WAAS GUS-Type 1 Receiver (GUST Receiver) User Manual

OM-20000082 **Rev 4** **July 2013**

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Associated Firmware Versions:

L1/L2	2.104 and 2.105
Clock	3.104 and 2.105
L5	4.104 and 2.105

Limited Rights Notice

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Notices

The following notices apply to the WAAS GUS-Type 1 Receiver.

The United States Federal Communications Commission (in 47 CFR 15) has specified that the following notices be brought to the attention of users of this product.

"This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own risk."

"Equipment changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment."

> In order to maintain compliance with the limits of a Class A digital device, it is required to use properly shielded interface cables when using the Serial Ports, such as Belden #9539, or equivalent, and Belden #8770 cable for input power source (ensuring the shield is connected to the protection ground).

Warranty Policy

Unless there are other contractual agreements in place (in which case those contractual agreements will take precedence), the following warranty applies:

NovAtel Inc. warrants that its Global Positioning System (GPS) products are free from defects in materials and workmanship, subject to the conditions set forth below, for the following periods of time:

WAAS GUS-Type 1 Receiver (GUST Receiver)	One (1) Year

Date of sale shall mean the date of the invoice to the original customer for the product. NovAtel's responsibility respecting this warranty is solely to product replacement or product repair at an authorized NovAtel location only.

Determination of replacement or repair will be made by NovAtel personnel or by technical personnel expressly authorized by NovAtel for this purpose.

Warranty Period: Subject to extended warranty provisions, Seller's standard warranty is one (1) year from the date of delivery for production hardware and three (3) months from the date of delivery for engineering units and internal retained models. Seller warrants that during the Warranty Period, NovAtel products will be free from defects in material and workmanship, conform to applicable specifications and the software will be free from error which materially affect performance. THESE WARRANTIES ARE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICAULAR PURPOSE. SELLER SHALL IN NO EVENT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR NATURE DUE TO ANY CAUSE. Buyer's exclusive remedy for a claim under this warranty shall be limited to the repair or replacement, at Seller's option, of defective or non conforming materials, parts or components. The foregoing warranties do not extend to (i) nonconformities, defects or errors in NovAtel products due to accident, abuse, misuse, or negligent use of NovAtel Products or use in other than a normal and customary manner., environmental conditions not conforming to applicable specifications, or failure to follow prescribed installation, operating and maintenance procedures, (ii) defects, errors or nonconformities in the NovAtel Products due to modifications, alterations, additions or changes not made in accordance with applicable specifications or authorized by Seller, (iii) normal wear and tear, (iv) damages caused by force or nature or act of any third person, (v) service or repair of NovAtel Products by Buyer without prior written consent from Seller, (vi) units with serial numbers or other factory identification removed or made illegible, (vii) shipping damage not applicable to improper packaging.

There are no user serviceable parts in the WAAS GUS-Type 1 Receiver (GUST Receiver) and no maintenance is required. When the status code indicates that a unit is faulty, replace with another unit and return the faulty unit to NovAtel Inc.

Before shipping any material to NovAtel or Dealer, obtain a Return Material Authorization (RMA) number from the point of purchase.

Once you have obtained an RMA number, you will be advised of proper shipping procedures to return any defective product. When returning any product to NovAtel, please return the defective product in the original packaging to avoid ESD and shipping damage.

Customer Service

Contact Information

If you have any questions or concerns regarding your GUST Receiver, contact NovAtel Customer Support using any one of the following methods:

NovAtel GPS Hotline:	**1-800-NOVATEL** (U.S. and Canada)
	403-295-4500 (International)
Fax:	403-295-4501
E-mail:	support@novatel.com
Website:	www.novatel.com
Write:	NovAtel Inc. Customer Service Dept.
	1120 - 68 Avenue NE
	Calgary, Alberta, Canada
	T2E 8S5

GUST Receiver Firmware Updates

Firmware updates are firmware revisions to an existing model, which improves basic functionality of the GPS receiver.

The process for obtaining firmware updates is discussed in *Chapter 7, Firmware Updates* on page 120. If you need further information, contact NovAtel using one of the methods given above.

Foreword

Scope

The *WAAS GUS-Type 1 Receiver (GUST Receiver) User Manual* is written for users of the GUST Receiver subsystem. It is organized into chapters that allow easy access to appropriate information about the receiver. The manual contains sufficient information on the installation and operation of the GUST Receiver to allow you to effectively integrate and fully operate it. Additionally, each command used to configure the GUST Receiver, as well as each log used to capture data, is described in detail, including the purpose, syntax, and structure of these messages. However, it is beyond the scope of this manual to provide details on service or repair. Contact NovAtel for any customer-service related inquiries. See *Customer Service* on page 11.

The versions of GUST Receiver firmware that are associated with the features described in this manual are 2.104, 3.104, 4.104, 2.105, 3.105 and 4.105.

Prerequisites

The GUST Receiver is a stand-alone, fully-functional GPS and SBAS receiver. Refer to *Chapter 2, Installation* on page 20, for more information on installation requirements and considerations. The GUST Receiver utilizes a comprehensive user-interface command structure and to utilize the full potential of the GUST Receiver, it is recommended that some time be taken to become familiar with this manual before operating the receiver.

Conventions

The conventions used throughout this document are:

H	The letter H in the *Binary Bytes* or *Binary Offset* columns represents the header length for that command or log. The binary header is described in *Section 4.3.2, Binary* on page 35.
`0x`	A number following `0x` is a hexadecimal number.
field (boxed)	Text surrounded by a box indicates a variable parameter to be entered as part of the command string.
`[ ]`	Parameters surrounded by [and] are optional in a command or are required for only some instances of the command depending on the values of other parameters.
< >	Text displayed between < and > indicates the entry of a keystroke in the case of the command or an automatic entry in the case of carriage return <CR> and line feed <LF> in data output.

In tables where no values are given, such fields should be assumed to be reserved for future use.

Compliance with GPS Week Rollover

The GPS week rollover issue refers to the way GPS receivers store information regarding the current GPS week. According to the official GPS system specifications document (*ICD-GPS-200*, paragraph 20.3.3.3.1.1), "… 10 bits shall represent the number of the current GPS week…". This means the GPS week is represented by an integer number between 0 and 1023. As GPS time started on Sunday January 6, 1980 at 0:00 hours, week 1023 ended on Saturday August 21, 1999 at 23:59:59.

As per the GPS system specifications document, NovAtel firmware reset the receiver's GPS week number back to zero. Users should be aware of this issue and keep in mind that there may be a compatibility issue when purchasing and using different makes of GPS receivers.

Chapter 1 Introduction

The NovAtel WAAS GUS-Type 1 Receiver (GUST Receiver) is a high-performance receiver designed for installation as a core component of Satellite-Based Augmentation Systems (SBAS). This chapter provides information on the features and functionality of the GUST Receiver and how it operates in the context of the SBAS system.

1.1 SBAS Overview

SBAS is a safety-critical system designed to augment the Department of Defense Global Positioning System (GPS) Standard Positioning Service (SPS). SBAS enhances GPS service by providing:

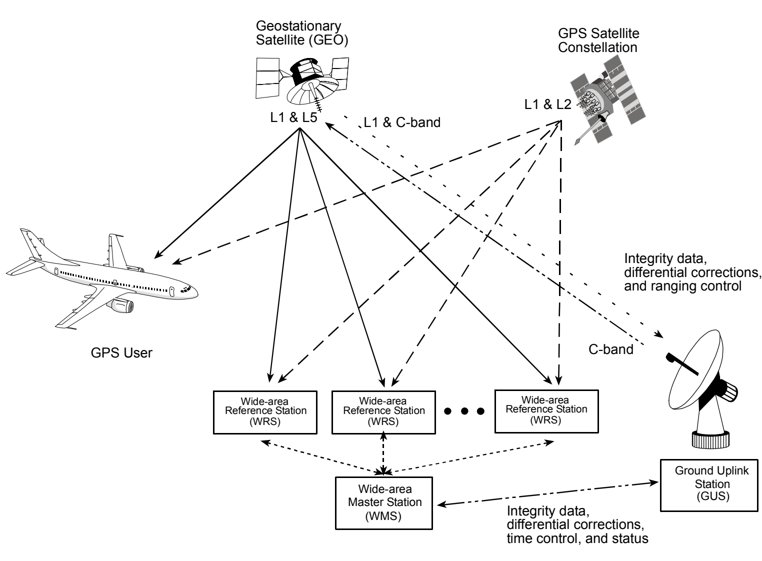
- a ranging function to the SBAS satellites, which improves signal availability and reliability
- GPS signal corrections, which improve accuracy
- integrity monitoring, which improves safety

The primary mission of SBAS is to provide a means for air navigation for all phases of flight in the National Airspace System (NAS) from departure, through en route, and approach. The principal functions of SBAS include:

- determining ionospheric corrections
- determining satellite orbits
- determining satellite clock corrections
- determining satellite integrity
- independent data verification
- SBAS message broadcast and ranging
- system operations & maintenance

As shown in *Figure 1*, the SBAS system consists of a series of *Reference Stations* and *Master Stations*, a *Ground Uplink Subsystem*, and *Geostationary Satellites* (*GEOs*). The *Reference Stations*, which are strategically located to provide adequate coverage, pick up GPS satellite data and route it to the *Master Stations*. The *Master Stations* then process the data to determine the signal integrity, signal corrections, and residual errors for each monitored satellite. This information is sent to the *Ground Uplink Subsystem* for transmission to the *GEOs*, which then re-transmit the data on the GPS L1 and L5 (not available at time of publication) frequency.

Figure 1: The SBAS Concept



The NovAtel GUST Receiver, shown in *Figure 2*, is designed to provide GPS monitoring functionality as part of the *Ground Uplink Stations* in the SBAS network.

Figure 2: WAAS GUS-Type 1 Receiver

1.2 Features

To assist the *Ground Uplink Stations* in providing data with the necessary precision, the GUST Receiver has been designed with the following features:

- Support for L1 and L2 GPS signal processing
- Support for L1, L2 and L5 GEO signal processing
- GPS signal quality monitoring (SQM) functionality, see *Section 1.2.4* on *Page 15*
- Digital pulse blanking for the L2 and L5 signal

The majority of these features are discussed further in the following sections.

1.2.1 GEO Signal Processing

Specific channels in the GUST Receiver have the capability to receive and process the SBAS signal provided by *GEOs*. These signals are in-band at L1, L2 and L5 and are identified through the use of SBAS-specific PRN numbers. The SBAS message is decoded and separated into its various components. The SBAS message and associated pseudorange are provided as an output.

1.2.2 Cross-Correlation Detection Channel

NovAtel's SafeTrak technology is also featured in the GUST Receiver.

The receiver tracks a satellite by replicating the satellite's PRN code and aligning it with the received PRN code. Cross-correlation happens when the receiver is tracking a certain PRN code with an incorrectly replicated PRN code. This is due to the receiver tracking a minor, rather than the required major, correlation peak. The Euro-3M performs a cross-correlation check on channels tracking at low C/No values. The cross-correlation channel aligns its code phase with that of the tracking channel under test. An initial power check between the two channels is made to check alignment and the cross-correlation channel shifts its code phase repeatedly to measure the power. If at any point it determines that the cross-correlation power is within a certain level of the initial power, the channel under test is tracking one of the minor cross-correlation peaks. The tracking channel then re-acquires the satellite to remove the cross-correlation error.

1.2.3 Bit Synchronization

Bit synchronization identifies the location of navigation bit edges with respect to the 1 ms C/A-code epochs. Bit edge detection is based on observing the sign transition between successive 1 ms accumulations that are aligned with the received C/A-code epochs. The bit synchronization is verified by an additional hardware channel and software steering. This additional hardware is configured to generate a stream of 1 ms accumulations until sufficient data has been collected to perform the test. The tracking channel is forced to re-acquire if the results of the second test do not confirm the bit alignment selected by the tracking channel.

1.2.4 Signal Quality Monitoring

Signal Quality Monitoring (SQM) technology is used to monitor GPS and GEO signals in space for anomalous behavior. To do this, the GUST Receiver outputs accumulations at specified correlation function values. It collects accurate accumulation values and outputs them in a timely fashion. The GUST Receiver hardware is capable of tracking the correlation function at multiple correlation locations. See also the ALLSQMIINFO and ALLSQMQINFO logs starting on *Page 87* for more information on correlator locations.

All L1 C/A channels output SQM data as shown in *Figure 3* below. Tracking is accomplished using an early-late (E-L) coherent delay lock loop. The two monitor channels, on the GEOTEST configuration, output data as shown in *Figures 4* and *5* on *Page 16*.

Figure 3: Correlator Positions for SQM Channels

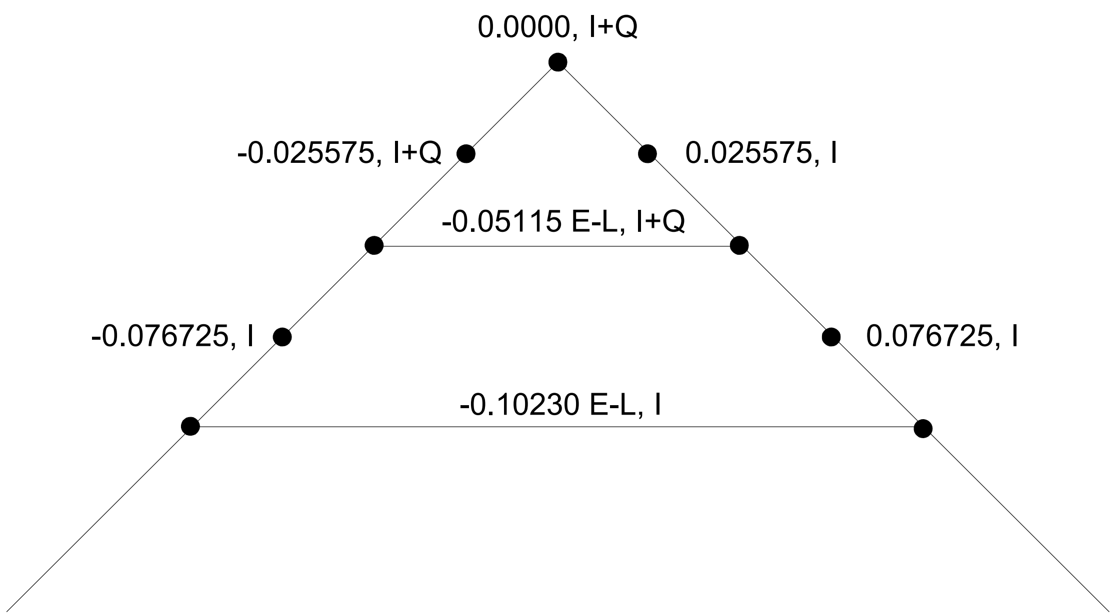


Figure 4: Early Correlator Positions for GEOTEST Monitor Channels

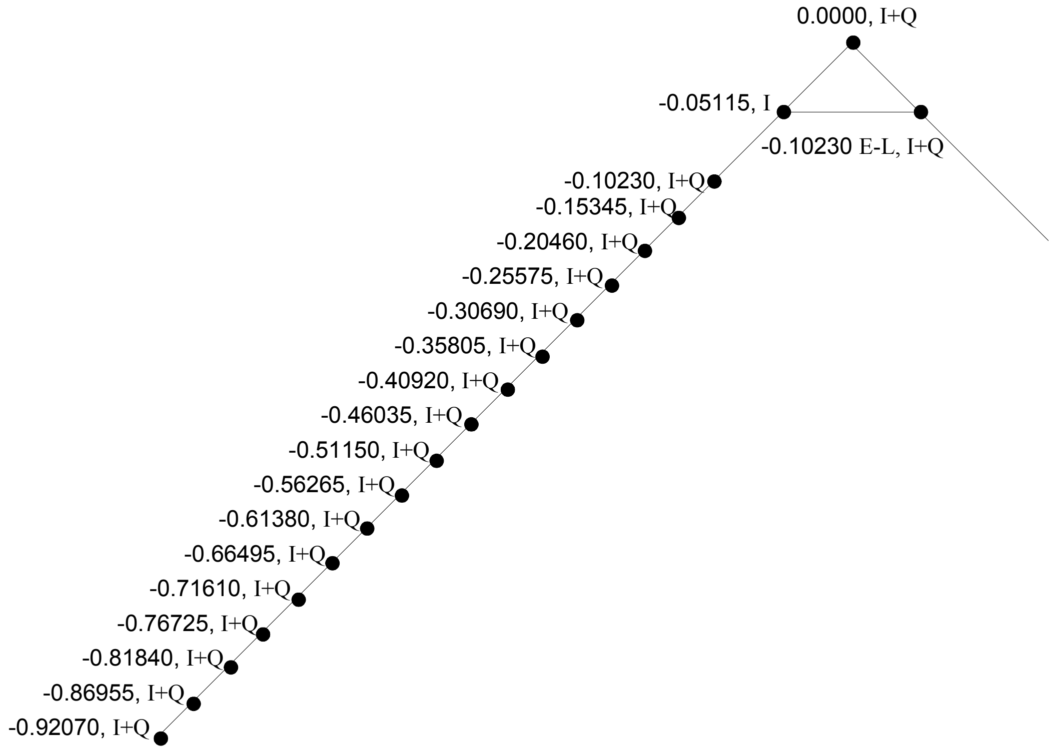
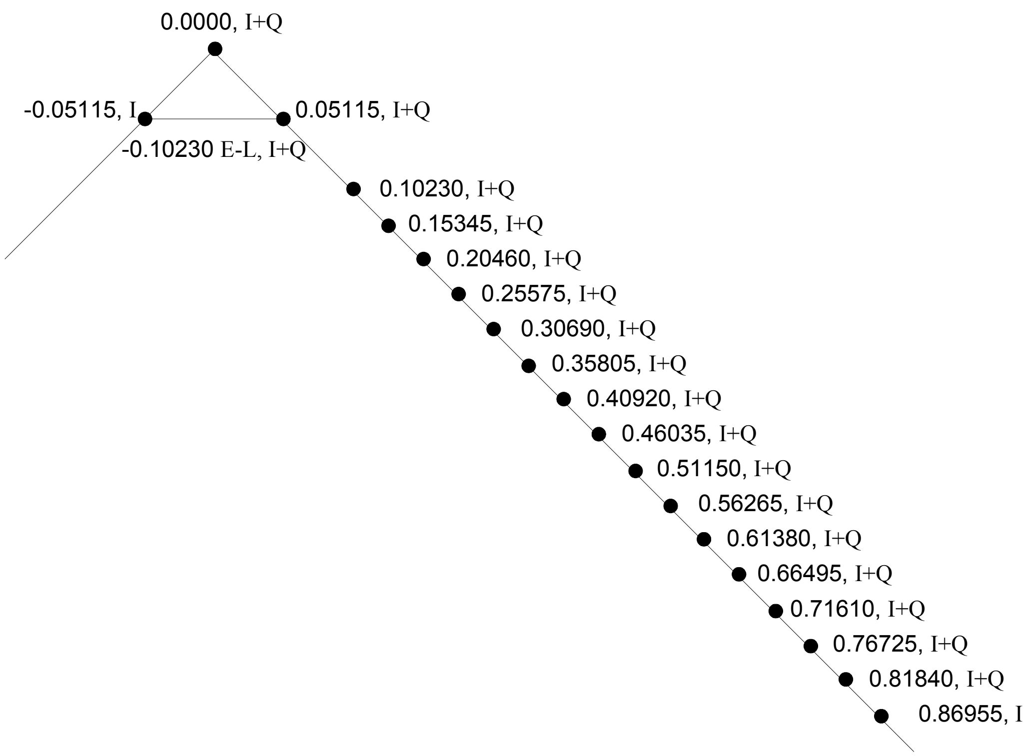


Figure 5: Late Correlator Positions for GEOTEST Monitor Channels



1.2.5 Digital Pulse Blanking

Digital pulse blanking involves removing or attenuating pulses in the RF signal that exceed a specified level. The GUST Receiver provides digital pulse blanking for the L2 and L5 signal paths only. Digital pulse blanking reduces the negative effects of pulsed interference.

Use the PULSEBLANKING command to enable/disable L2 or L5 pulse blanking or to control its sensitivity, see *Page 69*.

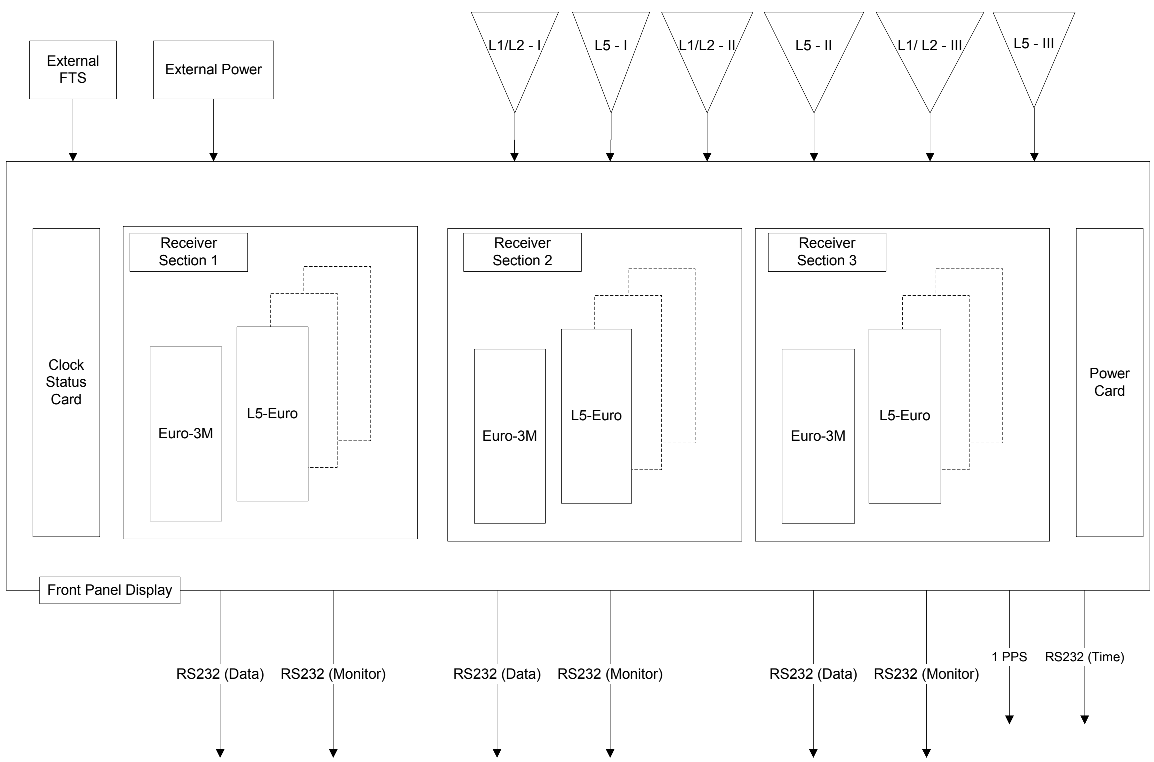
1.3 Functional Overview

The NovAtel GUST Receiver unit consists of the following:

- Standard enclosure for a 19" rack with built-in, forced air cooling
- Liquid crystal display (LCD) to indicate overall receiver status
- Input/output ports for power, antenna, frequency reference, and general communications
- Three receiver sections, one primary and two secondary:
    - Each receiver section has two receiver cards in a master/slave configuration. The master card is a Euro-3M and is capable of tracking the L1 (with SQM) and L2 signals. The slave card is a L5-Euro and is capable of tracking L5 signals.
- Auxiliary cards to provide power, clock, and overall status information throughout the unit

These sections are discussed in further detail in the sections that follow. *Figure 6* on *Page 17* shows the components of the GUST Receiver.

Figure 6: Block Diagram



1.3.1 Enclosure

The GUST Receiver is contained in a enclosure designed to fit standard 19” EIA racks. Within the enclosure, built-in, forced air cooling is provided to keep all components at an optimum temperature.

1.3.1.1 LCD Status Display

On the front of the GUST Receiver enclosure, an LCD has been included to provide basic status information regarding the unit. See *Status Display* on *Page 24* for more details.

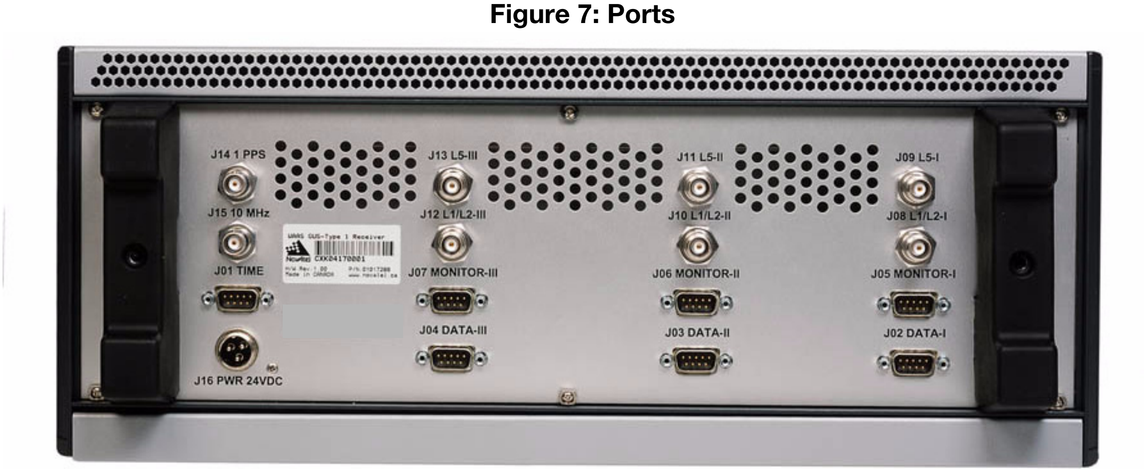
1.3.1.2 Input/Output Ports

As shown in *Figure 7*, the GUST Receiver provides a variety of ports on the back panel of the enclosure for power, antenna input, and general communications, including the following:

- Bi-directional serial data ports, used to configure the receiver section, receive commands and send measurements and status data
- Monitor ports, for sending measurement and status data
- An input port to connect an external 10 MHz oscillator for synchronization
- A *Time* port for sending GPS time and receiver time offset
- A 1 PPS output for synchronization with the *Time* port data
- 6 antenna inputs: 3 for L1/L2 and 3 for L5
- A single power input

Section 2.1 on *Page 20* provides information on connecting to the ports, while *Table 62* in *Appendix A* gives specifications on the connectors and signals provided at these ports.

Figure 7: Ports



1.3.2 Receiver Sections

The GUST Receiver consists of three receiver sections. The three sections are designed to be controlled independent of each other.

Each receiver section has the capacity to hold four receiver cards, which are each based on NovAtel’s Euro card. These cards are configured in a master-slave relationship. When commands are sent to the receiver section through the serial port, the master card coordinates the operation of all cards in that section in order to execute the command. This coordination between cards is transparent to the user.

In a standard GUST Receiver unit, all three receiver sections are populated. Within each section, there are two receiver cards, one master and one slave. The remaining two slots within each receiver section are empty, available for expansion at a later date.

1.3.2.1 Euro-3M Card

The Euro-3M card is the master card in each receiver section. This card is capable of tracking GPS L1 C/A, GPS L2 P(Y), GEO L1 C/A and GEO L2 C/A signals. Up to 18 satellites can be tracked simultaneously, and up to four of those can be GEOs.

1.3.2.2 L5-Euro Card

The L5-Euro card is the slave card in each receiver section. This card is capable of tracking up to four L5 GEO signals.

1.3.2.3 Clock Status Card

The clock status card provides all three receiver sections with a common clock signal. It also controls the LCD display and the cooling fans.

1.3.2.4 MINOS4

The Euro-3M card accommodates three GPS digital signal processors (DSP) named MINOS4. The MINOS4 is capable of processing L1 and L2 RF signals. The quantity of MINOS4 processors ensures the necessary hardware channels for extra satellite tracking capability and to support the output of SQM data.

Each MINOS4 has 24 hardware channels that are capable of tracking the L1/L2 RF signals. Multiple hardware channels are used to implement SQM.

1.3.3 L5 FPGA

The L5-Euro card contains a field programmable gate array (FPGA) made by Xilinx Incorporated for its DSP functionality. The FPGA has the capacity to support four L5 signals.

