# Galileo Test Receiver (GTR)

## USER MANUAL

# Galileo Test Receiver (GTR) User Manual

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|---|---|
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| **Associated Firmware Versions:** | **I/O Master** | 7.400 |
|---|---|---|
| | **L1/E5a I** | 5.400 |
| | **L1/E5a II** | 5.400 |
| | **E5a/E5b** | 6.400 |
| | **L1/E6** | 10.400 |
| | **Euro-3M** | 2.201S1 |

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# Notices

The following notices apply to the Galileo Test Receiver.

*The Canadian Standards Association has specified that the following notices be brought to the attention of users of this product.*

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

⚠ *WARNING!:*  **You must have a ground connection from the ground lug at the back of the unit to a reliable ground source. The connection is required for safety and must be connected prior to operating the unit. Failure to do so may result in unsafe operation of the equipment.**

**Please disconnect any antennas from the antenna ports on the GTR, which have TNC female connectors, as shown in *Figure 9* on *Page 22* prior to servicing.**

⊠  **IMPORTANT:** In order to maintain compliance with the limits of this 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).

# Customer Service

## Contact Information

If you have any questions or concerns regarding your GTR, please contact NovAtel's Aviation Group using any one of the following methods:

| | |
|---|---|
| NovAtel Hotline: | **1-800-NOVATEL** (U.S. and Canada)<br>+1-403-295-4900 (International) |
| Fax: | +1-403-295-4999 |
| E-mail: | support@novatel.com |
| Website: | www.novatel.com |
| Write: | NovAtel Inc. Customer Service Dept.<br>1120 - 68 Avenue NE<br>Calgary, Alberta, Canada<br>T2E 8S5 |

## GTR Firmware Updates

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

The process for obtaining firmware updates is discussed in *Chapter 7, Firmware Updates* starting on *Page 98*. If you need further information, please contact NovAtel using one of the methods given above.

# 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:

Galileo Test Receiver (GTR)          One (1) Year from date of sale

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 Galileo Test Receiver (GTR) 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, please 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.

# Foreword

## Scope

The *Galileo Test Receiver (GTR) User Manual* is written for users of the GTR receiver. 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 GTR to allow you to effectively integrate and fully operate it. Additionally, each command used to configure the GTR, 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. Please contact NovAtel for any customer-service related inquiries. See *Customer Service* on *Page 9*.

The versions of GTR firmware that are associated with the features described in this manual are listed on *Page 2* of this manual.

## Prerequisites

The GTR is a stand-alone, Global Navigation Satellite Systems (GNSS) receiver. Refer to *Chapter 2, Installation*, starting on *Page 19*, for more information on installation requirements and considerations. The GTR utilizes a comprehensive user-interface command structure and to utilize the full potential of the GTR, 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* on *Page 36*.

0x        A number following 0x is a hexadecimal number.

field        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 Galileo Test Receiver (GTR), see *Figure 1* below, is a high-performance receiver designed for installation as a core component of the Galileo and Global Positioning System (GPS) network.

The Galileo section of the European Space Agency (ESA) website[1] gives you information on the Galileo signals and their use. For extended GPS and Satellite-Based Augmentation System (SBAS) information, both of which are used by the Galileo Test Receiver, please refer to the *GPS+ Reference Manual* available from our website at http://www.novatel.com/support/docupdates.htm.

The rest of this chapter provides information on the features and functionality of the GTR and how it operates in the context of the GPS and Galileo systems.



**Figure 1: Galileo Test Receiver**

## 1.1  Galileo Overview

Galileo will be Europe's own global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. It will be inter-operable with GPS and GLONASS, the two other global satellite navigation systems.

A user will be able to take a position with the same receiver from any of the satellites in any combination. By offering dual frequencies as standard, however, Galileo will deliver real-time positioning accuracy down to the metre range, which is unprecedented for a publicly available system.

It will guarantee availability of the service under all but the most extreme circumstances and will inform users within seconds of a failure of any satellite. This will make it suitable for applications where safety is crucial, such as running trains, guiding cars and landing aircraft.

Galileo In-Orbit Validation Element (GIOVE-A), the first experimental satellite as part of the so-called Galileo System Test Bed (GSTB), was launched in December 2005. The objective of this experimental satellite is to characterize the critical technologies, which are already in development under ESA contracts. Thereafter up to four operational satellites will be launched in the 2010 time frame to validate the basic Galileo space and related ground segment. Once this In-Orbit Validation (IOV) phase has been completed, the remaining satellites will be installed to reach Full Operational Capability (FOC).

The fully deployed Galileo system consists of 30 satellites (27 operational + 3 active spares), positioned in three circular Medium Earth Orbit (MEO) planes in 23616 km altitude above the Earth, and at an inclination of

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1. Galileo information from ESA Navigation website - http://www.esa.int

the orbital planes of 56 degrees with reference to the equatorial plane. Once this is achieved, the Galileo navigation signals will provide a good coverage even at latitudes up to 75 degrees north, which corresponds to the North Cape, and beyond. The large number of satellites together with the optimisation of the constellation, and the availability of the three active spare satellites, will ensure that the loss of one satellite has no discernible effect on the user.

Two Galileo Control Centres (GCC) will be implemented on European ground to provide for the control of the satellites and to perform the navigation mission management. The data provided by a global network of twenty Galileo Sensor Stations (GSS) will be sent to the Galileo Control Centres through a redundant communications network. The GCC's will use the data of the Sensor Stations to compute the integrity information and to synchronize the time signal of all satellites and of the ground station clocks. The exchange of the data between the Control Centres and the satellites will be performed through so-called up-link stations. Five S-band up-link stations and 10 C-band up-link stations will be installed around the globe for this purpose.

As a further feature, Galileo will provide a global Search and Rescue (SAR) function, based on the operational search and rescue satellite aided tracking Cospas-Sarsat system. To do so, each satellite will be equipped with a transponder, which is able to transfer the distress signals from the user transmitters to the Rescue Co-ordination Centre (RCC), which will then initiate the rescue operation. At the same time, the system will provide a signal to the user, informing them that their situation has been detected and that help is under way. This latter feature is new and is considered a major upgrade compared to the existing system, which does not provide a feedback to the user.

Five categories of services have been defined:

1. A free Open Service (OS)

2. A highly reliable Commercial Service (CS)

3. A Safety-of-Life Service (SOL)

4. A government encrypted Public Regulated Service (PRS)

5. A Search and Rescue Service (SAR)

### 1.1.1   Open Service

This single-frequency service will involve the provision of a positioning, navigation and precise timing service. It will be available for use by any person in possession of a Galileo receiver. No authorisation will be required to access this service. Galileo is expected to be similar to GPS in this respect.

The principal applications will be general navigation and positioning, network timing, traffic information systems, systems including information on alternative routes in the event of congestion, and wireless location, for example, with mobile telephones.

Studies clearly show that the availability of these services will be significantly enhanced by the existence of a greater number of satellites, as is the case when both GPS and Galileo are in operation. This is particularly important for land-based services, such as private car navigation, where service is mostly required in downtown cores and where satellite shadowing is minimised by the combination of the systems.

The Open Service will be transmitted in the E5a frequency band at 1176.45 MHz.

### 1.1.2   Commercial Service

Service providers using the multi-frequency commercial services will have the opportunity to give added value to their range of products for which they can charge the end customer and will, in turn, pay a fee to the Galileo operator. The signal will contain data relating to the additional commercial services being offered. In return for the fee, the Galileo operator will be able to offer certain service guarantees. This aspect of service guarantee and the commensurate liabilities is one area where Galileo is significantly differentiated from GPS. A key component in achieving this is an independent system within Galileo for monitoring the satisfactory working of the system and informing the end user of this by an integrity signal incorporated in the data stream.

The main applications for this service concern professional users who are ready to pay for a service guaranteed by the Galileo operator, notably in the areas of technical surveys, in activities involving customs and excise operations, network synchronisation, sea fleet management, vehicle fleet management, and road tolls.

Controlled access to this service for end-users and the providers of value-added services will be based on protected access keys in the receivers. This will also enable revenue to be collected from users.

The commercial service will be transmitted in the E6 frequency band at 1278.75 MHz.

### 1.1.3    Safety-of-Life Service

The safety-of-life service will be offered to users who are highly dependant on precision, signal quality and signal transmission reliability. It will offer a high level of integrity, and consequently, provide the user with a very rapid warning of any possible malfunctions. It will need to be certified in accordance with the regulations applicable to the various modes of transport (the International Civil Aviation Organization (ICAO) regulations in the case of air transport; the International Maritime Organization (IMO) regulations in the case of sea transport). This service will require specialised receivers providing access to this enhanced-quality signal.

The safety-of-life service will be transmitted in two frequency bands – L1 at 1575.42 MHz, and E5b at 1207.14 MHz. Users may receive signals from the two frequency bands independently.

### 1.1.4    Public Regulated Service

The PRS will be a restricted access service, offered to government agencies that require a high availability navigation signal. The PRS service will utilize ranging codes that are encrypted with a highly secure government encryption scheme. To enhance availability, the PRS service is intended to have anti-jamming and anti-spoofing capabilities.

The PRS will be transmitted in two frequency bands – L1 at 1575.42 MHz, and E6 at 1278.75 MHz. Users may receive signals from the two frequency bands independently.

### 1.1.5    Search and Rescue Service

A specific public service designed to assist in search and rescue operations will make it possible to locate person and vehicles in distress. The vehicles will be fitted with beacons, which having been activated in the event of an emergency will send an alerting signal to the rescue centre.

The Galileo Program provides this search and rescue service for users based on humanitarian and public service principles of the international COSPAS-SARSAT system while at the same time making search and rescue operations more effective.

## 1.2   Features

To assist the *ground stations* in providing data with the necessary precision, the GTR has been designed with the following features:

- Support for L1 and L5 GPS signal processing
- Support for L1, E5a, E5b and E6 Galileo signal processing
- Digital pulse blanking for the L1, E5a/L5, E5b and E6 signals

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

### *1.2.1 Cross-Correlation Detection Channel*

NovAtel's SafeTrak technology is also featured in the GTR.

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.

### *1.2.2 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 channel 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.

### *1.2.3 Digital Pulse Blanking*

Digital pulse blanking involves removing or attenuating pulses in the RF signal that exceed a specified level. The GTR provides digital pulse blanking for the L1, E5a/L5, E5b and E6 signal paths. Digital pulse blanking reduces the negative effects of pulsed interference.

Use the PULSEBLANKING command to enable/disable L1, E5a/L5, E5b and E6 pulse blanking, or to control its sensitivity, see *Page 56*.

## 1.3  Functional Overview

The NovAtel GTR 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

- Two receiver sections:
    - The IO Master section has four receiver cards in a master/slave configuration with the I/O Master card. The I/O Master card is external to the IO Master section. The four slave cards are two L1/E5a cards, capable of tracking L1, L5 and E5a signals, one E5a/E5b card, capable of tracking E5a and E5b signals, and one L1/E6 card, capable of tracking L1 and E6 signals.
    - The GPS section has one single receiver card. It is a Euro-3M capable of tracking the L1 and L2 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 2* on *Page 16* shows the components of the GTR.

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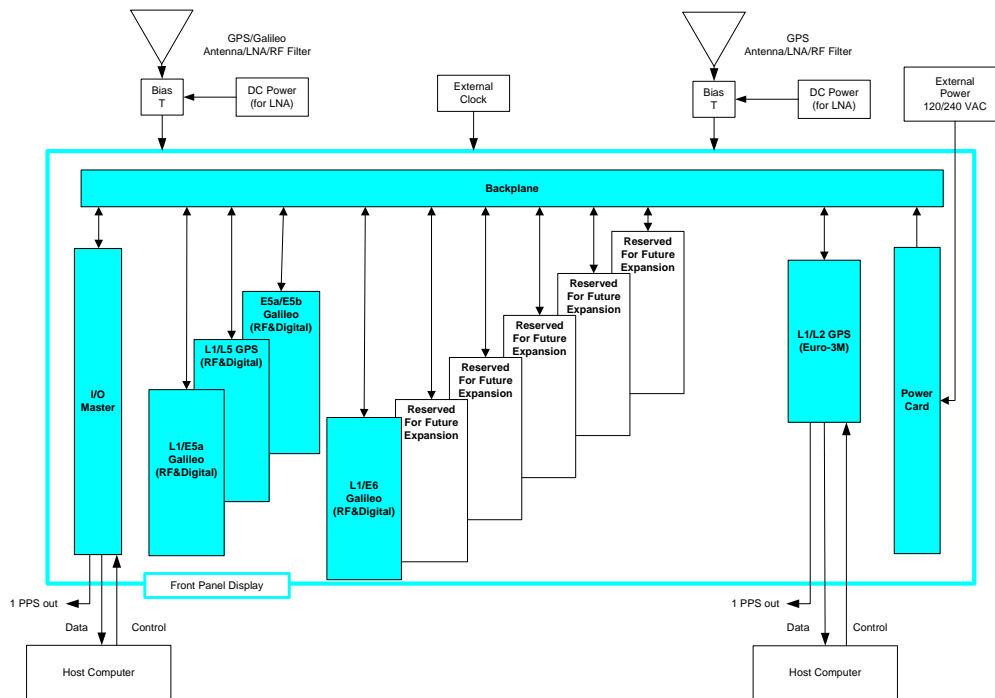
**Figure 2: Block Diagram**

## 1.3.1   *Enclosure*

The GTR 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 GTR enclosure, an LCD has been included to provide basic status information regarding the unit. See *Status Display* on *Page 23* for more details.

### 1.3.1.2   **Input/Output Ports**

As shown in *Figure 3*, the GTR provides a variety of ports on the back panel of the enclosure for power, antenna input, and general communications, including the following:

- • I/O
    - • A bi-directional serial DATA port, and/or a DATA USB port, used to configure the receiver section, receive commands and send measurements and status data
    - • An input port to connect an external 10 MHz oscillator for synchronization
    - • A bi-directional *Time* port for sending GPS time and receiver time offset

    ---
    ⊠  The current configuration uses the *Time* port as a debug port. Time logs are available on the DATA ports.
    ---

    - • A 1 PPS output for synchronization with receiver time
    - • A 1 PPS input port

    ---
    ⊠  This port is disabled in the current configuration.
    ---

    - • An antenna input for Galileo L1, E5a, E5b and E6 signals, and GPS L1 and L5 signals

- GPS
  - A bi-directional serial DATA port, and/or a DATA USB port, used to configure the receiver section, receive commands and send measurements and status data

  ⊠  The GPS DATA USB port is disabled for the current configuration.

