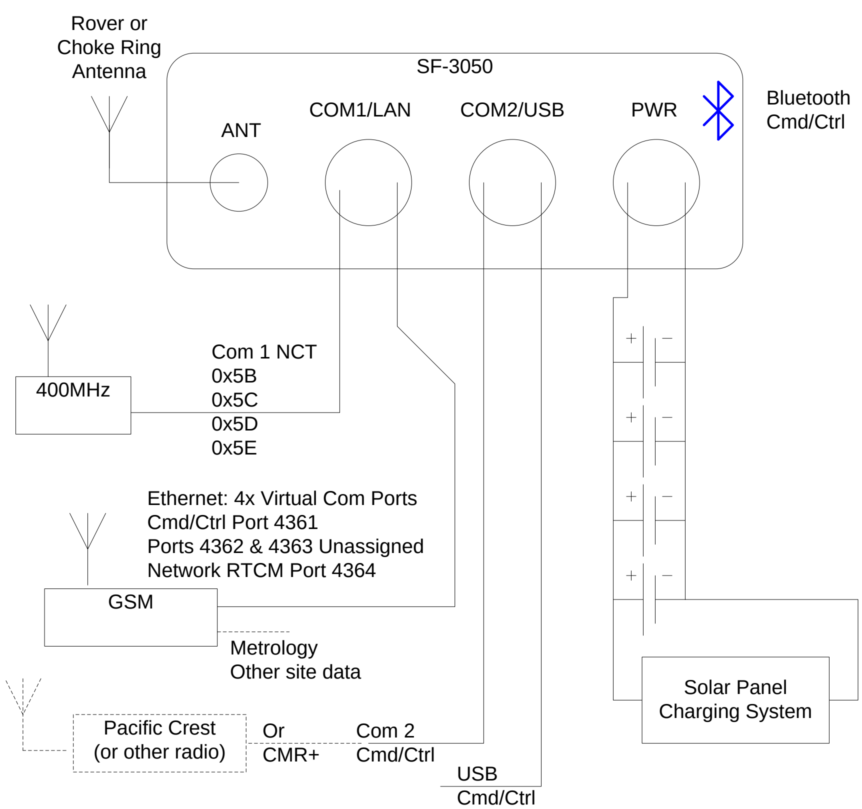

Figure 15: Typical Network Installation

Antenna Installation

Refer to the SF-3050 Product User Guide, Chapter 4, for antenna installation considerations. Table 215 describes the maximum cable length between the antenna and the SF-3050 based on cable type without an external LNA.

Table 215: 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-3050 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-3050, 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-3050 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,SP
I,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]SFRTG,ON
[PRDGPSTIMEOUT]RTCM1,300
[PRDGPSTIMEOUT]WAASEGNOS,300
[PRDGPSTIMEOUT]SFRTG,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 16: 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'.

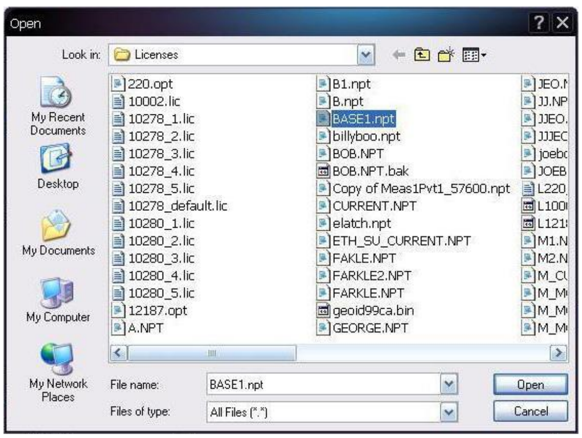

Figure 17: Network Base – Sample.npt Upload

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 17).
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-3050 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 schedu output messages will be sent to the IP address and port of the sender of tl 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 that there is a send error, other than a re-transmission of a lost packet, then th connection will be terminated, and the logical port will enter listen mode fo new connection. This may happen if the remote client experiences a pow 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 Solaris 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-3050 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-3050. 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-3050 in a listener mode.