Chapter 2 Installation

This chapter provides sufficient information to allow you to set up and prepare the GUST Receiver for initial operation.

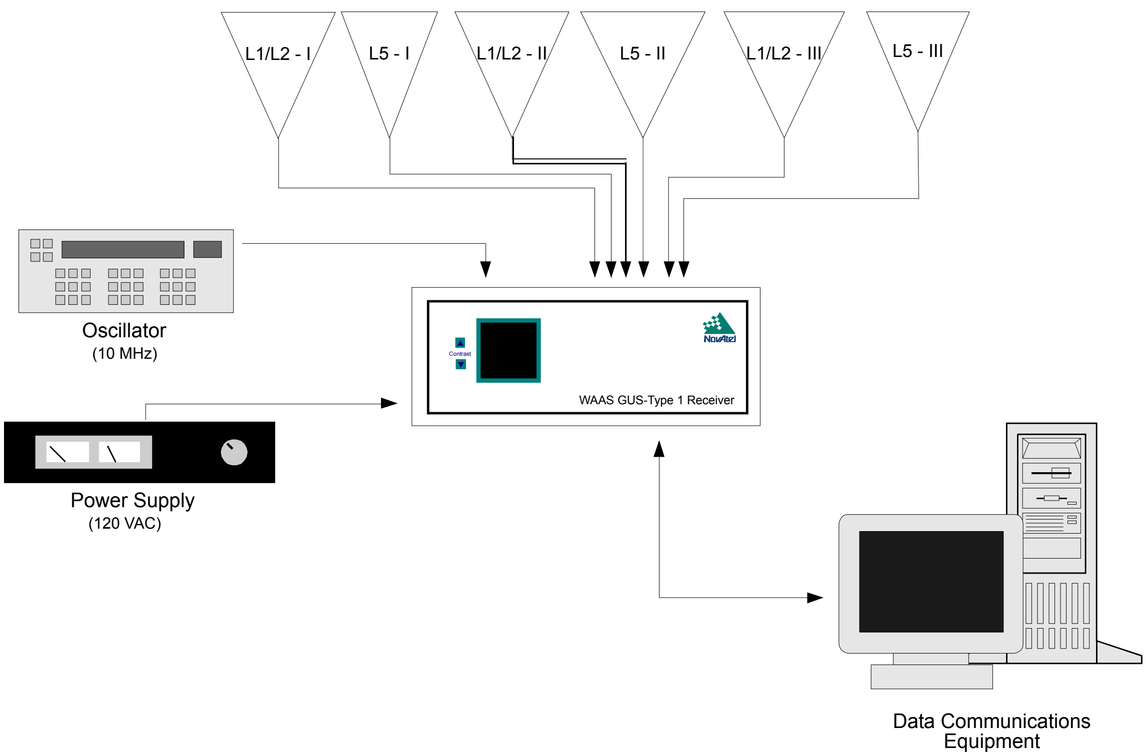
2.1 Typical Installation

In order for the GUST Receiver to function as a complete system, the following equipment is required:

- NovAtel WAAS GUS-Type 1 Receiver, which fits a standard 19” EIA rack
- User-supplied and powered L1/L2 GPS antenna, L5 antenna and low-noise amplifier (LNA)
- User-supplied power supply and cable (24 ±2 VDC, 31 W maximum power consumption)
- User-supplied external frequency reference (10 MHz)
- User-supplied data communications equipment capable of standard RS-232 serial communications, such as a PC
- User-supplied data and RF cables

The typical configuration of this equipment is shown in *Figure 8*.

Figure 8: Typical Configuration



To create the typical configuration, complete the steps below, which are described in more detail in the sections that follow.

1. Connect the external frequency reference to the GUST Receiver.
2. Connect the data communications equipment to the GUST Receiver.
3. Install the GPS antennas, including an LNA if applicable, and make the appropriate connections to the GUST Receiver and an LNA power supply.
4. Connect the external power supply to the GUST Receiver.

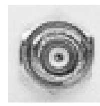
The steps provided on the previous page merely describe the basic system configuration, which you can modify to meet your specific situation. In order to take advantage of the many features the GUST Receiver has to offer, your intended set-up may differ significantly from this configuration. See *Section 2.1.5, Optional Installation Steps* on page 23 for more advanced configuration steps.

2.1.1 Connecting the External Frequency Reference

The GUST Receiver requires an external, user-supplied frequency reference, which typically takes the form of a high-accuracy oscillator. Please refer to *Table 63* on page 135 in *Appendix A* for the recommended specifications of this device.

The frequency reference is connected to the *J15 10 MHz* BNC female connector on the rear panel of the GUST Receiver, which is shown in *Figure 9*. *Table 62* on page 134 in *Appendix A* provides technical specifications on this port.

Figure 9: *J15 10 MHz* Port



The LCD status display on the front panel, shown in *Figure 16* on *Page 24*, displays the status of the connection between the GUST Receiver and the external clock reference.

2.1.2 Connecting Data Communications Equipment

There are seven RS-232 serial ports on the back panel of the GUST Receiver that allow you to communicate with the unit using external data communications equipment.

- The *Data* port is a bi-directional port that allows you to send commands to and receive data from the receiver section. It is configured as COM1.
- The *Monitor* port is an output-only maintenance port. It is configured as COM3.
- The *Time* port is an output only port. It is not possible to transmit data to this port. Although the *Time* port cannot accept commands directly, its operation can be configured indirectly through the Data port (COM1), with the port to apply the settings to specified as a parameter within the command. Data is available on this port at a rate of 1Hz, and is synchronized to the clock signal available at the 1PPS connector. The data transfer rate is fixed at 9600 bps, with one stop bit.

For your initial testing and communications, you will probably be using either a remote terminal or a personal computer that is directly connected to *COM1* by means of a serial cable.

When powered on, the following logs are output from the *Monitor* port at a default baud rate of 230400 bps:

- AGCSTATSB [ontime 1]
- ALLSQMDATAB [onnew]
- RAWEPHEMB [onchanged]
- SYSTEMLEVELSB [ontime 1]
- TIMEB [ontime 1]
- RANGEB [ontime 1]
- RAWGPSSUBFRAMEWPB [onnew]
- RAWWAASFRAMEWPB [onnew]
- RXSECSTATUSB [ontime 1]
- RXCOMMANDSA [ontime 900 offset 0.7]

The serial ports each have a DE9P connector, as shown in *Figure 10*, *Figure 11* and *Figure 12*. *Table 62* on page 134 in *Appendix A* provides technical specifications on these ports. See *Appendix B* starting on *page 139* for acronym meanings.

Figure 10: Data Ports: Sections 1, 2 and 3

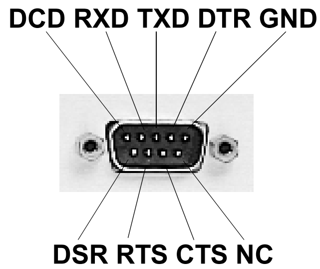


Figure 11: Monitor Ports: Sections 1, 2 and 3

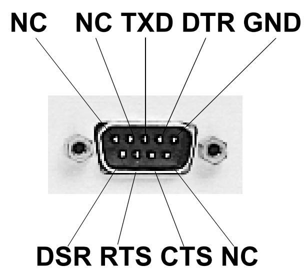
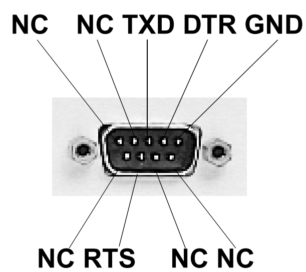


Figure 12: Time Ports: Sections 1, 2 and 3



2.1.2.1 Configuring the Data Communications Equipment for Communications

Because the GUST Receiver communicates with the equipment via serial ports, both units require the same port settings. The serial port settings of the data equipment should match these on the receiver:

- RS-232C protocol
- 115 200 bits per second (bps) (the default is 9600)
- No parity
- 8 data bits
- 1 stop bit
- No handshaking
- Echo off

> After the GUST Receiver has been powered on and initial communications are established, the port settings for the GUST Receiver can be changed using the *COM* command, which is described in *Section 5.3.8, COM* on page 57.

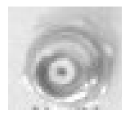
2.1.3 Connecting the GPS Antenna

Selecting and installing an appropriate antenna system is crucial to the proper operation of the GUST Receiver. Keep these points in mind when installing the antenna system:

- Ideally, select an antenna location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction.
- Ensure that the antenna is mounted on a secure, stable structure capable of withstanding relevant environmental loading forces (e.g. due to wind or ice).
- Use high-quality coaxial cables to minimize signal attenuation. When using active antennas, remember that you also need to connect each low-noise amplifier (LNA) to a suitable power source. The gain of the LNA must be sufficient to compensate for the cabling loss.

Connect the antennas to the desired antenna ports on the GUST Receiver, which have TNC female connectors, as shown in *Figure 7*. *Table 62* on page 134 in *Appendix A* provides technical specifications on these ports.

Figure 13: Antenna Ports

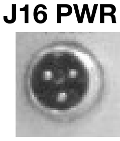


2.1.4 Connecting the External Power Input

The GUST Receiver requires a single external, regulated power source. It acts as an input to the GUST Receiver's internal power card, which performs filtering and voltage regulation functions.

The input can be in the 22-26 VDC range. The GUST Receiver draws up to 1.40 A at start-up, but the steady-state requirement is approximately 1.10 A. The external power source is connected to the *J16 PWR 24VDC* port on the GUST Receiver, shown in *Figure 14*. *Table 62, Port Specifications* on page 134 in *Appendix A* provides technical specifications on this port.

Figure 14: J16 PWR 24VDC Port



2.1.5 Optional Installation Steps

In addition to the required connections discussed in the previous sections, other ports on the GUST Receiver can be used to implement more advanced functionality.

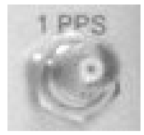
2.1.5.1 Accessing Time Output

The *Time* port, shown in *Figure 12* on *Page 22*, provides the time data for the *1 PPS* output through a DB9 connector. It is an output only and, therefore, it is not possible to transmit data to this port. However, it can be configured indirectly through the Data port (COM1). See also Section *Section 2.1.2* on *Page 21*.Data is available on this port at a rate of 1 Hz. See *Section 6.3.18* on *Page 115* for more information on the data provided by this port. *Section 3.3.1* on *Page 28* provides information on configuring the settings for this port.

2.1.5.2 Accessing the 1 PPS Output

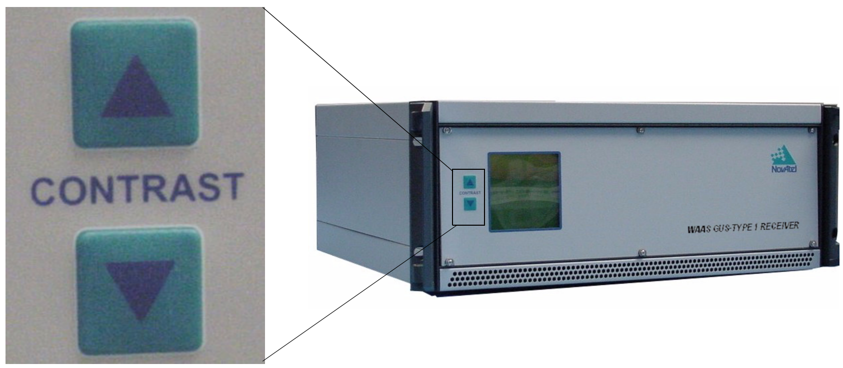
The clock signal available on the *J4 1 PPS* port is synchronized to the 10 MHz input. The specifications and electrical characteristics of this signal are described in *Table 62* on page 134 in *Appendix A*. The pulse train is accessed from the BNC female connector on the back of the GUST Receiver, as shown in *Figure 15*.

Figure 15: *J4 1 PPS* Port



2.2 Status Display

Figure 16: Front Panel with LCD Status Display



The receiver includes a display on the front panel indicating overall receiver status. You can increase or decrease the contrast by using the CONTRAST buttons shown in *Figure 16* above.

2.2.1 Start-up

At start-up of the clock/status card, the status display screen displays a NovAtel logo until the primary master card has successfully completed boot up. If a fatal error exists with any card, the status display screen backlight flashes at a rate of 0.5 Hz (once every 2 seconds). If a non-fatal error exists, the status display screen displays the error for each receiver card in each receiver section.

2.2.2 Reset

Upon issuing the RESET command, the status display screen displays the NovAtel logo until the reset is complete. One RESET command resets all three receiver sections.

2.2.3 Operational

The status display screen for the receiver contains three distinct columns.

Each column contains a total of sixteen distinct rows, one row for the header, twelve rows for the receiver cards and three rows for the clock/status card.

The first column of the status display screen shows the identification of the receiver cards that are in use in the receiver.

Receiver card identification is as follows:

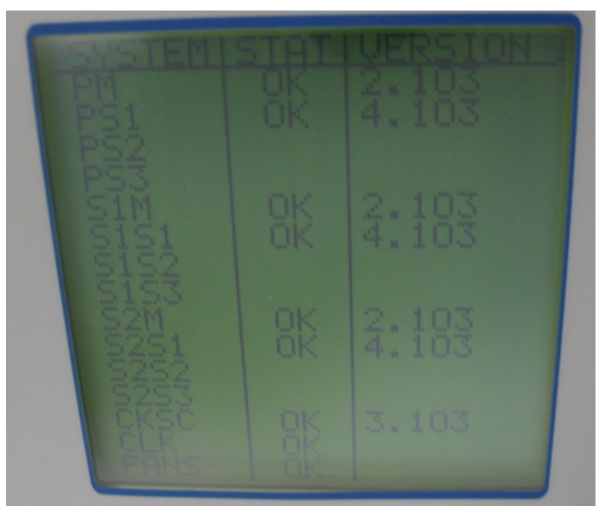
1. Primary section is denoted as P.
2. First secondary section is denoted as S1.
3. Second secondary section is denoted as S2.
4. Master card is denoted as M.
5. First Slave card is denoted as S1.
6. Second Slave card is denoted as S2.
7. Third Slave card is denoted as S3.

The receiver identification is as follows:

- PM - Primary section Master receiver card.
- PS1 - Primary section Slave1 receiver card.
- PS2 - Primary section Slave2 receiver card.
- PS3 - Primary section Slave3 receiver card.
- S1M - Secondary1 section Master receiver card.
- S1S1 - Secondary1 section Slave1 receiver card.
- S1S2 - Secondary1 section Slave2 receiver card.
- S1S3 - Secondary1 section Slave3 receiver card.
- S2M - Secondary2 section Master receiver card.
- S2S1 - Secondary2 section Slave1 receiver card.
- S2S2 - Secondary2 section Slave2 receiver card.
- S2S3 - Secondary2 section Slave3 receiver card.

Only populated cards are displayed in *Figure 17, Receiver Status Display*.

Figure 17: Receiver Status Display



The first column of the status display screen has a row for each of the following:

1. Clock/Status Card (CKSC)
2. System Clock (CLK)
3. Fans (FANS)

The second column of the status display screen provides a single OK/BAD flag for each of the receiver cards in each section that is in use and each of the above (CKSC, CLK and FANS).

The OK/BAD flag for each receiver card in each section that is in use is extracted from the receiver status word and the receiver error line.

If one or more errors exists for a receiver card, the third column of the status display screen toggles at 0.5 Hz between the software version on the receiver card and the receiver error on the receiver card, until the receiver is reset or the errors are corrected.

If no errors exist for a receiver card, the third column of the status display screen only displays the software version of the receiver card.

If one error exists for the clock/status system clock or cooling fans, the third column of the 15th row (clock/status system clock) or 16th row (cooling fans) of the status display screen displays the error message. If multiple errors exists in this case, the third column of the 15th row (clock/status system clock) or 16th row (cooling fans) cycles through at 0.5 Hz through each error.

If no errors exist for the clock/status system clock or cooling fans, the third column of the 15th row (clock/status system clock) or 16th row (cooling fans) of the status display is blank.

If one error exists for the clock/status card, the third column of the 14th row of the status display screen shall toggle at 0.5 Hz between the software version and the error on the clock/status card, until the clock/status card is reset or the errors are corrected. If multiple errors exist on the clock/status card, the third column of the 14th row of the status display screen shall cycle at 0.5 Hz through each clock/status card error and toggle the software version on the clock/status card, until the clock/status card is reset or the errors are corrected.

If no errors exist for the clock/status card, the third column of the 14th row of the status display shall only display the software version on the clock/status card.

If one cooling fan fails, the error message in the third column of the status display is FAN1 0 or FAN2 0 and the second column of the status display shows a BAD flag.

If both cooling fans fail, the error message in the third column on the status display is updated to NOFANS and the second column of the status display shows a BAD flag.

2.2.3.1 Receiver Error Display

If a fatal receiver error occurs, the entire status display screen backlight flashes at 0.5 Hz. Fatal errors are failures that put the receiver into an error state, see *Table 58* on page 130.

If non-fatal errors occur, the error is displayed in the third column of the status display screen. Non-fatal errors are failures that put the receiver into a warning state, see *Table 57* on page 129.

Error status is extracted from the receiver status word and the receiver error word. See also the *RXSECSTATUS* log on *page 106*.

Chapter 3 Operation

Before operating the GUST Receiver for the first time, ensure that you have followed the installation instructions in *Chapter 2*. From here on, it will be assumed that testing and operation of the GUST Receiver will be performed while using a personal computer (PC), which allows the greatest ease and versatility.

3.1 Pre-Start Check List

Before turning on power to the GUST Receiver, ensure that all of the following conditions have been met:

- The external frequency reference is properly installed, connected, powered-up, and stabilized.
- The antenna is properly installed, powered, and connected.
- The PC is properly connected using a serial cable, and its communications protocol has been configured to match that of the GUST Receiver.

Supply power to the GUST Receiver only after all of the above checks have been made. Note that the warm-up process may take several minutes, depending on ambient temperature. As discussed in *Section 2.2, Status Display* on page 24, the LCD status display will show three columns to indicate that the GUST Receiver has locked-on to the external frequency reference and is ready for operation.

3.2 Boot-up

The GUST Receiver's firmware resides in non-volatile memory. After supplying power to the unit, wait a few moments for self-boot, and the GUST Receiver will be ready for command input.

There are two initial start-up indicators to let you know that the GUST Receiver's main serial port is ready to communicate:

- The LCD status display on the GUST Receiver's front panel displays a NovAtel logo until the primary master card has successfully completed boot up and then displays a three column status indication to show that all internal systems are healthy. If the LCD does not display this, then the system should be considered unreliable. If this situation occurs, contact NovAtel Customer Service for assistance.
- Your PC will display the following prompt, indicating you are connected through the *COM1* port:

```
[COM1]
```

The receiver has 4 modes of operation including power-up mode:

- Power-Up
- Operational
- Fault
- Maintenance

The GUST Receiver is in power-up mode after receiving a reset signal. While in this mode, all sections of the receivers (for example, encoders, correlators, and so on) are disabled, except for the clock generators and microprocessor interface. During this mode, SW is transferred from Flash to RAM, the 32-bit CRC is verified on the SW load and the Initiated Built In Test (IBIT) is exercised to determine whether the receiver is usable. This mode ends when the functional blocks of the receiver have been enabled, initialized and the IBIT has been successfully executed.

The GUST Receiver is in operational mode following power-up mode. During operational mode, if a fault is discovered by the IBIT or by the Continuous Built In Test (CBIT), the GUST Receiver goes into fault mode. When the RESET command is used, the entire receiver resets and starts again in power-up mode.

The GUST Receiver is in maintenance mode when it is loading software. Maintenance mode can only be entered via the Power-up mode.

Once you are connected, commands can be entered as explained in *Section 3.3*.

3.3 Communicating with the GUST Receiver

Communicating with the GUST Receiver is a straightforward process and is accomplished by issuing commands at the [COM1] prompt displayed by the PC.

The commands and logs used by the GUST Receiver, as well as the fields within them, follow specific formats, which are discussed in *Chapter 4*. The valid commands, which are used to control the operation and data logging of the GUST Receiver, are specified in *Chapter 5*. *Chapter 6* provides details on the data logs that can be requested from the GUST Receiver. It is to your advantage to become thoroughly familiar with *Chapter 4* through *6* of this manual to ensure maximum utilization of the GUST Receiver's capabilities.

3.3.1 Configuring the Monitor and Time Ports

As mentioned previously, the *Monitor* (COM3) and *Time* (COM2) ports provide output only. However, although they cannot accept commands directly, their operation can be configured indirectly through the *Data* port (COM1), with the port to apply the settings to specified as a parameter within the command. See also *Section 2.1.2, Connecting Data Communications Equipment* on *Page 21*.

> The *Time* ports can only be modified from the Master section.

3.3.1.1 Configuring the Port Settings

The port settings, including baud rate, parity, and echo, can be configured for both the *Monitor* and *Time* ports. This is done through the *Data* port using the *COM* command, with the *port* parameter set to the appropriate value. For example, to configure the *Monitor* port for 115,200 bps, the following command would be sent.

```
[COM1]COM COM3 115200
```

See *Section 5.3.8, COM* on page 57 for more information on the *COM* command and the associated *port* parameter.

3.3.1.2 Configuring the Data Output on the Monitor Port

The *Monitor* port can be configured to output data independent of that output by the *Data* port. To do so, the *Monitor* port is specified as the output port when the *LOG* command is issued. For example, the following command configures the *Monitor* port to output the version log for the receiver section.

```
[COM1]LOG COM3 VERSION
```

See *Section 5.3.13, LOG* on page 64 for more information on the *LOG* command and the associated *port* parameter.

Chapter 4 Using Commands and Logs

Chapter 5 and *Chapter 6* provide the details of the commands and logs used to communicate with the GUST Receiver. The sections below give information on using these messages, including the formats they can take and the responses they may provide.

4.1 Entering Commands

The GUST Receiver is capable of responding to many different input commands. The commands offer a wide range of flexibility and can be used to control the following:

- The overall status of the GUST Receiver
- Input and output functions
- Configuration of a specific channel of the GUST Receiver

The following rules apply when entering commands and logs:

1. You must enter commands in *Abbreviated ASCII* format. The name of the command and its parameters are entered.
2. The commands are not case sensitive. For example:

   `FIX POSITION or fix position`

3. At the end of a command or command string, press `<Enter>`.

4.1.1 Command Settings on Power-Up

When the receiver is first powered up, or after an *FRESET* command, all commands revert to the factory default settings.

> The *FRESET* command causes all previously stored information saved to non-volatile memory to be erased. This command is detailed in *Section 5.3.12, FRESET* on page 63.

4.1.1.1 Factory Defaults

The factory defaults for each receiver section are:

```
CHANCONFIG 14GPS8GEO

COM COM1 9600 N 8 1 N OFF ON

COM COM2 9600 N 8 1 N OFF ON

COM COM3 230400 N 8 1 N OFF ON

DLLBW CA 0.2

DLLBW PY 0.2

DLLBW C5 0.2

PLLBW ca 3

PLLBW py 0.2

PLLBW C5 3

ECUTOFF 0

PULSEBLANKING L2 15

Pulseblanking L5 127

THREShold 36 20 36 CA GPS
```

```
Threshold 33 28 36 CA WAAS
Threshold 36 28 36 C5 WAAS
```

> The cooling fans are defaulted to operate at 50% capacity. The default tracking state of GEO satellites is IDLE and GPS satellites is Automatic.

4.1.2 Determining the Current Command Settings

To determine the current command settings of a receiver section, request an *RXCOMMANDS* log, which is described in *Section 6.3.14* on *Page 103*. This will provide a listing of all commands and their parameter settings. This log provides the most complete information on receiver configuration.

For some commands, including *COM* and *LOG*, multiple parameter sets can exist. For example, the *LOG* command can be entered with one set of parameters to enable logging of the *PSRPOS* log. It can then be entered again with a second set of parameters to configure the GUST Receiver to capture the *RANGE* log. When the *LOG* command is entered the second time, the new parameter set does not overwrite the first, it exists in addition to the first set.

4.1.3 Response Formats

The format of the response is dependent on the format of the input command. If the command is input as *Abbreviated ASCII*, the output will be *Abbreviated ASCII*.

The *Abbreviated ASCII* response consists of a leading < followed by the response string, like the example below:

```
<OK
```

4.1.4 Response Messages

The receiver is capable of outputting several responses for various conditions. Most of these responses are error messages to indicate when something is not correct. *Table 1, Response Messages* on page 31 outlines the various response strings and message IDs.

Table 1: Response Messages

String	ID	Meaning
OK	1	Command was received correctly.
NOT ENOUGH RESOURCES IN SYSTEM	3	The request has exceeded a limit (e.g. the maximum number of logs are being generated).
DATA PACKET DOESN'T VERIFY	4	Data packet is not verified
COMMAND FAILED ON RECEIVER	5	Command did not succeed in accomplishing requested task.
INVALID MESSAGE ID	6	The input message ID is not valid.
INVALID MESSAGE FIELD = *X*	7	Field *x* of the input message is not correct.
MESSAGE MISSING FIELD	9	A field is missing from the input message.
ARRAY SIZE FOR FIELD *X* EXCEEDS MAX	10	Field *x* contains more array elements than allowed.
PARAMETER *X* IS OUT OF RANGE	11	Field *x* of the input message is outside the acceptable limits.
TRIGGER *X* NOT VALID FOR THIS LOG	14	Input trigger *x* is not valid for this type of log.
NO VALID AUTH CODE FOR THAT MODEL	19	The model attached to the authcode is not valid.
CHANNEL IS INVALID	20	The channel number is not correct.
REQUESTED RATE IS INVALID	21	The requested rate is invalid.
CHANNELS LOCKED DUE TO ERROR	23	Channels are locked due to error.
INJECTED TIME INVALID	24	Injected time is invalid
COM PORT NOT SUPPORTED	25	The COM port is not supported.
MESSAGE IS INCORRECT	26	The message is invalid.
INVALID PRN	27	The PRN is invalid.
MESSAGE TIMED OUT	31	The message has timed out.
UNKNOWN COM PORT REQUESTED	33	Unknown COM port requested.
HEX STRING NOT FORMATTED CORRECTLY	34	Hex string not formatted correctly.
INVALID BAUD RATE	35	The baud rate is invalid.
MESSAGE IS INVALID FOR THIS MODEL	36	This message is invalid for this model of receiver.
COMMAND ONLY VALID IF IN NVM FAIL MODE	40	Command is only valid if NVM is in fail mode
INVALID OFFSET	41	The offset is invalid.
MAX NUMBER OF USER MESSAGES REACHED	78	The maximum number of user messages allowed has been reached.
GPS PRECISE TIME IS ALREADY KNOWN	84	GPS precise time is already known.

4.2 Logging Data

You can control how the GUST Receiver logs data by using the *LOG* command given on *page 64*. A field within this command allows you to specify which data log from *Chapter 6* to capture. There are some things to be noted however:

1. Each of the receiver sections in the GUST Receiver can handle 20 logs at a time. If you attempt to log more than 20 logs at a time, the receiver will respond with the error message:

   `Not enough resources in system`

2. Maximum flexibility for logging data is provided to you by these logs. You are cautioned, however, to recognize that each log requested requires additional CPU time and memory buffer space. Too many logs may result in lost data and degraded CPU performance. Receiver overload can be monitored using the *idle-time* field and the *buffer overrun* bits of the *Receiver Status* field, which are both found in any log header.

When a log is generated, it is sent to the serial port specified by the `port` parameter in the entered *LOG* command.

4.2.1 Log Types

The receiver is capable of generating many different logs. These logs are divided into the following three types:

- Synchronous — The data contained in *synchronous* logs is generated on a regular schedule.
- Asynchronous — The data in *asynchronous* logs is generated at irregular intervals. If these logs were collected on a regular schedule, there would be a delay in capturing the new data. The result is that changes to the data are not captured the moment they were available.
- Polled — The data in *polled* logs is generated only when requested. Typically the data in these logs, such as configuration settings, does not change.

4.2.2 Log Triggers

Each log can be configured for output when a certain condition, or *trigger*, is met. The possible triggers are:

- ONNEW — Output a new log whenever the message is updated (not necessarily changed).
- ONCHANGED — Output a new log whenever the message has changed.
- ONTIME — Output a new log at a specified interval (in seconds).
- ONCE — Output the current, existing message. Only a single log will be generated.