  - A *Time* port for sending GPS time and receiver time offset

  ⊠  The *Time* port is disabled in the current configuration.

  - A 1 PPS output for synchronization with receiver time
  - A 1 PPS input port

  ⊠  This port is disabled in the current configuration.

  - An antenna input for GPS L1/L2
- AC Power
  - A single power input

*Section 2.1* on *Page 19* provides information on connecting to the ports, while *Table 54* in *Appendix A* gives specifications on the connectors and signals provided at these ports.



**Figure 3: Ports**

## 1.3.2    Receiver Sections

The Safety of Life (SOL) GTR consists of two receiver sections. These two sections are the IO and GPS sections, see section *Section 1.3* on *Page 15*.

The IO section has the capacity to hold an I/O Master card and nine receiver cards, which are each based on NovAtel's Euro card. The SOL GTR has four receiver sections populated in this section. 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 the section in order to execute the command. This coordination between cards is transparent to the user.

The GPS section contains only the Euro-3M GPS card. This section is not used in the SOL application, however a GPS RF input is a required input into the GPS section so that the IO section can initialize time correctly.

### 1.3.2.1    L1/E5a Card

There are two L1/E5a cards as slave cards in the IO section. This card is capable of tracking up to 16 L1, L5 or E5a signals.

### 1.3.2.2    E5a/E5b Card

The E5a/E5b card is a slave card in the IO section. It is capable of tracking up to 16 E5a or E5b Galileo signals.

### 1.3.2.3    L1/E6 Card

The L1/E6 card is a slave card in the IO section. This card is capable of tracking up to 16 L1 or E6 Galileo signals.

### 1.3.2.4    I/O Master card

The I/O Master card provides the IO and GPS receiver sections with a common clock signal. It also controls the LCD display and the cooling fans.

### 1.3.2.5    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.

### 1.3.2.6    Euro-3M Card

The Euro-3M card is the single receiver card in the GPS section. This card is capable of tracking L1 C/A, L2 and L1/L2 C/A GEO code GPS signals. Up to 18 satellites can be tracked simultaneously, and up to four of those can be GEOs. This card can only be accessed through the GPS section.

### 1.3.2.7    L1/E5a FPGA

The L1/E5a card contains a field programmable gate array (FPGA) made by Altera Incorporated for its DSP functionality. The FPGA has the capacity to support 16 L1/L5/E5a signals.

### 1.3.2.8    E5a/E5b FPGA

The E5a/E5b card contains one FPGA made by Altera Incorporated. The FPGA has the capacity to support 16 E5a/E5b signals.

### 1.3.2.9    L1/E6 FPGA

The L1/E6 card contains one FPGA made by Altera Incorporated. The FPGA has the capacity to support 16 L1/E6 singals.

| Chapter 2 | Installation |
|-----------|--------------|

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

## 2.1 Typical Installation

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

- NovAtel Galileo Test Receiver, which fits a standard 19" EIA rack
- NovAtel Galileo Test Signal Generator
- User-supplied and powered GPS L1/L2 antenna, GPS/Galileo antenna and low-noise amplifier (LNA)
- 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 4*.
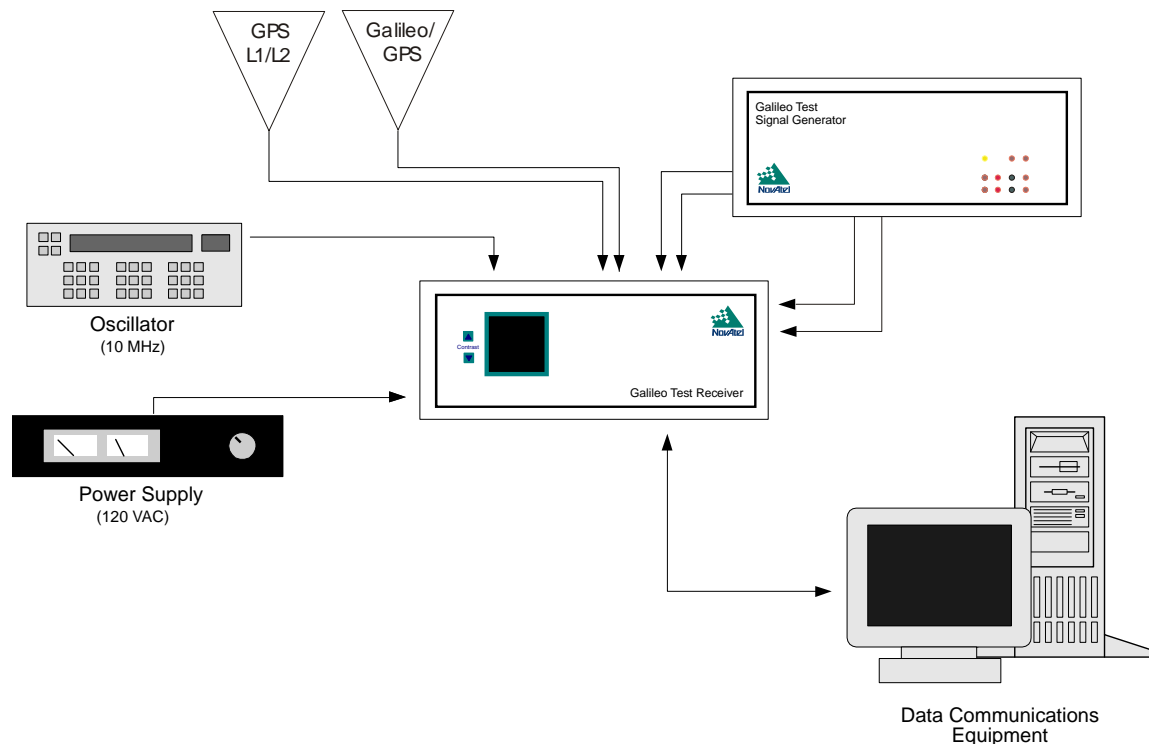


**Figure 4: Typical Configuration**

⚠️ *WARNING!:*   **You must have a ground connection from the ground lug at the back of the unit to a reliable ground source. The connection is required for safety and must be connected prior to operating the unit. Failure to do so may result in unsafe operation of the equipment.**

**Please disconnect any antennas from the antenna ports on the GTR, which have TNC female connectors, as shown in Figure 9 on Page 22 prior to servicing.**

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 GTR.
2. Connect the data communications equipment to the GTR.
3. Connect the Galileo Signal Generator to the GTR, refer to its *User Manual* for setup details.
4. Install the GPS and GPS/Galileo antennas, including an LNA if applicable, and make the appropriate connections to the GTR and an LNA power supply.
5. Connect the external power supply to the GTR.

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 GTR has to offer, your intended set-up may differ significantly from this configuration. See *Section 2.1.5* on *Page 22* for more advanced configuration steps.

## 2.1.1   Connecting the External Frequency Reference

The GTR requires an external, user-supplied frequency reference, which typically takes the form of a high-accuracy oscillator. Please refer to *Table 55* on *Page 111* 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 GTR, which is shown in *Figure 5*. *Table 54* on *Page 110* in *Appendix A* provides technical specifications on this port.



**Figure 5: *J15 10 MHz* Port**

The LCD status display on the front panel, shown in *Figure 12* on *Page 23*, displays the status of the connection between the GTR and the external clock reference.

## 2.1.2   Connecting Data Communications Equipment

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

• The *IO* and *GPS Data* ports are bi-directional and allow you to send commands to, and receive data from, applicable receiver sections. They are configured as COM1.

• The *Time* ports are bi-directional, from either section to the other, and are synchronized to the clock signal available at the 1PPS connector. The data transfer rate is fixed at 115200 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.

The serial ports have a DE9P connector, as shown in *Figure 6* and *Figure 8*. *Figure 7* shows a USB port used for the *USB Data* ports. *Table 54* on *Page 110* in *Appendix A* provides technical specifications on these ports. See *Appendix B* starting on *Page 115* for acronym meanings.

**DCD RXD TXD DTR GND**

**DSR RTS CTS NC**
**Figure 6: Data Port**

**Figure 7: USB Port**

**NC   NC TXD DTR GND**
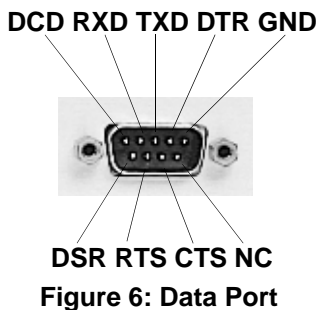
**NC RTS   NC NC**
**Figure 8: Time Port**
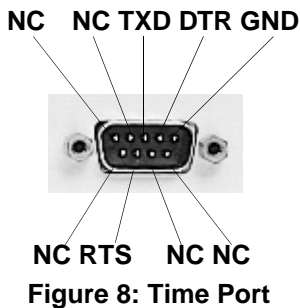
#### 2.1.2.1 Configuring the Data Communications Equipment for Communications

Because the GTR 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 115200)
- No parity
- 8 data bits
- 1 stop bit
- No handshaking
- Echo off

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⊠ After the GTR has been powered on and initial communications are established, the port settings for the GTR can be changed using the *COM* command, which is described in *Section 5.3.3* on *Page 49*.

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### 2.1.3 Connecting the GPS Antenna

Selecting and installing an appropriate antenna system is crucial to the proper operation of the GTR. 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.

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- 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 antenna ports on the GTR, which have TNC female connectors, as shown in *Figure 9*. *Table 54* on *Page 110* in *Appendix A* provides technical specifications on these ports.
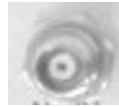


**Figure 9: Antenna Ports**

## 2.1.4    *Connecting the External Power Input*

After initial connection of the power supply to the GTR, press the power switch on the back of the unit (see *Figure 10* below).

The GTR requires an input supply voltage that comes from a normal AC power source of 100-240 volts at 50-60 Hz AC through its 3-pin power connector.

The Power Input connector on the GTR contains two 3 A, 250 V fast-blow fuses that can only be serviced when the GTR is disconnected from power.

For a listing of the required input supply voltages, see *Power Input on Page 110.* For more information on the supplied 3-pin power cable, see *Section A.1, Power Cable on Page 114.*



**Figure 10:** *Power* **Port**

## 2.1.5    *Optional Installation Steps*

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

### 2.1.5.1    Accessing Time Output

The *Time* port, shown in *Figure 8* on *Page 21*, provides the time data for the *1 PPS* output through a DB9 connector. Data is available on this port at a rate of 1 Hz. See also the TIME log on *Page 91*. *Section 3.3.1* on *Page 27* provides information on configuring the settings for this port.

---

✉    The *Time* port is currently disabled.

---

### 2.1.5.2    Accessing the 1 PPS Output

The clock signal available on the *1 PPS* port is synchronized to the 10 MHz input. The specifications and electrical characteristics of this signal are described in *Table 54* on *Page 110* in *Appendix A*. The pulse train is accessed from the BNC female connector on the back of the GTR, as shown in *Figure 11* on *Page 23*.

**Figure 11: 1 PPS Port**

#### 2.1.5.3     Accessing the 1PPS Input

Use this port to supply a 1 pulse per second input to the receiver.

---

⊠   1PPS input is currently disabled and is replaced by the internal OCXO output signal.

---

## 2.2   Status Display
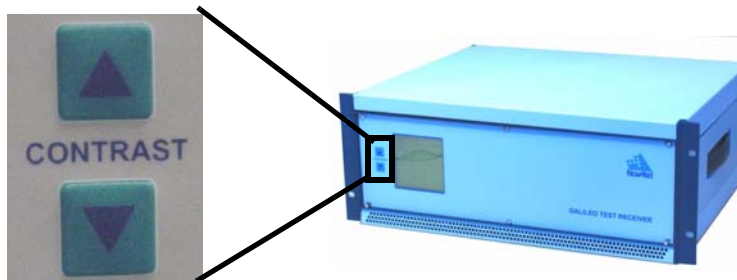


**Figure 12: Front Panel with LCD Status Display**

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 12* above.

### 2.2.1   Start-up

At start-up of the I/O Master card, the status display screen displays a NovAtel logo until the receiver cards have 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 both receiver sections.

### 2.2.3   Operational

The status display screen for the receiver contains three distinct columns. Each column contains a total of seven distinct rows, one row for the header, one row for each receiver card (L1E5a I, L1E5a II, L1E6, and E5aE5b) and three rows for the I/O Master card (software, clocks and fans).

The first column of the status display shows the identification of the receiver cards that are in use with receiver card identification is as follows:

- IOM      -    I/O Master card
- S1      -    L1E5a I card
- S2      -    L1E5a II card
- S3      -    E5aE5b card
- S4      -    L1E6 card

Only populated cards are displayed in *Table 1* on *Page 24*.

---

**Table 1: Receiver Status Display**

| SYSTEM | STAT | VERSION |
|--------|------|---------|
| IOM    | OK   | 7.400   |
| S1     | OK   | 5.400   |
| S2     | OK   | 5.400   |
| S3     | OK   | 6.400   |
| S4     | OK   | 10.400  |
| S5     |      |         |
| S6     |      |         |
| S7     |      |         |
| S8     |      |         |
| S9     |      |         |
| CLK    | OK   |         |
| FANS   | OK   |         |

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

1. I/O Master card (IOM)
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 (IOM, 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 I/O Master system clock or cooling fans, the third column of the 11th row (I/O Master system clock) or 12th row (cooling fans) of the status display screen displays the error message. If multiple errors exists in this case, the third column of the 11th row (I/O Master system clock) or 12th row (cooling fans) cycles through at 0.5 Hz through each error.

If no errors exist for the I/O Master system clock or cooling fans, the third column of the 11th row (I/O Master system clock) or 12th row (cooling fans) of the status display is blank.

