MSAS / NES / UPC RECEIVER SUBSYSTEM

Installation and Operation Manual

MSAS / NES / UPC Receiver Subsystem

Installation and Operation Manual

Publication Number: OM-20000030

Revision Level: 3 2003/03/18

This manual reflects firmware revision level 5.446 / 4.446.

Proprietary Notice

TABLE OF CONTENTS

Warranty Policy viii
Customer Service ix
Notices x
Foreword xi
Prerequisites xi
Compliance with GPS Week Rollover xi
What's New in this Manual xi
1 Introduction 1
The NovAtel MSAS & NES / UPC Receiver Subsystems 2
Operational Overview 3
MEDLL 4
GEO Processing 4
Dual Frequency L1/L2 I 4
Dual Frequency L1/L2 II 4
Other Outputs & Inputs 5
2 Installing the MSAS Receiver 6
Minimum Configuration 6
Connecting the External Frequency Reference 7
Connecting Data Communications Equipment 8
Using the 1PPS Output 9
Connecting the GPS Antenna 10
Connecting the External Power Input 10
Using the 20.473 MHz Output Signal 11
Accessing the Strobe signals 11
3 Operating the MSAS / NES / UPC Receiver 12
Pre-Start Check List 12
Serial Ports - Default Settings 12
Boot-Up 13
Initial Communications with the MSAS / NES / UPC Receiver 13
4 Firmware Updates 15
Contact Customer Service 15
Download Compressed Files 16
Decompress Files 16
Run LOADER 16
Menu Mode 17
Command-Line Mode 18
Updating Individual GPSCards 18
Updating the GPSCards in the MEDLL Subsystem 19
Entire Receiver Update Mode 20
Updating Remotely Over a Network (Proposed) 20

Requesting a Card's PSN....21
5 Command Descriptions....22
$AGC....25
ASSIGN....27
$ASSIGNG2TOPRN....28
$CARRIEROFFSET....29
$CCRATIO....29
CLOCKADJUST....30
COM1....31
CONFIG....31
CSMOOTH....32
$DLLORDER....32
ECUTOFF....33
FIX POSITION....33
$JAMMODE....34
LOG....35
$PLLBW....37
$PLL_CONFIG....37
RESET....38
$SETFRAMETYPE....38
$THRESHOLD....39
UNASSIGN....39
UNASSIGNALL....40
$UNASSIGNG2TOPRN....40
UNDULATION....41
UNFIX....41
UNLOG....42
UNLOGALL....42
VERSION....42
6 Output Logging....44
7 NovAtel Format Data Logs....47
ASCII Log Structure....47
Binary Log Structure....47
Time Conventions....48
Log Descriptions....48
$ACPA/B AGC Control Parameter Information....48
$AGCA/B AGC and A/D Information....51
ALMA/B Decoded Almanac....53
CDSA/B Communication and Differential Decode Status....54
CLKA/B Receiver Clock Offset Data....56
DOPA/B Dilution of Precision....58
ETSA/B Extended Tracking Status....59
FRMA/B Framed Raw Navigation Data....64
IONA/B Ionospheric Model Parameters....65

POSA/B Computed Position 66
RBTA/B Satellite Broadcast Data: Raw Bits 68
RCCA Receiver Configuration 69
REPA/B Raw Ephemeris 70
RGEA/B Channel Range Measurements 71
Receiver Status – Detailed Bit Descriptions of Self-Test Word 74
RVSA/B Receiver Status 78
SATA/B Satellite Specific Data 79
SBTA/B Satellite Broadcast Data: Raw Symbols 81
TM1A/B Time of 1PPS 82
UTCA/B UTC Time Parameters 83
WBCA/B Wide Band Carrier Range Correction 84
WRCA/B Wide Band Code Range Correction 85

A Installing the NES / UPC Receiver 86

Minimum Configuration 86
Connecting the External Frequency Reference 88
Connecting Data Communications Equipment 89
Using the 1PPS Output 89
Connecting the Antennas 90
Connecting the External Power Input 90
Using the 20.473 MHz output signal 91
Accessing the Strobe signals 91

B MSAS Receiver - Technical Specifications 92

C NES / UPC Receiver - Technical Specifications 96

D Information Messages 100

E Associated Suppliers 105

INDEX 106

TABLES

Table 1 Filtering Bandwidths and Integration Times 3
Table 2 MSAS / NES / UPC Commands by Category 23
Table 3 MSAS / NES / UPC Command Summary 24
Table 4 MSAS / NES / UPC Logs by Category 45
Table 5 MSAS / NES / UPC Log Summary 46
Table 6 GPSCard Solution Status 61
Table 7 Channel Tracking Status Bits 62
Table 8 Range Reject Codes 63
Table 9 Receiver Self-Test Status Codes 73
Table 10 Additional Information about MSAS / NES / UPC Receiver Self-Test Status Word....77
Table 11 Type 1 !ERRA Messages....101
Table 12 Type 1 !MSGA Messages....101
Table 13 Type 2 Information Messages....102