For each log type described in *Section 4.2.1, Log Types* on page 32, only certain triggers are valid. For example, the *ALLSQMIINFO* log is a *polled* log because it does not change. Therefore, it would not make sense to log this kind of data using the *ONCHANGED* or *ONNEW* triggers. *Table 2* outlines the valid triggers for each log type:

Table 2: Log Triggers for Each Log Type

Type	Recommended Triggers	Illegal Triggers
Synchronous	ONTIME	ONNEW ONCHANGED
Asynchronous	ONCHANGED	-
Polled	ONCE	ONNEW ONCHANGED

4.2.3 Specifying Log Formats

Logs can be requested in two formats, *ASCII* or *Binary,* described in *Section 4.3* on *Page 33*.

When entering the *LOG* command using *ASCII* format, the default format for the output log is *ASCII*. To generate logs in a different format, a suffix is added to the name of the message being requested. To request a log in *ASCII* format, add `A` to the end of the log as shown below.

```
LOG ALMANACA
```

To request a log in *Binary* format, `B` is added to the end of the log name.

```
LOG RANGEB ONTIME 30
```

When issuing *Binary* logs, the output message type is set in the *Message Type* field in the command header, as described in *Table 4, Binary Message Header Structure* on page 36.

4.3 Log Formats

The receiver handles all incoming and outgoing NovAtel logs using two different formats:

- ASCII
- Binary

This allows for some versatility in the way the GUST Receiver can be used.

4.3.1 ASCII

The *ASCII* format is readable by both you and a computer. The structures of all *ASCII* messages follow the general conventions as noted here:

1. Basic format:

   ```
   #HEADER_PARAMS;PARAM_1,PARAM_2, ..., PARAM_N* XXXXXXXX [CR][LF]
   ```

2. The lead code identifier for each record is '#'. This identifier is followed by the header parameters, as described in *Table 3*.
3. Each log is of variable length depending on the amount of data and field formats.
4. All data fields are delimited by a comma ',' with two exceptions. The first exception is the last header field which is followed by a ';' to denote the start of the data message. The other exception is the last data field, which is followed by a '*' to indicate end of message data.
5. Each log ends with a hexadecimal number preceded by an asterisk and followed by a line termination using the carriage return and line feed characters, e.g., `*1234ABCD[CR][LF]`. This value is a 32-bit cyclic redundancy check (CRC) of all bytes in the message, excluding the '#' identifier and the asterisk preceding the checksum digits. See *Section 4.4.2.6* on *Page 41* for the algorithm used to generate the CRC.
6. An ASCII string is one field and is surrounded by double quotation marks, e.g. `"ASCII string"`. If separators are surrounded by quotation marks then the string is still one field and the separator will be ignored, e.g. `"xxx,xxx"` is one field. Double quotation marks within a string are not allowed.
7. If the receiver detects an error parsing an input message, it will return an error response message. Please see *Section 4.1.4, Response Messages* on page 30 for a list of response messages from the receiver.

The *ASCII* message header is formatted as follows:

Table 3: ASCII Message Header Structure

Field	Field Name	Field Type	Description	Ignored on Input
1	sync	Char	Sync character. The *ASCII* message is always preceded by a single '#' symbol.	N
2	message	Char	The ASCII name of the message. The names of logs are given in *Table 31, Log Summary* on page 80.	N
3	port	Char	The name of the port from which the log was generated. See *Table 6, Serial Port Identifier Values* on page 38.	Y
4	Reserved	ULong	Reserved for internal use	N
5	idle time	Float	Idle time (%)	Y
6	time status	Enum	The quality of the GPS time, as described in *Section 4.4.2.5, GPS Time Status* on page 40.	Y
7	week	ULong	GPS week number	Y
8	seconds	GPSec	Seconds from the beginning of the GPS week accurate to the millisecond level	Y
9	receiver status	ULong	An eight digit hexadecimal number representing the status of various hardware and software components of the receiver. This number is described in *Table 46, Receiver Status* on page 109.	Y
10	Reserved	ULong	Reserved for internal use	Y
11	Reserved	ULong	Reserved for internal use	Y
12	;	Char	The ';' character indicates the end of the header	N

Example ASCII Format Log:

```
#PSRPOSA,COM1,0,58.0,FINE,1027,324231.000,00000000,FC91,0;
SOL_COMPUTED,SINGLE,51.11615533807,114.03850611829,1010.452,
-16.271,61,19.50677306162,14.52973740177,39.584,"0",0.0,60.000,
9,8,8,1,0,0,0,0*DE152DF7[CR][LF]
```

4.3.2 Binary

Binary messages are meant strictly as a machine readable format. They are also ideal for applications where the amount of data being transmitted is fairly high. Because of the inherent compactness of binary as opposed to ASCII data, the messages are much smaller. This allows a larger amount of data to be transmitted and received by the receiver's communication ports. The structure of all *Binary* format messages follows the general conventions as noted here:

1. Basic format:

   Header — 3 sync bytes plus 25 bytes of header information. The header length is variable as fields may be appended in the future. Always check the header length.

   Parameters — Variable length binary data

   CRC — 4 bytes

2. The 3 Sync bytes are always:

Byte	Hex	Decimal
First	AA	170
Second	44	68
Third	12	18

3. The CRC is a 32-bit cyclic redundancy check performed on all data including the header. See *Section 4.4.2.6, 32-Bit CRC* on page 41 for the CRC algorithm.
4. The header is in the format shown in *Table 4, Binary Message Header Structure* on page 36.

Table 4: Binary Message Header Structure

Field	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignored on Input
1	sync	Char	Hexadecimal 0xAA	1	0	N
2	sync	Char	Hexadecimal 0x44	1	1	N
3	sync	Char	Hexadecimal 0x12	1	2	N
4	header length	UChar	Length of the header	1	3	N
5	message ID	UShort	Message ID. The message IDs for logs are given in *Table 31, Log Summary* on page 80.	2	4	N
6	message type	Char	Message type indicator, as explained in *Section 4.2.1, Log Types* on page 32.	1	6	N
7	port address	Char	The port from which the log was generated. See *Table 6, Serial Port Identifier Values* on page 38.	1	7	N
8	message length	UShort	The length in bytes of the body of the message. This does not include the header nor the CRC.	2	8	N
9	sequence	UShort	For multiple related logs. A number that counts down from N-1 to 0 where N is the number of related logs and 0 means it is the last one of the set. Most logs only come out one at a time in which case this number is 0.	2	10	N
10	idle time	Char	The percentage of time that the processor is idle in the last second. Take the time (0 - 200) and divide by two to give the percentage of time (0 - 100%).	1	12	Y
11	time status	Enum	The quality of the GPS time, as described in *Section 4.4.2.5, GPS Time Status* on page 40.	1 [a]	13	N [b]
12	week	UShort	GPS week number	2	14	N [b]
13	milli-seconds	GPSec	Milliseconds from the beginning of the GPS week	4	16	N [b]
14	receiver status	ULong	32 bits representing the status of various hardware and software components of the receiver. This number is described in *Table 46, Receiver Status* on *Page 109*.	4	20	Y
15	Reserved	UShort	Reserved for internal use	2	24	Y
16	Reserved	UShort	Reserved for internal use	2	26	Y

a. This ENUM is not 4 bytes long but, as indicated in the table, is only 1 byte.

b. These time fields are ignored if Field #11, Time Status, is invalid. In this case the current receiver time is used. The recommended values for the three time fields are 0, 0, 0.

4.4 Fields

The commands and logs for the GUST Receiver use a variety of field types to convey data. The following sections provide information on the types of fields used and some of the more commonly-used fields.

4.4.1 Field Types

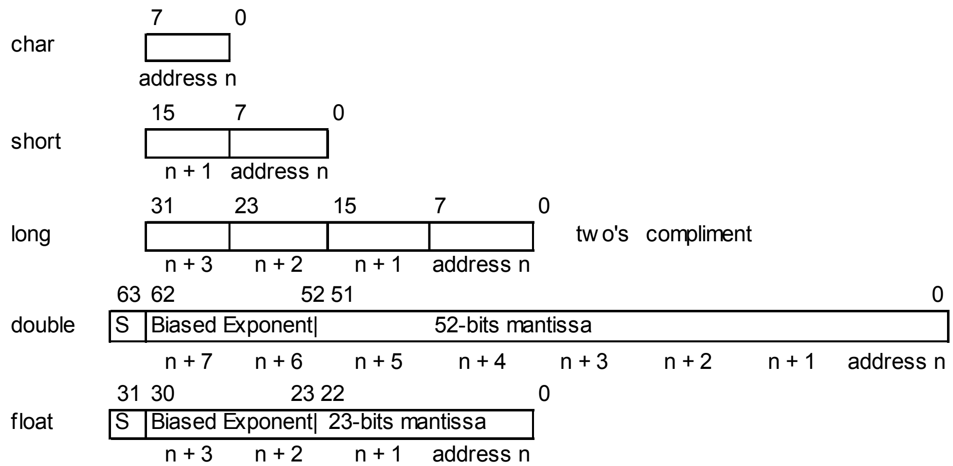
The following table describes the field types used in the commands and logs.

Table 5: Field Types

Type	Binary Size (Bytes)	Description
Char	1	An 8-bit signed integer in the range -128 to +127. This integer value may be the ASCII code corresponding to the specified character. In *ASCII* or *Abbreviated ASCII* this comes out as an actual character.
UChar	1	An 8-bit unsigned integer. Values are in the range from +0 to +255. In *ASCII* or *Abbreviated ASCII* this comes out as a number.
Short	2	A 16-bit signed integer in the range -32768 to +32767.
UShort	2	A 16-bit unsigned integer in the range +0 to +65535.
Long	4	A 32-bit signed integer in the range -2147483648 to +2147483647.
ULong	4	A 32-bit unsigned integer in the range +0 to +4294967295.
Double	8	64 bits, with 1 for the sign, 11 for the exponent, and 52 for the mantissa. Its range is ±1.7E308 with at least 15 digits of precision. This is IEEE 754.
Float	4	32 bits, with 1 for the sign, 8 for the exponent, and 23 for the mantissa. Its range is ±3.4E38 with at least 7 digits of precision. This is IEEE 754.
Enum	4	A 4-byte enumerated type beginning at zero (an unsigned long). In *Binary*, the enumerated value is output. In *ASCII* or *Abbreviated ASCII*, the enumeration label is spelled out.
GPSec	4	Two separate formats that depend on whether the output is requested in *Binary* or an *ASCII* format. For *Binary* the output is in milliseconds and is a **long** type. For *ASCII* the output is in seconds and is a **float** type.
Hex	n	A packed, fixed length (n) array of bytes in *Binary* but in *ASCII* or *Abbreviated ASCII* is converted into 2 character hexadecimal pairs.
String	n	A variable length array of bytes that is null-terminated in the *Binary* case. The maximum byte length for the field is shown in the row in the log or command table.

Figure 18, Byte Arrangements shows the arrangement of bytes within each field type when used by IBM PC computers. All data sent to or from the GUST Receiver, however, is read least significant bit (LSB) first, opposite to what is shown in *Figure 18, Byte Arrangements*. Data is then stored in the GUST Receiver LSB first. For example, in *char* type data, the LSB is bit 0 and the most significant bit (MSB) is bit 7.

Figure 18: Byte Arrangements



4.4.2 Commonly-Used Fields

Some of the more commonly-used fields are discussed in this section.

4.4.2.1 Serial Port Identifiers

The values used to indicate serial ports are given below.

Table 6: Serial Port Identifier Values

ASCII	Binary	Description
COM1	32	Represents the *Data* port.
COM2	64	Represents the *Time* port.[a]
COM3	96	Represents the *Monitor* port.[b]

a. As only the port settings for the *Time* port can be configured, the only command this value is valid for is the *COM* command. The *Time* port is only controllable from the Master section.

b. The only commands this value is valid for are *COM*, *LOG*, *UNLOG*, and *UNLOGALL*, as this port is an output only.

4.4.2.2 Message Type Indicator

The *Message Type Indicator* is a byte given in numerous binary format messages and all binary headers. It follows the format in *Table 7, Message Type Byte Format* on page 39.

Table 7: Message Type Byte Format

Bit	Description
0-4	Reserved
5-6	Message format, where 00 = *Binary* 01 = *ASCII* 10 = *Abbreviated ASCII*, NMEA 11 = Reserved
7	Response indicator, where 0 = original message 1 = response message. (See *Section 4.2, Logging Data* on page 32 for more information on logging data.)

4.4.2.3 Message Time Stamps

All NovAtel format messages generated by the GUST Receiver have a GPS time stamp in their header. GPS time is referenced to UTC with zero point defined as midnight on the night of January 5, 1980. The time stamp consists of the number of weeks since that zero point, adjusted for rollover, (0 to 1023) and the number of seconds since the last week number change (0 to 603,799). GPS time differs from UTC time since leap seconds are occasionally inserted into UTC but GPS time is continuous. In addition a small error (less than 1 microsecond) can exist in synchronization between UTC and GPS time. The *TIME* log reports both GPS and UTC time and the offset between the two.

The data in synchronous logs, like the *RANGE* log, are based on a periodic measurement of satellite pseudoranges. The time stamp on these logs is the receiver estimate of GPS time at the time of the measurement. When setting time in external equipment, a small synchronous log with a high baud rate will be accurate to a fraction of a second. A synchronous log with trigger `ONTIME 1` can be used in conjunction with the 1 PPS signal to provide relative accuracy better than 250 ns.

Other log types (asynchronous and polled) are triggered by an external event and the time in the header may not be synchronized to the current GPS time. Logs that contain satellite broadcast data have the transmit time of their last subframe in the header. In the header of differential time matched logs, the time of the matched reference and local observation that they are based on is given. Logs triggered by a mark event have the estimated GPS time of the mark event in their header. The header of a polled log, like *VERSION*, gives the approximate GPS time when its data was generated.

4.4.2.4 Locktime

The maximum allowable satellite locktime is 65, 535 seconds. GEO satellites are stationary and therefore, the possibility exists for a locktime longer than the maximum.

If the locktime is larger than 65, 535 s, the GEO locktime rolls back to 32768 s.

Locktime is reported in the RANGE and TRACKSTAT logs, see *page 96* and *page 116* respectively.

4.4.2.5 GPS Time Status

All reported receiver times are subject to a qualifying time status. This status gives you an indication of how well a time is known, as shown in *Table 8, GPS Time Status*.

Table 8: GPS Time Status

GPS Time Status		Description
ASCII	Binary	
UNKNOWN	20	Time validity is unknown.
APPROXIMATE	60	Time is set approximately.
COARSEADJUSTING	80	Time is approaching coarse precision.
COARSE	100	This time is valid to coarse precision.
FREEWHEELING	130	Position is lost, and the range bias cannot be calculated.
FINEADJUSTING	140	Time is adjusting to fine precision.
FINE	160	Time has fine precision.
SATTIME	200	Time from satellite. This is only used in logs containing satellite data such as ephemeris and almanac.

There are several distinct states that the GUST Receiver will go through:

1. UNKNOWN
2. COARSE
3. FREEWHEELING
4. FINE

On start up, and before any satellites are being tracked, the GUST Receiver can not possibly know the current time. As such, the receiver time starts counting at GPS week 0 and second 0.0. The time status flag is set to *UNKNOWN*.

If time is input to the receiver using the *SETAPPROXTIME* command from *page 72*, the time status will be *APPROXIMATE*.

After the first ephemeris is decoded, the receiver time is set to a resolution of ±10 milliseconds. This state is qualified by the *COARSE* time status flag.

Once a position is known and range biases are being calculated, the internal clock model will begin modelling the position range biases and the receiver clock offset.

Modelling will continue until the model is a good estimation of the actual receiver clock behavior. At this time, the receiver time will again be adjusted, this time to an accuracy of ±1 microsecond. This state is qualified by the *FINE* time status flag.

The time status flag will never improve on *FINE*. The time will only be adjusted again to within ±1 microsecond if the range bias gets larger than ±250 milliseconds.

If for some reason position is lost and the range bias cannot be calculated, the time status will be degraded to *FREEWHEELING*.

4.4.2.6 32-Bit CRC

The *ASCII* and *Binary* message formats all contain a 32-bit Cyclic Redundancy Check (CRC) for data verification. This allows you to ensure that the data received (or transmitted) is valid with a high level of certainty. This CRC can be generated using the following C algorithm:

```
#define CRC32_POLYNOMIAL   0xEDB88320L

/* --------------------------------------------------------------------------
Calculate a CRC value to be used by CRC calculation functions.
-------------------------------------------------------------------------- */
unsigned long CRC32Value(int i)
{
   int j;
   unsigned long ulCRC;

   ulCRC = i;
   for ( j = 8 ; j > 0; j-- )
   {
      if ( ulCRC & 1 )
         ulCRC = ( ulCRC >> 1 ) ^ CRC32_POLYNOMIAL;
      else
         ulCRC >>= 1;
   }
   return ulCRC;
}

/* --------------------------------------------------------------------------
Calculates the CRC-32 of a block of data all at once
-------------------------------------------------------------------------- */
unsigned long CalculateBlockCRC32(
   unsigned long ulCount,     /* Number of bytes in the data block */
   unsigned char *ucBuffer ) /* Data block */
{
   unsigned long ulTemp1;
   unsigned long ulTemp2;
   unsigned long ulCRC = 0;

   while ( ulCount-- != 0 )
   {
      ulTemp1 = ( ulCRC >> 8 ) & 0x00FFFFFFL;
      ulTemp2 = CRC32Value( ((int) ulCRC ^ *ucBuffer++ ) & 0xff );
      ulCRC = ulTemp1 ^ ulTemp2;
   }
   return( ulCRC );
}
```

Chapter 5 Commands

5.1 Functional Listing of Commands

Table 9 lists the commands by function. See *Section 5.3, Command Reference* on page 44 for a more detailed description of each individual command.

Table 9: Commands By Function

Command	Description
COMMUNICATIONS, CONTROL AND STATUS	
Command	**Description**
COM	Set serial port configuration
LOG	Request a log
UNLOG	Remove a specified log from logging control
UNLOGALL	Remove all logs from logging control
GENERAL RECEIVER CONTROL	
Command	**Description**
AGCMODE	Control Automatic Gain Control (AGC) functionality
DLLBW	Configure receiver's DLL filter bandwidth
PLLBW	Configure receiver's phase-lock-loop bandwidths
RESET	Perform a hardware reset
FRESET	Reset receiver to factory default
POSITION CONTROL	
Command	**Description**
FIX	Constrain receiver position
SATELLITE TRACKING AND CHANNEL CONTROL	
Command	**Description**
ALMANAC	Inject almanac data into the receiver
ASSIGN	Assign individual satellite channel
ASSIGNALL	Assign all satellite channels
CARRIERFREQOFFSET	Change the expected carrier frequency
CHANCONFIG	Set receiver channel tracking configuration
CODEFREQOFFSET	Change the expected code frequency
ECUTOFF	Set satellite elevation cut-off angle
PLLTHRESHOLD	Control P(Y) code signal thresholds
PULSEBLANKING	Enables or disables digital pulse blanking for L2 or L5 signals
SETSATELLITE	Set the health of a satellite PRN

Continued on the following page

SATELLITE TRACKING AND CHANNEL CONTROL	
Command	**Description**
THRESHOLD	Control signal thresholds for acquisition, tracking and cross correlation
UNASSIGN	Unassign a previously *ASSIGN*ed channel
UNASSIGNALL	Unassign all previously *ASSIGN*ed channels
CLOCK INFORMATION, STATUS, AND TIME	
Command	**Description**
SETAPPROXTIME	Set an approximate time

5.2 Command Summary

Table 10: Command Summary

Command Name	Message ID	Description	Syntax
AGCMODE	229	Control Automatic Gain Control (AGC)	**agcmode** frequency mode pulsewidth loadvalue
ALMANAC	73	Inject almanac data into the receiver	See *Section 5.3.2, ALMANAC* on page 47.
ASSIGN	27	Assign individual satellite channel to a PRN	**assign** *channel state prn Doppler window*
ASSIGNALL	28	Assign all satellite channels to a PRN	**assignall** *system state prn Doppler window*
CARRIERFREQOFFSET	626	Change the expected carrier frequency	**carrierfreqoffset** *channel offset*
CHANCONFIG	501	Set receiver channel tracking configuration	**chanconfig** *config*
CODEFREQOFFSET	627	Change the expected code frequency	**codefreqoffset** *channel offset*
COM	4	Serial port configuration control	**com** *port bps parity databits stopbits handshake echo break*
DLLBW	517	Configure receiver's DLL filter bandwidth	**dllbw** *codetype bw*
ECUTOFF	50	Set satellite elevation cutoffs	**ecutoff** *angle*
FIX	44	Fix height, position or velocity	**fix** *type param1 param2 param3*
FRESET	20	Clear data stored in non-volatile memory. Followed by a receiver reset.	freset
LOG	1	Request logs from receiver	**log** *port message trigger period offset hold*

Continued on the following page

PLLBW	518	Configure receiver's phase-lock-loop bw	**pllbw** *codetype bw*
PLLTHRESHOLD	659	Controls signal acquisition and steady-state-lock threshold for the P(Y) code.	**pllthreshold** *lock acqui codetype*
PULSEBLANKING	519	Enables or disables digital pulse blanking for L2 or L5 signals.	**pulseblanking** *frequency switch*
RESET	18	Perform a hardware reset	**reset** *delay*
SETAPPROXTIME	102	Set an approximate GPS time	**setapproxtime** *week sec*
SETSATELLITE	425	Set the health of a satellite PRN	**setsatellite** *prn health*
THRESHOLD	449	Control signal thresholds for acquisition, tracking and cross correlation	**threshold** *acqui lock crosscorr codetype system [sigchan]*
UNASSIGN	29	Unassign a previously *ASSIGN*ed channel	**unassign** *channel*
UNASSIGNALL	30	Unassign all previously *ASSIGN*ed channels	**unassignall** *system*
UNLOG	36	Remove log from logging control	**unlog** *port datatype*
UNLOGALL	38	Remove all logs from logging control	**unlogall** *port*

5.3 Command Reference

> All syntax strings and command examples given in this section are in the *Abbreviated ASCII* format, unless otherwise indicated. The tables provided show the fields necessary for all formats unless otherwise noted.

> As mentioned in *Section 4.1, Entering Commands* on page 29, all command strings must be followed by `<Enter>`.

5.3.1 AGCMODE

> This command can fundamentally change the way that the receiver operates. Do not alter the default settings unless you are confident that you understand the consequences.

This command controls the GUST Receiver's Automatic Gain Control (AGC) mechanism, which has two primary functions:

- To perform the analog-to-digital conversions in the receiver's front end
- Mitigate jamming

> When the AGC mode is disabled, the *Receiver Status* word in the message header, discussed in *Table 46, Receiver Status* on page 109, will report the AGC as *GOOD* as long as the control metric used in the feedback loop is within 7.5% of the set point.

Table 11: Frequency Values for AGCMODE Command

ASCII	Description
L1	GPS and GEO L1 channels only
L2	GPS and GEO L2 channels only
L5	GEO L5 channels only

Table 12: AGC Mode Values

ASCII	Description
AUTO	Specifies that the default pulse width and load values should be used.
MANUAL	Specifies that the values specified in the *pulsewidth* and *loadvalue* fields should be used.

Syntax: **Message ID: 229**

```
AGCMODE  FREQUENCY  MODE  [ PULSEWIDTH  LOADVALUE ]
```

Field	Field Name	Valid Values ASCII	Valid Values Binary	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.				H	0
2	frequency	See *Table 11, Frequency Values for AGCMODE Command* on page 45.		Specifies which signal type to apply the command to.	Enum	4	H
3	mode	See *Table 12, AGC Mode Values* on page 45.		Specifies whether to use the default or custom values for the pulse width and load value.	Enum	4	H+4

Field	Field Name	Valid Values ASCII	Valid Values Binary	Description	Format	Binary Bytes	Binary Offset
4	pulsewidth	35 to 262144		Pulse width. A value is only required when the *mode* field is set to MANUAL.	Float	4	H+8
5	loadvalue	35 to 262144		Modulus load value. A value is only required when the *mode* field is set to MANUAL.	Float	4	H+12

Example:

```
AGCMODE L1 MANUAL 40 50
```

5.3.2 ALMANAC

This command provides a means of injecting almanac data into the receiver. The injected almanac is overwritten when a new almanac is received from the satellite constellation.

The best way to prepare an almanac for injection is to connect to the receiver, let the receiver collect an almanac, and capture the almanac using the almanac log (either ALMANACA or ALMANACB, refer to page 90). Use the collected almanac to inject for future usage.

> LOG ALMANAC (abbreviated ASCII) will not work.

The full ALMANACA or ALMANACB, including header and CRC must be injected into the receiver. Refer to *Section 4.3.1, ASCII* on page 33 or *Section 4.3.2, Binary* on page 35 for header details. Refer to *Section 4.4.2.6, 32-Bit CRC* on page 41 for CRC computation.

> The syntax shown below is for ALMANACA. For ALMANACB, there are no commas (,) or asterisks (*) separating the data.