If one error exists for the I/O Master card, the third column of the 1st row of the status display screen shall toggle at 0.5 Hz between the software version and the error on the I/O Master card, until the I/O Master card is reset or the errors are corrected. If multiple errors exist on the I/O Master card, the third column of the 1st row of the status display screen shall cycle at 0.5 Hz through each I/O Master card error and toggle the software version on the I/O Master card, until the I/O Master card is reset or the errors are corrected.

If no errors exist for the I/O Master card, the third column of the 1st row of the status display shall only display the software version on the I/O Master 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 49* on *Page 105*.

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 47* on *Page 104*.

Error status is extracted from the receiver status word and the receiver error word. See also the *RXSECSTATUS* log on *Page 83*.

# Chapter 3    Operation

Before operating the GTR 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 GTR 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 GTR, 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 GTR.

Supply power to the GTR 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* on *Page 23*, the LCD status display will show three columns to indicate that the GTR has locked-on to the external frequency reference and is ready for operation.

## 3.2   Boot-up

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

There are two initial start-up indicators to let you know that the GTR's main serial port is ready to communicate:
- The LCD status display on the GTR's front panel displays a NovAtel logo until the receiver cards have 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 GTR 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, firmware (FW) is transferred from Flash to RAM, the 32-bit CRC is verified on the FW 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 GTR is in operational mode following power-up mode. During operational mode, if a fault is discovered by the Continuous Built In Test (CBIT), the GTR goes into fault mode. When the RESET command is used, the entire receiver resets and starts again in power-up mode.

The GTR is in maintenance mode when it is loading firmware. 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 GTR

Communication with the receiver consists of issuing commands through the communication ports from an external serial communications device. This could be either a PC or laptop that is directly connected to the receiver serial port using a null modem cable.

The commands and logs used by the GTR, as well as the fields within them, follow specific formats, which are discussed in *Chapter 4,* starting on *Page 29*. The valid commands, which are used to control the operation and data logging of the GTR, are specified in *Chapter 5,* starting on *Page 43*. *Chapter 6,* starting on *Page 63*, provides details on the data logs that can be requested from the GTR. It is to your advantage to become thoroughly familiar with *Chapters 4* through *6* of this manual to ensure maximum utilization of the GTR's capabilities.

### 3.3.1 Configuring the Serial Time Ports

See *Section 2.1.2, Connecting Data Communications Equipment* on *Page 20*.

## 3.4 Getting Started

Included with your receiver are NovAtel's *GPSolution (Aviation)* and *Convert* programs. *GPSolution (Aviation)* is a Microsoft Windows-based Graphical User Interface (GUI), which allows you to access the receiver's many features without the need for communications protocol or to write special software. The *Convert* utility is a Windows-based utility that allows you to convert between file formats, and strips unwanted records for data file compilation. Refer to the *Quick Start Guide,* on the accompanying CD, for more information on their installation.

---

⊠ **IMPORTANT**: The current configuration of the GTR does not work with *GPSolution*. Please use Hyperterminal or another terminal emulator program instead.

---

### 3.4.1 Starting the Receiver

The receiver's software resides in read-only memory. When first powered, it undergoes a complete self-test. If an error condition is detected during a self-test, the self-test status word changes. This self-test status word can be viewed in the header of any data output log. See also *Chapter 8, Built-In Status Test* starting on *Page 103*.

### 3.4.2 Communicating with the Receiver

Launch Hyperterminal, or other terminal emulator program, and open communication with the GTR:

**Open**

Available device configs
Primary 1

Open
Cancel
New...
Edit...
Delete
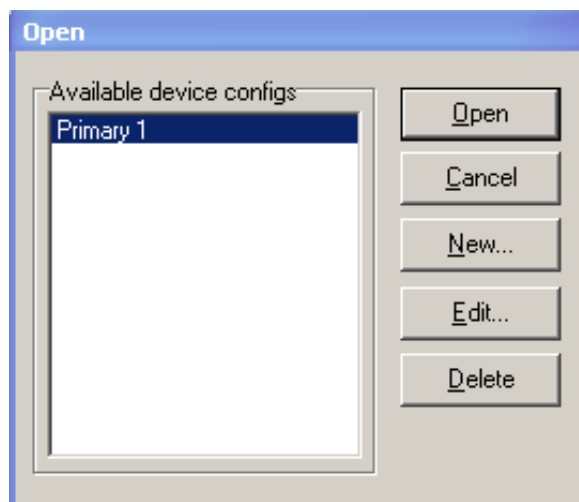
Refer to *GPSolution (Aviation)*'s Help file by selecting *Help | Contents* from the main menu to see Help for GUI windows and their descriptions. Ensure you can see the *Console* and *ASCII Messages* windows by selecting them under *View* in the main menu.

When the receiver is first turned on, no data is transmitted from the COM ports except for the port prompt. The screen displays a port name:

**[COM1]** *if connected to COM1 port*

Any of the above prompts indicate that the receiver is ready and waiting for command input.

Commands are typed at the interfacing computing device's keypad or keyboard, and executed after issuing a carriage return command which is usually the same as pressing the <Enter> key.

An example of a response to an input command is the FIX POSITION command. It can be entered like this:

    [COM1] **fix position 51.11635 -114.0383 1048.2** *[carriage return]*
    <OK

where [COM1] is the port prompt, the bolded type is the command you enter from you keypad or keyboard and *[carriage return]* indicates that you should press the <Enter> key.

The above example illustrates command input to the base receiver's COM1 port, which sets the position of the receiver. Confirmation that the command was actually accepted is the appearance of <**OK**.

If a command is entered incorrectly, the receiver responds on the debug port with:

        <INVALID MESSAGE ID          *(or a more detailed message)*

*WARNING!:*    **Ensure the Control Panel's Power Settings on your PC are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.**

☒ **IMPORTANT**: The current configuration of the GTR does not work with *GPSolution*. Please use Hyperterminal or another terminal emulator program instead.

# Chapter 4          Using Commands and Logs

*Chapter 5* and *Chapter 6* provide the details of the commands and logs used to communicate with the GTR. 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 GTR 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 GTR

- Input and output functions

- Configuration of a specific channel of the GTR

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, all commands revert to the factory default settings.

#### 4.1.1.1    Factory Defaults

The factory defaults for each receiver section are:

```
COM COM1 115200 N 8 1 N OFF ON
FIX NONE
PULSEBLANKING L1 127
PULSEBLANKING L5 127
PULSEBLANKING E5B 127
PULSEBLANKING E6 127
SDLLBW n 0.2                    where n is for channel numbers 0 to 63 inclusive
SPLLBW n 3                      where n is for channel numbers 0 to 63 inclusive
STHRESHOLD n 36 20 36           where n for is channel numbers 0 to 63 inclusive
```

✉ The cooling fans are defaulted to operate at 50% capacity.

### 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 6.3.6* on *Page 80*. 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 GTR 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

---

$\boxtimes$   There is no response to a RESET command.

---

### 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 2* outlines the various response strings and message IDs.

**Table 2: 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. |

| String | ID | Meaning |
|---|---|---|
| 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 GTR logs data by using the *LOG* command given on *Page 54*. 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 GTR 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*, only certain triggers are valid. For example, the *VERSION* 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. The following table outlines the valid triggers for each log type:

**Table 3: 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 *Abbreviated ASCII* format, the default format for the output log is *Abbreviated 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 ALMANAC**A**

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

    LOG RANGE**B** 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 5* on *Page 37*.

## 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 GTR 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 4*.

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 4.4.2.5* on *Page 42* 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* on *Page 30* for a list of response messages from the receiver.

The *ASCII* message header is formatted as follows:

**Table 4: 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 26* on *Page 64*. | N |
| 3 | port | Char | The name of the port from which the log was generated. See *Table 8* on *Page 40*. | 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 4.4.2.4* on *Page 41*. | 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 40, Receiver Status* on *Page 86*. | Y |
| 10 | Reserved | ULong | Reserved for internal use | Y |
| 11 | | ULong | | Y |
| 12 | ; | Char | The ';' character indicates the end of the header | N |

**Example ASCII Format Log:**

```
#PSRPOSA,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;
SOL_COMPUTED,SINGLE,51.11632963531,114.03829724755,1046.5948,
0.0000,WGS84,1.5464,1.2791,2.7786,"",0.000,0.000,10,9,0,0,0,0,0,
0*F1BA4EC7
```

### *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 4.4.2.5* on *Page 42* for the CRC algorithm.

4. The header is in the format shown in *Table 5*.

**Table 5: 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 26* on *Page 64*. | 2 | 4 | N |
| 6 | message type | Char | Message type indicator, as explained in *Section 4.2.1* on *Page 32*. | 1 | 6 | N |
| 7 | port address | Char | The port from which the log was generated. See *Table 8* on *Page 40*. | 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 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 4.4.2.4* on *Page 41*. | 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 40, Receiver Status* on *Page 86*. | 4 | 20 | Y |
| 15 | Reserved | UShort | Reserved for internal use | 2 | 24 | Y |
| 16 | | UShort | | 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 GTR 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 6: 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. |

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

**Table 7: Byte Arrangements**

| | 7 0 |
|---|---|
| char | □ |
| | address n |

| | 15 7 0 |
|---|---|
| short | □ |
| | n + 1   address n |

| | 31    23    15    7     0 | |
|---|---|---|
| long | □ □ □ □ | two's compliment |
| | n + 3   n + 2   n + 1   address n | |

| | 63 62       52 51                               0 |
|---|---|
| double | S \| Biased Exponent\|          52-bits mantissa |
| | n + 7    n + 6    n + 5    n + 4    n + 3    n + 2    n + 1    address n |

| | 31 30       23 22             0 |
|---|---|
| float | S \| Biased Exponent\| 23-bits mantissa |
| | n + 3    n + 2    n + 1    address n |
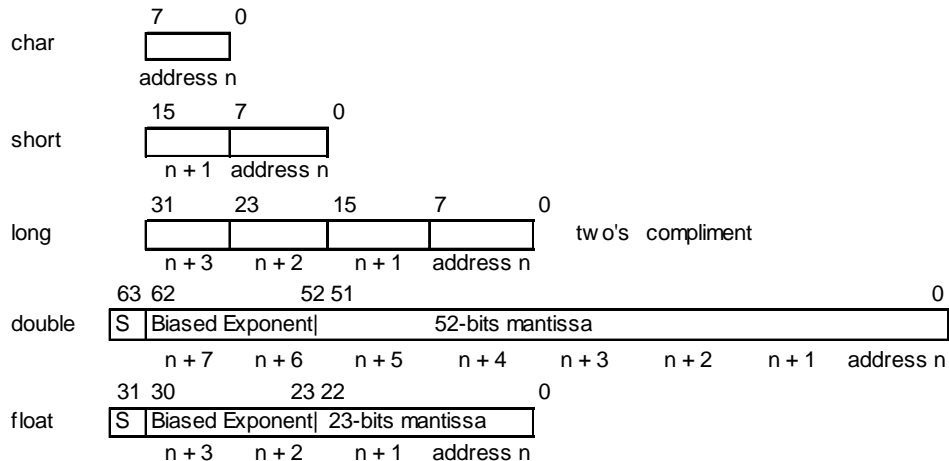
### *4.4.2    Commonly-Used Fields*

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 8: Serial Port Identifier Values**

| ASCII | Binary | Description |
|-------|--------|-------------|
| COM1  | 32     | Represents the *Data* port. |
| USB1  | 224    | Represents the USB port.[a] |

> a.  The only commands this value is valid for are *COM, LOG, UNLOG,* and *UN-LOGALL*, 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 9* below.

**Table 9: Message Type Byte Format**

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

#### 4.4.2.3    Message Time Stamps

All NovAtel format messages generated by the 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 604,799). 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    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 10.*

**Table 10: GPS Time Status**

| GPS Time Status | | Description |
|---|---|---|
| ASCII | Binary | |
| UNKNOWN | 20 | Time validity is unknown. |
| APPROXIMATE | 60 | Time is set approximately. |
| COARSE | 100 | This time is valid to coarse precision. |
| FREEWHEELING | 130 | Position is lost, and the range bias cannot be calculated. |
| 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 receiver will go through:

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

On start up, and before any satellites are being tracked, the 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*.

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.*

### 4.4.2.5    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 11* lists the commands by function. Please see *Section 5.3* on *Page 45* for a more detailed description of each individual command.

**Table 11: Commands By Function**

| Command | Description |
|---|---|
| **COMMUNICATIONS, CONTROL AND STATUS** | |
| 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** | |
| AGCMODE | Control Automatic Gain Control (AGC) functionality |
| SDLLBW | Configure receiver's DLL filter bandwidth |
| SPLLBW | Configure receiver's phase-lock-loop bandwidths |
| RESET | Perform a hardware reset |
| **POSITION CONTROL** | |
| FIX | Constrain to fixed position |
| **SATELLITE TRACKING AND CHANNEL CONTROL** | |
| ASSIGN | Assign individual satellite channel |
| ECUTOFF | Set satellite elevation cut-off angle |
| PULSEBLANKING | Enable/disable digital pulse blanking for L1, E5a/L5, E5b and E6 signals |
| STHRESHOLD | Control signal thresholds for acquisition, tracking and cross correlation |

## 5.2   Command Summary

**Table 12: Command Summary**

| Command Name | Message ID | Description | Syntax |
|---|---|---|---|
| AGCMODE | 229 | Control Automatic Gain Control (AGC) | **agcmode** *frequency mode [pulsewidth loadvalue]* |
| ASSIGN | 27 | Assign individual satellite channel to a PRN | **assign** *channel [state] [prn [Doppler window]]* |
| COM | 4 | Serial port configuration control | **com** *[port] bps [parity [databits [stopbits [handshake [echo [break]]]]]]* |
| ECUTOFF | 50 | Set satellite elevation cutoffs | **ecutoff** *angle* |
| FIX | 44 | Constrain to fixed position | **fix** *type [param1 param2 param3]* |
| LOG | 1 | Request logs from receiver | **log** *[port] message [trigger] [period [offset] [hold]]* |
| PULSEBLANKING | 519 | Enable/disable digital pulse blanking for L1, E5a/L5 and E5b signals | **pulseblanking** *frequency switch* |
| RESET | 18 | Perform a hardware reset | **reset** *[delay]* |
| SDLLBW | 800 | Configure receiver's DLL filter bandwidth | **sdllbw** *sigchan bw* |
| SPLLBW | 801 | Configure receiver's phase-lock-loop bw | **spllbw** *sigchan bw* |
| STHRESHOLD | 803 | Control signal thresholds for acquisition, tracking and cross correlation | **sthreshold** *sigchan acqui lock crosscorr* |
| 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* on *Page 29*, all command strings must be followed by ‹Enter›.