1. Use the Input Terminal to issue the following commands (Figure 18).

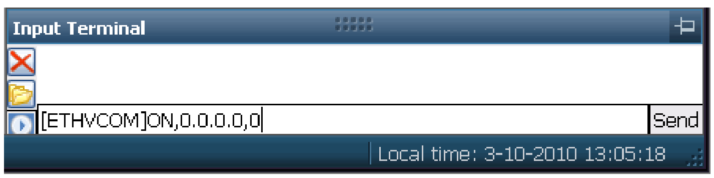

Figure 18: Input Terminal

2. Enter the [ETHVCOM]ON,0.0.0.0,0 command. This allows the SF-3050 to be called by a remote device.
3. The remote device should then call the SF-3050 address and port assigned in Exercise 2: 192.168.0.2, 4361

Resetting the Ethernet Virtual Com Connection

If the SF-3050 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-3050 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. Refer to [RTKMODE] in this manual for further instructions.

When the rover is operating in MBRTK, PVT1B is not impacted. PVT1B operates in the mode based on the input correction format. In other words, if StarFire corrections are being received, PVT1B will be in StarFire (5cm) operation and MBRTK1B (with corrections from a moving base) will be at RTK levels.

[RTKMODE]

Examples:

[RTKMODE]BASE5E,,,1,DYNAMIC

Configures the receiver as an NCT moving base RTK base and output corrections on port 1

[RTKMODE]ROVER,NCT,,,DYNAMIC

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 3 – 7 indicates moving base RTK).

Table 216: Base Modes

Mode	Description	
Rover	Receiver operates as a rover; all ports accept corrections	
BaseRTCM1	Receiver operates as an RTCM type 1 base station	Do not use
BaseRTCM9	Receiver operates as an RTCM type 9 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	
BaseCMR	Receiver operates as a CMR base station	
BaseCMRPLUS	Receiver operates as a CMR+ base station	
Base5B	Receiver operates as a proprietary 5B base station	
Base5E	Receiver operates as a proprietary 5E base station; for Sapphire, this supports multi-GNSS RTK	

The following commands are supported; refer to the individual commands in the section *Sapphire 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 *Sapphire 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 RTG 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 RTG 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 RTG 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.

MBRTK Port-Loading Requirement

Table 217 lists the port-loading requirement from the base to the rover.

Table 217: Port-Loading Requirements

Message ID	Max. Byte Count	Message Rate (Hz)	Total Byte Count	Bits Per Second
NCT23	28	10	280	
NCT5C	30	1	30	
NCT5D	47	1	47	
NCT5E	1420	1	1420	
		SUM	1777	17,770 – to include Start & Stop bits

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G...Loading Firmware Without StarUtil 3000

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 218 and Table 219).

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

The SF-3050 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-3050 does not support bootloading through the Bluetooth interface.

Example: [BOOTLOADA] PING, BOOT2, LOADSERIALBOOT2

Table 218: 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-3050, bootloader1 only supports loading through COM1.

Table 219: BOOTLOADA Bootloader2 Actions

Bootloader2 Action	Description
LOADSERIALBOOT2	Bootload through the serial port using bootloader2. For the SF-3050, 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-3050 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 220.

Table 220: 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 221: 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 222.

This field has other meanings under different circumstances.

Table 222: 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 223.

Table 223: 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 224. For this command, the valid value is ST_Bootblock1 or ST_Bootblock2. For SF-3050, 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 224: 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 225.

Table 225: 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 226.

For SF-3050, 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 226: 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 227.

Table 227: 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 228.

Table 228: 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 229.

Table 229: 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 230.

Table 230: SubID NB_LoadDataCmd Format

Field	Data Type	Value and Description
Function Type SubID	U08	Enum *NB_LoadDataCmd*
Pass or Fail	U08	For the SF-3050 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-3050 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-3050 bootloader1 doesn't implement this mechanism. (This field is not used in SF-3050 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 231.

Table 231: 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-3050 bootloader1 1 for SF-3050 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-3050 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 232.

Table 232: 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 233.

Table 233: 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 234.

Table 234: 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 235.

Table 235: 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 236.

Table 236: 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 237.

Table 237: 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 238.

Table 238: 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 239.

Table 239: 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 .... Connecting to the StarFire Over IP Caster

These instructions enable the user to connect to the StarFire Over IP caster provided the receiver is properly optioned.

NTRIPCONFIG (ASCII)

This command specifies the information the NTRIP client requires to connect to the StarFire Over IP caster.