Syntax: **Message ID: 73**

#ALMANACA, | HEADER, | #MSG,

| PRN, | WEEK, | SECONDS, | ECC, | $\mathring{\omega}$, | ω_0, | ω, | MO, | A_{FO}, | A_{F1}, | N, | A, |

| INCLANGLE, | SVCONFIG, | HEALTHPRN, | HEALTHALM, | ANTISPOOF, |

...

| PRN, | WEEK, | SECONDS, | ECC, | $\mathring{\omega}$, | ω_0, | ω, | MO, | A_{FO}, | A_{F1}, | N, | A, |

| INCLANGLE, | SVCONFIG, | HEALTHPRN, | HEALTHALM, | ANTISPOOF, | *CRC |

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1* on *Page 29*.			H	0
2	# msg	Any valid long value	The number of satellite PRN almanac data sets to follow.	Long	4	H
3	PRN	0 to 37	Satellite PRN number for current message, dimensionless	ULong	4	H+4
4	week	0 to 1023	Almanac reference week (GPS week number)	ULong	4	H+8
5	seconds	0 to 604799	Almanac reference time, seconds into the week	Double	8	H+12
6	ecc	Any valid double value	Eccentricity, dimensionless	Double	8	H+20
7	$\mathring{\omega}$	Any valid double value	Rate of right ascension, radians/second	Double	8	H+28
8	ω_0	Any valid double value	Right ascension, radians	Double	8	H+36

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
9	ω	Any valid double value	Argument of perigee, radians	Double	8	H+44
10	M_o	Any valid double value	Mean anomaly of reference time, radians	Double	8	H+52
11	a_{fo}	Any valid double value	Clock aging parameter, seconds	Double	8	H+60
12	a_{f1}	Any valid double value	Clock aging parameter, seconds/second	Double	8	H+68
13	N	Any valid double value	Corrected mean motion, radians/second	Double	8	H+76
14	A	Any valid double value	Semi-major axis, metres	Double	8	H+84
15	inclangle	Any valid double value	Angle of inclination relative to 0.3 π, radians	Double	8	H+92
16	SV config	Any valid ulong value	Satellite configuration	ULong	4	H+100
17	health-prn	Any valid ulong value	SV health from subframe 4 or 5	ULong	4	H+104
18	health-alm	Any valid ulong value	SV health from almanac	ULong	4	H+108
19	antispoof	See *Table 13, Antispoofing Flag Values* on page 49	Flag for antispoofing	Enum	4	H+112
20...	Next PRN data set, offset = H+4 + (# previous msgs x 112)					
21	32-bit CRC (*ASCII* and *Binary* only)			Hex	4	H+4+ (112 x #msg)

Example:

```
#ALMANACA,COM1,0,41.0,SATTIME,345,219144.000,00E40008,0000,33331;27,1,345,
466944.0,0.000000,0.00000000,1.8645967E+00,0.00000000,-2.85737253E-01,
0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,
TRUE,2,345,466944.0,0.000000,0.00000000,1.8645967E+00,0.00000000,2.30880212E
-01,0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,
TRUE,3,345,466944.0,0.000000,0.00000000,1.8645967E+00,0.00000000,2.1455066E+
00,0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,
TRUE,4,345,466944.0,0.000000,0.00000000,1.8645967E+00,0.00000000,
-2.1584754E+00,0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,
1.74550236E-02,1,0,0,TRUE,5,345,466944.0,0.000000,0.00000000,2.9117940E+00,
0.00000000,7.44006898E-01,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,6,345,466944.0,0.000000,0.00000000,
2.9117940E+00,0.00000000,2.5277337E+00,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,7,345,466944.0,0.000000,0.00000000,
2.9117940E+00,0.00000000,3.1054374E+00,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,8,345,466944.0,0.000000,0.00000000,
2.9117940E+00,0.00000000,-1.4516173E+00,0.00000000,0.00000000,1.45851649E-
```

```
04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,9,345,466944.0,0.000000,
0.00000000,-2.3241936E+00,0.00000000,1.3775616E+00,0.00000000,0.00000000,
1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,10,345,466944.0,
0.000000,0.00000000,-2.3241936E+00,0.00000000,-2.7641049E+00,0.00000000,
0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,11,345,
466944.0,0.000000,0.00000000,-2.3241936E+00,0.00000000,-9.10565153E-01,
0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,
TRUE,12,345,466944.0,0.000000,0.00000000,-2.3241936E+00,0.00000000,
-4.11400839E-01,0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,
1.74550236E-02,1,0,0,TRUE,13,345,466944.0,0.000000,0.00000000,
-1.2769959E+00,0.00000000,1.8330924E+00,0.00000000,0.00000000,1.45851649E-
04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,14,345,466944.0,0.000000,
0.00000000,-1.2769959E+00,0.00000000,2.3322567E+00,0.00000000,0.00000000,
1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,15,345,466944.0,
0.000000,0.00000000,-1.2769959E+00,0.00000000,-2.0991344E+00,0.00000000,
0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,16,345,
466944.0,0.000000,0.00000000,-1.2769959E+00,0.00000000,4.41300357E-02,
0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,
TRUE,17,345,466944.0,0.000000,0.00000000,-2.29798636E-01,0.00000000,
2.8733089E+00,0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,
1.74550236E-02,1,0,0,TRUE,18,345,466944.0,0.000000,0.00000000,-2.29798636E-
01,0.00000000,-1.6854914E+00,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,19,345,466944.0,0.000000,0.00000000,
-2.29798636E-01,0.00000000,-1.1060421E+00,0.00000000,0.00000000,1.45851649E-
04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,20,345,466944.0,0.000000,
0.00000000,-2.29798636E-01,0.00000000,6.77684699E-01,0.00000000,0.00000000,
1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,21,345,466944.0,
0.000000,0.00000000,8.17399040E-01,0.00000000,-1.3835492E+00,0.00000000,
0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE,22,345,
466944.0,0.000000,0.00000000,8.17399040E-01,0.00000000,-7.23814977E-01,
0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,1.74550236E-02,1,0,0,
TRUE,23,345,466944.0,0.000000,0.00000000,8.17399040E-01,0.00000000,
1.1908114E+00,0.00000000,0.00000000,1.45851649E-04,2.6560631E+07,
1.74550236E-02,1,0,0,TRUE,24,345,466944.0,0.000000,0.00000000,8.17399040E-
01,0.00000000,1.7056836E+00,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,25,345,466944.0,0.000000,0.00000000,
2.0428658E+00,0.00000000,2.8654548E+00,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,26,345,466944.0,0.000000,0.00000000,
2.0428658E+00,0.00000000,3.0618043E+00,0.00000000,0.00000000,1.45851649E-04,
2.6560631E+07,1.74550236E-02,1,0,0,TRUE,27,345,466944.0,0.000000,0.00000000,
2.0428658E+00,0.00000000,-3.0250315E+00,0.00000000,0.00000000,1.45851649E-
04,2.6560631E+07,1.74550236E-02,1,0,0,TRUE*BA66F6E6
```

Table 13: Antispoofing Flag Values

ASCII	Description
FALSE	Antispoofing is disabled.
TRUE	Antispoofing is enabled.

5.3.3 ASSIGN

> The *ASSIGN* command should only be used by advanced users of GPS.

This command may be used to aid in the initial acquisition of a satellite by allowing you to override the automatic satellite/channel assignment and reacquisition processes with manual instructions. The command specifies that the selected tracking channel should search for a specified satellite at a specified Doppler frequency within a specified Doppler window.

The instruction will remain in effect for the specified SV channel and PRN, even if the assigned satellite subsequently sets. If the satellite Doppler offset of the assigned SV channel exceeds that specified by the *window* parameter of the *ASSIGN* command, the satellite may never be acquired or re-acquired. If a PRN has been assigned to a channel and the channel is currently tracking that satellite, when the channel is set to *AUTO* tracking, the channel will immediately idle and return to automatic mode.

To cancel the effects of *ASSIGN*, you must issue one of the following:

- The *ASSIGN* command with the *state* set to *AUTO*
- The *UNASSIGN* command
- The *UNASSIGNALL* command.

These will return SV channel control to the automatic search engine immediately.

> 1. Assigning a PRN to an SV channel does not remove the PRN from the search space of the automatic searcher; only the SV channel is removed (i.e. the searcher may search and lock onto this PRN on another channel). The automatic searcher only searches for PRNs 0 to 37 for GPS channels.
> 2. Assigning an SV channel will set the *Channel Assignment* bit to 1 for forced assignment in the *Channel Tracking Status* field of the *RANGE* log. The *RANGE* log is specified in *Section 6.3.10, RANGE Satellite Range Information* on page 96.
> 3. The doppler field does not apply to L2 P(Y) channels.

Syntax: **Message ID: 27**

```
ASSIGN CHANNEL [ STATE ] [ PRN [ DOPPLER WINDOW ] ]
```


Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	channel	0 to 21	SV channel number to apply the command to. 0 is the first SV channel and 20 is the last: 14GPS8GEO: 0-13 for GPS and 14-20 for GEO GEOTEST: 0-8 for GEO 14GPS8GEONAR: 0-13 for GPS and 14-21 for GEO GEOTESTNAR: 0-9 for GEO 14GPS7GEONAR: 0-13 for GPS and 14-20 for GEO 9GEOTESTNAR: 0-8 for GEO See also *Section 5.3.6, CHANCONFIG* on page 55 and *Table 64, Channel Configurations* on page 136.	ULong	4	H
3	state	See *Table 14, Channel State Values* on page 52.	Optional desired SV channel state. If a value is not given, the default of *ACTIVE* is used.	Enum	4	H+4
4	prn	0 to 37, 120 to 138	Optional satellite PRN code from 0 -37 for GPS channels and 120-138 for GEO channels. A value is required only when the *state* field is set to *ACTIVE*.	Long	4	H+8
5	doppler	-100 000 to 100 000	Optional current L1 Doppler offset of the satellite specified in the *prn* field in Hz. *NOTE*: Satellite motion, receiver antenna motion, and receiver clock frequency error must be included in the calculation of Doppler frequency.	Long	4	H+12
6	window	0 to 10 000	Error or uncertainty in the L1 Doppler estimate given in the *doppler* field, in Hz. *NOTE*: This is a ± value. For example, enter 500 for ± 500 Hz.	ULong	4	H+16

Examples:

```
ASSIGN 0 ACTIVE 29 0 2000

ASSIGN 15 120 -250 0

ASSIGN 11 28 -250 0
```

The first example sets the first SV channel to acquire satellite PRN 29 in a range from -2000 Hz to +2000 Hz until the satellite signal has been detected. SV channel 11 is set to acquire satellite PRN 28 at an offset of -250 Hz only in the third example.

Table 14: Channel State Values

ASCII	Description
IDLE	Set the SV channel to not track any satellites.
ACTIVE	Set the SV channel active.
AUTO	Tell the receiver to automatically assign PRN codes to channels.

5.3.4 *ASSIGNALL*

> The *ASSIGNALL* command should only be used by advanced users of GPS.

This command allows you to override the automatic satellite/channel assignment and reacquisition processes for all channels with manual instructions. This command works the same way as *ASSIGN* except that it affects all SV channels.

Syntax: **Message ID: 28**

```
ASSIGNALL [ SYSTEM ] [ STATE ] [ PRN [ DOPPLER WINDOW ] ]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	system	See *Table 15, Channel System Values* on page 53.	Optional system that SV channel is tracking. If a value is not given, the default of *GPS* is used.	Enum	4	H
3	state	See *Table 14, Channel State Values* on page 52.	Optional desired SV channel state. If a value is not given, the default of *ACTIVE* is used.	Enum	4	H+4
4	prn	0 to 37, 120-138	Optional satellite PRN code from 0-37 for GPS channels and 120-138 for GEO channels. A value is required only when the *state* field is set to *ACTIVE*.	Long	4	H+8
5	doppler	-100 000 to 100 000	Optional current Doppler offset of the satellite specified in the *prn* field in Hz. *NOTE*: Satellite motion, receiver antenna motion, and receiver clock frequency error must be included in the calculation of Doppler frequency.	Long	4	H+12
6	window	0 to 10 000	Error or uncertainty in the Doppler estimate given in the *doppler* field, in Hz. *NOTE*: This is a ± value. For example, enter 500 for ± 500 Hz.	ULong	4	H+16

Example:

```
ASSIGNALL GPS ACTIVE 29 0 2000
```

Table 15: Channel System Values

ASCII	Description
GPS	GPS SV channels
ALL	All channels
WAAS	GEO SV channels

5.3.5 CARRIERFREQOFFSET

This command is used to change the expected carrier frequency away from the nominal values of 1575.42, 1227.6 or 1176.45 MHz. This command was implemented to accommodate a specific purpose and should not be used if the receiver is tracking GPS signals.

The command currently changes the configuration of all the signal channels that share the same RF data as the channel specified. This format was selected to provide possible future enhancements to the receiver software without altering the command interface.

Syntax: **Message ID: 626**

```
CARRIERFREQOFFSET  SIGCHAN  OFFSET
```

Field	Field Name	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.				H	0
2	sigchan	0-39		Specifies the signal channel to change, see *Table 64, Channel Configurations* on page 136	Ulong	4	H
3	offset	-10000 Hz to +10000 Hz		Specifies the change in the nominal carrier frequency	Ulong	4	H+4

Example:

```
CARRIERFREQOFFSET 0 -1000
```

5.3.6 CHANCONFIG

This command changes the channel configuration of the receiver. This will effect the number of channels tracking GPS signals and the number of channels tracking GEO signals. Entering this command will reset the receiver, causing the receiver to initiate a cold-start bootup and reset all data stored in NVM to factory default values (except for the channel configuration). The default configuration is `14GPS8GEO`.

Syntax: **Message ID: 501**

```
CHANCONFIG CONFIG
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	config	See *Table 16* below.	Specifies the channel configuration for the receiver to use. Refer to *Table 64, Channel Configurations* on page 136.	Enum	4	H

Example:

```
CHANCONFIG GEOTEST
```

Table 16: Config Values

ASCII	Description
14GPS8GEO[a]	14 GPS L1 L2 channels and 7 GEO L1 L2 L5 channels (default)
GEOTEST[b]	9 GEO L1 L2 L5 channels
14GPS8GEONAR[c]	14 GPS L1 L2 channels and 8 GEO L1 L2 channels. All GEO channels contain narrow correlator spacing.
GEOTESTNAR[c]	10 GEO L1 L5 channels. All channels contain narrow correlator spacing.
14GPS7GEONAR[c]	14 GPS L1 L2 channels and 7 GEO L1 L2 channels. All GEO channels contain narrow correlator spacing.
9GEOTESTNAR[c]	9 GEO L1 L5 channels. All channels contain narrow correlator spacing.

a. For firmware versions X.103 and earlier, there are 14 GPS L1 L2 channels and 8 GEO L1 L2 L5 channels (default)

b. For firmware versions X.103 and earlier, there are 10 GEO L1 L2 L5 channels

c. 14GPS8GEONAR, GEOTESTNAR, 14GPS7GEONAR and 9GEOTESTNAR are not supported in version X.104.

5.3.7 CODEFREQOFFSET

This command is used to change the expected code frequency away from the nominal values of 1.023 MHz or 10.23 MHz. This command was implemented to accommodate a specific purpose and should not be used if the receiver is tracking GPS signals.

The command currently changes the configuration of all the signal channels that share the same RF data as the channel specified. This format was selected to provide possible future enhancements to the receiver software without altering the command interface.

Carrier aiding is disabled if the sum of the code frequency offset and the current code frequency, on the channel specified, is less than or equal to 0.

Syntax: **Message ID: 627**

```
CODEFREQOFFSET  SIGCHAN  OFFSET
```

Field	Field Name	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.				H	0
2	sigchan	0-39		Specifies the signal channel to change, see *Table 64, Channel Configurations* on page 136	Ulong	4	H
3	offset	± 10.23 x 10^6 Hz		Specifies the change in the nominal code rate	Ulong	4	H+4

Example:

```
CODEFREQOFFSET 0 -1000
```

5.3.8 COM

This command permits you to configure the receiver's asynchronous serial port communications drivers.See *Section 4.1.1.1, Factory Defaults* on page 29 for a description of the factory defaults.

Syntax: **Message ID: 4**

```
COM [PORT]BPS[ PARITY [DATABITS [ STOPBITS [HANDSHAKE [ECHO [BREAK]]]]]]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	port	See *Table 6, Serial Port Identifier Values* on page 38.	Serial port to apply the settings to. If no value is supplied, the settings are applied to COM1.	Enum	4	H
3	bps	9600, 19200, 38400, 57600, 115200, or 230400[a]	Communication baud rate (bps)	ULong	4	H+4
4	parity	See *Table 17, Parity Values* on page 57.	Parity. If not specified, no parity is assumed.	Enum	4	H+8
5	databits	7 or 8	Number of data bits	ULong	4	H+12
6	stopbits	1 or 2	Number of stop bits	ULong	4	H+16
7	handshake	See *Table 18, Handshaking Values* on page 58.	Handshaking	Enum	4	H+20
8	echo	See *Table 19, Echo Values* on page 58.	Echo ability	Enum	4	H+24
9	break	See *Table 20, Break Values* on page 58.	Break detection	Enum	4	H+28

a. Baud rates higher than 115,200 bps are not supported by standard PC hardware. Special PC hardware is required for higher rates, such as 230,400 bps.

Example:

```
COM COM3 57600 N 8 1 N OFF ON
```

Table 17: Parity Values

ASCII	Description
N	No parity
E	Even parity
O	Odd parity

Table 18: Handshaking Values

ASCII	Description
N	No handshaking
XON	XON/XOFF software handshaking
CTS	CTS/RTS hardware handshaking

Table 19: Echo Values

ASCII	Description
OFF	No echo
ON	Transmit any input characters

Table 20: Break Values

ASCII	Description
OFF	Disable break detection
ON	Enable break detection

5.3.9 DLLBW

This is the noise equivalent bandwidth command for the DLL filter bandwidth. Upon issuing the command, the locktime for all tracking satellites is reset to zero.

> The DLLBW command should only be used by advanced users. It may not be suitable for every GPS application. When using DLLBW in a differential mode, the same setting should be used at both the monitor and remote station.

> The greater the DLL bandwidth, the noisier the measurement is.

Syntax: **Message ID: 517**

```
DLLBW  CODETYPE  BW
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	codetype	See *Table 25, Code Type Values* on page 67	The code type field specifies to which signal type to apply the parameters.	Enum	4	H
3	bw	See *Table 21, DLL Bandwidth Values* below.	Noise equivalent bandwidth of DLL filter in Hz.	Float	4	H+4

Table 21: DLL Bandwidth Values

Frequency	Valid Bandwidth Values
GPS + GEO C/A signals	0.001 to 0.5 Hz
GPS P(Y) signals	0.001 to 0.5 Hz
GPS C5 signals	0.001 to 0.5 Hz

Example:

```
DLLBW CA 0.01
```

5.3.10 ECUTOFF

This command sets the elevation cut-off angle for tracked satellites. The receiver will not track a satellite until it rises above the cut-off angle. Tracked satellites that fall below the cut-off angle will no longer be tracked unless they were manually assigned using the *ASSIGN* command.

In either case, satellites below the *ECUTOFF* angle will be eliminated from the internal position and clock offset solution computations.

If the receiver has not yet received an almanac, satellites below the cut-off angle may be tracked.

This command permits a negative cut-off angle, which could be used in these situations:

- the antenna is at a high altitude, and thus can look below the local horizon
- satellites are visible below the horizon due to atmospheric refraction

1. This command only effects GPS satellites. GEO satellites maintain their lock.
2. Care must be taken when using *ECUTOFF* because the signals from lower elevation satellites are travelling through more atmosphere and are therefore degraded.

Syntax: **Message ID: 50**

```
ECUTOFF ANGLE
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	angle	-90.0 to +90.0	Elevation cut-off angle relative to horizon in degrees.	Float	4	H

Example:

```
ECUTOFF 10.0
```

5.3.11 FIX

This command fixes position parameters for the GUST Receiver. For various applications, fixing this value can assist in improving acquisition times and accuracy of position or corrections.

Syntax: **Message ID: 44**

```
FIX TYPE [LAT LONG HEIGHT]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1* on *Page 29*.			H	0
2	type	See *Table 22, Fix Type Values* below.	Fix type	Enum	4	H
3	lat	-90 to +90	Latitude parameter for a fixed position in degrees. Only entered when the fix type is set to *POSITION*.	Double	8	H+4
4	long	-360 to +360	Longitude parameter for a fixed position in degrees. Only entered when the fix type is set to *POSITION*.	Double	8	H+12
5	height	-1000 to +20000000	Ellipsoidal height parameter for a fixed position in metres.Only entered when the fix type is set to *POSITION*.	Double	8	H+20

Example:

```
FIX POSITION 51.116381983333 -114.03829231944 1048.215
```

Table 22: Fix Type Values

ASCII	Description
NONE	Unfix or none. Clears any previous FIX commands.
POSITION	Configures the receiver with its position fixed. The receiver performs all computations based on WGS84, which is illustrated in *Figure 19, The WGS84 ECEF Coordinate System* on page 62.

Figure 19: The WGS84 ECEF Coordinate System

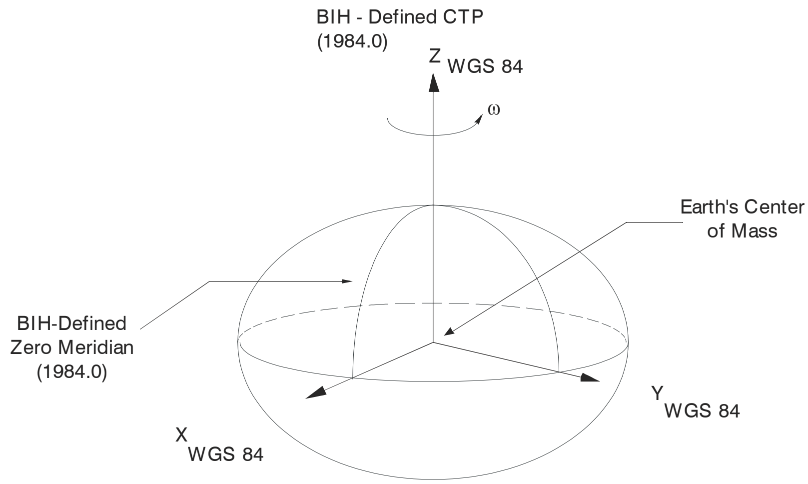
- Definitions - *

Origin = Earth's center of mass

Z-Axis = Parallel to the direction of the Conventional Terrestrial Pole (CTP) for polar motion, as defined by the Bureau International de l'Heure (BIH) on the basis of the coordinates adopted for the BIH stations.

X-Axis = Intersection of the WGS 84 Reference Meridian Plane and the plane of the CTP's Equator, the Reference Meridian being parallel to the Zero Meridian defined by the BIH on the basis of the coordinates adopted for the BIH stations.

Y-Axis = Completes a right-handed, earth-centered, earth-fixed (ECEF) orthogonal coordinate system, measured in the plane of the CTP Equator, 90° East of the X-Axis.



* Analogous to the BIH Defined Conventional Terrestrial System (CTS), or BTS, 1984.0.

5.3.12 FRESET

This command clears data which is stored in the receiver's non-volatile memory and restores the receiver to factory default settings. The receiver is forced to hardware reset.

> One FRESET command affects all three receiver sections simultaneously.

Syntax: **Message ID: 20**

```
FRESET
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	Reserved field required for *Binary* format only. Set to 0 when entering the command in *Binary*.			Enum	4	H

Example:

```
FRESET
```

5.3.13 LOG

Many different types of data can be logged using several different methods of triggering the log events. See *Chapter 6, Data Logs* starting on page 79 for further information and a complete list of data log structures.

The *hold* parameter, which is only valid when the *ONTIME* trigger is being used, will prevent a log from being removed when the *UNLOGALL* command is issued. To remove a log that was invoked using the *hold* parameter requires the specific use of the *UNLOG* command.

The *period* and *offset* parameters are only valid when the *ONTIME* trigger is being used as well. For example, to log data at 1 second after every minute you would set the *period* to 60 and the *offset* to 1.

> Maximum flexibility for logging data is provided to you by these logs. You are cautioned, however, to recognize that each log requested requires additional CPU time and memory buffer space. Too many logs may result in lost data and degraded CPU performance. Receiver overload can be monitored using the *Buffer Over-run* bits of the *Receiver Status* word in any log header.

Syntax: **Message ID: 1**

```
LOG [PORT] MESSAGE [TRIGGER] [PERIOD] [OFFSET] [HOLD]
```

Field	Field Name	Valid Values ASCII	Valid Values Binary	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.				H	0
2	port	See *Table 6, Serial Port Identifier Values* on page 38.		Serial port at which to output the log data.	Enum	4	H
3	message	Any valid message name, with a suffix to specify the output format as explained in *Section 4.2.3, Specifying Log Formats* on page 33.	Any valid message ID	Log to output	UShort	2	H+4
4	message type	This field is only present in *Binary* format. See *Table 7* on page 39.		Message type of log.	Char	1	H+6
5	Reserved field required for *Binary* format only. Set to 0 when entering the command in *Binary*.				Char	1	H+7
6	trigger	See *Table 23* on page 65.		Trigger, or condition, to generate log on.	Enum	4	H+8
7	period	Any positive double value.		Log period for *ONTIME* trigger in seconds	Double	8	H+12
8	offset	Any positive double value smaller than the value specified in the *period* field.		Offset for *ONTIME* trigger in seconds.	Double	8	H+20
9	hold	See *Table 24* on page 65.		Flag for whether or not the log is removed by the *UNLOGALL* command. Valid for *ONTIME* trigger only.	Enum	4	H+28

Examples:

```
LOG COM1 PSRPOSA ONTIME 7 2.5 HOLD

LOG COM3 PRSPOSA ONCE
```

The first example configures the GUST Receiver to output the *PSRPOS* log in *ASCII* format to COM1 at 7 second intervals offset by 2.5 seconds (output at 2.5 seconds then 9.5 seconds and so on). The second example outputs the log only once on COM3.

Table 23: Log Trigger Values

ASCII	Binary	Description
ONNEW	0	Output when the message is updated (not necessarily changed).
ONCHANGED	1	Output when the message is changed.
ONTIME	2	Output on a time interval.
ONCE	4	Output only the current message.

Table 24: Log Hold Values

ASCII	Binary	Description
NOHOLD	0	Allow log to be removed by the *UNLOGALL* command.
HOLD	1	Prevent log from being removed by the *UNLOGALL* command.

5.3.14 PLLBW

This command can fundamentally change the way that the receiver operates. Do not alter the default settings unless you are confident that you understand the consequences.

The log orders for C/A and P(Y) signals are 3rd order.

This command sets the following for one or all channels:

- L1 PLL low-pass filter bandwidth
- L2 PLL low-pass filter bandwidth

A time filtered square of the L5 PLL low-pass filter bandwidth carrier phase tracking loop error signal is used to track the performance of this tracking loop. This value is used as the variance of carrier phase measurements. The threshold specified by this command is compared with the loop variance to determine when the signal tracking lock time is reset. The resetting of the signal lock time is used to indicate that conditions exist in which a cycle slip might occur.

The time filtering that is performed on the loop variance determination is controlled using the third argument of this command. This value is used to compute the first order time constant that provides a noise equivalent bandwidth for the specified bandwidth. The filtering equation used is:

$$\text{new value} = e^{-\Delta T\omega} \times (\text{old data}) + (1 - e^{-\Delta T\omega}) \times (\text{new data})$$

where

ΔT = the PLL sampling rate, and

$\omega = 4 \times$ filter constant

Syntax: **Message ID: 518**

```
PLLBW [CODETYPE] [BW]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	codetype	See *Table 25, Code Type Values* on page 67.	Specifies which signal type the parameters should be applied to.	Enum	4	H
3	bw	See *Table 26, PLL Bandwidth Values* on page 67.	PLL low-pass filter bandwidth in Hz.	Float	4	H+4

Example:

```
PLLBW PY 1.0
```

Table 25: Code Type Values

ASCII	Description
CA	GPS and GEO C/A signals
PY	GPS P(Y) signals
C5	GEO C5 signals

Table 26: PLL Bandwidth Values

Frequency	Valid Bandwidth Values
GPS and GEO C/A signals	0.5 to 15 Hz
GPS P(Y) signals	0.01 to 1.0 Hz
GEO C5 signals	0.5 to 15 Hz

5.3.15 PLLTHRESHOLD

This command controls signal acquisition and a steady-state-lock threshold for the P(Y) code. The *acqui* and *lock* fields must have values.

Syntax: **Message ID: 659**

```
PLLTHRESHOLD LOCK ACQUI CODETYPE
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	lock	0.01-1.00	Steady-state tracking lock threshold in cycles.	Float	4	H
3	acqui	0.01-1.00	Acquisition threshold in cycles (not implemented).	Float	4	H+4
4	codetype	PY	Specifies which signal type the parameters should be applied to.	Enum	4	H+8

Example:

```
PLLTHRESHOLD 0.6 0.05 PY
```

5.3.16 PULSEBLANKING

> The PULSEBLANKING command should only be used by advanced users of GPS.

This command enables or disables digital pulse blanking. By default, the digital pulse blanking is enabled. The sensitivity of the digital pulse blanking may be adjusted using the switch field. *Figure 20, L2 DPB Threshold* on page 70 displays the relationship between the L2 digital pulse blanking (DPB) threshold value and the AGC bins.

Syntax: **Message ID: 519**

```
PULSEBLANKING    FREQUENCY    SWITCH
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	frequency	L2 or L5	Pulse blanking frequency. See *Table 27, Frequency Switch* below.	Enum	4	H
3	switch	0-15 for L2 0-127 for L5	Pulse blanking switch using thresholds. See *Table 28, Pulse Blanking Switch* below.	Ulong	4	H+4

Examples:

```
PULSEBLANKING L2 5
```

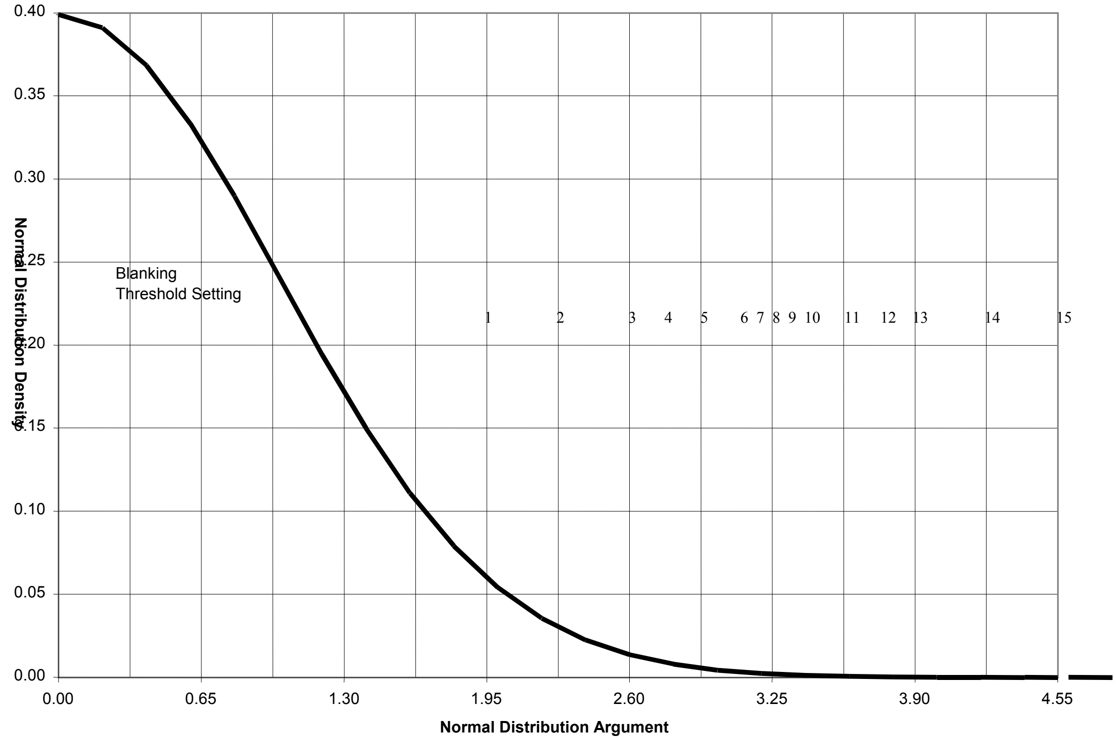
Table 27: Frequency Switch

ASCII	Description
L2	GPS and GEO L2 frequency
L5	GEO L5 frequency

Table 28: Pulse Blanking Switch

ASCII	Description
0	Disable pulse blanking.
0-127	Enable pulse blanking with thresholds set according to *Figure 20, L2 DPB Threshold* on page 70 *(L2)*. 0-15 for L2 or 0-127 for L5

Figure 20: L2 DPB Threshold



5.3.17 RESET

This command performs a hardware reset. Following a *RESET* command, the receiver will initiate a cold-start bootup and will retain the most recent receiver configuration (that is, channel configuration).