---

## *5.3.1 AGCMODE Control Automatic Gain Control*

---

✉ 1. 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.

2. When the AGC mode is disabled, the *Receiver Status* word in the message header, discussed in *Table 40, Receiver Status* on *Page 86*, 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.

---

This command controls the GTR'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.

### Table 13: Frequency Values for AGCMODE Command

| ASCII | Description |
|-------|-------------|
| L1 | L1 GPS and Galileo channels [a] |
| L5 | L5 and E5a Galileo channels [a] |
| E5b | E5b Galileo channels |
| E6 | E6 Galileo channels |

a. Changing GPS L1 affects Galileo L1 and changing GPS L5 affects Galileo E5a.

### Table 14: 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 | | Description | Format | Binary Bytes | Binary Offset |
|---|---|---|---|---|---|---|---|
| | | **ASCII** | **Binary** | | | | |
| 1 | header | This field contains the *Abbreviated ASCII* command name. See *Section 4.1* on *Page 29*. | | | H | 0 |
| 2 | frequency | See *Table 13* on *Page 45*. | | Specifies which signal type to apply the command to. | Enum | 4 | H |
| 3 | mode | See *Table 14* on *Page 45*. | | Specifies whether to use the default or custom values for the pulse width and load value. | Enum | 4 | H+4 |
| 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    ASSIGN    Assign Individual Satellite Channels

---

⊠    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 the following:

- • The *ASSIGN* command with the *state* set to *AUTO*

This 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 1 to 32. To track the Galileo GIOVE-A experimental satellite, use PRN 51. To track the Galileo GIOVE-B experimental satellite, use PRN 52.

2.   Assigning an SV channel sets 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 6.3.5* on *Page 75*.

3.   Channels 44-47 cannot be assigned. These channels are always idled.

---

**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* on *Page 29*. | | H | | 0 |
| 2 | channel | 0 to 63 | SV channel number to apply the command to. 0 is the first SV channel and 63 is the last. See also *Table 56* on *Page 112*. | ULong | 4 | H |
| 3 | state | See *Table 15* below. | 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 for GPS 0 to 52 for Galileo 120 to 138 for GEO | Optional satellite PRN code from 0 -37 for GPS channels, 0 - 52 for Galileo channels, and 120 to 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. default = 0 | 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. default = 5000 for GPS L1 GPS L5 Galileo L1 default = 3000 for Galileo E5a Galileo E5b Galileo E6 | ULong | 4 | H+16 |

**Examples:**

```
ASSIGN 0 ACTIVE 37 0 2000
ASSIGN 11 28 -250 0
```

The first example sets the first SV channel to acquire satellite PRN 37 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 15: 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. |

### 5.3.3   *COM   Serial Port Configuration Control*

This command permits you to configure the receiver's asynchronous serial port communications drivers.

See *Section 4.1.1.1* 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* on *Page 29*. | | H | 0 | |
| 2 | port | See *Table 8* on *Page 40*. | 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 16* on *Page 50*. | 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 17* on *Page 50*. | Handshaking | Enum | 4 | H+20 |
| 8 | echo | See *Table 18* on *Page 50*. | Echo ability | Enum | 4 | H+24 |
| 9 | break | See *Table 19* on *Page 50*. | 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 COM1 57600 N 8 1 N OFF ON
```

**Table 16: Parity Values**

| ASCII | Description |
|:-----:|-------------|
| N | No parity |
| E | Even parity |
| O | Odd parity |

**Table 17: Handshaking Values**

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

**Table 18: Echo Values**

| ASCII | Description |
|:-----:|-------------|
| OFF | No echo |
| ON | Transmit any input characters as they are received. |

**Table 19: Break Values**

| ASCII | Description |
|:-----:|-------------|
| OFF | Disable break detection |
| ON | Enable break detection |

## *5.3.4   ECUTOFF    Set Satellite Elevation Cut-off*

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 and computed position, 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

---

&#9993;   1.   This command only affects GPS satellites used in the GPS receiver section. Galileo and 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* 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
```

### 5.3.5   *FIX   Constrain to Fixed Position*

This command fixes position parameters for the GTR. 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 20* 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 20: 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 13* on *Page 53*. |

- 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.
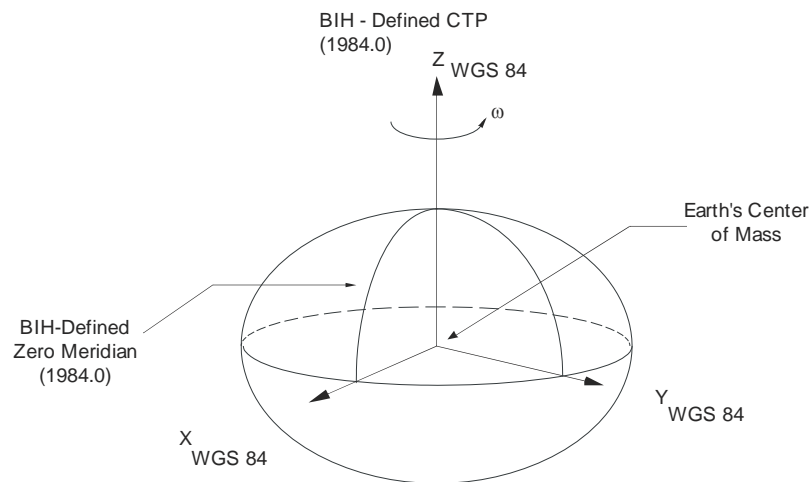


**\*** Analogous to the BIH Defined Conventional Terrestrial System (CTS), or BTS,
1984.0.

**Figure 13: The WGS84 ECEF Coordinate System**

## *5.3.6  LOG  Request Logs from Receiver*

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 63* 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 which 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 | Binary | 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 8* on *Page 40*. | | Serial port at which to output the log data. | Enum | 4 | H |
| 3 | message | Any valid message name, listed in *Table 25* on *Page 63*, with a suffix to specify the output format as explained in *Section 4.2.3* 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 9* on *Page 40*. | | 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 21* on *Page 55*. | | 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 22* on *Page 55*. | | 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 COM1 TRACKSTATA ONCE
```

The first example configures the GTR 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 TRACKSTAT log only once on COM1.

**Table 21: 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 22: 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. |

### *5.3.7    PULSEBLANKING    Enable/Disable Digital Pulse Blanking for L1, E5a/L5 and E5b*

⊠  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.

**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* on *Page 29*. | | H | | 0 |
| 2 | frequency | L1, L5, E5b and E6 | Pulse blanking frequency. See *Table 23* below. | Enum | 4 | H |
| 3 | switch | 0-127 | Pulse blanking switch using thresholds. See *Table 24* below. | Ulong | 4 | H+4 |

**Examples:**

PULSEBLANKING L1 5

**Table 23: Frequency Switch**

| ASCII | Description |
|---|---|
| L1 | Galileo L1 frequency / GPS L1 Frequency |
| L5 | Galileo E5a frequency / GPS L5 Frequency |
| E5B | Galileo E5b frequency |
| E6 | Galileo E6 frequency |

**Table 24: Pulse Blanking Switch**

| ASCII | Description |
|---|---|
| 0 | Disable pulse blanking. |
| 1-127 | Enable pulse blanking |

### *5.3.8 RESET Hardware 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 affects all receiver cards 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* 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

### *5.3.9  SDLLBW  Configure DLL Filter Bandwidth*

This is the noise equivalent bandwidth command for the DLL filter bandwidth.

---

⊠ 1. The SDLLBW command should only be used by advanced users. It may not be suitable for every application. When using SDLLBW in a differential mode, the same setting should be used at both the monitor and remote station.

2. When you issue the SDLLBW command, all channels lose lock and the locktime for all tracking satellites is reset to zero.

3. The measurement becomes noisier as the DLL bandwidth increases.

---

**Syntax:**                                             **Message ID: 800**

SDLLBW   | SIGCHAN |   | 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* on *Page 29*. | | H | 0 | |
| 2 | sigchan | 0-63 | The parameters should be applied to this signal channel. | Ulong | 4 | H |
| 3 | bw | 0.001-0.5 | Noise equivalent bandwidth of DLL filter in Hz. | Float | 4 | H+4 |

**Example:**

SDLLBW 0 0.01

## *5.3.10 SPLLBW Configure Phase-Lock-Loop Bandwidth*

⊠ 1. 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.

2. When you change this command, the selected channel loses lock and the locktime for its tracking satellite is reset to zero.

3. The log orders for C/A signals are 3rd order.

This command sets the PLL low-pass filter bandwidth for one channel.

A time filtered square of the L1 carrier phase tracking loop error signal is used to track the performance of this tracking loop. This value is used as the variance of L1 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

$\Delta T$ = the PLL sampling rate, and
$\omega = 4 \times$ filter constant

**Syntax:**                                                                    **Message ID: 801**

```
SPLLBW   SIGCHAN    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* on *Page 29*. | | H | | 0 |
| 2 | sigchan | 0-63 | The parameters should be applied to this signal channel. | Ulong | 4 | H |
| 3 | bw | 0.5 to 15 | PLL low-pass filter bandwidth in Hz. | Float | 4 | H+4 |

**Example:**

```
SPLLBW 0 1.0
```

## *5.3.11   STHRESHOLD   Control Signal Thresholds*

This command controls signal acquisition and steady-state-lock signal thresholds. The *sigchan, acqui, lock* and *crosscorr* fields must have values.

See also *Table 56* on *Page 112* for the mapping of signal channels.

---

⊠   When you change this command, the selected channel loses lock and the locktime for its tracking satellite is reset to zero.

---

**Syntax:**                                                                          **Message ID: 803**

STHRESHOLD   | SIGCHAN |   | ACQUI |   | LOCK |   | CROSSCORR |

| 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 | sigchan | 0-63 | The parameters should be applied to this signal channel. | Ulong | 4 | H+20 |
| 3 | acqui | 25-80 | Acquisition power threshold in dBHz. | ULong | 4 | H |
| 4 | lock | 10-80 | Steady-state tracking lock threshold in dBHz. | ULong | 4 | H+4 |
| 5 | crosscorr | 10-80 | Specifies the cross-correlation power threshold in dBHz, at which point, the checks are performed. | ULong | 4 | H+8 |

**Example:**
STHRESHOLD 0 35 20 35

### *5.3.12   UNLOG   Remove Log from Logging Control*

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* on *Page 29*. | | | H | 0 | |
| 2 | port | See *Table 8* on *Page 40*. | | 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 COM1 PSRPOSA

### *5.3.13   UNLOGALL    Remove All Logs from Logging Control*

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 5.3.6* on *Page 54* 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 8* on *Page 40*. | 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 25* lists the logs by function and provides the type of each log. The valid types are discussed in *Section 4.2.1* on *Page 32*.

**Table 25: Logs By Function**

| Log | Description | Type |
|---|---|---|
| **GENERAL RECEIVER CONTROL AND STATUS** | | |
| AGCSTATS | Automatic gain control status | Synch |
| 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** | | |
| PSRPOS | Position data | Synch |
| **CLOCK INFORMATION, STATUS, AND TIME** | | |
| TIME | Receiver time information | Synch |
| CLOCKMODEL | Range bias information | Synch |
| **POST PROCESSING DATA** | | |
| RANGE | Satellite range information | Synch |
| **SATELLITE TRACKING AND CHANNEL CONTROL** | | |
| ALMANAC | Current decoded almanac data | Asynch |
| RANGE | Satellite range information | Synch |
| RAWFRAME | Raw subframes | 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 26*.

**Table 26: Log Summary**

| Log Name | Message ID | Description |
|----------|:----------:|-------------|
| AGCSTATS | 630 | Automatic gain control status |
| ALMANAC | 73 | Current decoded almanac data |
| CLOCKMODEL | 16 | Current clock model matrices |
| PSRPOS | 47 | Position data |
| RANGE | 43 | Satellite range information |
| RAWFRAME | 804 | Raw subframes |
| 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: Synchronous**                                                                 **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* 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 27* on *Page 66*) | 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 27: AGC Status Word**

| Bit | Description | Bit = 0 | Bit = 1 |
|-----|-------------|---------|---------|
| 0 | Jam Detected | Jamming Not Present | Jamming Present |
| 1 | AGC Calibrated | Coarse Calibration = 0<br>Fine Calibration = 1 | |
| 2 | | | |
| 3 | RF Type | 1 = L1<br>2 = Reserved<br>3 = L5/E5a<br>4 = E5b<br>5 = E6 | |
| 4 | | | |
| 5 | | | |
| 6 | Analog-to-Digital Convertor (ADC) Range indicates which 3 bits of the 8-bit ADC output are currently being used by the receiver. | 0 = Bits 7, 6, 5<br>1 = Bits 7, 5, 4<br>2 = Bits 7, 4, 3<br>3 = Bits 7, 3, 2<br>4 = Bits 7, 2, 1<br>5 = Bits 7, 1, 0 | |
| 7 | | | |
| 8 | | | |
| 9 | Method of Noise Floor Calculation | 1 = AGC<br>2 = Post Correlation<br>3 = … | |
| 10 | | | |
| 11 | | | |
| 12 | Receiver Card | 0 = E5a/E5b<br>1 = L1/E5a-I<br>2 = L1/E5a-II<br>3 = L1/E6 | |
| 13 | | | |
| 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;8,
25A,3618,1318,8000,0.0600,0.1456,0.2394,0.2568,0.1857,0.1125,
1312854.000000,0.000000,0.000000,
262,4088,1788,8000,0.0554,0.1281,0.2321,0.2692,0.1934,0.1218,
1317006.875000,0.000000,0.000000,
128A,7127,2527,8000,0.0750,0.1452,0.2442,0.2528,0.1739,0.1089,
1318117.000000,0.000000,0.000000,
129A,6644,2044,8000,0.0772,0.1404,0.2433,0.2546,0.1762,0.1082,
1343828.250000,0.000000,0.000000,
228A,7153,2553,8000,0.0996,0.1748,0.2468,0.2483,0.1492,0.0813,
1262912.375000,0.000000,0.000000,
229A,6525,1925,8000,0.0323,0.0983,0.2150,0.2733,0.2264,0.1547,
1360973.375000,0.000000,0.000000,
324A,4413,2113,8000,0.0410,0.1125,0.2215,0.2688,0.2185,0.1376,
1312806.250000,0.000000,0.000000,
326A,3617,1317,8000,0.0662,0.1497,0.2406,0.2551,0.1816,0.1069,
1232804.375000,0.000000,0.000000*6904e747
```

## *6.3.2 ALMANAC Decoded Almanac*

This log contains the decoded GPS 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. For more information on Almanac data, refer to the GPS SPS Signal Specification. A list of standards and references with contact information can be found in the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

**Log Type: Asynchronous**                                             **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* 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 | $\overset{\circ}{\omega}$ | Rate of right ascension, radians/second | Double | 8 | H+28 |
| 8 | $\omega_0$ | Right ascension, radians | Double | 8 | H+36 |
| 9 | $\omega$ | Argument of perigee, radians | Double | 8 | H+44 |
| 10 | Mo | 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 $0.3\,\pi$, 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* on *Page 46*. | 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,24,508014.000,00000028,42F1,0;31,1,
1049,61440.0,5.10788E-03,-7.8974718E-09,-4.5666114E-01,
-1.7361153E+00,-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
```