Command:	[NTRIPCONFIG] {Caster IP} {Caster port} {Mountpoint} {Username} {Password} {NMEAGGA} {Autoconnect} {Correction port}
Parameter	Definition
Caster IP address	NTRIP.STARFIRENETWORK.COM
Caster port number	2101
Mountpoint name	There are four server names which correspond to different corrections types at different rates. a. SFGNSS.1: CF corrections every 1 second b. SFGNSS.15: CF corrections every 15 second c. SFGNSS.30: CF corrections every 15 second d. SFGNSS.60 :CF corrections every 60 second e. SFGNSSCOMPACT.1: CD/CE corrections every 1 second The mountpoint name is combined with the caster name in the command line.
Username	Leave blank. Generated by receiver, any entry will be ignored.
Password	Leave blank. Generated by receiver, any entry will be ignored.
NMEAGGA	Send NMEAGGA once, if desired. However, it is not needed.
Autoconnect	Recommended. Use CLIENT instead of OFF to better ensure connection to the receiver if the unit ever disconnects due to a bad link.
Connection type	Eth/Mobile. Use ETH for SF-3050 ethernet connection or MOBILE for use with a modem (i.e. SF-3040 via Nautiz controller).
Authentication method	Receiver will use automatically use DIGEST for StarFire mountpoints regardless of settings.

Examples:

[NTRIPCONFIG] "NTRIP.STARFIRENETWORK.COM", 2101, "SFGNSS.1", , , OFF, CLIENT, ETH, DIGEST

NTRIPCLIENT (ASCII)

Use the [NTRIPCLIENT]CONNECT command only if the [NTRIPCONFIG] autocommand option is set to OFF. Using [NTRIPCLIENT]DISCONNECT command will automatically switch the Autonnect setting to OFF.

MPAUTOCONNECT (ASCII)

Use [MPAUTOCONNECT] to ensure that you are always connected to a starfire mountpoint. This feature ensures that you will automatically connect to a new mountpoint if one goes down.

Command:	[MPAUTOCONNECT] mode, “Name1”, “Name2”, “Name3”, “Name4”
Parameter	Definition
Mode	Keyword (ON, OFF) ON: The user must specify all four mountpoints. If the first mountpoint which streams starfire corrections every 1 second goes down and the receiver is not able to re-establish a connection after 10 tries, the receiver will automatically switch to the second mountpoint in the list which streams corrections every 15 seconds. If the second mountpoint fails to connect, the receiver will try the third and fourth in the order in which they were entered. If all mountpoints fail to connect, then the receiver will begin again at the first mountpoint and retry the connection. This process will continue until a connection is made. OFF: The receiver will default to the mountpoint set by the [NTRIPCONFIG] command. If that mountpoint fails to connect, the receiver will not retry the connection.
Name 1-4	Keyword (StarFire caster mountpoints) User must specify the mountpoints by server name. The mountpoint names are the same as those specified in the [NTRIPCONFIG] command. All mountpoints must be specified in order for the Autoconnect feature to function.

Example:

[MPAUTOCONNECT]ON, “SFGNSS.1”, “SFGNSS.15”, “SFGNSS.60”, “SFGNSSCOMPACT.1”

This feature can only be used if the [NTRIPCONFIG] command autoconnect option is set to CLIENT.

I .... Web Server

The web server allows the user to view and control the receiver via a web browser.

Supported Product

SF-3050 (software version 3.3.7 or greater)

Supported Browsers

1. Firefox
2. Chrome
3. Safari
4. Internet Explorer (supported but not recommended)

Storage Location

1. Internal SD Storage file system that is accessible by the user via mass storage.
    a. The webpages need to be stored under A:\WEB\NCT or A:\WEB\OEM in order to be loaded.
2. Hidden part of the Internal SD Storage
    a. The user needs to format the internal storage via FSFORMAT in order to this feature to work properly.
    b. WEBCONTROL must be set to NORMAL (default) to access the web pages from the hidden file system.
        i. On boot up, all the web pages of the current type (NCT/OEM) are loaded to memory to speed up the web page loading.
    c. There will be about 100MB trimmed off the end of the file system that will be allocated for both the NCT and OEM. This section will not be visible to the user via mass storage and will not be affected by FSFORMAT.
    d. To format this section, the user must run [WEBPAGES]FORMAT
    e. To update this section, the user must use StarUtil3000 web loader feature.

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 can have its password updated via StarUtil3000.
7. NVCLEAR will wipe out all the user accounts except the admin and return the admin to its default password.

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 (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 web pages are not designed to display multi-hertz data. Data displayed on the web pages are ‘called’ by the web page and cannot be routed to the web page using the [OUTPUT] command.