The optional delay field is used to set the number of seconds the receiver is to wait before resetting.

> One RESET command resets all three receiver sections simultaneously.

Syntax: **Message ID: 18**

```
RESET [ DELAY ]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	delay	Any ulong value.	Seconds to wait before resetting. If no value is provided, the default of 0 seconds is assumed.	ULong	4	H

Example:

```
RESET 5
```

See also the *FRESET* command on page 63.

5.3.18 SETAPPROXTIME

This command sets an approximate time in the receiver. The receiver will use this time as a system time until a GPS coarse time can be acquired. This can be used to improve time to first fix (TTFF). For more information on TTFF, refer to our *GNSS Reference Book*, available on our website at www.novatel.com/an-introduction-to-gnss/.

This command is only valid if time has not yet been determined by the receiver.

The time entered should be within 10 minutes of the actual GPS time for best results.

Syntax: **Message ID: 102**

```
SETAPPROXTIME WEEK SEC
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	week	0-1023	GPS week number	ULong	4	H
3	sec	0-604799	Number of seconds into GPS week	Double	8	H+4

Example:

```
SETAPPROXTIME 850 425384
```

5.3.19 SETSATELLITE

Set the health of a PRN to disable it from being tracked, or to enable it.

All satellites are defaulted as enabled.

Syntax: **Message ID: 425**

```
SETSATELLITE PRN HEALTH
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	prn	0-37, 120-138	A satellite PRN integer number.	Long	4	H
3	health	See *Table 29, Desired Health Values* below.	Desired health tracking mode.	Enum	4	H+4

Example:

```
SETSATELLITE 29 DISABLE
```

Table 29: Desired Health Values

ASCII	Binary	Description
DISABLE	0	Disable tracking.
ENABLE	1	Enable tracking.

5.3.20 THRESHOLD

This command controls signal acquisition and steady-state-lock signal thresholds. The *acqui* and *lock* fields must have values. They set the thresholds for the L1 channel.

See also *Table 64, Channel Configurations* on page 136 for the mapping of signal channels.

1. If a signal channel is specified, see the optional sigchan field below, it overrides the codetype and system fields. The threshold values are applied to that particular signal channel.
2. When you change this command, the selected channel loses lock and the locktime for its tracking satellite is reset to zero.
3. For the *codetype* and *sigchan* fields below, the L2 P(Y) code type or signal channel is not acceptable. Instead, use the PLLTHRESHOLD command to set the L2 P(Y) thresholds, see also page 68.

Syntax: **Message ID: 449**

```
THRESHOLD ACQUI LOCK CROSSCORR CODETYPE SYSTEM [SIGCHAN]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	acqui	25-80	Acquisition power threshold in dBHz.	ULong	4	H
3	lock	10-80	Steady-state tracking lock threshold in dBHz.	ULong	4	H+4
4	crosscorr	10-80	It specifies the cross-correlation power threshold in dBHz, at which point, the checks are performed.	ULong	4	H+8
5	codetype	See *Table 25, Code Type Values* on page 67	Specifies which signal type the parameters should be applied to.	Enum	4	H+12
6	system	See *Table 15, Channel System Values* on page 53	System that the SV channel is tracking. If a value is not given, the default is GPS.	Enum	4	H+16
7	sigchan	See *Table 64, Channel Configurations* on page 136	The parameters should be applied to this signal channel. If specified, this signal channel overrides the codetype and system fields.	Ulong	4	H+20

Example:

```
THRESHOLD 35 15 25 CA GPS
```

5.3.21 UNASSIGN

This command cancels a previously issued *ASSIGN* command and the SV channel reverts to automatic control.

Syntax: **Message ID: 29**

```
UNASSIGN CHANNEL
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	channel	0 to 21	Previously selected SV channel to apply automatic search and acquisition mode, see *Table 64, Channel Configurations* on page 136	ULong	4	H
3	Reserved field required for *Binary* format only. Set to 2 when entering the command in *Binary*.			Enum	4	H+4

Example:

```
UNASSIGN 11
```

5.3.22 UNASSIGNALL

This command cancels all previously issued *ASSIGN* commands, forces all channels to idle, and then tracking and control for each SV channel reverts to automatic mode. See the *ASSIGN* command on *page 50* for more details.

Syntax: **Message ID: 30**

```
UNASSIGNALL [ SYSTEM ]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.			H	0
2	system	See *Table 15, Channel System Values* on page 53.	Optional field specifying the system that the SV channel is tracking. If no value is provided, the default of *ALL* is assumed.	Enum	4	H

Example:

```
UNASSIGNALL GPS
```

5.3.23 UNLOG

This command permits you to remove a specific log request from the system.

Syntax: **Message ID: 36**

```
UNLOG [ PORT ] DATATYPE
```

Field	Field Name	Valid Values		Description	Format	Binary Bytes	Binary Offset
		ASCII	Binary				
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1, Entering Commands* on page 29.				H	0
2	port	See *Table 6, Serial Port Identifier Values* on page 38.		Serial port at which log is being output. If a value is not provided, *COM1* is assumed.	Enum	4	H
3	datatype	Message name	Message ID	Log to be disabled.	ULong	4	H+4

Example:

```
UNLOG COM3 PSRPOSA
```

5.3.24 UNLOGALL

This command disables all logs on the specified port only. All other ports are unaffected.

> This command does not disable logs that have the *HOLD* attribute set. (See the *LOG* command in *Section 5.3.13, LOG* on page 64 for more information on this attribute). To disable logs with the *HOLD* attribute, use the *UNLOG* command.

Syntax: **Message ID: 38**

```
UNLOGALL [ PORT ]
```

Field	Field Name	Valid Values	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the *Abbreviated ASCII* command name. See *Section 4.1* on *Page 29*.			H	0
2	port	See *Table 6, Serial Port Identifier Values* on page 38.	Serial port at which logging is to disabled. If a value is not provided, *COM1* is assumed.	Enum	4	H
3	Reserved (always 0).			Enum	4	H+4

Example:

```
UNLOGALL
```

Chapter 6 Data Logs

6.1 Functional Listing of Logs

Table 30, Logs By Function lists the logs by function and provides the type of each log. The valid types are discussed in *Section 4.2.1, Log Types* on page 32.

Table 30: Logs By Function

GENERAL RECEIVER CONTROL AND STATUS		
Log	**Description**	**Type**
AGCSTATS	Automatic gain control status	Synch
ALLSQMIINFO	I correlator locations	Polled
ALLSQMQINFO	Q correlator locations	Polled
RXCOMMANDS	Receiver configuration information	Polled
RXSECSTATUS	Receiver section status	Synch
SYSTEMLEVELS	System hardware levels	Synch
VERSION	Receiver hardware and software version numbers	Polled
POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL		
Log	**Description**	**Type**
PSRPOS	Position data	Synch
CLOCK INFORMATION, STATUS, AND TIME		
Log	**Description**	**Type**
CLOCKMODEL	Range bias information	Synch
TIME	Receiver time information	Synch
POST PROCESSING DATA		
Log	**Description**	**Type**
RANGE	Satellite range information	Synch
SATELLITE TRACKING AND CHANNEL CONTROL		
Log	**Description**	**Type**
ALLSQMDATA	Signal quality monitoring data	Synch
ALLSQMI	I accumulation signal quality monitoring data	Asynch
ALLSQMQ	Q signal quality monitoring data	Asynch
ALMANAC	Current decoded almanac data	Asynch
RANGE	Satellite range information	Synch
RAWEPHEM	Raw ephemeris	Asynch
RAWGPSSUBFRAMEWP	Raw subframe data	Asynch
RAWWAASFRAMEWP	Raw SBAS frame data	Asynch
SATVIS	Satellite azimuth and elevation angle data	Synch
TRACKSTAT	Channel tracking information	Synch

6.2 Log Summary

The available logs are listed alphabetically in *Table 31, Log Summary*.

Table 31: Log Summary

Log Name	Message ID	Description
AGCSTATS	630	Automatic gain control status
ALLSQMDATA	617	Satellite quality monitoring data
ALLSQMI	632	I accumulation signal quality monitoring data
ALLSQMIINFO	656	I accumulation signal quality monitoring information
ALLSQMQ	633	Q signal quality monitoring data
ALLSQMQINFO	657	Q signal quality monitoring information
ALMANAC	73	Current decoded almanac data
CLOCKMODEL	16	Current clock model matrices
PSRPOS	47	Position data
RANGE	43	Satellite range information
RAWEPHEM	41	Raw ephemeris
RAWGPSSUBFRAMEWP	570	Raw subframe data with parity information
RAWWAASFRAMEWP	571	Raw SBAS frame data with parity information
RXCOMMANDS	579	Receiver configuration information
RXSECSTATUS	638	Receiver section status
SATVIS	48	Satellite azimuth and elevation angle data
SYSTEMLEVELS	653	System hardware levels
TIME	101	Receiver time information
TRACKSTAT	83	Channel tracking information
VERSION	37	Receiver hardware and software version numbers

6.3 Log Reference

For each log, the recommended input command for generating the log is provided. The recommended command is shown in *ASCII* format, unless otherwise specified. An example of the log output, in *ASCII* format, is provided for each recommended input.

> All logs are followed by a carriage return and line feed. However, in some of the examples, carriage returns have been inserted in the middle of the log to clearly indicate different data sets.

6.3.1 AGCSTATS Automatic Gain Control Status

This log provides status information for the automatic gain control mechanism and details of the parameters it is currently using.

Log Type: Synch **Message ID: 630**

Field	Field Name	Data Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	# RF decks	Number of RF decks reported in this message.	Ulong	4	H
3	AGCword	AGC status word (see *Table 32, AGC Status Word* on page 82)	Ulong	4	H+4
4	gain	AGC gain (0 to 99999)	Ulong	4	H+8
5	pulse width	VARF pulse width	Ulong	4	H+12
6	modulus	VARF modulus	Ulong	4	H+16
7	bin1	A/D bin 1 (decimal percentage)	Double	8	H+20
8	bin2	A/D bin 2 (decimal percentage)	Double	8	H+28
9	bin3	A/D bin 3 (decimal percentage)	Double	8	H+36
10	bin4	A/D bin 4 (decimal percentage)	Double	8	H+44
11	bin5	A/D bin 5 (decimal percentage)	Double	8	H+52
12	bin6	A/D bin 6 (decimal percentage)	Double	8	H+60
13	noise floor	Calculated noise floor	Double	8	H+68
14	Reserved		Double	8	H+76
15			Double	8	H+84
16...	Next RF deck, offset = H+ 4 + (#RF *88) Bytes				
	32-bit CRC (ASCII and Binary only)		Hex	4	H+ 4 (#RF*88)

Table 32: AGC Status Word

Bit	Description	Bit = 0	Bit = 1
0	Jam Detected	Jamming Not Present	Jamming Present
1 2	AGC Calibrated	Coarse Calibration = 0 Fine Calibration = 1	
3 4 5	RF Type	1 = L1, 2 = L2, 3 = L5	
6 7 8	ADC Range indicates which 3 bits of the 8-bit ADC output are currently being used by the receiver.	0 = Bits 7, 6, 5 1 = Bits 7, 5, 4 2 = Bits 7, 4, 3 3 = Bits 7, 3, 2 4 = Bits 7, 2, 1 5 = Bits 7, 1, 0	
9 10 11	Method of Noise Floor Calculation	1 = AGC 2 = Post Correlation 3 = …	
12	Reserved		
13	Reserved		
14	Reserved		
15	Reserved		
16	Reserved		
17	Reserved		
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	Reserved		
31	Reserved		

Recommended Input:

```
LOG AGCSTATSA ONTIME 10
```

Example Output:

```
#AGCSTATSA,COM1,0,62.5,FINE,250,423507.824,00A40008,0000,33331;
3,44A,3876,1576,8000,0.0890,0.1601,0.2398,0.2547,0.1664,0.0899,
1027809.187500,0.493587,0.000000,412,658,658,8000,0.0886,0.1553,
0.2392,0.2556,0.1815,0.0962,1017745.500000,0.485263,0.000000,25A,
2734,434,8000,0.0438,0.1114,0.2153,0.2705,0.2194,0.1396,
1606221.250000,0.488824,0.000000*8DCA127B
```

6.3.2 ALLSQMDATA Signal Quality Monitoring Data

ALLSQMDATA, *ALLSQMI* and *ALLSQMQ,* see *Section 6.3.2* on page 84, *Section 6.3.3* on page 86 and *Section 6.3.5* on page 88, are for signal quality monitoring (SQM), which is described in *Section 1.2.4, Signal Quality Monitoring* on page 15.

This log provides information about the correlation function and multiple data sets can be provided. A data set is provided for each tracked satellite and, within each tracked satellite data set, a data set is provided for each channel. The message is updated every second and is therefore best to be logged *ONNEW* or *ONCHANGED*.

This information can be used as a means to detect anomalous waveforms in the broadcast signal from the satellite.

Log Type: Synch **Message ID: 617**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.2, Logging Data* on page 32.		H	0
2	svobs	Number of tracked satellite data sets to follow	ULong	4	H
3	prn	Satellite PRN being tracked	ULong	4	H+4
4	sigchan#	Signal channel number of the master hardware channel tracking the satellite	ULong	4	H+8
5	obs	Number of channel data sets to follow	ULong	4	H+12
6	A1sum	Accumulation 1	Long	4	H+8
7	A2sum	Accumulation 2	Long	4	H+12
8	A3sum	Accumulation 3	Long	4	H+16
9	A4sum	Accumulation 4	Long	4	H+20
10	A5sum	Accumulation 5	Long	4	H+24
11	sync	Synchronization flag for channel. See *Table 33, Synchronization Flag Values* on page 85.	Enum	4	H+28
12…	Next channel data set, offset = H+12 + (# previous prn x (# previous obs x 24))				
variable...	Next satellite data set, offset = variable				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	variable

Recommended Input:

```
LOG ALLSQMDATAA ONNEW
```

Example Output:

```
#ALLSQMDATAA,COM1,0,53.5,FINE,510,238418.250,00A40008,0000,33331;
11,20,0,2,10562562,27210,3918,31819,13337,TRUE,
10465694,41704,10459178,9914848,9890642,TRUE,
1,2,2,7600530,-7442,8161,5261,22002,TRUE,
7532045,-5251,7522923,7135497,7104613,TRUE,
12,4,2,8827676,6070,5074,11355,7840,TRUE,
8744587,2611,8738161,8306135,8294817,TRUE,
5,6,2,6066461,50327,-4577,18810,-142,TRUE,
6008145,63450,6006961,5682629,5696395,TRUE,
23,8,2,5886715,-12738,4118,-1302,-11481,TRUE,
5838411,-14645,5828139,5525097,5535155,TRUE,
11,12,2,10894448,-62831,7721,36997,10818,TRUE,
10797594,-39425,10777162,10221954,10206902,TRUE,
32,14,2,15197204,122192,832,35162,2613,TRUE,
15045554,151295,15045548,14244254,14245208,TRUE,
17,16,2,6073006,5729,1574,1653,261,TRUE,
6019043,553,6010359,5720581,5712253,TRUE,
31,18,2,18205730,-15477,-880,1728,11712,TRUE,
18023011,-15556,18026861,17076319,17056455,TRUE,
30,24,2,8600378,34732,6052,26431,10275,TRUE,
8510285,53571,8509913,8074871,8047905,TRUE,
14,26,2,9924012,9292,-1003,13403,-16356,TRUE,
9828326,8385,9837676,9316010,9342868,TRUE*A7F10D27
```

Table 33: Synchronization Flag Values

ASCII	Binary	Description
TRUE	1	Correlators are synchronized with the master channel.
FALSE	0	Correlators are not synchronized with the master channel.

6.3.3 ALLSQMI I Accumulation Signal Quality Monitoring Data

ALLSQMI is for signal quality monitoring (SQM) which is described in *Section 1.2.4, Signal Quality Monitoring* on page 15.

This log provides information about the I correlation function. Multiple data sets can be provided. A data set is provided for each tracked satellite and, within each tracked satellite data set, a data set is provided for each correlator. The message is updated every second and is therefore best to be logged ONNEW or ONCHANGED.

This information can be used as a means to detect anomalous waveforms in the broadcast signal from the satellite.

Log Type: Asynch **Message ID: 632**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	#svobs	Number of tracked satellite data sets to follow	ULong	4	H
3	prn	Satellite PRN being tracked	ULong	4	H+4
4	sigchan#	Signal channel for the tracked satellite	ULong	4	H+8
5	#accums	Number of accumulation values to follow	Ulong	4	H+12
6	Asum	I Accumulation value	Long	4	H+16
variable	Next channel data set, offset = H + 4 + #svobs(12 + (4 x #accums))				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	variable

Recommended Input:

```
LOG ALLSQMIA ONNEW
```

Example Output:

```
#ALLSQMIA,COM1,0,49.0,FINE,510,238423.251,00A40008,0000,33331;11,20,0,
7,3313,8526779,4665,8977563,9067134,8977985,8509911,1,2,7,3623,7191414
,-948,7593226,7684498,7601504,7183788,12,4,7,-7693,8448571,-1576,
8913753,8992773,8905659,8448529,5,6,7,-7258,5692362,-6032,6014208,
6082378,6030036,5712158,23,8,7,-20080,5447593,-7482,5752685,5804328,
5746781,5471567,11,12,7,-7075,10322259,7859,10887491,10990709,
10887163,10341365,32,14,7,5277,14388377,2585,15183667,15334379,
15180953,14375845,17,16,7,-2829,5682098,4560,5985652,6046871,5992268,
5690554,31,18,7,11206,171 08528,-2820,18061564,18253010,18073084,
17100876,30,24,7,-4917,8039534,-2608,8488448,8565278,8486104,8048308,
14,26,7,6757,9114962,2796,9613742,9708243,9615190,9108458*4250774B
```

6.3.4 ALLSQMIINFO I Accumulation Signal Quality Monitoring Information

This log provides information about the correlation locations found in the ALLSQMI log, see *Section 6.3.3* on *Page 86*. An individual message is sent for each configured channel of the receiver. The message contents will be constant for a specific software version.

Log Type: Polled **Message ID: 656**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	#svobs	Number of tracked satellite data sets to follow	ULong	4	H
3	sigchan#	Signal channel for the tracked satellite	ULong	4	H+4
4	Reserved		Ulong	4	H+8
5			Ulong	4	H+12
6	#locations	Number of correlator locations to follow	Long	4	H+16
7	AIxval	Correlator spacing, in C/A code chips, from punctual	Float	4	H+20
variable	Next channel data set, offset = H + 4 + #svobs(16 + (4 x #locations))				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	variable

Recommended Input:

```
LOG ALLSQMIINFOA ONNEW
```

Example Output:

```
#ALLSQMIINFOA,COM1,0,41.5,FINE,510,238408.381,00A40008,0000,33331;
14,0,28,0,7,-0.1023000,-0.0767250,-0.0511500,-0.0255750,0.0000000,
0.0255750,0.0767250,2,28,0,7,-0.1023000,-0.0767250,-0.0511500,
0.0255750,0.0000000,0.0255750,0.0767250,4,28,0,7,-0.1023000,-
0.0767250,-0.0511500,-0.0255750,0.0000000,0.0255750,0.0767250,
6,28,0,7,-0.1023000,-0.0767250,-0.0511500,-0.0255750,0.0000000,
0.0255750,0.0767250,8,28,0,7,-0.1023000,-0.0767250,-0.0511500,-
0.0255750,0.0000000,0.0255750,0.0767250,10,28,0,7,-0.1023000,-
0.0767250,-0.0511500,-0.0255750,0.0000000,0.0255750,0.0767250,12,
28,0,7,-0.1023000,-0.0767250,-0.0511500,-0.0255750,0.0000000,
0.0255750,0.0767250,14,28,0,7,-0.1023000,-0.0767250,-0.0511500,-
0.0255750,0.0000000,0.0255750,0.0767250,16,28,0,7,-0.1023000,-
0.0767250,-0.0511500,-0.0255750,0.0000000,0.0255750,0.0767250,18,
28,0,7,-0.1023000,-0.0767250,-0.0511500,-0.0255750,0.0000000,
0.0255750,0.0767250,20,28,0,7,-0.1023000,-0.0767250,-0.0511500,-
0.0255750,0.0000000,0.0255750,0.0767250,22,28,0,7,-0.1023000,-
0.0767250,-0.0511500,-0.0255750,0.0000000,0.0255750,0.0767250,24,
28,0,7,-0.1023000,-0.0767250,-0.0511500,-0.0255750,0.0000000,
0.0255750,0.0767250,26,28,0,7,-0.1023000,-0.0767250,-0.0511500,-
0.0255750,0.0000000,0.0255750,0.0767250*A73B283C
```

6.3.5 ALLSQMQ Q Signal Quality Monitoring Data

This log provides information about the Q correlation function. Multiple data sets can be provided. One data set for each tracked satellite and, within each tracked satellite data set, a data set for each correlator. The message is updated every second and is therefore best logged ONNEW or ONCHANGED.

Log Type: Asynch **Message ID: 633**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	#svobs	Number of tracked satellite data sets to follow	ULong	4	H
3	prn	Satellite PRN being tracked	ULong	4	H+4
4	sigchan#	Signal channel for the tracked satellite	ULong	4	H+8
5	#accums	Number of accumulation values to follow	Ulong	4	H+12
6	Asum	Q Accumulation value	Long	4	H+16
variable	Next channel data set, offset = H + 4 + #svobs(12 + (4 x #accums))				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	variable

Recommended Input:

```
LOG ALLSQMQA ONNEW
```

Example Output:

```
#ALLSQMQA,COM1,0,46.0,FINE,510,238428.253,00A40008,0000,33331;
11,20,0,3, 26025,-47138,-62332,1,2,3,12406,-62815,-70740,12,4,3,453,
-48113,-55627,5,6,3,2942,-24683,-37666,23,8,3,13957,-6014,-25324,11,
12,3,41236,-39344,-76061,32,14,3,45763,33080,-6404,17,16,3,-764,
-30600,-31045,31,18,3,5172,-84176,-76933,30,24,3,-7251,-27332,-22597,
14,26,3,15599,-62062,-64427*32109FF1
```

6.3.6 ALLSQMQINFO Q Signal Quality Monitoring Information

This log provides information about the correlation locations found in the ALLSQMQ log, see *Section 6.3.5* on *Page 88*. An individual message is sent for each configured channel of the receiver. The message contents will be constant for a specific software version.

Log Type: Polled **Message ID: 657**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	#svobs	Number of tracked satellite data sets to follow	ULong	4	H
3	sigchan#	Signal channel for the tracked satellite	ULong	4	H+4
4	Reserved		Ulong	4	H+8
5			Ulong	4	H+12
6	#locations	Number of correlator locations to follow	Long	4	H+16
7	AQxval	Correlator spacing, in C/A code chips, from punctual	Float	4	H+20
variable	Next channel data set, offset = H + 4 + #svobs(16 + (4 x #locations))				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	variable

Recommended Input:

```
LOG ALLSQMQINFOA ONNEW
```

Example Output:

```
#ALLSQMQINFOA,COM1,0,55.0,FINE,510,238414.471,00A40008,0000,33331;
14,0,28,0,3,-0.0511500,-0.0255750,0.0000000,2,28,0,3,-0.0511500,
-0.0255750,0.0000000,4,28,0,3,-0.0511500,-0.0255750,0.0000000,6,28,0,
3,-0.0511500,-0.0255750,0.0000000,8,28,0,3,-0.0511500,-0.0255750,
0.0000000,10,28,0,3,-0.0511500,-0.0255750,0.0000000, 12,28,0,3,
-0.0511500,-0.0255750,0.0000000,14,28,0,3,-0.0511500,-0.0255750,
0.0000000,16,28,0,3,-0.0511500,-0.0255750,0.0000000, 18,28,0,3,
-0.0511500,-0.0255750,0.0000000,20,28,0,3,-0.0511500,-0.0255750,
0.0000000,22,28,0,3,-0.0511500,-0.0255750,0.0000000, 24,28,0,3,
-0.0511500,-0.0255750,0.0000000,26,28,0,3,-0.0511500,-0.0255750,
0.0000000*E671C35D
```

6.3.7 ALMANAC Decoded Almanac

This log contains the decoded almanac parameters from subframes four and five as received from the satellite with the parity information removed and appropriate scaling applied. Multiple messages are transmitted, one for each SV almanac collected. More information on Almanac data may be found in ICD-GPS-200. To obtain copies of ICD-GPS-200, refer to the ARINC contact details in the *Standards/ References* section of our *GNSS Reference Book* available on our website at www.novatel.com/an-introduction-to-gnss/.

Log Type: Asynch **Message ID: 73**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	#msg	The number of satellite PRN almanac data sets to follow.	Long	4	H
3	PRN	Satellite PRN number for current message, dimensionless	ULong	4	H+4
4	week	Almanac reference week (GPS week number)	ULong	4	H+8
5	seconds	Almanac reference time, seconds into the week	Double	8	H+12
6	ecc	Eccentricity, dimensionless	Double	8	H+20
7	$\mathring{\omega}$	Rate of right ascension, radians/second	Double	8	H+28
8	ω_0	Right ascension, radians	Double	8	H+36
9	ω	Argument of perigee, radians	Double	8	H+44
10	M_o	Mean anomaly of reference time, radians	Double	8	H+52
11	a_{fo}	Clock aging parameter, seconds	Double	8	H+60
12	a_{f1}	Clock aging parameter, seconds/second	Double	8	H+68
13	N	Corrected mean motion, radians/second	Double	8	H+76
14	A	Semi-major axis, meters	Double	8	H+84
15	incl-angle	Angle of inclination relative to 0.3 π, radians	Double	8	H+92
16	SV config	Satellite configuration	ULong	4	H+100
17	health-prn	SV health from subframe 4 or 5	ULong	4	H+104
18	health-alm	SV health from almanac	ULong	4	H+108
19	antispoof	Anti-spoofing flag. See *Table 13, Antispoofing Flag Values* on page 49.	Enum	4	H+112
20...	Next almanac data set, offset = H + 4 + (# previous msg x 112)				
21	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H + 4 + (112 x #msg)

Recommended Input:

```
LOG ALMANACA ONCHANGED
```

ASCII Example:

```
#ALMANACA,COM1,0,64.5,SATTIME,1048,508014.000,00000028,42F1,0;
31,
1,1049,61440.0,5.10788E-03,-7.8974718E-09,-4.5666114E-01,-1.7361153E+0
0,-9.1286238E-01,1.1730194E-04,0.00000000,1.4584974E-04,2.6560862E+07,
1.7532921E-02,1,0,0,FALSE,
2,1049,61440.0,1.95422E-02,-8.0917656E-09,1.5495060E+00,-2.1449823E+00
,2.5208892E+00,-1.7547607E-04,-3.6379788E-12,1.4585339E-04,2.6560419E+
07,-8.2930836E-03,1,0,0,FALSE
...
30,1049,61440.0,5.61333E-03,-7.9889042E-09,1.5991652E+00,1.4759191E+00
,2.7901058E+00,-9.5367432E-06,0.00000000,1.4585534E-04,2.6560183E+07,1
.9534287E-03,1,0,0,FALSE
31,1049,61440.0,9.47952E-03,-8.0917656E-09,2.6421445E+00,8.0564663E-01
,1.9109259E-01,3.7193298E-05,0.00000000,1.4585948E-04,2.6559680E+07,8.
8922949E-03,1,0,0,TRUE
*fc97918d
```

6.3.8 CLOCKMODEL Current Clock Model Status

The *CLOCKMODEL* log contains the current clock-model status of the receiver.