### 6.3.3   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* on *Page 33*. | H | H | 0 |
| 2 | clock status | Clock model status as computed from current measurement data. See *Table 43* on *Page 91*. | 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 | | | | 8 | H+16 |
| 7 | parameters | Clock correction parameters (a 1x3 array of length 3), listed left-to-right | Double | 8 | H+24 |
| 8 | | | | 8 | H+32 |
| 9 | | | | 8 | H+40 |
| 10 | | | | 8 | H+48 |
| 11 | | | | 8 | H+56 |
| 12 | | | | 8 | H+64 |
| 13 | cov data | Covariance of the straight line fit (a 3x3 array of length 9), listed left-to-right by rows | Double | 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 (meters) | 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 29* on *Page 72*. | 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 28: 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 29: Constellation Change Flag Values**

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

## 6.3.4    PSRPOS    Pseudorange Position

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

**Log Type: Synchronous**                                                                                 **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* on *Page 33*. | H | | 0 |
| 2 | sol status | Solution status. See *Table 30* on *Page 74*. | Enum | 4 | H |
| 3 | pos type | Position type. See *Table 31* on *Page 74*. | 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 $\sigma$ | Latitude standard deviation (m) | Float | 4 | H+40 |
| 10 | lon $\sigma$ | Longitude standard deviation (m) | Float | 4 | H+44 |
| 11 | hgt $\sigma$ | 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 | #obs comp | Number of observations 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;
SOL_COMPUTED,SINGLE,51.11632963531,-114.03829724755,1046.5948,
0.0000,WGS84,1.5464,1.2791,2.7786,"",0.000,0.000,10,9,0,0,0,0,0,
0*f1ba4ec7
```

**Table 30: 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 31: 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 |

## 6.3.5   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 (GPS L1, L5, Galileo L1, E5a, E5b or E6), multiple entries with the same PRN will appear in the range logs. As shown in *Table 32* on *Page 78*, these entries can be differentiated by bits 21-22 of the *ch-tr-status* field, which denote whether the observation is for GPS L1, L5, Galileo L1, E5a or E5b. This is to aid in parsing data.

The channel number is computed using parameters from the channel tracking status field:

```
Receiver Card x 16 + SV Channel Number
```

**Log Type: Synchronous** **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* 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 32* on *Page 78*. | 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;38,
12,0,73392150.510,0.019,-288006562.491,0.003,-280.328,52.4,
1989.530,05433c04,
25,0,73151818.188,0.019,-287063446.682,0.003,1809.716,52.4,
1110.730,05433c24,
11,0,72593184.134,0.019,-284871246.478,0.003,-345.818,52.4,
1987.510,05433c44,
4,0,72969747.944,0.019,-286348964.503,0.003,1643.476,52.4,
2044.510,05433c64,
19,0,74308534.984,0.019,-291602651.801,0.002,-928.721,52.4,
1662.790,05433c84,
26,0,70845868.612,0.019,-278014405.155,0.003,1351.511,52.4,
705.800,05433ca4,
10,0,73698994.893,0.019,-296755311.618,0.002,-182.382,52.2,
2027.132,05e33d04,
19,0,74308534.821,0.019,-299209677.373,0.003,-952.958,52.2,
1856.112,05e33d24,
12,0,73392150.408,0.019,-295519777.036,0.003,-287.644,52.2,
2016.752,05e33d44,
4,0,72969747.813,0.019,-293818936.350,0.003,1686.347,52.2,
2070.516,05e33d64,
7,0,73615184.250,0.019,-296417841.939,0.003,-1998.736,52.2,
508.592,05e33d84,
11,0,72593183.970,0.019,-292302670.176,0.003,-354.847,52.2,
293.876,05e33da4,
10,0,73698975.984,0.113,129447027.256,0.003,-238.025,51.3,
1227.812,040b5c04,
19,0,74308516.008,0.114,-390493885.742,0.004,-1243.674,51.3,
875.772,040b5c24,
29,0,73398708.506,0.114,-184059056.812,0.004,-292.397,51.3,
372.996,040b5c44,
25,0,73151799.161,0.113,-384415298.019,0.004,2423.443,51.3,
1693.916,040b5c64,
30,0,73717634.549,0.113,759516976.467,0.004,-1058.625,51.3,
302.512,040b5c84,
26,0,70845849.548,0.114,-372297452.106,0.004,1809.850,51.3,
506.004,040b5ca4,
11,0,72593164.921,0.114,-494909897.011,0.004,-463.102,51.3,
1185.296,040b5cc4,
12,0,73392131.323,0.113,-385678252.602,0.003,-375.387,51.3,
2063.968,042b5ce4,
19,0,23374218.878,0.249,-122832347.491,0.007,-2284.907,44.4,
2084.740,00105c04,
14,0,20386499.881,0.127,-107131779.245,0.004,465.734,50.3,
2093.570,00105c24,
3,0,25368413.879,0.383,-133311899.955,0.011,-3251.793,40.7,
2097.150,00105c44,
31,0,24239611.040,0.171,-127380026.812,0.005,3773.745,47.7,
1019.330,00105c64,
```

```
18,0,23213833.497,0.233,-121989516.277,0.008,-2859.917,45.0,
2087.500,00105c84,
22,0,20974251.108,0.107,-110220432.556,0.003,-1649.832,51.9,
2086.150,00105ce4,
9,0,22948411.726,0.226,-120594715.003,0.006,-2453.190,45.3,
2098.720,00105d04,
32,0,24060920.270,0.186,-126440997.956,0.006,2965.209,47.0,
1913.830,00105d24,
11,0,22913825.477,0.193,-120412969.613,0.007,2375.712,46.7,
2094.820,00105d44,
6,0,25469785.009,0.819,-133844606.635,0.020,-3172.542,34.1,
2028.630,00105d64,
11,0,72593160.039,0.042,-309642554.388,0.006,-375.892,51.5,
2058.000,04bb3c04,
12,0,73392126.530,0.041,-313050505.572,0.006,-304.696,51.8,
2056.080,04bb3c24,
5,0,70026994.368,0.041,-298696705.762,0.006,346.924,51.7,
543.180,04bb3c44,
25,0,73151794.072,0.041,-312025389.692,0.003,1967.088,51.6,
1953.000,04bb3c64,
4,0,72969726.236,0.042,-311248787.327,0.004,1786.392,51.4,
1792.240,04bb3c84,
30,0,73717629.476,0.042,-314438915.136,0.004,-859.282,51.4,
716.300,04bb3ca4,
10,0,73698971.337,0.040,-314359339.638,0.006,-193.197,51.9,
2073.480,04bb3cc4,
19,0,74308510.867,0.041,-316959299.301,0.004,-1009.474,51.8,
1438.180,04bb3ce4*d978acbc
```

**Table 32: Channel Tracking Status**

| Nibble # | Bit # | Mask | Description | Range Value |
|---|---|---|---|---|
| N0 | 0 | 0x00000001 | Tracking state | 0 to 22<br>See *Table 33* on *Page 79* |
| | 1 | 0x00000002 | | |
| | 2 | 0x00000004 | | |
| | 3 | 0x00000008 | | |
| N1 | 4 | 0x00000010 | SV channel number | 0-n (0 = first, n = last)<br>n depends on the receiver |
| | 5 | 0x00000020 | | |
| | 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 34* on *Page 79* |
| | 14 | 0x00004000 | | |
| | 15 | 0x00008000 | | |
| N4 | 16 | 0x00010000 | Satellite system | 0 = GPS<br>1, 4-7 = Reserved<br>2 = GEO<br>3 = Galileo |
| | 17 | 0x00020000 | | |
| | 18 | 0x00040000 | | |
| | 19 | 0x00080000 | Receiver Card | 0 = E5a/E5b<br>1 = L1/E5a-I<br>2 = L1/E5a-II<br>3 = L1/E6 |
| N5 | 20 | 0x00100000 | | |
| | 21 | 0x00200000 | Signal Type<br>(depends on satellite system) | If GPS:       If Galileo:<br>0 = L1 C/A    0 = L1 dataless<br>14 = L5 C5 dataless  1 = L1 data<br>26 = L5 C5 data  5 = E5 dataless<br>              6 = E6 data<br>              10 = E5a dataless<br>              11 = E5a data<br>              15 = E5b dataless<br>              16 = E5b data |
| | 22 | 0x00400000 | | |
| | 23 | 0x00800000 | | |
| N6 | 24 | 0x01000000 | | |
| | 25 | 0x02000000 | | |
| | 26 | 0x04000000 | Forward Error Correction (FEC) | 0 = Not FEC, 1 = FEC |
| | 27 | Reserved (always 0) | | |

| Nibble # | Bit # | Mask | Description | Range Value |
|---|---|---|---|---|
| N7 | 28 | 0x10000000 | Reserved (always 0) | |
| | 29 | 0x20000000 | | |
| | 30 | Reserved (always 0) | | |
| | 31 | 0x80000000 | Channel assignment | 0 = Automatic, 1 = Forced |

**Table 33: Tracking State Bit Values**

| Bit Value | Description |
|---|---|
| 0 | Idle |
| 1 | Sky search |
| 2 | Wide frequency band pull-in |
| 3 | Narrow frequency band pull-in |
| 4 | PLL |
| 5 | Reacquisition |
| 6 | Steering |
| 7 | Frequency-lock loop |
| 8-14 | Reserved |
| 15 | Newman-Hoffman alignment |

**Table 34: 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.    Galileo Narrow Correlator:
L1 = 0.07 chips
E5a = 0.73 chips
E5b = 0.73 chips
E6 = 0.365 chips

### *6.3.6 RAWFRAME Raw Subframes*

This log contains the raw subframes. The subframes are output even when there are parity failures.

**Log Type: Asynchronous**                                             **Message ID: 804**

| 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* on *Page 33*. | H | H | 0 |
| 2 | sigchan | The parameters should be applied to this signal channel | Ulong | 4 | H |
| 3 | PRN | Satellite PRN number | Ulong | 4 | H+4 |
| 4 | #parity failures | Number of consecutive parity failures | Ulong | 4 | H+8 |
| 5 | #bits in frame | Number of bits in subframe | Ulong | 4 | H+12 |
| 6 | #bytes | Number of bytes to follow | Ulong | 4 | H+16 |
| 7 | data | Raw subframe data | Hex [variable] | 40[a] | H+20 |
| 8 | | 32-bit CRC (*ASCII* and *Binary* only) | Hex | 4 | H+60 |

a. In the Binary log case, the data field will only output the number of bits in the subframe. This is 120 for L1, 120 for E5b, 244 for E5a, and 484 for E6.