Monitoring the *CLOCKMODEL* log will allow you to determine the error in your receiver reference oscillator as compared to the GPS satellite reference.

All logs report GPS time not corrected for local receiver clock error. To derive the closest GPS time, subtract the clock offset from the GPS time reported. The clock offset can be calculated by dividing the value of the range bias given in field *6* of the CLOCKMODEL log by the speed of light (*c*).

The following symbols are used throughout this section:

B = Range bias (m)
BR = Range bias rate (m/s)
SAB = Gauss-Markov process representing range bias error due to SA clock dither (m)

The standard clock model now used is as follows:

clock parameters array = [B BR SAB]

covariance matrix =

$$\begin{bmatrix} \sigma_B^2 & \sigma_B\sigma_{BR} & \sigma_B\sigma_{SAB} \\ \sigma_{BR}\sigma_B & \sigma_{BR}^2 & \sigma_{BR}\sigma_{SAB} \\ \sigma_{SAB}\sigma_B & \sigma_{SAB}\sigma_{BR} & \sigma_{SAB}^2 \end{bmatrix}$$

Log Type: Synch **Message ID: 16**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	clock status	Clock model status as computed from current measurement data. See *Table 34, Clock Model Status Values* on page 93.	Enum	4	H
3	reject	Number of rejected range bias measurements	ULong	4	H+4
4	noise time	GPS time of last noise addition	GPSec	4	H+8
5	update time	GPS time of last update	GPSec	4	H+12
6	parameters	Clock correction parameters (a 1x3 array of length 3), listed left-to-right	Double	8	H+16
7				8	H+24
8				8	H+32

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
9	cov data	Covariance of the straight line fit (a 3x3 array of length 9), listed left-to-right by rows	Double	8	H+40
10				8	H+48
11				8	H+56
12				8	H+64
13				8	H+72
14				8	H+80
15				8	H+88
16				8	H+96
17				8	H+104
18	range bias	Last instantaneous measurement of the range bias (m)	Double	8	H+112
19	range bias rate	Last instantaneous measurement of the range bias rate (m/s)	Double	8	H+120
20	change	Indicates whether or not there is a change in the constellation. See *Table 35, Constellation Change Flag Values* on page 93.	Enum	4	H+128
21	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+132

Recommended Input:

```
LOG CLOCKMODELA ONTIME 1
```

Example Output:

```
#CLOCKMODELA,COM1,0,55.0,FINE,1048,497224.500,00000128,879E,0;
VALID,0,497224.500,497224.500,6.59596736E-01,-9.29232987E-02,
-3.40165918E+00,4.63006778E+02,1.19966616E+00,-4.50054493E+02,
1.19966616E+00,2.15673338E-01,-7.90256149E-01,-4.50054493E+02,
-7.90256149E-01,4.76057122E+02,-2.902,-1.03659974E-01,FALSE*f33b4465
```

Table 34: Clock Model Status Values

ASCII	Binary	Description
VALID	0	The clock model is valid
CONVERGING	1	The clock model is near validity
ITERATING	2	The clock model is iterating towards validity
INVALID	3	The clock model is not valid
ERROR	4	Clock model error

Table 35: Constellation Change Flag Values

ASCII	Binary	Description
FALSE	0	There has not been a change in the constellation
TRUE	1	The constellation has changed

6.3.9 PSRPOS Pseudorange Position

This log contains the pseudorange position computed by the receiver, along with three status flags.

Log Type: Synch **Message ID: 47**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	sol status	Solution status. See *Table 36, Solution Status Values* on page 95.	Enum	4	H
3	pos type	Position type. See *Table 37, Position Type Values* on page 95.	Enum	4	H+4
4	lat	Latitude (percentage degrees)	Double	8	H+8
5	lon	Longitude (percentage degrees)	Double	8	H+16
6	hgt	Height above ellipsoid (m)	Double	8	H+24
7	Reserved		Float	4	H+32
8	datum id#	Datum ID number. This will always be 61 for the WGS84 coordinate system.	Enum	4	H+36
9	lat σ	Latitude standard deviation (m)	Float	4	H+40
10	lon σ	Longitude standard deviation (m)	Float	4	H+44
11	hgt σ	Height standard deviation (m)	Float	4	H+48
12	Reserved		Char[4]	4	H+52
13			Float	4	H+56
14			Float	4	H+60
15	#obs	Number of observations tracked	UChar	1	H+64
16	#GPSL1	Number of GPS L1 ranges used in computation	UChar	1	H+65
17	Reserved		UChar	1	H+66
18			UChar	1	H+67
19			UChar	1	H+68
20			UChar	1	H+69
21			UChar	1	H+70
22			UChar	1	H+71
23	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+72

Recommended Input:

```
LOG PSRPOSA ONTIME 1
```

Example Output:

```
#PSRPOSA,COM1,0,58.0,FINE,1027,324231.000,00000000,FC91,0;
SOL_COMPUTED,SINGLE,51.11615533807,-114.03850611829,1010.452,-16.271,
61,19.50677306162,14.52973740177,39.584,”0”,0.0,60.000,9,8,8,1,0,0,0,
0*de152df7
```

Table 36: Solution Status Values

ASCII	Binary	Description
SOL_COMPUTED	0	Solution computed
INSUFFICIENT_OBS	1	Insufficient observations
NO_CONVERGENCE	2	No convergence
SINGULARITY	3	Singularity at parameters matrix
CONV_TRACE	4	Covariance trace exceeds maximum (trace > 1000 m)
TEST_DIST	5	Test distance exceeded (maximum of 3 rejections if distance > 10 km)
COLD_START	6	Not yet converged from cold start
V_H_LIMIT	7	Height or velocity limits exceeded (in accordance with COCOM export licensing restrictions)
VARIANCE	8	Variance exceeds limits
RESIDUALS	9	Residuals are too large
DELTA_POS	10	Delta position is too large
negative_VAR	11	Negative variance

Table 37: Position Type Values

ASCII	Binary	Description
NONE	0	No solution
FIXEDPOS	1	Position has been fixed by the *FIX POSITION* command or by position averaging
SINGLE	16	Single point position

6.3.10 RANGE Satellite Range Information

RANGE contains the channel measurements for the currently tracked satellites. When using this log, please keep in mind the constraints noted along with the description.

It is important to ensure that the receiver clock model is valid. This can be monitored by the bits in the *Receiver Status* field of the log header. Large jumps in pseudorange as well as accumulated Doppler range (ADR) will occur as the clock is being adjusted. If the ADR measurement is being used in precise phase processing, it is important not to use the ADR if the *parity known* flag in the *ch-tr-status* field is not set as there may exist a half (1/2) cycle ambiguity on the measurement. The tracking error estimate of the pseudorange and carrier phase (ADR) is the thermal noise of the receiver tracking loops only. It does not account for possible multipath errors or atmospheric delays.

If a PRN is being tracked on more than one signal (L1, L2 or L5), multiple entries with the same PRN will appear in the range logs. As shown in *Table 38, Channel Tracking Status* on page 98, these entries can be differentiated by bits 21-22 of the *ch-tr-status* field, which denote whether the observation is for L1, L2 or L5. This is to aid in parsing data.

Log Type: Synch **Message ID: 43**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	# obs	Number of data sets to follow.	Long	4	H
3	PRN	Satellite PRN number of range measurement.	UShort	2	H+4
4	Reserved		UShort	2	H+6
5	psr	Pseudorange measurement (m).	Double	8	H+8
6	psr std	Pseudorange measurement standard deviation (m).	Float	4	H+16
7	adr	Carrier phase, in cycles (accumulated Doppler range).	Double	8	H+20
8	adr std	Estimated carrier phase standard deviation (cycles).	Float	4	H+28
9	dopp	Instantaneous carrier Doppler frequency (Hz).	Float	4	H+32
10	C/N_0	Carrier to noise density ratio $C/N_0 = 10[\log_{10}(S/N_0)]$ (dB-Hz)	Float	4	H+36
11	locktime	Number of seconds of continuous tracking (no cycle slipping).	Float	4	H+40
12	ch-tr-status	Tracking status. See *Table 38, Channel Tracking Status* on page 98.	ULong	4	H+44
13...	Next data set, offset = H + 4 + (# previous obs x 44)				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+4+ (#obs x 44)

Recommended Input:

```
LOG RANGEA ONTIME 30
```

Example Output:

```
#RANGEA,COM1,0,65.5,FINE,250,424649.000,00a00008,0000,33331;
21,
7,0,25517528.057,1.052,-134095506.251,0.009,488.168,38.9,593.930,
08105C04,
7,0,25517544.819,0.256,-104490036.206,0.034,380.391,31.2,522.900,
01305C04,
20,0,23706523.612,0.990,-124578635.804,0.009,3151.864,39.5, 1309.440,
08105C24,
20,0,23706536.383,0.109,-97074291.470,0.018,2455.999,38.6,1281.940,
01305C24,
22,0,23711220.131,0.625,-124603289.762,0.008,-3322.840,43.4,1346.880,
08105C44,
22,0,23711231.012,0.100,-97093512.158,0.007,-2589.227,39.4,1328.440,
01305C44,
31,0,25351020.184,0.799,-133220493.443,0.009,-3010.174,41.3,1335.650,
08105C84,
31,0,25351033.857,0.209,-103808222.913,0.022,-2345.595,32.9,1305.420,
01305C84,
5,0,24193083.474,0.661,-127135507.316,0.006,-169.805,43.0,1324.670,
08105CA4,
5,0,24193098.346,0.117,-99066642.288,0.012,-132.316,38.0,1236.380,
01305CA4,
30,0,23936966.122,0.690,-125789616.793,0.007,1961.647,42.6,1335.980,
08105D04,
30,0,23936978.779,0.125,-98017896.557,0.009,1528.557,37.4,1275.900,
01305D04,
11,0,21749756.680,0.353,-114295742.907,0.004,-330.741,48.4,1349.200,
08105D44,
11,0,21749768.273,0.060,-89061630.382,0.003,-257.721,43.8,1296.900,
01305D44,
25,0,21576933.102,0.279,-113387555.106,0.003,2017.025,50.4,1347.120,
08105D84,
25,0,21576945.585,0.051,-88353992.093,0.002,1571.708,45.3,1319.960,
01305D84,
14,0,21106156.536,0.325,-110913596.840,0.003,-2094.299,49.1,1351.300,
08105DA4,
14,0,21106167.623,0.055,-86426221.429,0.003,-1631.922,44.5,1331.900,
01305DA4,
120,0,19611346.418,0.010,-76959136.863,0.002,-177.933,52.6,33.214,
8DC25E64,
120,0,19611346.419,0.010,-76959136.170,0.002,-177.933,52.6,1314.096,
8DC25E84,
120,0,19611346.420,0.010,-76959142.015,0.002,-177.933,52.6,54.816,
8DC25EA4*EDEA8B95
```

Table 38: Channel Tracking Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Tracking state	0 to 22 See *Table 39, Tracking State Bit Values* on page 99
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010		
	5	0x00000020	SV channel number	0-n (0 = first, n = last) n depends on the receiver
	6	0x00000040		
	7	0x00000080		
N2	8	0x00000100		
	9	0x00000200		
	10	0x00000400	Phase lock flag	0 = Not locked, 1 = Locked
	11	0x00000800	Parity known flag	0 = Not known, 1 = Known
N3	12	0x00001000	Code locked flag	0 = Not locked, 1 = Locked
	13	0x00002000	Correlator spacing	See *Table 40, Correlator Spacing Bit Values* on page 99
	14	0x00004000		
	15	0x00008000		
N4	16	0x00010000	Satellite system	0 = GPS 1, 3-7 = Reserved 2 = GEO
	17	0x00020000		
	18	0x00040000		
	19	Reserved (always 0)		
N5	20	0x00100000	Grouping [a]	0 = Not grouped, 1 = Grouped
	21	0x00200000	Frequency	0 = L1 1 = L2 2 = L5 3 = Reserved
	22	0x00400000		
	23	0x00800000	Code type	0 = C/A 1 = P 2 = P codeless 3 = L5 4-7 = Reserved
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000	Forward Error Correction (FEC)	0 = Not FEC, 1 = FEC
N7	27-30	Reserved (always 0)		
	31	0x80000000	Channel assignment	0 = Automatic, 1 = Forced

a. Grouped: Channel has an associated channel (L1/L2 pairs)

Table 39: Tracking State Bit Values

Bit Value	Description
0	C/A or C5 idle
1	C/A or C5 sky search
2	C/A or C5 wide frequency band pull-in
3	C/A or C5 narrow frequency band pull-in
4	C/A or C5 PLL
5	C/A or C5 reacquisition
6	C/A or C5 steering
7	C/A or C5 frequency-lock loop
8	P(Y) idle
9	P(Y) P-code alignment
10	P(Y) search
11	P(Y) PLL

Table 40: Correlator Spacing Bit Values

Bit Value	Description
0	Reserved
1	Standard correlator: spacing > 0.1 chip
2	Narrow correlator: spacing = 0.1 chip [a]
3	Reserved
4	Reserved

a. L5 Narrow Correlators = 0.73 chip

6.3.11 RAWEPHEM Raw Ephemeris

This log contains the raw binary information for subframes one, two and three from the satellite with the parity information removed. Each subframe is 240 bits long (10 words - 24 bits each) and the log contains a total 720 bits (90 bytes) of information (240 bits x 3 subframes). This information is preceded by the PRN number of the satellite from which it originated. This message will not be generated unless all 10 words from all 3 frames have passed parity.

Ephemeris data whose Time Of Ephemeris (TOE) is older than six hours will not be shown.

Log Type: Asynch **Message ID: 41**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33		H	0
2	prn	Satellite PRN number	Ulong	4	H
3	ref week	Ephemeris reference week number	Ulong	4	H+4
4	ref secs	Ephemeris reference time (seconds.)	Ulong	4	H+8
5	subframe1	Subframe 1 data.	Hex [30]	30	H+12
6	subframe2	Subframe 2 data.	Hex [30]	30	H+42
7	subframe3	Subframe 3 data.	Hex [30]	32[a]	H+72
8	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+104

a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment.

Recommended Input:

```
LOG RAWEPHEMA ONCHANGED
```

Example Output:

```
#RAWEPHEMA,COM1,0,70.0,FINESTEERING,1023,512190.000,00000000,2E9F,0;
7,1023,518400,
8B0FFCA6BB24FFD70173931172F3B03C9C99C678FC267E9000FFE14B88A0,
8B0FFCA6B92B26087A3187CBF13A9E079605828CD00EE8A10D73527E907E,
8B0FFCA6B9AD0088F0526BA5005A26E038131E06A8925200FFA76826FCD8
*2DDCF8B5
```

6.3.12 RAWGPSSUBFRAMEWP Raw Subframe Data

This log contains the raw GPS 300-bit subframes. The subframes will be output even when there are parity failures.

Log Type: Asynch **Message ID: 570**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	chan	Signal channel number that the frame was decoded on. See also *Table 64, Channel Configurations* on page 136.	ULong	4	H
3	PRN	Satellite PRN number	ULong	4	H+4
4	#parity failures	Number of words that had parity failures.	ULong	4	H+8
5	data	Raw subframe data	Hex[38]	40[a]	H+12
6	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+52

a. In the *Binary* log case an additional 2 bytes of padding is added to maintain 4 byte alignment.

Recommended Input:

```
LOG RAWGPSSUBFRAMEWPA ONNEW
```

Example Output:

```
#RAWGPSSUBFRAMEWPA,COM1,0,47.0,SATTIME,172,333828.000,00A40000,0000,
33331;12,7,0,8B02B079B2AEC645A728C4E13AB81B02A7FFD57BCB35701E1C4D7BA30
707C3D74668B002F040*0210cc20
```

6.3.13 RAWWAASFRAMEWP Raw SBAS Frame Data

This log contains the raw SBAS 250-bit frame. The frames are output even when there are parity failures.

Log Type: Asynch **Message ID: 571**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	chan	Signal channel number that the frame was decoded on. See *Table 64, Channel Configurations* on page 136.	ULong	4	H
3	PRN	GEO satellite PRN number	ULong	4	H+4
4	parity flag	Parity failure flag	ULong	4	H+8
5	data	Raw SBAS frame data	Hex[32]	32	H+12
6	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+44

Recommended Input:

```
LOG RAWWAASFRAMEWPA ONNEW
```

Example Output:

```
#RAWWAASFRAMEWPA,COM1,0,51.0,SATTIME,235,149994.000,00A00008,0000,3333
1;35,122,0,5363FFDFFC011FFFFBC0057B3AB190884003BFB80400E00020000F8875C
D29C0*ED5D2887
```

6.3.14 RXCOMMANDS Receiver Configuration

This log outputs all of the current receiver configuration parameters set using the commands in *Chapter 5*. When requested, one RXCOMMANDS log is output for each command type. The embedded message is the most-recent command string entered by you for that command type. If you have not yet entered a command string for that command type, the default configuration values from start-up are provided.

Log Type: Polled **Message ID: 579**

Field	Field Name	Data Description	Format	Bytes	Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	command type	Indicates which command the embedded message represents, see *Table 41, Command Type Values* on page 105.	Int	4	H
3	e msg	Embedded message of the most-recent command string you entered. If a command string has not been entered yet, the default values from start-up will be provided.	Uchar [variable]	variable	H+4
4	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	variable

Recommended Input:

```
LOG RXCOMMANDSA ONCE
```

Example Output:

```
#RXCOMMANDSA,COM1,32,84.5,COARSE,259,159079.773,00EC0008,0000,33331;
4,COM COM1 115200 N 8 1 N OFF ON*6CEEA65D
#RXCOMMANDSA,COM1,31,84.5,COARSE,259,159079.776, 00EC0008,0000,33331;
20,CHANCONFIG 14GPS8GEO*A4D8C85A
#RXCOMMANDSA,COM1,30,84.5,COARSE,259,159079.778,00EC0008,0000,33331;
15,DLLBW CA 0.2000*92BC87B6
#RXCOMMANDSA,COM1,29,84.5,COARSE,259,159079.778,00EC0008,0000,33331;
15,DLLBW PY 0.2000*F1FA98A0
#RXCOMMANDSA,COM1,28,84.5,COARSE,259,159079.780,00EC0008,0000,33331;
15,DLLBW C5 0.2000*CC4C53EF
#RXCOMMANDSA,COM1,27,84.5,COARSE,259,159079.780,00EC0008,0000,33331;
16,PLLBW CA 3.0000*F0415144
#RXCOMMANDSA,COM1,26,84.5,COARSE,259,159079.782,00EC0008,0000,33331;
16,PLLBW PY 0.2000*EE7679DC
#RXCOMMANDSA,COM1,25,84.5,COARSE,259,159079.782,00EC0008,0000,33331;
16,PLLBW C5 3.0000*9C512210
#RXCOMMANDSA,COM1,24,84.5,COARSE,259,159079.784,00EC0008,0000,33331;
5,ECUTOFF 0.0*6FAAE5BE
#RXCOMMANDSA,COM1,23,84.5,COARSE,259,159079.784,00EC0008,0000,33331;
7,FIX NONE*2092F075
#RXCOMMANDSA,COM1,22,84.5,COARSE,259,159079.786,00EC0008,0000,33331;
21,PULSEBLANKING L2 15*3F120C88
#RXCOMMANDSA,COM1,21,84.5,COARSE,259,159079.786,00EC0008,0000,33331;
21,PULSEBLANKING L5 127*8FEC043B
#RXCOMMANDSA,COM1,20,84.5,COARSE,259,159079.788,00EC0008,0000,33331;
14,PLLTHRESHOLD 0.24 0.08 PY*D812EEBC
```

```
#RXCOMMANDSA,COM1,19,84.5,COARSE,259,159079.788,00EC0008,0000,33331;
39,DLLORDER GPS 1*3F35AC11
#RXCOMMANDSA,COM1,18,84.5,COARSE,259,159079.790,00EC0008,0000,33331;
39,DLLORDER WAAS 2*1C55677C
#RXCOMMANDSA,COM1,17,84.5,COARSE,259,159079.790,00EC0008,0000,33331;
6,EXTERNALCLOCK OCXO 5MHZ 0.000000 0.000000 0.000000*1693AB6B
#RXCOMMANDSA,COM1,16,84.5,COARSE,259,159079.792,00EC0008,0000,33331;
2,ANTENNAPOWER OFF*52449F3F
#RXCOMMANDSA,COM1,15,84.5,COARSE,259,159079.794,00EC0008,0000,33331;
3,CLOCKADJUST DISABLE*2E60C42B
#RXCOMMANDSA,COM1,14,84.5,COARSE,259,159079.794,00EC0008,0000,33331;
4,COM COM2 9600 N 8 1 N OFF ON*DB700069
#RXCOMMANDSA,COM1,13,84.5,COARSE,259,159079.794,00EC0008,0000,33331;
13,THRESHOLD 36 20 36 CA GPS*7D76909B
#RXCOMMANDSA,COM1,12,84.5,COARSE,259,159079.796,00EC0008,0000,33331;
13,THRESHOLD 33 28 36 CA WAAS*27EFED2E
#RXCOMMANDSA,COM1,11,84.5,COARSE,259,159079.796,00EC0008,0000,33331;
13,THRESHOLD 36 28 36 C5 WAAS*594F205C
#RXCOMMANDSA,COM1,10,84.5,COARSE,259,159079.798,00EC0008,0000,33331;
4,COM COM3 230400 N 8 1 N OFF ON*9AC97102
#RXCOMMANDSA,COM1,9,84.5,COARSE,259,159079.800,00EC0008,0000,33331;
9,LOG COM3 AGCSTATSB ONTIME 1.000000 0.000000 NOHOLD*5F037189
#RXCOMMANDSA,COM1,8,84.5,COARSE,259,159079.802,00EC0008,0000,33331;
9,LOG COM3 ALLSQMDATAB ONNEW 0.000000 0.000000 NOHOLD*4EA68B65
#RXCOMMANDSA,COM1,7,84.5,COARSE,259,159079.802,00EC0008,0000,33331;
9,LOG COM3 RANGEB ONTIME 1.000000 0.000000 NOHOLD*DCEBE08F
#RXCOMMANDSA,COM1,6,84.5,COARSE,259,159079.804,00EC0008,0000,33331;
9,LOG COM3 RAWGPSSUBFRAMEWPB ONNEW 0.000000 0.000000 NOHOLD*E37A244E
#RXCOMMANDSA,COM1,5,84.5,COARSE,259,159079.806,00EC0008,0000,33331;
9,LOG COM3 RAWWAASFRAMEWPB ONNEW 0.000000 0.000000 NOHOLD*6C4D2C05
#RXCOMMANDSA,COM1,4,84.5,COARSE,259,159079.806,00EC0008,0000,33331;
9,LOG COM3 RXSECSTATUSB ONTIME 1.000000 0.000000 NOHOLD*DEFA4B65
#RXCOMMANDSA,COM1,3,84.5,COARSE,259,159079.808,00EC0008,0000,33331;
9,LOG COM3 SYSTEMLEVELSB ONTIME 1.000000 0.000000 NOHOLD*B9F64E27
#RXCOMMANDSA,COM1,2,84.5,COARSE,259,159079.808,00EC0008,0000,33331;
9,LOG COM3 TIMEB ONTIME 1.000000 0.000000 NOHOLD*2A99A140
#RXCOMMANDSA,COM1,1,84.5,COARSE,259,159079.810,00EC0008,0000,33331;
9,LOG COM3 RAWEPHEMB ONCHANGED 0.000000 0.000000 NOHOLD*CD848C24
#RXCOMMANDSA,COM1,0,84.5,COARSE,259,159079.812,00EC0008,0000,33331;
9,LOG COM3 RXCOMMANDSA ONTIME 900.000000 0.700000 NOHOLD*F0B72136
```

Table 41: Command Type Values

ASCII	BINARY	Description
0	0	ASSIGN command
1	1	ASSIGNALL command
2	2	Reserved
3	3	
4	4	COM command
5	5	ECUTOFF command
6	6	Reserved
7	7	FIX command
8	8	FRESET command
9	9	LOG command
10	10	RESET command
11	11	SETAPPROXTIME command
12	12	SETSATELLITE command
13	13	THRESHOLD command
14	14	PLLTHRESHOLD command
15	15	DLLBW command
16	16	PLLBW command
17	17	Reserved
18	18	
19	19	AGCMODE command
20	20	CHANCONFIG command
21	21	PULSEBLANKING command
22	22	UNLOG command
23	23	CARRIERFREQOFFSET command
24	24	CODEFREQOFFSET command

6.3.15 RXSECSTATUS Receiver Section Status

This log is used to output the version and status information for each receiver card in the receiver section.