**Recommended Input:**
```
LOG RAWFRAMEA ONNEW
```

**Example Output:**
```
#RAWFRAMEA,COM1,0,44.5,SATTIME,494,345301.000,00000000,0000,0;55,
19,0,492,62,2B26BCEF0C04F6711BF86137086A12C14F87C07B4C6AA4DE04BCEB8
612C34C691BFABCECEB86BCED4F851BFB0C074C68613604BFF48448D33487C2D588
00*357FD5E5
```

## *6.3.7 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, that command is not included in RXCOMMANDS.

**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* on *Page 33*. | H | | 0 |
| 2 | command type | Indicates which command the embedded message represents, see *Table 35* on *Page 82*. | 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,COM1,0,71.0,EXACT,0,0.000,00000000,0000,0;
9,LOG COM1 VERSION ONCE 0.000000 0.000000 HOLD
43,STHRESHOLD 15 36 20 36
43,STHRESHOLD 0 36 20 36
0,ASSIGN 0 ACTIVE 51 -2500 1250
0,ASSIGN 1 ACTIVE 51 -1250 1250
0,ASSIGN 2 ACTIVE 51 0 1250
0,ASSIGN 3 ACTIVE 51 1250 1250
0,ASSIGN 4 ACTIVE 51 2500 1250
0,ASSIGN 5 ACTIVE 52 -2500 1250
0,ASSIGN 6 ACTIVE 52 -1250 1250
0,ASSIGN 7 ACTIVE 52 0 1250
0,ASSIGN 8 ACTIVE 51 -2500 1250
0,ASSIGN 9 ACTIVE 51 -1250 1250
0,ASSIGN 10 ACTIVE 51 0 1250
0,ASSIGN 11 ACTIVE 51 1250 1250
0,ASSIGN 12 ACTIVE 51 2500 1250
0,ASSIGN 13 ACTIVE 52 -2500 1250
0,ASSIGN 14 ACTIVE 52 -1250 1250
0,ASSIGN 15 ACTIVE 51 -1300 5000
0,ASSIGN 16 ACTIVE 51 -2500 1250
0,ASSIGN 17 ACTIVE 51 -1250 1250
0,ASSIGN 18 ACTIVE 51 0 1250
0,ASSIGN 19 ACTIVE 51 1250 1250
0,ASSIGN 20 ACTIVE 52 2500 1250
0,ASSIGN 21 ACTIVE 52 -2500 1250
```

```
0,ASSIGN 22 ACTIVE 52 -1250 1250
0,ASSIGN 23 ACTIVE 52 0 5000
9,LOG COM1 AGCSTATS ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 PSRPOS ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 RANGE ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 RXSECSTATUS ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 SATVIS ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 SYSTEMLEVELS ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 TIME ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 TRACKSTAT ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 VERSION ONTIME 10.000000 0.000000 HOLD
9,LOG COM1 RAWFRAME ONNEW 0.000000 0.000000 HOLD
*D30D79C8
```

**Table 35: Command Type Values**

| ASCII | BINARY | Command Type |
|-------|--------|--------------|
| 0 | 0 | ASSIGN |
| 1-3 | 1-3 | Reserved |
| 4 | 4 | COM |
| 5-6 | 5-6 | ECUTOFF |
| 7 | 7 | FIX |
| 8 | 8 | Reserved |
| 9 | 9 | LOG |
| 10 | 10 | RESET |
| 11-18 | 11-18 | Reserved |
| 19 | 19 | AGCMODE |
| 20 | 20 | Reserved |
| 21 | 21 | PULSEBLANKING |
| 22 | 22 | UNLOG |
| 23-24 | 23-24 | Reserved |
| 25 | 25 | UNLOGALL |
| 26-42 | 26-42 | Reserved |
| 43 | 43 | STHRESHOLD |
| 44 | 44 | Reserved |
| 45 | 45 | SDLLBW |
| 46 | 46 | SPLLBW |

### 6.3.8 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* on *Page 33*. | H | | 0 |
| 2 | # comp | Number of components (cards, and so on) | Ulong | 4 | H |
| 3 | Reserved | | Enum | 4 | H+4 |
| 4 | | | 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. See *Table 40* on *Page 86*. | Ulong | 4 | H+60 |
| 9 | error word | Receiver error word. A value of zero indicates no errors. See *Table 38* on *Page 85*. | Ulong | 4 | H+64 |
| 10 | Reserved | | 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 RXSECSTATUSA ONNEW
```

**Example Output:**
```
#RXSECSTATUSA,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;5,
IOMASTER,IOM,"","DAG06500004","7.400A3",00000000,00000000,
00000000,
L1E5A,PM,"L1L5GPST","DZN06300008","5.400A5",00C81008,00000000,
00401000,
L1E5A,PS1,"GALT","DZN06300004","5.400A5",00CC1008,00000000,
00401000,
E5AB,PS2,"GALT","DBH06270003","6.400A5",00EC0000,00000000,
00000000,
L1E6,PS3,"GALT","DFG08510002","10.400A2",00EC0000,00000000,
00000000*6cea5562
```

**Table 36: Component Type**

| ASCII | Binary | Description |
|---|---|---|
| UNKNOWN | 0 | Unknown Component |
| GPSCARD | 1 | OEM4 Family Component |
| Reserved | 2,3,4, 6 | Reserved |
| FPGA | 5 | Field Programmable Gate Array |
| L5EURO | 7 | Reserved |
| CPLD | 8 | Complex Programmable Logic Device |
| L1E5A | 9 | L1/E5a Card |
| IOMASTER | 10 | I/O Master Card |
| E5AB | 11 | E5a/E5b Card |
| L1E6 | 12 | L1/E6 Card |

**Table 37: Receiver Section**

| ASCII | Binary | Description |
|---|---|---|
| GPS | 0 | GPS Section Master Card (Euro-3M) |
| S1 | 1 | I/O Section Slave 1 Card (L1/E5a) |
| S2 | 2 | I/O Section Slave 2 Card (L1/E5a) |
| S3 | 3 | I/O Section Slave 3 Card (E5a/E5b) |
| S4 | 4 | I/O Section Slave 4 Card (L1/E6) |
| IOM | 12 | I/O Master Card |
| UNKNOWN | 13 | Unknown Receiver Section |

**Table 38: 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 | | OK | Error |
| N1 | 4 | 0x00000010 | Electronic Serial Number (ESN) access status | OK | Error |
| | 5 | 0x00000020 | Authorization code status | OK | Error |
| | 6 | 0x00000040 | Sensor ADC status | 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 | OK | Error |
| N3 | 12 | 0x00001000 | PLL RF2 hardware status | 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 39: 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 40: Receiver Status**

| Nibble # | Bit # | Mask | Description | Bit = 0 | Bit = 1 |
|---|---|---|---|---|---|
| N0 | 0 | 0x00000001 | Error flag, see *Table 38, Receiver Error on Page 85* | 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 | COM1 buffer overrun flag | No overrun | Overrun |
| N3 | 11 | 0x00000800 | Reserved | | |
| | 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 *Section 5.3.5* on *Page 52* | Not fixed | Fixed |
| | 21 | 0x00200000 | Clocksteering 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 Euro4-G2 cards

## 6.3.9   SATVIS   Satellite Visibility

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

**Log Type: Synchronous**                                                                      **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* on *Page 33*. | H | | 0 |
| 2 | sat vis | Indicates if the satellite visibility is valid. See *Table 41* on *Page 88*. | Enum | 4 | H |
| 3 | comp alm | Indicates if the complete almanac was used. See *Table 42* on *Page 88*. | 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 ARINC. A list of standards and references with contact information can be found in the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

**Recommended Input:**
```
LOG SATVISA ONTIME 60
```

**ASCII Example:**
```
#SATVISA,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;
TRUE,TRUE,30,
14,0,0,82.2,184.2,433.718,471.225,
22,0,0,57.7,94.2,-1691.642,-1654.135,
11,0,0,26.6,306.0,2338.609,2376.116,
18,0,0,24.3,97.8,-2898.892,-2861.385,
9,0,0,21.9,42.3,-2493.568,-2456.061,
32,0,0,16.1,279.6,2935.138,2972.645,
31,0,0,13.4,171.3,3739.715,3777.222,
3,0,0,5.0,224.4,-3285.719,-3248.212,
```

```
6,0,0,2.2,213.1,-3205.242,-3167.735,
5,0,0,1.9,90.0,2813.896,2851.404,
12,0,0,0.3,78.8,2535.593,2573.100,
28,0,0,-5.0,330.2,-1858.116,-1820.609,
17,0,0,-5.2,355.3,2796.473,2833.980,
30,0,0,-6.4,111.6,3136.163,3173.670,
21,0,0,-8.1,145.7,-3888.059,-3850.552,
20,0,0,-8.3,282.3,3431.021,3468.528,
15,0,0,-23.9,53.2,-3295.386,-3257.879,
16,0,0,-29.9,196.6,124.497,162.004,
23,0,0,-30.4,234.6,3007.430,3044.937,
27,0,0,-35.0,357.8,-2794.683,-2757.176,
24,0,0,-39.3,134.1,-2598.078,-2560.571,
26,0,0,-39.7,47.9,-3095.257,-3057.750,
29,0,0,-42.3,131.7,-442.580,-405.072,
8,0,0,-51.3,325.2,-2388.066,-2350.559,
13,0,0,-52.8,234.7,2175.409,2212.916,
4,0,0,-53.7,344.1,2478.824,2516.331,
25,0,0,-58.9,250.3,697.310,734.817,
7,0,0,-60.7,276.7,-574.554,-537.046,
10,0,0,-62.5,105.2,-1430.878,-1393.371,
2,0,0,-73.6,31.8,680.826,718.333*4D4FBD3F
```

**Table 41: Satellite Visibility Values**

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

**Table 42: Complete Almanac Flag Values**

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

### *6.3.10 SYSTEMLEVELS System Hardware Levels*

This log contains environmental and voltage parameters for the receiver card and the I/O Master 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* on *Page 33*. | H | | 0 |
| 2 | # comp | Number of components | Ulong | 4 | H |
| 3 | type | Component type, see *Table 36* on *Page 84* | Enum | 4 | H + 4 |
| 4 | receiver section | Receiver section, see *Table 37* on *Page 84* | Enum | 4 | H + 8 |
| 5 | board 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 (I/O Master card) | Float | 4 | H + 16 |
| 7 | core volt | 1.5 V CPU core voltage (V) | Float | 4 | H + 20 |
| 8 | supply volt | 12 V supply voltage (V) | Float | 4 | H + 24 |
| 9 | RF volt/ Fan1 volt | 5 V RF supply voltage (V) (receiver cards) or Fan1 voltage (I/O Master card) | Float | 4 | H+28 |
| 10 | FPGA temp/ Fan2 volt | FPGA temperature (°C) (receiver cards) or Fan2 voltage (I/O Master 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 (I/O Master cards) | Float | 4 | H+36 |
| 12 | TCXO control volt/Fan2 RPM | Control voltage for TCXO (receiver cards) or Fan 2 rotations per minute (I/O Master cards) | Float | 4 | H+40 |
| 13 | idle time/oscillator control volt | Idle time (%) (receiver cards) or oscillator control voltage (I/O Master card) | Float | 4 | H+44 |
| 14 | LNA output volt/ local oscillator power | LNA output voltage (V) (receiver cards) or oscillator power (I/O Master 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;5,
IOMASTER,IOM,43.000,11.824,0.011,1.501,4.909,51.000,
1079261824.000,1069572096.000,44.317,0.000,
L1E5A,PM,48.000,0.000,1.204,11.918,5.007,0.011,3.284,1.557,
80.995,0.000,
L1E5A,PS1,52.000,0.000,1.204,11.918,5.023,0.022,3.262,1.562,
69.043,0.000,
E5AB,PS2,46.000,0.000,1.496,11.824,4.888,57.000,3.294,1.527,
22.991,0.000,
L1E6,PS3,43.000,0.011,1.501,11.824,4.909,51.000,3.316,1.503,
44.317,0.000*7a3fd481
```

### 6.3.11   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: Synchronous**                                                    **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* on *Page 33*. | H | | 0 |
| 2 | clock status | Clock model status (not including current measurement data). See *Table 43* below. | 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;VALID,
-4.927184044e-05,8.604988375e-08,-14.99999999715,1989,6,28,
23,55,5000,VALID*3333502a
```

**Table 43: 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 |

## 6.3.12   TRACKSTAT   Tracking Status

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

**Log Type: Synchronous**                                                    **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* on *Page 33*. | H | | 0 |
| 2 | sol status | Solution status. See *Table 30* on *Page 74*. | Enum | 4 | H |
| 3 | pos type | Position type. See *Table 31* on *Page 74*. | 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 32* on *Page 78*. | 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 44* on *Page 95*. | 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;
INSUFFICIENT_OBS,NONE,0.000,64,
12,0,05433c04,73392150.510,-280.328,52.383,1989.530,0.000,
GOOD,0.000,
25,0,05433c24,73151818.188,1809.716,52.367,1110.730,0.000,
GOOD,0.000,
11,0,05433c44,72593184.134,-345.818,52.396,1987.510,0.000,
GOOD,0.000,
4,0,05433c64,72969747.944,1643.476,52.425,2044.510,0.000,
GOOD,0.000,
19,0,05433c84,74308534.984,-928.721,52.370,1662.790,0.000,
GOOD,0.000,
26,0,05433ca4,70845868.612,1351.511,52.397,705.800,0.000,
GOOD,0.000,
0,0,854320c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,854320e0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
10,0,05e33d04,73698994.893,-182.382,52.184,2027.132,0.000,
GOOD,0.000,
19,0,05e33d24,74308534.821,-952.958,52.174,1856.112,0.000,
GOOD,0.000,
12,0,05e33d44,73392150.408,-287.644,52.162,2016.752,0.000,
GOOD,0.000,
4,0,05e33d64,72969747.813,1686.347,52.190,2070.516,0.000,
GOOD,0.000,
7,0,05e33d84,73615184.250,-1998.736,52.165,508.592,0.000,
GOOD,0.000,
11,0,05e33da4,72593183.970,-354.847,52.174,293.876,0.000,
GOOD,0.000,
0,0,85e321c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,860321e0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
10,0,040b5c04,73698975.984,-238.025,51.313,1227.812,0.000,
GALL1,0.000,
19,0,040b5c24,74308516.008,-1243.674,51.288,875.772,0.000,
GALL1,0.000,
29,0,040b5c44,73398708.506,-292.397,51.280,372.996,0.000,
GALL1,0.000,
25,0,040b5c64,73151799.161,2423.443,51.316,1693.916,0.000,
GALL1,0.000,
30,0,040b5c84,73717634.549,-1058.625,51.313,302.512,0.000,
GALL1,0.000,
26,0,040b5ca4,70845849.548,1809.850,51.288,506.004,0.000,
GALL1,0.000,
11,0,040b5cc4,72593164.921,-463.102,51.288,1185.296,0.000,
GALL1,0.000,
12,0,042b5ce4,73392131.323,-375.387,51.293,2063.968,0.000,
GALL1,0.000,
0,0,05c84100,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,05c84120,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,05c84140,0.000,0.000,0.047,0.000,0.000,NA,0.000,
```

```
0,0,05c84160,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,05c84180,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,05c841a0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,05c841c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,05c841e0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
19,0,00105c04,23374218.878,-2284.907,44.436,2084.740,0.000,
OBSL1,0.000,
14,0,00105c24,20386499.881,465.734,50.262,2093.570,0.000,
OBSL1,0.000,
3,0,00105c44,25368413.879,-3251.793,40.725,2097.150,0.000,
OBSL1,0.000,
31,0,00105c64,24239611.040,3773.745,47.694,1019.330,0.000,
OBSL1,0.000,
18,0,00105c84,23213833.497,-2859.917,45.002,2087.500,0.000,
OBSL1,0.000,
17,0,001040a1,0.000,-4000.000,0.047,0.000,0.000,NA,0.000,
20,0,001040c1,0.000,-3000.000,0.047,0.000,0.000,NA,0.000,
22,0,00105ce4,20974251.108,-1649.832,51.853,2086.150,0.000,
OBSL1,0.000,
9,0,00105d04,22948411.726,-2453.190,45.297,2098.720,0.000,
OBSL1,0.000,
32,0,00105d24,24060920.270,2965.209,46.980,1913.830,0.000,
OBSL1,0.000,
11,0,00105d44,22913825.477,2375.712,46.706,2094.820,0.000,
OBSL1,0.000,
6,0,00105d64,25469785.009,-3172.542,34.118,2028.630,0.000,
OBSL1,0.000,
0,0,84122180,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,841221a0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,875241c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,875241e0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
11,0,04bb3c04,72593160.039,-375.892,51.475,2058.000,0.000,
GOOD,0.000,
12,0,04bb3c24,73392126.530,-304.696,51.764,2056.080,0.000,
GOOD,0.000,
5,0,04bb3c44,70026994.368,346.924,51.671,543.180,0.000,
GOOD,0.000,
25,0,04bb3c64,73151794.072,1967.088,51.613,1953.000,0.000,
GOOD,0.000,
4,0,04bb3c84,72969726.236,1786.392,51.399,1792.240,0.000,
GOOD,0.000,
30,0,04bb3ca4,73717629.476,-859.282,51.430,716.300,0.000,
GOOD,0.000,
10,0,04bb3cc4,73698971.337,-193.197,51.932,2073.480,0.000,
GOOD,0.000,
19,0,04bb3ce4,74308510.867,-1009.474,51.789,1438.180,0.000,
GOOD,0.000,
0,0,041b4100,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,041b4120,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,041b4140,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,041b4160,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,041b4180,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,041b41a0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,041b41c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
```

```
0,0,041b41e0,0.000,0.000,0.047,0.000,0.000,NA,0.000*68c450e1
```

**Table 44: 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 |
| 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 | Tracking a GPS L5 signal |
| GALL1 | 19 | Tracking a Galileo L1 signal |
| GALE5A | 20 | Tracking a Galileo E5a signal |
| GALE5B | 21 | Tracking a Galileo E5b signal |
| GALE6 | 22 | Tracking a Galileo E6 signal |
| OBSL1 | 23 | Tracking a GPS L1 signal on I/O Master section |
| NA | 99 | No observation (a reject code is not applicable) |

### 6.3.13 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* on *Page 33*. | H | | 0 |
| 2 | # comp | Number of components (cards, etc.) | Long | 4 | H |
| 3 | type | Component type. See *Table 36* on *Page 84*. | 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 45* on *Page 97*. | Char[16] | 16 | H+40 |
| 7 | sw version | Firmware software version. See*Table 45* on *Page 97*. | Char[16] | 16 | H+56 |
| 8 | boot version | Boot code version. See *Table 45* on *Page 97*. | Char[16] | 16 | H+72 |
| 9 | comp date | Firmware compile date. See *Table 45* on *Page 97*. | Char[12] | 12 | H+88 |
| 10 | comp time | Firmware compile time. See *Table 45* on *Page 97*. | 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,COM1,0,46.5,FINE,494,345320.000,00000000,0000,0;12,
IOMASTER,"","DAG06500004","IOM-2.02-2XX","7.400A3",
"7.000D5","2009/Feb/ 6","15:26:38",
FPGA,"","","2.5.0","","","","",
L1E5A,"L1L5GPST","DZN06300008","L1E5A-2.02-2X2","5.400A5",
"5.001A1db","2009/Feb/11","15:54:00",
FPGA,"Altera","","1.5.2","galileo","","2009/Feb/11","11:23:59",
L1E5A,"GALT","DZN06300004","L1E5A-2.02-2X2","5.400A5",
"5.002D2db","2009/Feb/11","15:54:00",
FPGA,"Altera","","1.5.2","galileo","","2009/Feb/11","11:23:59",
E5AB,"GALT","DBH06270003","E5AB-1.02-2XX","6.400A5",
"6.000db","2009/Feb/11","14:58:19",
```

```
FPGA,"","","3.5.1","","","","",
CPLD,"","","CPLD-2","","","","",
L1E6,"GALT","DFG08510002","L1E6-1.00-2XX","10.400A2",
"6.000db","2009/Feb/11","15:32:25",
FPGA,"","","5.5.1","","","","",
CPLD,"","","CPLD-2","","","","","*b2898f1f
```

**Table 45: Version Log Field Formats**

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

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

1. Contact the NovAtel Aviation Group.
2. Download update files.
3. Decompress files.
4. Run the firmware loading utility.

## 7.1  Contacting the NovAtel Aviation Department

The first step in updating the receiver is to contact the NovAtel Aviation Group via any of the methods described in *Customer Service* on *Page 9*.

When you call, be sure to have the GTR's serial number and program revision level available. This information is printed on the rear panel of the GTR, as shown in *Figure 14*.



**Figure 14: Serial Number and Version Label**

You can also verify the information by powering up the receiver and requesting the *VERSION* log (*Page 96*).

After conferring with the Aviation Group to establish the required revision level, as well as the terms and conditions of your firmware update, the Aviation Group 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, the Aviation Group 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 the Aviation Group 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 GTR firmware files might be named 5000.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; the Aviation Group will advise you as to the exact names of the files you need. As well, the Aviation Group 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<br>where XXXX = program version level (for example 2000.hex) |

# 7.4   Running the Utility

WinLoad is a windows based program used to download firmware to GPSCards. The main screen is shown in *Figure 15*.
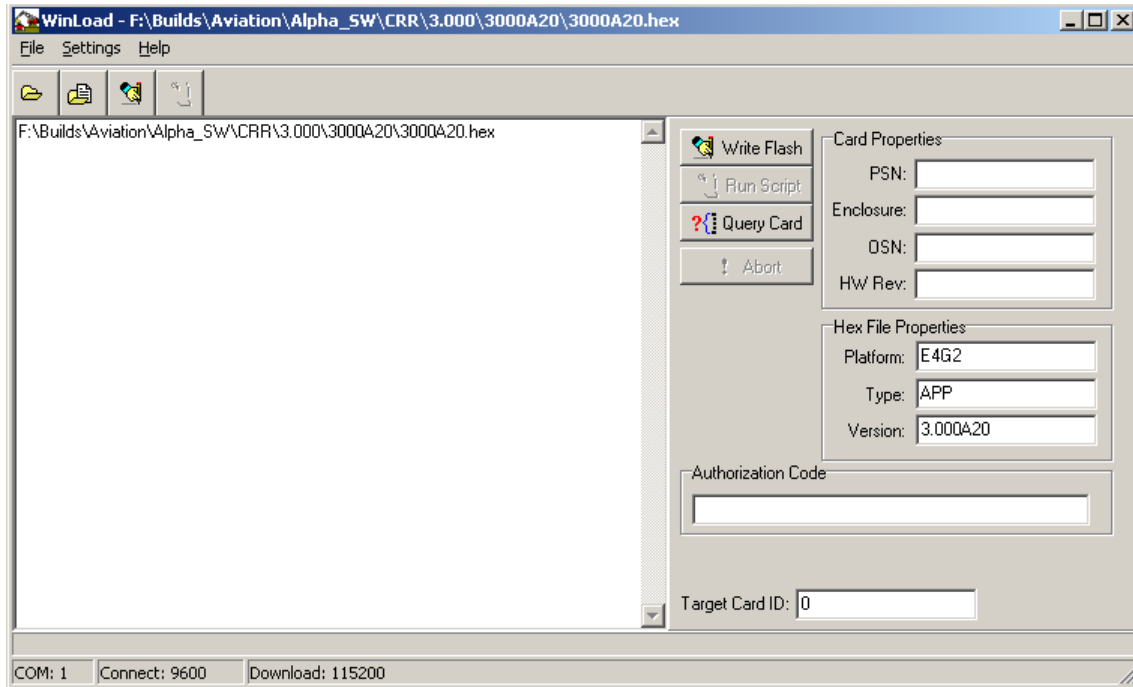


**Figure 15: Main Screen of WinLoad**

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

## 7.4.1   Open a File to Download

From the file menu choose Open. Use the Open dialog to browse for your file, see *Figure 16*.
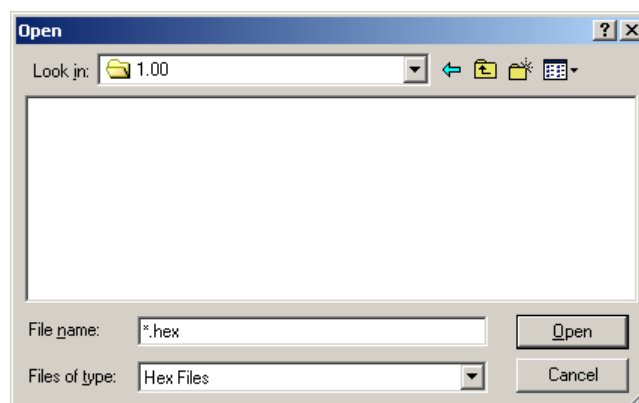


**Figure 16: WinLoad's Open Dialog**

Once you have selected your file, the name should appear in the main display area and in the title bar, see *Figure 17*.
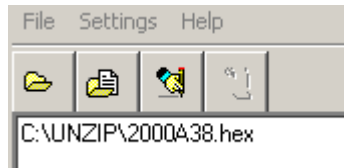


**Figure 17: Open File in WinLoad**

WinLoad automatically determines which receiver card to load based on the selected file.

### 7.4.2    Communications Settings

To set the communications port and baud rate, select COM Settings from the Settings menu, see *Figure 18* on *Page 101*. 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).
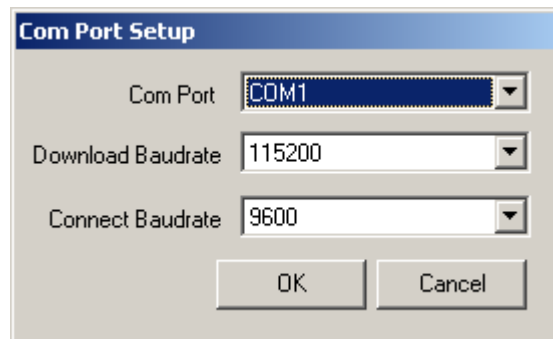


**Figure 18: COM Port Setup**

### 7.4.3    Downloading firmware

To download firmware follow these steps:

1. Set up the communications port as described in Communications Settings *above*.

2. Change the Boot Target Card ID to:

    0 - IO Master

    1 - L1/E5A I

    2 - L1/E5A II

    3 - E5A/E5B

    4 - L1/E6

3. Select the file to download, see Open a File to Download *on Page 100*.

4. Make sure the file path and file name are displayed in main display area, see *Figure 17*.

5. Click on the Write Flash button to download the firmware:



6. 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.

7.  WinLoad should be able to locate the card and the hex file should start downloading. When the Authorization Code dialog opens, see *Figure 19*, enter the auth code and select OK.
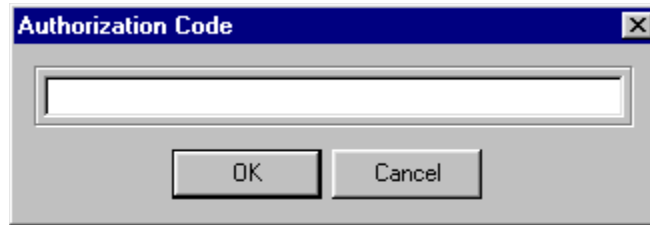


**Figure 19: Authorization Code Dialog**

8.  The receiver should finish downloading and reset. The process is complete when "Done." is displayed in the main display area, see *Figure 20* on *Page 102*.
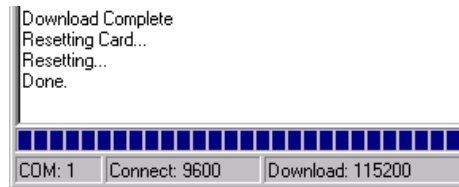


**Figure 20: Update Process Complete**

9.  Close WinLoad.

This completes the procedure required to update a GTR 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 106*.

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 49* on *Page 105*

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

**Table 46: LCD Display in Normal Operation**

| SYSTEM | STAT | VERSION |
|--------|------|---------|
| IOM | OK | 7.400 |
| S1 | OK | 5.400 |
| S2 | OK | 5.400 |
| S3 | OK | 6.400 |
| S4 | OK | 10.400 |
| S5 | | |
| S6 | | |
| S7 | | |
| S8 | | |
| S9 | | |
| CLK | OK | |
| FANS | OK | |

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 47: LCD Display of a Non-Fatal Error Event**

| SYSTEM | STAT | VERSION | VERSION |
|--------|------|---------|---------|
| IOM | BAD | 7.400 | No Pos |
| S1 | OK | 5.400 | 5.400 |
| S2 | OK | 5.400 | 5.400 |
| S3 | OK | 6.400 | 6.400 |
| S4 | OK | 10.400 | 10.400 |
| S5 | | | |
| S6 | | | |
| S7 | | | |
| S8 | | | |
| S9 | | | |
| 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 in *Table 48*:

**Table 48: Non-Fatal Errors**

| 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 locked |
| 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 49* on *Page 105*, where the double line denotes that the LCD toggles between these two screens and the shading means these screens have a flashing backlight.

**Table 49: LCD Display of a Fatal Error Event**

| SYSTEM | STAT | VERSION | VERSION |
|--------|------|---------|---------|
| IOM | OK | 7.400 | 7.400 |
| S1 | OK | 5.400 | 5.400 |
| S2 | OK | 5.400 | 5.400 |
| S3 | OK | 6.400 | 6.400 |
| S4 | OK | 10.400 | 10.400 |
| S5 | | | |
| S6 | | | |
| S7 | | | |
| S8 | | | |
| S9 | | | |
| 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 in *Table 50*:

**Table 50: Fatal Errors**

| Error Code | Error |
|------------|-------|
| Auth | Authorization code |
| ADCBad | Slow ADC |
| SupVol | Supply voltage |
| Therm | Thermometer |
| Temp | Temperature |
| M4Fail [a] | MINOS4 |
| RF1PLL [b] | PLL RF1 |
| RF2PLL | PLL RF2 |
| RF1Bad | RF1 hardware |
| RF2Bad | RF2 hardware |
| NVMBad | NVM |

    a.   Indicates FPGA failure if the board has an FPGA
    b.   RF1 and RF2 indicate RF decks and not frequencies

## 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 40, Receiver Status* on *Page 86* 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 47* on *Page 104*. If the error is fatal, the backlight flashes at 0.5 Hz, see *Table 49* on *Page 105*. See also *Section 2.2.3.1, Receiver Error Display* starting on *Page 25*.