Log Type: Synchronous **Message ID: 638**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	# comp	Number of components (cards, and so on)	Ulong	4	H
3	type	Component type. See *Table 42, Component Type* on page 107.	Enum	4	H+4
4	section	Receiver section. See *Table 43, Receiver Section* on page 107.	Enum	4	H+8
5	model	Model	Char[16]	16	H+12
6	psn	Product serial number	Char[16]	16	H+28
7	sw version	Firmware software version	Char[16]	16	H+44
8	status word	Receiver status word (receiver cards) or clock status word (clock/status card). See *Table 46, Receiver Status* on page 109 or *Table 49, Clock Status* on page 111 respectively.	Ulong	4	H+60
9	error word	Receiver error word (receiver cards) or clock error word (clock/status card). A value of zero indicates no errors. See *Table 44, Receiver Error* on page 108 or *Table 47, Clock Error* on page 110 respectively.	Ulong	4	H+64
10	aux1stat	Receiver auxiliary 1 status word (receiver cards) or clock auxiliary 1 status word (clock/status card). See *Table 45, Receiver Auxiliary 1 Status* on page 108 or *Table 48, Clock Auxiliary 1 Status* on page 110 respectively.	Ulong	4	H+68
11...	Next component offset = H + 4 + (#comp x 68)				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+4+ (#comp x 68)

Recommended Input:

```
LOG RXSECSTATUS ONNEW
```

Example Output:

```
#RXSECSTATUSA,COM1,0,70.0,FINE,250,425024.000,00A00008,0000,33331;
3,
GPSCARD,PM,"L1L2GEO","SVM04040005","2.100A3",00A00008,00000000,
00400000,L5EURO,PS1,"L5GEO","DXB03490022","4.100A3",00800008,00000000,
00400000,CLKSTAT,CLKSTAT,"CLKSTAT","DVW03220009","3.100A3",00A00000,
00000000,00000000*7E41FFC3
```

Table 42: Component Type

ASCII	Binary	Description
UNKNOWN	0	Unknown component
GPSCARD	1	OEM4 Family component
CLKSTAT	6	Clock/Status Card component
L5EURO	7	L5 Euro component

Table 43: Receiver Section

ASCII	Binary	Description
PM	0	Primary receiver section master card
PS1	1	Primary receiver section slave 1 card
PS2	2	Primary receiver section slave 2 card
PS3	3	Primary receiver section slave 3 card
S1M	4	First secondary receiver section master card
S1S1	5	First secondary receiver section slave 1 card
S1S2	6	First secondary receiver section slave 2 card
S1S3	7	First secondary receiver section slave 3 card
S2M	8	Second secondary receiver section master card
S2S1	9	Second secondary receiver section slave 1 card
S2S2	10	Second secondary receiver section slave 2 card
S2S3	11	Second secondary receiver section slave 3 card
CLKSTAT	12	Clock/Status card
UNKNOWN	13	Unknown receiver section

Table 44: Receiver Error

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Dynamic Random Access Memory (DRAM) status	OK	Error
	1	0x00000002	Reserved	OK	Error
	2	0x00000004		OK	Error
	3	0x00000008	PLL RF5 - hardware status - L5	OK	Error
N1	4	0x00000010	Electronic Serial Number (ESN) access status	OK	Error
	5	0x00000020	Authorization code status	OK	Error
	6	0x00000040	Reserved	OK	Error
	7	0x00000080	Supply voltage status	OK	Error
N2	8	0x00000100	Reserved	OK	Error
	9	0x00000200	Temperature status (as compared against acceptable limits)	OK	Error
	10	0x00000400	MINOS4 status (FPGA)	OK	Error
	11	0x00000800	PLL RF1 hardware status - L1	OK	Error
N3	12	0x00001000	PLL RF2 hardware status - L2	OK	Error
	13	0x00002000	Reserved	OK	Error
	14	0x00004000		OK	Error
	15	0x00008000	NVM status	OK	Error
N4	16	0x00010000	Stack usage status	OK	Error
	17	0x00020000	Memory usage status	OK	Error
	18	0x00040000	Message queue usage status	OK	Error
	19	0x00080000	Message usage status	OK	Error

Table 45: Receiver Auxiliary 1 Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Reserved		
	1	0x00000002			
	2	0x00000004			
	3	0x00000008			
N1	4	0x00000010			
	5	0x00000020	USB1 buffer overrun flag	No overrun	Overrun
	6	0x00000040	USB2 buffer overrun flag	No overrun	Overrun
	7	0x00000080	USB3 buffer overrun flag	No overrun	Overrun
N2	8	0x00000100	OTG243 Port 1 overrun flag	No overrun	Overrun
	9	0x00000200	OTG243 Port 2 overrun flag	No overrun	Overrun
	10	0x00000400	OTG243 Port 3 overrun flag	No overrun	Overrun
	11	0x00000800	Reserved		

Table 46: Receiver Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Error flag, see *Table 44, Receiver Error* on page 108	No error	Error
	1	0x00000002	Temperature status	Within specifications	Warning
	2	0x00000004	Voltage supply status	OK	Warning
	3	0x00000008	Antenna power status	Powered	Not powered
N1	4	0x00000010	LNA status	OK	Failure
	5	0x00000020	Antenna open flag	OK	Open
	6	0x00000040	Antenna shorted flag	OK	Shorted
	7	0x00000080	CPU overload flag	No overload	Overload
N2	8	0x00000100	COM1 buffer overrun flag	No overrun	Overrun
	9	0x00000200	COM2 buffer overrun flag [a]	No overrun	Overrun
	10	0x00000400	COM3 buffer overrun flag	No overrun	Overrun
	11	0x00000800	Reserved		
N3	12	0x00001000			
	13	0x00002000			
	14	0x00004000			
	15	0x00008000			
N4	16	0x00010000			
	17	0x00020000			
	18	0x00040000	Almanac flag	Valid	Invalid
	19	0x00080000	Position solution flag	Valid	Invalid
N5	20	0x00100000	Position fixed flag, see *FIX* on *Page 61*	Not fixed	Fixed
	21	0x00200000	Clock steering status	Enabled	Disabled
	22	0x00400000	Clock model flag	Valid	Invalid
	23	0x00800000	External oscillator flag	PLL not locked	PLL locked
N6	24	0x01000000	Stack warning	OK	Warning
	25	0x02000000	Memory warning	OK	Warning
	26	0x04000000	Message queue warning	OK	Warning
	27	0x08000000	Message block usage warning	OK	Warning
N7	28	0x10000000	Reserved		
	29	0x20000000			
	30	0x40000000			
	31	0x80000000	AUX1 status event flag	No event	Event

a. Only applies to Euro-3M cards

Table 47: Clock Error

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Dynamic Random Access Memory (DRAM) status	OK	Error
	1	0x00000002	Reserved	OK	Error
	2	0x00000004	Fan status	OK	Error
	3	0x00000008	Reserved	OK	Error
N1	4	0x00000010		OK	Error
	5	0x00000020		OK	Error
	6	0x00000040		OK	Error
	7	0x00000080		OK	Error
N2	8	0x00000100		OK	Error
	9	0x00000200	Temperature status (as compared against acceptable limits)	OK	Error
	10	0x00000400	Reserved	OK	Error
	11	0x00000800		OK	Error
N3	12	0x00001000		OK	Error
	13	0x00002000		OK	Error
	14	0x00004000		OK	Error
	15	0x00008000	NVM status	OK	Error
N4	16	0x00010000	Stack usage status	OK	Error
	17	0x00020000	Memory usage status	OK	Error
	18	0x00040000	Message queue usage status	OK	Error
	19	0x00080000	Message usage status	OK	Error

Table 48: Clock Auxiliary 1 Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Status of card 1	OK	Error
	1	0x00000002	Status of card 2	OK	Error
	2	0x00000004	Status of card 3	OK	Error
	3	0x00000008	Status of card 4	OK	Error
N1	4	0x00000010	Status of card 5	OK	Error
	5	0x00000020	Status of card 6	OK	Error
	6	0x00000040	Status of card 7	OK	Error
	7	0x00000080	Status of card 8	OK	Error
N2	8	0x00000100	Status of card 9	OK	Error
	9	0x00000200	Status of card 10	OK	Error
	10	0x00000400	Status of card 11	OK	Error
	11	0x00000800	Status of card 12	OK	Error

Table 49: Clock Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Error flag, see *Table 47, Clock Error* on page 110	No error	Error
	1	0x00000002	Temperature status	Within specifications	Warning
	2	0x00000004	Fan 1 voltage status	Within specifications	Warning
	3	0x00000008	Fan 2 voltage status	Within specifications	Warning
N1	4	0x00000010	Fan 1 operational status	Running	Shut down
	5	0x00000020	Fan 2 operational status	Running	Shut down
	6	0x00000040	CPU core voltage status	Within specifications	Warning
	7	0x00000080	Reserved		
N2	8	0x00000100			
	9	0x00000200	USB1 buffer overrun flag	No overrun	Overrun
	10	0x00000400	USB2 buffer overrun flag	No overrun	Overrun
	11	0x00000800	USB3 buffer overrun flag	No overrun	Overrun
N3	12	0x00001000	Reserved		
	13	0x00002000			
	14	0x00004000	5 V supply voltage status	Within specifications	Warning
	15	0x00008000	3.3 supply voltage status	Within specifications	Warning
N4	16	0x00010000	External clock voltage supply status	Within specifications	Warning
	17	0x00020000	External clock power status	Within specifications	Warning
	18	0x00040000	OTG243 Port 1 overrun flag	No overrun	Overrun
	19	0x00080000	OTG243 Port 2 overrun flag	No overrun	Overrun
N5	20	0x00100000	OTG243 Port 3 overrun flag	No overrun	Overrun
	21	0x00200000	LCD detection	Detected	Not Detected
	22	0x00400000	Reserved		
	23	0x00800000	External oscillator detection	PLL not locked	PLL locked
N6	24	0x01000000	Stack usage status	OK	Warning
	25	0x02000000	Memory usage status	OK	Warning
	26	0x04000000	Message queue usage status	OK	Warning
	27	0x08000000	Message usage status	OK	Warning
N7	28	0x10000000	Reserved		
	29	0x20000000			
	30	0x40000000			
	31	0x80000000	AUX1 status event flag	No event	Event

6.3.16 SATVIS Satellite Visibility

Satellite visibility log with additional satellite information. This log only gives GPS data (no GEO data).

Log Type: Synch **Message ID: 48**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	sat vis	Indicates if the satellite visibility is valid. See *Table 50, Satellite Visibility Values* on page 113.	Enum	4	H
3	comp alm	Indicates if the complete almanac was used. See *Table 51, Complete Almanac Flag Values* on page 113.	Enum	4	H+4
4	#sat	Number of satellite data sets to follow	ULong	4	H+8
5	PRN	GPS satellite PRN number of range measurement (GPS only).	Short	2	H+12
6	Reserved		Short	2	H+14
7	health	Satellite health[a]	ULong	4	H+16
8	elev	Elevation (degrees)	Double	8	H+20
9	az	Azimuth (degrees)	Double	8	H+28
10	true dop	Theoretical Doppler of satellite (Hz)	Double	8	H+36
11	app dop	Apparent Doppler for this receiver (Hz)	Double	8	H+44
12	Next satellite data set, offset = H + 12 + (# previous sat x 40)				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+12+ (#sat x 40)

a. Satellite health values may be found in ICD-GPS-200. To obtain copies of ICD-GPS-200, refer to the ARINC contact details in the *Standards/References* section of our *GNSS Reference Book* available on our website at www.novatel.com/an-introduction-to-gnss/.

Recommended Input:

```
LOG SATVISA ONTIME 60
```

ASCII Example:

```
#SATVISA,COM1,0,44.0,FINE,1039,490308.000,00000028,6002,0;
TRUE,TRUE,27,
14,0,0,74.5,267.4,458.2,458.926672761,
25,0,0,61.3,73.7,-1252.6,-1251.902056196,
1,0,0,55.9,277.4,1799.2,1799.897879028,
16,0,0,33.6,305.9,2874.8,2875.534296744,
...
26,0,0,-82.0,114.8,-188.9,-188.237459086
*bf8c9522
```

Table 50: Satellite Visibility Values

ASCII	Binary	Description
FALSE	0	Satellite visibility is invalid
TRUE	1	Satellite visibility is valid

Table 51: Complete Almanac Flag Values

ASCII	Binary	Description
FALSE	0	Complete almanac was not used
TRUE	1	Complete almanac was used

6.3.17 SYSTEMLEVELS System Hardware Levels

This log contains environmental and voltage parameters for the receiver card and the clock/status card.

Log Type: Synchronous **Message ID: 653**

Field	Field Name	Data Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	# comp	Number of components	Ulong	4	H
3	type	Component type, see *Table 42, Component Type* on page 107	Enum	4	H + 4
4	receiver section	Receiver section, see *Table 43, Receiver Section* on page 107	Enum	4	H + 8
5	temp	Board temperature (°C)	Float	4	H + 12
6	ant current/ logic volt	Approximate internal antenna current (A) (receiver cards) or 3.3 V digital logic voltage (clock/status card)	Float	4	H + 16
7	core volt	1V CPU core voltage (V)	Float	4	H + 20
8	supply volt	5V supply voltage (V)	Float	4	H + 24
9	RF volt/ Fan1 volt	5V RF supply voltage (V) (receiver cards) or Fan1 voltage (clock/status card)	Float	4	H+28
10	Internal LNA volt/ Fan2 volt	Internal LNA voltage (V) (receiver cards) or Fan2 voltage (clock/status card)	Float	4	H+32
11	3.3 V supply/ Fan1 RPM	3.3 V supply voltage (receiver cards) or Fan 1 rotations per minute (clock/status cards)	Float	4	H+36
12	TCXO control volt/ Fan2 RPM	Control voltage for TCXO (receiver cards) or Fan 2 rotations per minute (clock/status cards)	Float	4	H+40
13	idle time/oscillator control volt	Idle time (%) (receiver cards) or card clock voltage (clock/status card)	Float	4	H+44
14	LNA output volt/ local oscillator power	LNA output voltage (V) (receiver cards) or card clock power (clock/status card)	Float	4	H+48
15...	Next component offset = H + 4 + (# comp x 48)				
variable	32-bit CRC (ASCII and Binary only)		Hex	4	H + 4 + (# comp x 48)

Recommended Input:

```
LOG SYSTEMLEVELSA ONTIME 1
```

Example Output:

```
#SYSTEMLEVELSA,COM1,0,47.0,FINE,258,508948.000,00A40008,0000,33331;
3,
CLKSTAT,CLKSTAT,37.000,3.285,1.196,5.070,9.650,9.580,1795.000,
1795.000,2.679,12.938,
GPSCARD,PM,37.000,0.000,1.204,4.974,5.023,0.043,3.311,1.457,48.723,
0.000,
L5EURO,PS1,31.000,0.000,1.204,5.021,5.007,0.275,3.311,1.444,86.541,
0.047*406940FC
```

6.3.18 TIME Time Data

This log is output at the *Time* port at a maximum rate of 1 Hz and provides the GPS time of the receiver's 1 PPS signal. It also includes the information on the receiver clock offset and the clock model status.

Log Type: Sync **Message ID: 101**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	clock status	Clock model status (not including current measurement data). See *Table 34, Clock Model Status Values* on page 93.	Enum	4	H
3	offset	Receiver clock offset, in seconds from GPS time. A positive offset implies that the receiver clock is ahead of GPS time. To derive GPS time, use the following formula: GPS time = receiver time - offset	Double	8	H+4
4	offset std	Receiver clock offset standard deviation (s)	Double	8	H+12
5-12	Reserved			24	H+20
13	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+44

Recommended Input:

```
LOG TIMEA ONTIME 1
```

Example Output:

```
#TIMEA,COM1,0,58.0,FINE,1049,248050.000,00000128,5C46,0;
VALID,-0.000000002,0.000001901,-13.00000000294,2000,2,15,20,53,57011,
VALID*d6f14d5d
```

6.3.19 TRACKSTAT Tracking Status

These logs provide channel tracking status information for each of the receiver's channels.

Log Type: Synch **Message ID: 83**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	sol status	Solution status. See *Table 36, Solution Status Values* on page 95.	Enum	4	H
3	pos type	Position type. See *Table 37, Position Type Values* on page 95.	Enum	4	H+4
4	cutoff	Primary antenna low elevation cut-off angle	Float	4	H+8
5	# chans	Number of hardware channel data sets to follow	Long	4	H+12
6	PRN	Satellite PRN number of range measurement.	Short	2	H+16
7	Reserved		Short	2	H+18
8	ch-tr-status	Channel tracking status. See *Table 38, Channel Tracking Status* on page 98.	ULong	4	H+20
9	psr	Pseudorange (m)	Double	8	H+24
10	Doppler	Doppler frequency (Hz)	Float	4	H+32
11	C/No	Carrier to noise density ratio (dB-Hz)	Float	4	H+38
12	locktime	Number of seconds of continuous tracking (no cycle slips)	Float	4	H+42
13	psr res	Pseudorange residual from pseudorange filter (m)	Float	4	H+46
14	reject	Range reject code from pseudorange filter. See *Table 52, Reject Code Values* on page 117.	Enum	4	H+50
15	psr weight	Pseudorange filter weighting	Float	4	H+54
16...	Next hardware channel data set, offset = H+16 + (# previous chans x 40)				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+16 + (#chans x 40)

Recommended Input:

```
LOG TRACKSTATA ONTIME 1
```

Example Output:

```
#TRACKSTATA,COM1,0,64.5,FINE,1048,507426.700,00000028,228E,0;
SOL_COMPUTED,SINGLE,0.0,24,
5,0,8105C04,25052294.167,3388.063,40.188,63.560,7.209,GOOD, 1.000,
...
2,0,1305C2B,21433408.821,1310.921,43.913,514.040,0.000,OBSL2, 1.000,
...
26,0,1305D6B,24444419.776,2365.217,31.530,1506.520,0.000,OBSL2, 1.000
*cd40e0aa
```

Table 52: Reject Code Values

ASCII	Binary	Description
GOOD	0	Observations are good
BADHEALTH	1	Bad satellite health is indicated by ephemeris data
OLDEPHEMERIS	2	Old ephemeris due to date not being updated during the last 3 hours
ECCENTRICANOMALY	3	Eccentric anomaly error during computation of the satellite's position
TRUEANOMALY	4	True anomaly error during computation of the satellite's position
SATCOORDINATEERROR	5	Satellite coordinate error during computation of the satellite's position
ELEVATIONERROR	6	Elevation error due to the satellite being below the cut-off angle
MISCLOSURE	7	Misclosure too large due to excessive gap between estimated and actual positions
NOEPHEMERIS	9	Ephemeris data for this satellite has not yet been received
INVALIDIODE	10	Invalid IODE (Issue Of Data Ephemeris) due to mismatch between differential stations
LOWPOWER	12	Low power meaning that the satellite is rejected due to low carrier/noise ratio
OBSL2	13	Observation is on L2
NOIONOCORR	16	No compatible ionospheric correction is available for this particular satellite
BAD_INTEGRITY	17	Bad integrity indicating a large variation between the measured range to the satellite and the theoretical range computed from the ephemeris
OBSL5	18	Observation is on L5 (GEO satellite)
NA	99	No observation (a reject code is not applicable)

6.3.20 VERSION Version Information

This log contains the version information for all components of a system. When using a standard receiver, there will only be one component in the log.

Log Type: Polled **Message ID: 37**

Field	Field Name	Description	Format	Binary Bytes	Binary Offset
1	header	This field contains the message header, in *ASCII* or *Binary* format. See *Section 4.3, Log Formats* on page 33.		H	0
2	# comp	Number of components (cards, etc.)	Long	4	H
3	type	Component type. See *Table 53, Component Type Values* on page 119.	Enum	4	H+4
4	model	Model	Char[16]	16	H+8
5	psn	Product serial number	Char[16]	16	H+24
6	hw version	Hardware version. See *Table 54, Version Log Field Formats* on page 119.	Char[16]	16	H+40
7	sw version	Firmware software version. See*Table 54, Version Log Field Formats* on page 119.	Char[16]	16	H+56
8	boot version	Boot code version. See *Table 54, Version Log Field Formats* on page 119.	Char[16]	16	H+72
9	comp date	Firmware compile date. See *Table 54, Version Log Field Formats* on page 119.	Char[12]	12	H+88
10	comp time	Firmware compile time. See *Table 54, Version Log Field Formats* on page 119.	Char[12]	12	H+100
11...	Next component, offset = H + 4 + (# previous comp x 108)				
variable	32-bit CRC (*ASCII* and *Binary* only)		Hex	4	H+4+ (#comp x 108)

Recommended Input:

```
LOG VERSIONA ONCE
```

Example Output:

```
#VERSIONA,COM1,0,69.5,FINE,250,425075.594,00A00008,0000,33331;
5,
GPSCARD,"L1L2GEO","SVM04040005","E4G2-2.00-222","2.100A3","2.100A3DB",
"2004/JUN/ 7","13:57:57",
CPLD,"","","CPLD-1","","","","",
L5EURO,"L5GEO","DXB03490022","L5EURO-1.00-222","4.100A3","2.100A3DB",
"2004/JUN/ 7","14:01:18",
FPGA,"XILINX","","0.0.12","GPS","","2004/MAR/23","17:35:29",CLKSTAT,
"CLKSTAT","DVW03220009","CLKS-1.00-222","3.100A3",
"2.100A3DB","2004/JUN/ 7","14:00:21"*D9683AE7
```

Table 53: Component Type Values

ASCII	Binary	Description
UNKNOWN	0	Unknown component
GPSCARD	1	Receiver component
FPGA	5	Field Programmable Gate Array
CLKSTAT	6	Clock/Status card
L5EURO	7	L5 Euro card
CPLD	8	Complex programmable logic device

Table 54: Version Log Field Formats

Field Name	Field Format	Description
hw version	P-RS-CCC	P = hardware platform (e.g. OEM4) R = hardware revision (e.g.3.10) S = processor revision (e.g. A) CCC = COM port configuration (e.g. 22T)[a]
sw version, boot version	VV.RRR[Xxxx]	VV = major revision number RRR = minor revision number X = Special (S), Beta (B), Internal Development (D, A) xxx = number
comp date	YYYY/MM/DD	YYYY = year MM = month DD = day (1 - 31)
comp time	HH:MM:SS	HH = hour MM = minutes SS = seconds

a. One character for each of the COM ports 1, 2, and 3. Characters are: 2 for RS-232, 4 for RS-422, and T for LV-TTL. Therefore, the example is for a receiver that uses RS-232 for COM 1 and COM 2 and LV-TTL for COM 3.

Chapter 7 Firmware Updates

As described in *Chapter 1*, the GUST Receiver is comprised of multiple receiver cards. Each receiver card has its own firmware (program software) but all the cards in one receiver section must have the same firmware. The firmware is stored in on-board, non-volatile memory, which allows the receiver's firmware to be updated in the field. Thus, updating firmware takes only a few minutes instead of the several days which would be required if the receiver had to be sent to a service depot.

When updating to a higher revision level, you will need to transfer the new firmware to the appropriate card using one of NovAtel's firmware loading utilities. *WinLoad* is designed for use with Window-based systems and *MultiLoad* was developed for use with Unix-based systems.

Below is shown an outline of the procedure for updating your receiver's firmware:

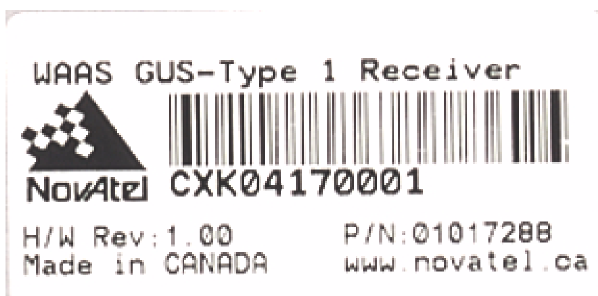
1. Contact the NovAtel at the support@novatel.com e-mail address
2. Download update files
3. Decompress files
4. Run the firmware loading utility

7.1 Contacting the NovAtel

The first step in updating the receiver is to contact NovAtel Customer Support via any of the methods described in *Customer Service* on *Page 11*.

When you call, be sure to have the GUST Receiver's serial number and program revision level available. This information is printed on the rear panel of the GUST Receiver, as shown in *Figure 21*.

Figure 21: Serial Number and Version Label



You can also verify the information by powering up the receiver and requesting the VERSION log (page 118).

After conferring with Customer Support to establish the required revision level, as well as the terms and conditions of your firmware update, Customer Support will issue you authorization codes or *auth-codes*, for each of the receiver cards. The auth-code is required to unlock the receiver features according to your authorized model type.

If it is determined that you will be updating to a higher revision level with the use of the firmware loading utility, Customer Support will confirm with you as to the procedures, files, and methods required for using this utility. As the main utility and other necessary files are generally provided in a compressed file format, you will also be given a file decompression password. The utility and update files are available from Customer Support by FTP, e-mail or diskette.

7.2 Downloading the Files

Typically, there are two files required when performing firmware updates on a particular receiver card:

- WINLOAD.EXE (the firmware loading utility program)
- `XXXX.HEX` (the firmware update file)

Typical GUST Receiver firmware files might be named 2100.HEX, for example.

To proceed with your update, you will first need to download the appropriate files from NovAtel's FTP site at ftp.novatel.ca, or via e-mail at support@novatel.com. If downloading is not possible, the files can be mailed to you on diskette.

The files are available in compressed, password-protected file format. The compressed form of the files may have different names than the names discussed above; Customer Support will advise you as to the exact names of the files you need. As well, Customer Support will provide you with a file de-compression password.

7.3 Decompressing the Files

After copying the compressed files to an appropriate directory on your computer, each file must be decompressed. The syntax for decompression is as follows:

Syntax:

[filename][password]

where filename is the name of the compressed file (but not including the .EXE extension) and password is the password required to allow decompression.

A window-based dialog is provided for password entry.

The self-extracting archive then generates the following files:

WinLoad.exe	WinLoad utility program
HowTo.txt	Instructions on how to use the WinLoad utility
WhatsNew.txt	Information on the changes made in the firmware since the last revision
XXXX.hex	Firmware version update file where XXXX = program version level (for example 2000.hex)

7.4 Running MultiLoad

MultiLoad is used to load GUST receivers. The current version of MultiLoad operates on AIX 5.2 and AIX 4.2.1 versions of Unix.

When run, MultiLoad loads all receiver cards within a receiver section. Any interruption in loading any receiver card results in the firmware being deleted from all receiver cards within the receiver section being loaded.

7.4.1 Loading Firmware Onto GUST Receivers

MultiLoad is executed using the following format

```
MultiLoad -u <filename> [options]
```

> The *.dat and *.hex files must be in the same directory as MultiLoad.

Valid options are shown below:

Option	Option	Input	Default	Description	Valid Range
--version	-v			Version Information	
--help	-h			Help File	
--update	-u	<x.xxx.dat>		Update all cards for the platform type specified in the hex file with software x.xxx	
--baud	-b	<rate>	38400	Download baud rate	9600, 19200, 38400
--comport	-c	<port>	Com4	Communications port	com1 – com11
--suppress	-s			Suppress output of results file	
--quiet	-q			No output information	
--clks	-z	<hexfilename>		Load clock card with different software version (hexfilename is the software)	
--debug	-d			Output debug information	

The –u option must be chosen, and for the Euro-3M cards a *.dat file must be specified, for the program to run.

The following example is for an update disk to load SW version 2.000A5 on Euro-3M cards and 3.000A5 on the clock status card. If Euro-L5 cards are present, it loads the Euro-L5 cards with 4.000A5.

```
MultiLoad -u 2.000A5.dat -c com5
```

The following example will load 2.100A12 on all Euro-3M cards and 4.100A12 on all Euro-L5 cards (if present). 3.100A10 will be loaded on the clock status card.

```
MultiLoad -u 2.100A12.dat -z 3.100A10
```

7.4.1.1 Update File (-u option)

```
-u <updatefilename>
```

The update filename must be in the format 2.xxx.dat, where 2.xxx is the software version to be loaded (for example, 2.100 or 2.000). The update file name MUST begin with a “2” since we assume a Euro-3M card is always present.

The program makes the assumption that the filename for the software for the clock status cards is of the format 3.xxx and the filename for the Euro-L5 cards is of the format 4.xxx. All cards within the receiver section are loaded with the same software version. Euro-3M cards are loaded with 2.xxx, clock status cards are loaded with 3.xxx and Euro-L5 cards, if present, are loaded with 4.xxx.

The format of the input file MUST be in this format:

```
PSN Model AuthCode
```

Example:

```
DVM03060017 MEDLL 80A4,2C7A,A31F,60AA,4EF3,MEDLL
DVM03060018 MEDLL 90A4,3C7A,B31F,70AA,4EF3,MEDLL
DVM03060019 MEDLL A0A4,4C7A,C31F,8AA,4EF3,MEDLL
```

7.4.1.2 Load Clock Status Card with Different Software (-z option)

A different software version can be loaded onto the clock status card by using the –z option.

```
-z <hexfilename> option
```

When this option is chosen, a hex filename must be specified. The clock card is loaded with the firmware specified by hexfilename.

7.4.1.3 Communications

MultiLoad currently allows communications on COM ports 1 through 11 at a baud rate of 9600, 19200 or 38400 bps. The default COM port is COM3 and the default download rate is 38400 bps.

Assuming there are 3 receiver cards, MultiLoad will take approximately the following amount of time to load each receiver section:

Baud Rate (bps)	Approximate Download Time
9600	27 minutes
19200	15 minutes
38400	8 minutes

7.4.1.4 Output File

An output file named loadresults.txt is created when MultiLoad is run. This file contains information on whether the loading of software was successful. The file is created in the same directory as the MultiLoad program. If it cannot create the file in that directory, it creates one in the root directory. Using the –s option suppresses the creation of this file.

An example of all 3 receiver cards having been loaded successfully is shown below:

```
MultiLoad Version: 1.103
Starting First Stage loader.
First Stage loader completed.
Starting Second Stage loader.
Receiver card SVM03060017 in position 0 was loaded successfully with
2000A43.hex
Starting Second Stage loader.
Receiver card DVM03060018 in position 1 was loaded successfully with
2000A43.hex
Starting Second Stage loader.
Receiver card DVW03220013 in position 2 was loaded successfully with
3000.hex

Successfully loaded 3 cards out of 3 cards
```

7.4.2 Additional Program Options

7.4.2.1 Version (-v option)

Choosing this option outputs the MultiLoad version. This command is for information only and does not allow the program to run, even when other options are entered on the same line. Start a new command line to load cards.

7.4.2.2 Help (-h option)

Choosing this option outputs the following help menu. This command is for information only and does not allow the program to run, even when other options are entered on the same line. Start a new command line to load cards.

"--update, -u <filename>:	update disk file (2.xxx.dat to load SW 2.xxx)"
"--clk, -z <hexfile>:	load only clock status cards with hexfile"
"--baud, -b <rate>:	specify baud rate to use for transfer; default 38400bps"
"--commport, -c <port>:	communications port [com1|com2|...com11]; default=com3"
"--quiet, -q:	execute without output"
"--debug, -d:	execute with debug output"
"--suppress, -s:	suppress results file"
"--version, -v:	application version info"
"--help, -h, ?:	bring up this display"

7.4.2.3 Debug (-d option)

This option outputs extra information to the screen. It displays certain events to help in debugging MultiLoad. No additional information is output in the LoadResults.txt file.