# Appendix A    Technical Specifications

**Table 51: Performance Specifications**

| PERFORMANCE | |
|---|---|
| *All values subject to GPS system characteristics* | |
| **Frequency      GPS**<br>                       **Galileo** | L1(1575.42 MHz), L5 (1176.45 MHz)<br>L1 (1575.42 MHz), E5a (1176.45 MHz), E5b (1207.14 MHz),<br>E6 (1278.75 MHz) |
| **Codes Tracked** | GPS L1-C/A Code<br>Galileo L1 Code<br>Galileo E5a Code<br>Galileo E5b Code<br>Galileo E6 Code<br>GPS SVN (PRN 0-37)<br>GEO SVN (PRN 120-138)<br>Galileo SVN (PRN 1-48)<br>GIOVE-A<br>GIOVE-B |
| **Satellite Tracking Channels** | 60 |
| **Position Accuracy (stand-alone)** | 1.5 m CEP |
| **Pseudorange Measurement Accuracy**<br>        **L1 C/A Narrow**<br>        **L1 C/A Wide**<br>        **L5**<br>        **BOC L1**<br>        **E5a**<br>        **E5b**<br>        **E6** | <br>10 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz<br>1 m RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz<br>4 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz<br>7 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz<br>4 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz<br>4 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz<br>6 cm RMS, C/No > 44 dB-Hz, DLL BW = 0.05 Hz |
| **Single Channel Phase Accuracy**<br>        **L1 C/A**<br>        **L5**<br>        **BOC L1**<br>        **E5a**<br>        **E5b**<br>        **E6** | <br>3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz<br>3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz<br>3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz<br>3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz<br>3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz<br>3 mm RMS, C/No > 44 dB-Hz, Loop PLL = 3 Hz |
| **C/No Accuracy**<br>        **L1/L5/E5a/E5b/E6** | <br>±2.5 dB, 30-65 dB-Hz |
| **Raw Data Availability Rate**<br>        **L1SQM/L5/BOCL1/E5a/E5b**<br>        **Time**<br>        **Almanac Data** | <br>One phase and code measurement per second/per satellite<br>One message per second<br>< 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** | 5 seconds C/No = 44 dB-Hz 1$\sigma$ |
|    **L5** | 60 seconds C/No = 44 dB-Hz 1$\sigma$ |
|    **BOC L1** | 60 seconds C/No = 44 dB-Hz 1$\sigma$ |
|    **E5a** | 60 seconds C/No = 44 dB-Hz 1$\sigma$ |
|    **E5b** | 60 seconds C/No = 44 dB-Hz 1$\sigma$ |
|    **E6** | 60 seconds C/No = 44 dB-Hz 1$\sigma$ |
| **Height Measurements** | Up to 18,288 metres (60,000 feet) maximum[a] |

a. In accordance with export licensing.

**Table 52: Physical Specifications**

| PHYSICAL | |
|---|---|
| **Size** | 448.8 x 361 x 177.8 mm (without the 19" mounting brackets) |
| **Weight** | 11kg (24.25 lbs) |
| MECHANICAL DRAWINGS | |

**Figure 21: GTR Dimensions**



**Table 53: Environmental Specifications**

| ENVIRONMENTAL | |
|---|---|
| **Operating Temperature** | -25°C to +40°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 54: Port Specifications**

| POWER INPUT | |
|---|---|
| **Connector** | 3-pin input power connector<br>3-pin power cord provided (for North American standard A/C) |
| **Voltage** | 100 to 240 V AC |
| **Frequency** | 50 to 60 Hz |
| **Current** | 0.8 A @ 110 V AC or 0.4 A @ 220 V AC |
| **Fuse Rating** | 3 A/250 V fast-blow (there are 2 of these) |
| ANTENNA INPUT | |
| **Connector** | TNC female |
| **RF Input Frequencies (MHz)** | L1(1575.42), L5/E5a (1176.45), E5b (1207.14) |
| **Power** | Power to the LNA is supplied by the user |
| DATA PORTS | |
| **Connector** | DE9P or USB |
| **Data Transfer Rate** | User-selectable rate including 9600 (default), 19200, 38400, 57600, 115200, and 230400[a] bps |
| **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 55 on Page 111 for specifications on the external frequency reference.* | |
| **Connector** | BNC female |
| **Capture Range** | 10 MHz ± 1Hz |
| **Sensitivity** | 0 dBm to +17 dBm into 50 $\Omega$ |
| 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)**<br>**Voltage (low)**<br>**Nominal Load Impedance** | > 2.4 V DC<br>< 0.55 V DC<br>50 $\Omega$ |
| OCXO OUTPUT | |
| **10 MHz OCXO Output** | -1 dBm ± 3 dB |

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 55: Recommended External Frequency Reference Specifications**

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

**Table 56: 40GALILEO24GPS Channel Configuration**

| Signal Channel | SV Channel | SV Type | Code | Sky Search |
|:---:|:---:|:---:|:---:|:---:|
| 0 | 0 | Galileo | E5a dataless | Auto |
| 1 | 1 | Galileo | E5a dataless | Auto |
| 2 | 2 | Galileo | E5a dataless | Auto |
| 3 | 3 | Galileo | E5a dataless | Auto |
| 4 | 4 | Galileo | E5a dataless | Auto |
| 5 | 5 | Galileo | E5a dataless | Auto |
| 6 | 6 | Galileo | E5a dataless | Auto |
| 7 | 7 | Galileo | E5a dataless | Auto |
| 8 | 8 | Galileo | E5b dataless | Auto |
| 9 | 9 | Galileo | E5b dataless | Auto |
| 10 | 10 | Galileo | E5b dataless | Auto |
| 11 | 11 | Galileo | E5b dataless | Auto |
| 12 | 12 | Galileo | E5b dataless | Auto |
| 13 | 13 | Galileo | E5b dataless | Auto |
| 14 | 14 | Galileo | E5b dataless | Auto |
| 15 | 15 | Galileo | E5b data | Auto |
| 16 | 16 | Galileo | L1 dataless | Auto |
| 17 | 17 | Galileo | L1 dataless | Auto |
| 18 | 18 | Galileo | L1 dataless | Auto |
| 19 | 19 | Galileo | L1 dataless | Auto |
| 20 | 20 | Galileo | L1 dataless | Auto |
| 21 | 21 | Galileo | L1 dataless | Auto |
| 22 | 22 | Galileo | L1 dataless | Auto |
| 23 | 23 | Galileo | L1 data | Auto |
| 24 | 24 | GPS | L5 dataless | Assign |
| 25 | 25 | GPS | L5 dataless | Assign |
| 26 | 26 | GPS | L5 dataless | Assign |
| 27 | 27 | GPS | L5 dataless | Assign |
| 28 | 28 | GPS | L5 dataless | Assign |
| 29 | 29 | GPS | L5 dataless | Assign |
| 30 | 30 | GPS | L5 dataless | Assign |
| 31 | 31 | GPS | L5 dataless | Assign |
| 32 | 32 | GPS | L1 C/A | Auto |
| 33 | 33 | GPS | L1 C/A | Auto |
| 34 | 34 | GPS | L1 C/A | Auto |
| 35 | 35 | GPS | L1 C/A | Auto |
| 36 | 36 | GPS | L1 C/A | Auto |
| 37 | 37 | GPS | L1 C/A | Auto |
| 38 | 38 | GPS | L1 C/A | Auto |
| 39 | 39 | GPS | L1 C/A | Auto |
| 40 | 40 | GPS | L1 C/A | Auto |
| 41 | 41 | GPS | L1 C/A | Auto |

(continued on next page)

| Signal Channel | SV   Channel | SV Type | Code | Sky Search |
|:---:|:---:|:---:|:---:|:---:|
| 42 | 42 | GPS | L1 C/A | Auto |
| 43 | 43 | GPS | L1 C/A | Auto |
| 44 | 44 | GEO | L1 C/A | Idle |
| 45 | 45 | GEO | L1 C/A | Idle |
| 46 | 46 | GEO | L5 C5 data | Idle |
| 47 | 47 | GEO | L5 C5 data | Idle |
| 48 | 48 | Galileo | E6 dataless | Auto |
| 49 | 49 | Galileo | E6 dataless | Auto |
| 50 | 50 | Galileo | E6 dataless | Auto |
| 51 | 51 | Galileo | E6 dataless | Auto |
| 52 | 52 | Galileo | E6 dataless | Auto |
| 53 | 53 | Galileo | E6 dataless | Auto |
| 54 | 54 | Galileo | E6 dataless | Auto |
| 55 | 55 | Galileo | E6 dataless | Auto |
| 56 | 56 | Galileo | L1 dataless | Assign |
| 57 | 57 | Galileo | L1 dataless | Assign |
| 58 | 58 | Galileo | L1 dataless | Assign |
| 59 | 59 | Galileo | L1 dataless | Assign |
| 60 | 60 | Galileo | L1 dataless | Assign |
| 61 | 61 | Galileo | L1 dataless | Assign |
| 62 | 62 | Galileo | L1 dataless | Assign |
| 63 | 63 | Galileo | L1 dataless | Assign |

## A.1   Power Cable

The power cable supplied with the GTR connects from the Power Input port on the back of the GTR to an external power source (+100 to +240 V AC). An input voltage of less than +100 V AC may cause the unit to suspend operation while an input voltage greater than +240 V AC may physically damage the unit, voiding the warranty. The power supply automatically adapts its input power to the national power source in the country of use as long as it is within the above range and you have an adapter for your local power receptacle.



**Figure 22: Power Cable**

# Appendix B    Acronyms

1 PPS       One Pulse Per Second

A/D         Analog-to-Digital
ADC         Analog-to-Digital Convertor
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
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
C/No        Carrier to Noise Ratio
CoCom       Coordinating Committee on Multilateral Export Controls
COSPAS      Cosmitscheskaja Sistema Poiska Awarinitsch Sudow (Russian: space system for search of vessels
            in distress)
CPLD        Complex Programmable Logic Device
CPU         Central Processing Unit
CR          Carriage Return
CRC         Cyclic Redundancy Check
CS          Commercial Service
CTS         Conventional Terrestrial System or Clear To Send

dB          Decibel
DCD         Data Carrier Detected
DLL         Delay Lock Loop
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
E-L         Early - Late
ESA         European Space Agency
ESD         Electrostatic Discharge
ESN         Electronic Serial Number

FCC         Federal Communications Commission (USA)
FEC         Forward Error Correction
FOC         Full Operational Capability
FPGA        Field Programmable Gate Array
FTP         File Transfer Protocol
FTS         Frequency and Time Standard

GCC         Galileo Control Centre
GEO         Geostationary Satellite
GLONASS     Global Navigation Satellite System
GND         Ground
GPS         Global Positioning System
GSS         Galileo Sensor Stations

---

| | |
|---|---|
| GSTB | Galileo System Test Bed |
| GTR | Galileo Test Receiver |
| GTS | Galileo Test Signal Generator |
| | |
| IBIT | Initiated Built In Test |
| ICAO | International Civil Aviation Organization |
| ICD | Interface Control Document |
| ID | Identification |
| IEEE | Institute of Electrical & Electronics Engineers |
| IF | Intermediate Frequency |
| IMO | International Maritime Organization |
| I/O | Input/Output |
| IODE | Issue of Data (Ephemeris) |
| IOV | In-Orbit Validation |
| | |
| LCD | Liquid Crystal Display |
| LF | Line Feed |
| LNA | Low Noise Amplifier |
| LSB | Least significant bit |
| | |
| MEO | Medium Earth Orbit |
| MKI | Mark Input |
| MP | Message Processor |
| MSAS | MTSAT Satellite Based Augmentation System |
| MSB | Most significant bit |
| MSL | Mean sea level |
| | |
| NAS | National Airspace System (United States) |
| NC | Not Connected |
| NMEA | National Marine Electronics Association |
| NVM | Non-Volatile Memory |
| | |
| OCXO | Oven Controlled Crystal Oscillator |
| OEM | Original Equipment Manufacturer |
| OS | Open Service |
| | |
| PC | Personal Computer |
| PLL | Phase Lock Loop |
| PPS | Precise Positioning Service or Pulse Per Second |
| PRN | PseudoRandom Noise number |
| PRS | Public Regulated Service |
| | |
| RAM | Random Access Memory |
| RCC | Rescue Co-ordination Centre |
| RF | Radio Frequency |
| RMA | Return Material Authorization |
| RMS | Root-Mean-Square |
| ROM | Read Only Memory |
| RTS | Request To Send |
| RXD | Received Data |
| | |
| SA | Selective Availability |
| SAR | Search and Rescue |
| SARSAT | Search and Rescue Satellite Aided Tracking |
| SBAS | Satellite-Based Augmentation System |
| SEP | Spherical Error Probable |
| SNR | Signal-to-Noise Ratio |
| SOL | Safety-of-Life |
| SPS | Standard Positioning Service |

| | |
|---|---|
| SQM | Signal Quality Monitoring |
| SV | Space Vehicle |
| SVN | Space Vehicle Number |
| SW | Software |
| | |
| TCXO | Temperature-Compensated Crystal Oscillator |
| TOE | Time of Ephemeris |
| TTFF | Time To First Fix |
| TXD | Transmitted Data |
| | |
| USB | Universal Serial Bus |
| | |
| UTC | Coordinated Universal Time |
| | |
| VARF | Variable Frequency |
| VDC | Volts Direct Current |
| | |
| WAAS | Wide-Area Augmentation System |
| WGS | World Geodetic System |
| | |
| XTE | Crosstrack Error |

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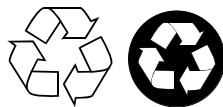WGS84, 52
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