7.4.2.4 Quiet (-q option)

This option suppresses the majority of data output to the screen while the program is running, including the progress bar. Only program initiation and program termination is indicated on the screen. The `LoadResults.txt` file is still created.

7.4.3 Errors During Loading

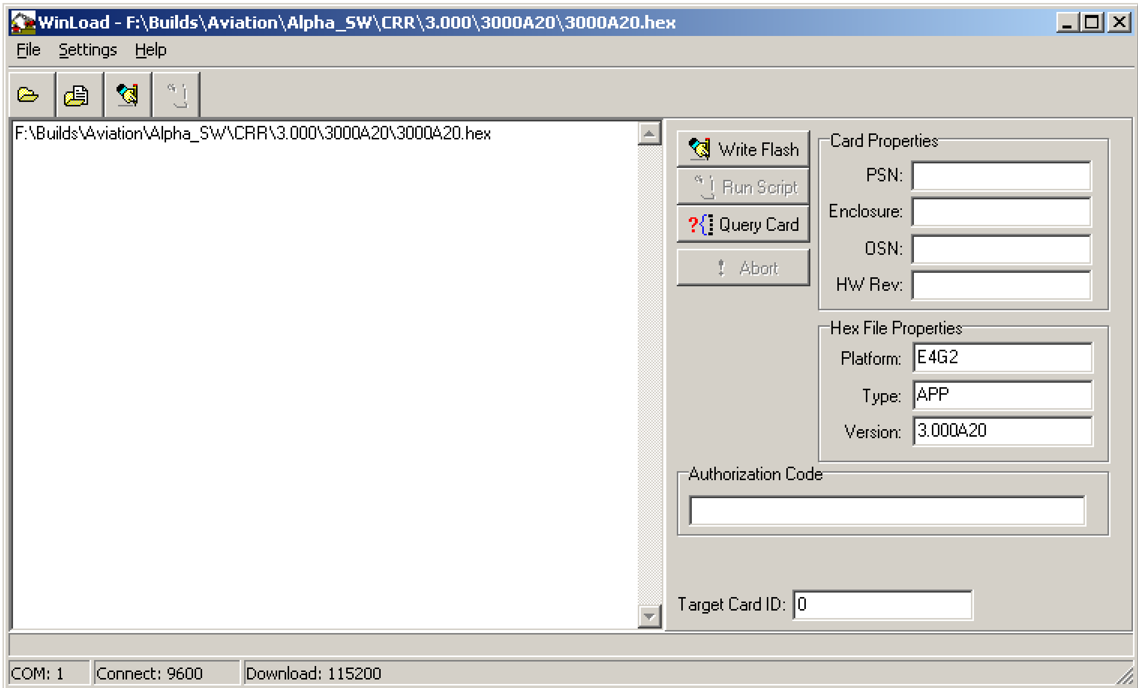
If an error occurs during loading, all receiver cards within the receiver section will have their firmware deleted, including the clock card. All cards must be reloaded.

In order to reload the cards, first allow the receiver to recover from the error for approximately 2 minutes. Rerun MultiLoad. Multiple retries may be required to connect to the receiver properly.

7.5 Running WinLoad

WinLoad is a windows based program used to download firmware to receiver cards. The main screen is shown in *Figure 22*.

Figure 22: Main Screen of WinLoad

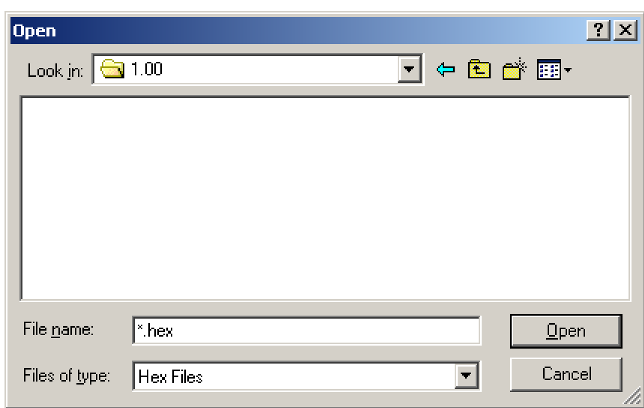


If you are running WinLoad for the first time you will need to make sure the file and communications settings are correct.

7.5.1 Open a File to Download

From the file menu choose Open. Use the Open dialog to browse for your file, see *Figure 23*.

Figure 23: WinLoad's Open Dialog



Once you have selected your file, the name should appear in the main display area and in the title bar, see *Figure 24.*

Figure 24: Open File in WinLoad

The *Target Card ID* field allows you to specify which receiver card to update, see *Table 55* below.

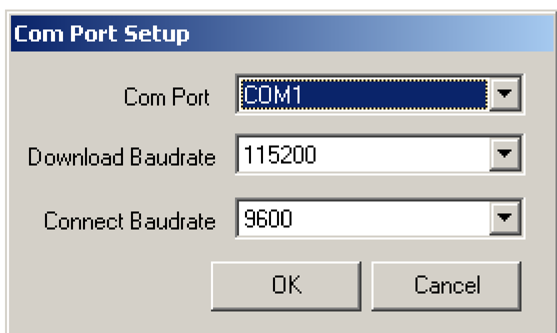
Table 55: Target Card Identification

Entry	Description
0	Euro-3M Master Card
1	L5-Euro Slave Card
2	Clock Status Card

7.5.2 Communications Settings

To set the communications port and baud rate, select COM Settings from the Settings menu, see *Figure 25* on *Page 126*. Choose the port on your PC from the Com Port drop down list and the baud rate from the Download Baudrate torpedoing list. The baud rate should be as high as possible (the default of 115200 is preferred).

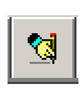
Figure 25: COM Port Setup



7.5.3 Downloading firmware

To download firmware follow these steps:

1. Set up the communications port as described in Communications Settings *above*.
2. Select the file to download, see *Open a File to Download* on *page 125.*
3. Make sure the file path and file name are displayed in main display area, see *Figure 24*.
4. Click on the Write Flash button to download the firmware:



5. While WinLoad searches for the card, power cycle the receiver (turn it off and then on again).

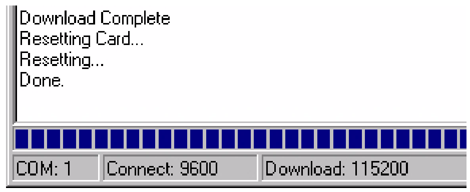
> You will only be able to access information from the card and download new firmware during the first few seconds after power initiation.

6. WinLoad should be able to locate the card and the hex file should start downloading. When the Authorization Code dialog opens, see *Figure 26*, enter the auth code and select OK.

Figure 26: Authorization Code Dialog

7. The GUST Receiver should finish downloading and reset. The process is complete when "Done." is displayed in the main display area, see *Figure 27*.

Figure 27: Update Process Complete



8. Close WinLoad.

This completes the procedure required to update a GUST Receiver.

Chapter 8 Built-In Status Test

The built-in test monitors system performance and status to ensure the receiver is operating within its specifications. If an exceptional condition is detected, you are informed through one or more indicators. The receiver status system is used to configure and monitor these indicators:

- *Receiver Status* word in log headers
- LCD status display

See also *page 131*.

This section describes factory default behavior.

The LCD screen:

1. Comes on after the receiver is powered up
2. Goes to sleep after 4 minutes of non-use
3. Wakes up if one of the contrast buttons is pressed and goes to sleep again after 4 minutes of non-use
4. Wakes up if a fatal error occurs and stays on, see also *Table 58, LCD Display of a Fatal Error Event* on page 130

In normal operation the LCD on the receiver displays the following:

Table 56: LCD Display in Normal Operation

SYSTEM	STAT	VERSION
PM	OK	2.105
PS1	OK	4.105
PS2		
PS3		
S1M	OK	2.105
S1S1	OK	4.105
S1S2		
S1S3		
S2M	OK	2.105
S2S1	OK	4.105
S2S2		
S2S3		
CKSC	OK	3.105
CLK	OK	
FANS	OK	

The version number shown on the LCD display will vary depending on whether the firmware is X.104 or X.105.

When an unusual and non-fatal event occurs, for example if there is no valid position solution, a bit is set in the *Receiver Status* word. If the receiver operation continues normally, the LCD continues to display the following where the double line denotes that the LCD toggles between these two screens:

Table 57: LCD Display of a Non-Fatal Error Event

SYSTEM	STAT	VERSION	VERSION
PM	BAD	2.105	No Pos
PS1	OK	4.105	4.105
PS2			
PS3			
S1M	OK	2.105	2.105
S1S1	OK	4.105	4.105
S1S2			
S1S3			
S2M	OK	2.105	2.105
S2S1	OK	4.105	4.105
S2S2			
S2S3			
CKSC	OK	3.105	3.105
CLK	OK		
FANS	OK		

When the event ends, in this case when there is a valid position solution, the bit in the *Receiver Status* word is cleared and the LCD returns to its default display. Non-fatal errors are displayed as follows:

Error Code	Error
TEMP	Temperature
VOLT	Voltage
CPU	CPU overload
COM1	COM1 buffer overrun
USB	USB buffer overrun
No Pos	Invalid position
NoOCXO	External oscillator not
BADCM	Bad clock model
140PLL	140 MHz PLL unlocked

When a fatal event occurs, like a receiver hardware failure, there may be damage to the hardware or erroneous data so the receiver is put into an error state. Bit *0* is set in the *Receiver Status* word to show that an error occurred. The LCD displays as follows, in *Table 58, LCD Display of a Fatal Error Event* on page 130, where the double line denotes that the LCD toggles between these two screens and the shading means these screens have a flashing backlight.

Table 58: LCD Display of a Fatal Error Event

SYSTEM	STAT	VERSION	VERSION
PM	BAD	2.105	RF1PLL
PS1	OK	4.105	4.105
PS2			
PS3			
S1M	OK	2.105	2.105
S1S1	OK	4.105	4.105
S1S2			
S1S3			
S2M	OK	2.105	2.105
S2S1	OK	4.105	4.105
S2S2			
S2S3			
CKSC	OK	3.105	3.105
CLK	OK		
FANS	OK		

Receiver tracking is disabled at this point but command and log processing continues to allow you to diagnose the error. Even if the source of the error is corrected at this point, the receiver must be reset to resume normal operation. Fatal errors are displayed as follows:

Error Code	Error
Auth	Authorization code
ADCBad	Slow ADC
SupVol	Supply voltage
Therm	Thermometer
Temp	Temperature
M4Fail	MINOS4
RF1PLL	PLL RF1
RF2PLL	PLL RF2
RF5PLL	PLL RF5
RF1Bad	RF1 hardware
RF2Bad	RF2 hardware
RF5Bad	RF5 hardware
NVMBad	NVM

8.1 Receiver Status Word

The *Receiver Status* word is a 32-bit field that indicates the current status of the receiver. This word is found in the header of all logs. See *Table 46, Receiver Status* on page 109 for the contents of this word.

8.2 LCD Status Display

When there is a non-fatal error, the display toggles between the error and the software version, see *Table 57, LCD Display of a Non-Fatal Error Event* on page 129. If the error is fatal, the backlight flashes at 0.5 Hz, see *Table 58, LCD Display of a Fatal Error Event* on page 130. See also *Section 2.2.3.1, Receiver Error Display* on page 26.

Appendix A Technical Specifications

Table 59: Performance Specifications

PERFORMANCE	
All values subject to GPS system characteristics	
Frequency	L1(1575.42 MHz), L2 (1227.6 MHz), L5 (1176.45 MHz)
Codes Tracked	GPS L1-C/A Code GPS L2-P(Y) Code SBAS GEO L1-C/A Code SBAS GEO L2-C/A Code SBAS L5 GEO GPS SVN (PRN 0-37) GEO SVN (PRN 120-138)
Satellite Tracking Channels	See the configuration mode values in *Table 16, Config Values* on page 55
Position Accuracy (stand-alone)	1.5 m CEP
Pseudorange Measurement Accuracy **L1 C/A Narrow** **L1 C/A Wide** **L2 P(Y)** **L5 C5**	 10 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz 1 m RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz 50 cm RMS, C/No > 38 dB-Hz, DLL BW = 0.05 Hz 1 m RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz
Single Channel Phase Accuracy **L1 C/A** **L2 P(Y)** **L5 C5**	 3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz 5 mm RMS, C/No > 30 dB-Hz, Loop PLL = 0.2 Hz 3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz
C/No Accuracy **C/A** **P(Y)** **C5**	 ±2.5 dB, 30-65 dB-Hz ±4 dB, 34-54 dB-Hz ±8 dB, 30-33 dB-Hz ±2.5 dB, 30-65 dB-Hz
Raw Data Availability Rate **L1SQM/L2/L5** **Time** **Almanac Data**	 One phase and code measurement per second/per satellite One message per second < 15 minutes after reset
Time to First Fix	100 seconds (95%) with stabilized internal and external oscillators and initial time, almanac and position.
Re-acquisition **L1 C/A** **L2 P(Y)** **L5 C5** **GEO**	 5 seconds C/No = 44 dB-Hz 1σ 60 seconds C/No = 38 dB-Hz 1σ 60 seconds C/No = 44 dB-Hz 1σ 10 seconds C/No = 44 dB-Hz 1σ
Height Measurements	Up to 18,288 metres (60,000 feet) maximum[a]

a. In accordance with export licensing.

Table 60: Physical Specifications

PHYSICAL	
Size	448.8 x 361 x 177.8 mm (without the 19” mounting brackets)
Weight	9.8 kg (21.6 lb.)
MECHANICAL DRAWINGS	

Figure 28: GUST Receiver Dimensions

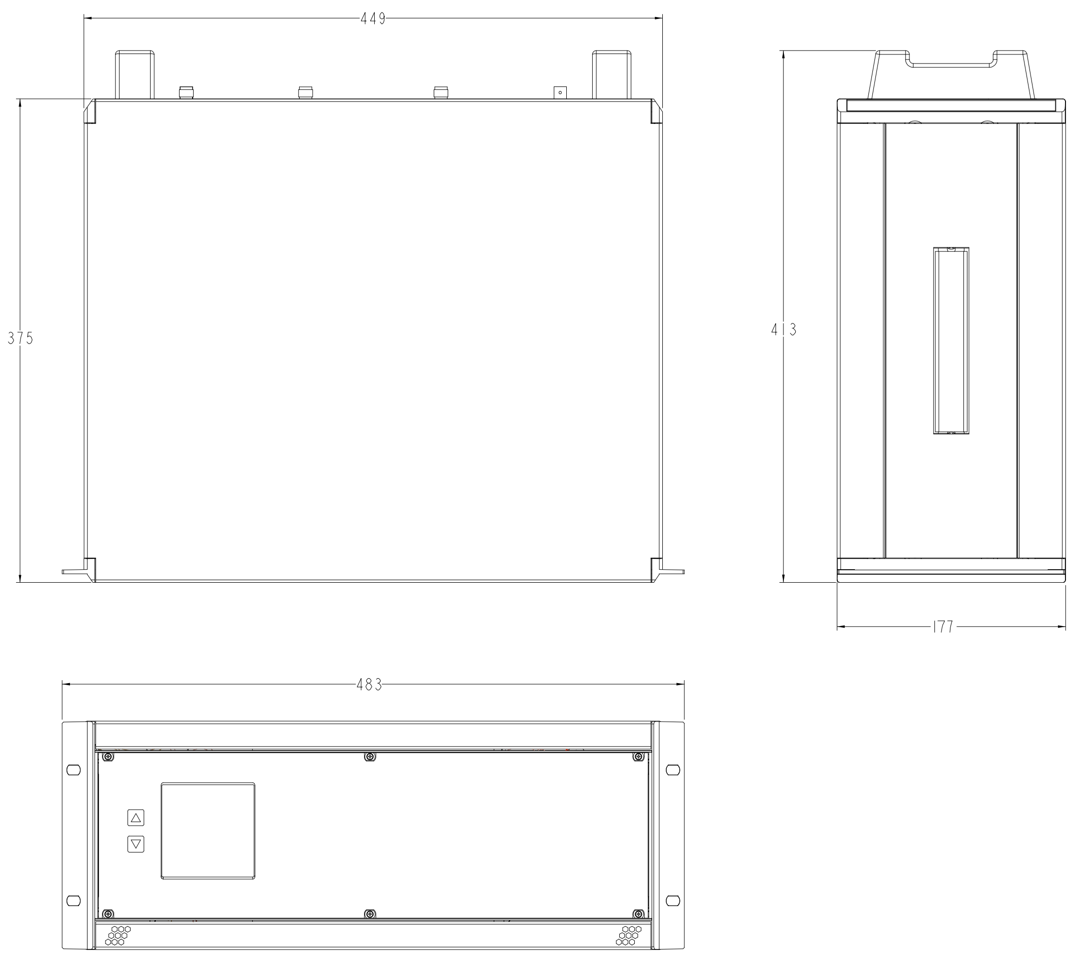


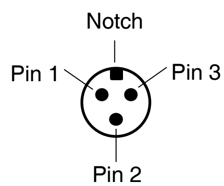
Table 61: Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-25°C to +55°C
Storage Temperature	-40°C to +85°C
Humidity	10% - 80%
Altitude	3,000 metres[a]

a. May operate above 3,000 m in a controlled environment, however is not certified as such

Table 62: Port Specifications

POWER INPUT	
Connector	3-position chassis jack
Voltage	24 ± 2 VDC
Maximum Power Consumption	31 W



Pin	Colour	Description
1	Red	22-26 V DC
2	Black	Ground
3	Green	Ground Protection

Figure 29: Power Port Pinout

ANTENNA INPUT	
Connector	TNC female
RF Input Frequencies	L1(1575.42 MHz), L2 (1227.6 MHz) & L5 (1176.45 MHz)
Power	Power to the LNA is supplied by the user
SERIAL PORTS	
Connector	DE9P
Data Transfer Rate	User-selectable rate including 9600 (*Time* and *Data* default), 19200, 38400, 57600, 115200, and 230400 (*Monitor* default) bps[a]
Standard	RS-232C
TIME PORT	
Connector	DE9P
Data Transfer Rate	User-selectable rate including 9600 (default), 19200, 38400, 57600, 115200, and 230400[a] bps
Standard	RS-232C
10 MHZ INPUT	
See *Table 63, Recommended External Frequency Reference Specifications* on page 135 for specifications on the external frequency reference.	
Connector	BNC female
Capture Range	10 MHz ± 1Hz
Sensitivity	0 dBm to +17 dBm into 50 Ω

Continued on page 135

1 PPS OUTPUT	
Connector	BNC female
Signal Description	A one-pulse-per-second time synchronization output. This is a normally high, active low pulse (1 ms) where the falling edge is the reference.
Output Level **Voltage (high)** **Voltage (low)** **Nominal Load Impedance**	 > 2.4 VDC < 0.55 VDC 50 Ω

a. Baud rates higher than 115,200 bps are not supported by standard PC hardware. Special PC hardware is required for higher rates, such as 230,400 bps.

Table 63: Recommended External Frequency Reference Specifications

EXTERNAL FREQUENCY REFERENCE	
Connector	BNC female
Frequency	10.000 MHz
Short-Term Stability (Allen Variance)	2×10^{-11}, 1 second
Accuracy Over Operating Temperature Range	$\pm 5 \times 10^{-12}$
RF Output Power	+17 dBm into 50 Ω
Output Waveform **Harmonics** **Spurious**	Sine wave -40 dBc -80 dBc
Phase Noise **at 10 Hz** **at 100 Hz** **at 1 kHz**	 -120 dBc/Hz -140 dBc/Hz -150 dBc/Hz

Table 64: Channel Configurations

Signal Channel	SV Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
14GPS8GEO									
0	0	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
1	0	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
2	1	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
3	1	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
4	2	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
5	2	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
6	3	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
7	3	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
8	4	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
9	4	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
10	5	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
11	5	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
12	6	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
13	6	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
14	7	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
15	7	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
16	8	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
17	8	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
18	9	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
19	9	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
20	10	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
21	10	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
22	11	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
23	11	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
24	12	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
25	12	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
26	13	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
27	13	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
28	14	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
29	15	GEO	L1 C/A	Standard	WAAS	WAAS	500	Yes	Idle
30	16	GEO	L2 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
31	17	GEO	L2 C/A	Standard	WAAS	WAAS	500	Yes	Idle
32-35	Reserved, see *Section 1.2.2* and *Section 1.2.3* starting on *page 14*.								
36	18	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
37	19	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
38	20	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
39[a]	21	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
GEOTEST									
0	0	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
1	1	GEO	L1 C/A	Standard	WAAS	WAAS	500	Yes	Idle
2	2	GEO	L2 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
3	3	GEO	L2 C/A	Standard	WAAS	WAAS	500	Yes	Idle
4 [b]	4	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
5 [b]	5	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
6-8	Reserved, see *Section 1.2.2* and *Section 1.2.3* starting on *page 14*.								
9	6	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
10	7	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
11	8	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
12[a]	9	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle

Signal Channel	SV Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
14GPS8GEONAR									
0	0	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
1	0	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
2	1	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
3	1	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
4	2	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
5	2	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
6	3	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
7	3	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
8	4	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
9	4	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
10	5	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
11	5	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
12	6	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
13	6	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
14	7	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
15	7	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
16	8	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
17	8	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
18	9	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
19	9	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
20	10	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
21	10	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
22	11	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
23	11	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
24	12	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
25	12	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
26	13	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
27	13	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
28	14	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
29	15	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
30	16	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
31	17	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
32-35	Reserved, see *Section 1.2.2* and *Section 1.2.3* starting on *page 14*								
36	18	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
37	19	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
38	20	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
39	21	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
GEOTESTNAR									
0	0	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
1	1	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
2	2	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
3	3	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
4[b]	4	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
5[b]	5	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
6-8	Reserved, see *Section 1.2.2* and *Section 1.2.3* starting on *page 14*								
9	6	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
10	7	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
11	8	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
12	9	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle

Signal Channel	SV Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
14GPS7GEONAR									
0	0	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
1	0	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
2	1	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
3	1	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
4	2	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
5	2	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
6	3	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
7	3	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
8	4	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
9	4	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
10	5	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
11	5	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
12	6	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
13	6	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
14	7	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
15	7	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
16	8	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
17	8	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
18	9	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
19	9	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
20	10	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
21	10	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
22	11	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
23	11	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
24	12	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
25	12	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
26	13	GPS	L1 C/A	Narrow	GPS	GPS	50	No	Auto
27	13	GPS	L2 P(Y)	Standard	GPS	GPS	50	No	Auto
28	14	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
29	15	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
30	16	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
31	17	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
32-35	Reserved, see *Section 1.2.2* and *Section 1.2.3* starting on *page 14*								
36	18	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
37	19	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
38	20	GEO	L5 C5	Narrow	WAAS	WAAS	500	Yes	Idle
9GEOTESTNAR									
0	0	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
1	1	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
2	2	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
3	3	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
4[b]	4	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
5[b]	5	GEO	L1 C/A	Narrow	WAAS	WAAS	500	Yes	Idle
6-8	Reserved, see *Section 1.2.2* and *Section 1.2.3* starting on *page 14*								
9	6	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
10	7	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle
11	8	GEO	L5	Narrow	WAAS	WAAS	500	Yes	Idle

a. This signal channel is not available in software version X.104 and later.

b. 4 and 5 output SQM data and should both be assigned to the same PRN for full SQM satellite data. See also *Section 1.2.4, Signal Quality Monitoring* on page 15.

Appendix B GPS Acronyms

1 PPS	One Pulse Per Second
2-D	Two Dimensional
3-D	Three Dimensional
A/D	Analog-to-Digital
ADR	Accumulated Doppler Range
AGC	Automatic Gain Control
AS	Anti-Spoofing
ASCII	American Standard Code for Information Interchange
BIH	Bureau l’International de l’Heure
BIST	Built-In-Self-Test
BIT	Built-In Test
BPS	Bits per Second
BW	Bandwidth
C/A Code	Coarse/Acquisition Code
CBIT	Continuous Built In Test
CEP	Circular Error Probable
CMR	Compact Measurement Record
C/No	Carrier to Noise Ratio
CoCom	Coordinating Committee on Multilateral Export Controls
CPLD	Complex Programmable Logic Device
CPU	Central Processing Unit
CR	Carriage Return
CRC	Cyclic Redundancy Check
CTP	Conventional Terrestrial Pole
CTS	Conventional Terrestrial System or Clear To Send
dB	Decibel
DCD	Data Carrier Detected
DCE	Data Communications Equipment (Modem)
DGPS	Differential GPS
DLL	Delay Lock Loop
DOP	Dilution Of Precision
DPB	Digital Pulse Blanking
DRAM	Dynamic Random Access Memory
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
ECEF	Earth-Centred-Earth-Fixed
EGNOS	European Geo-Stationary Navigation System
E-L	Early - Late
ESN	Electronic Serial Number
ESD	Electrostatic Discharge
FCC	Federal Communications Commission (USA)
FEC	Forward Error Correction
FPGA	Field Programmable Gate Array
FR	Factory Reset
FTP	File Transfer Protocol

FTS	Frequency and Time Standard
GDOP	Geometric Dilution Of Precision
GEO	Geostationary Satellite
GMT	Greenwich Mean Time
GND	Ground
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPAI	General Purpose Analog Input
GUS	Ground Uplink Subsystem
GUST	GUS-Type 1
HDOP	Horizontal Dilution Of Precision
HTDOP	Horizontal Position and Time Dilution Of Precision
IBIT	Initiated Built In Test
IC	Integrated Circuit
ICD	Interface Control Document
ID	Identification
IEEE	Institute of Electrical & Electronics Engineers
IF	Intermediate Frequency
IGRF	International Geometric Reference Field
IMLA	Integrated Multipath Limiting Antenna
INS	Inertial Navigation System
I/O	Input/Output
IODE	Issue of Data (Ephemeris)
IRQ	Interrupt Request
LCD	Liquid Crystal Display
LF	Line Feed
LHCP	Left Hand Circular Polarization
LNA	Low Noise Amplifier
LO	Local Oscillator
LSB	Least significant bit
MET	Multipath Elimination Technology
MINOS	Multiple Independent NOmadic Stargazer
MKI	Mark Input
MSAS	MTSAT Satellite Based Augmentation System
MSB	Most significant bit
MSL	Mean sea level
NC	Not Connected
NAS	National Airspace System (United States)
NAVSTAR	NAVigation Satellite Timing And Ranging (synonymous with GPS)
NMEA	National Marine Electronics Association
NVM	Non-Volatile Memory
OCXO	Oven Controlled Crystal Oscillator
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCB	Printed Circuit Board
P Code	Precise Code
PDOP	Position Dilution Of Precision

PLL	Phase Lock Loop
PPS	Precise Positioning Service or Pulse Per Second
PRN	PseudoRandom Noise number
PV	Position Valid
RAM	Random Access Memory
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RMA	Return Material Authorization
RMS	Root-Mean-Square
ROM	Read Only Memory
RTS	Request To Send
RXD	Received Data
SA	Selective Availability
SBAS	Satellite-Based Augmentation System
SCAT-I	Special Category I
SEP	Spherical Error Probable
SI	Système International d'Unités (international system of units based on the Meter, Kilogram, Second, Ampere, Kelvin, Candela, and Mole)
SNR	Signal-to-Noise Ratio
SPS	Standard Positioning Service
SQM	Signal Quality Monitoring
SV	Space Vehicle
SVN	Space Vehicle Number
SW	Software
TCXO	Temperature-Compensated Crystal Oscillator
TDOP	Time Dilution Of Precision
TOE	Time of Ephemeris
TTFF	Time-To-First-Fix
TXD	Transmitted Data
USB	Universal Serial Bus
UTC	Coordinated Universal Time
VARF	Variable Frequency
VCTCXO	Voltage-Controlled, Temperature-Compensated Crystal Oscillator
VDOP	Vertical Dilution of Precision
WAAS	Wide-Area Augmentation System
WGS	World Geodetic System
WMS	WAAS Master Station
WRS	WAAS Reference Station
VDC	Volts Direct Current
XTE	Crosstrack Error

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