FIGURES

Figure 1 The NovAtel MSAS & NES / UPC Receiver Subsystems 2
Figure 2 MSAS / NES / UPC Receiver Functional Block Diagram 3
Figure 3 MSAS Minimum System Configuration 6
Figure 4 Rear Panel of MSAS Receiver 7
Figure 5 10 MHz In (External Frequency Reference) - MSAS 7
Figure 6 Lights on Front Panel of MSAS Receiver 8
Figure 7 Pinout for L1-C/A, L1/L2 I, & L1/L2 II Ports - MSAS 9
Figure 8 Pinout for TIME Port - MSAS 9
Figure 9 1 PPS Output - MSAS 9
Figure 10 Antenna Input - MSAS 10
Figure 11 External Power Connections - MSAS 10
Figure 12 20.473 MHz Output – MSAS 11
Figure 13 Strobe 9-pin D-Connector Pinout - MSAS 11
Figure 14 Main Screen of LOADER Program 17
Figure 15 Height Relationships 41
Figure 16 NES / UPC Minimum System Configuration 86
Figure 17 Rear Panel of NES / UPC Receiver 87
Figure 18 10 MHz In (External Frequency Reference) - NES / UPC 88
Figure 19 Lights on Front Panel of NES / UPC Receiver 88
Figure 20 Pinout for L1-C/A, L1/L2 I, & L1/L2 II Ports - NES / UPC 89
Figure 21 Pinout for TIME Port - NES / UPC 89
Figure 22 1 PPS Output - NES / UPC 89
Figure 23 Antenna Input - NES / UPC 90
Figure 24 External Power Connections - NES / UPC 90
Figure 25 20.473 MHz Output - NES / UPC 91
Figure 26 Strobe 9-pin D-Connector Pinout - NES / UPC 91

WARRANTY POLICY

Warranty Period: one (1) year from the date of delivery. NovAtel warrants that during the Warranty Period the MSAS / NES / UPC Receiver will be free from defects in material and workmanship, will conform to applicable specifications, and the software will be free from errors 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 particular purpose. NovAtel shall in no event be liable for special, indirect, incidental or consequential damages of any kind or nature due to any cause.

The Customer's exclusive remedy for a claim under this warranty shall be limited to the repair or replacement, at NovAtel's option, of defective or nonconforming materials, part or components. The foregoing warranties do not extend to (i) nonconformities, defects or errors in the MSAS / NES / UPC Receivers due to accidents, abuse, misuse or negligent use of the MSAS / NES / UPC Receivers 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 MSAS / NES / UPC Receiver due to modifications, alterations, additions or changes not made in accordance with applicable specifications or authorized by NovAtel, (iii) normal wear and tear, (iv) damages caused by force of nature or act of any third person, (v) service or repair of the MSAS / NES / UPC Receiver by the Customer without prior written consent from NovAtel, (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 MSAS / NES / UPC Receiver and no maintenance is required. When the status code or the lights on the front panel indicate that a unit is faulty, call NovAtel Customer Service to confirm the fault diagnosis.

You must obtain a **RETURN MATERIAL AUTHORIZATION** (**RMA**) number by calling GPS Customer Service at 1-800-NOVATEL in the U.S. and Canada or 403-295-4900 elsewhere before shipping any product to NovAtel.

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

CUSTOMER SERVICE

If you require customer service, please provide the following information along with a detailed description of the problem when you call or write:

Serial No. ______________________________ Model No. ______________________________

Software Release No. ______________________ Authorization No. ______________________

Date Purchased: __________________________

Purchased from: ____

User name: ____________________________ Title:__________________________________

Company: ____

Address: ____

City: ________________________________ Prov/State: ____________________________

Zip/Postal Code:_________________________ Country:______________________________

Phone #: _____________________________ Fax #:________________________________

Receiver interface: Computer type: _____________________Operating Shell: _________________

Other interface used:____

Please provide a complete description of any problems you may be experiencing, or the nature of your inquiry (attach additional sheets if needed):

____

____

____

____

____

You may photocopy and fax this page, call, or mail the above information to the address listed below.

For customer support, contact the NovAtel GPS Hotline by phone at **1-800-NOVATEL** (in Canada & U.S.A.) or **1-403-295-4900** (world-wide) between 8:00 AM – 4:30 PM MST; by fax at **1-403-295-4901**; by e-mail at support@novatel.ca; over the World Wide Web at http://www.novatel.ca; or by mail at:

NovAtel Inc.
GPS Customer Service
1120 – 68 Avenue N.E.
Calgary, Alberta, Canada
T2E 8S5

NOTICES

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

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

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

IMPORTANT: In order to maintain compliance with the limits of a Class A digital device, it is required to use properly shielded interface cables when using the Serial Ports, such as Belden #9539, or equivalent, double-shielded cables when using the Strobe Port, such as Belden #9945, or equivalent, and Belden #8770 cable for input power source (ensuring the shield is connected to the protection ground).

FOREWORD

The *MSAS / NES / UPC Receiver Subsystem Installation and Operation Manual* is written for users of the MSAS / NES / UPC Receiver Subsystem. The manual describes the MSAS, NES and UPC receivers. Except for those cases where a section states that it specifically applies to a MSAS receiver or a NES / UPC receiver, everything else applies to the three receivers.

This manual describes the NovAtel MSAS / NES / UPC Receiver Subsystem in sufficient detail to allow effective integration and operation. The manual is organized into chapters and appendices, which allow easy access to appropriate information. From here on, the MSAS / NES / UPC Receiver Subsystem shall be referred to as the "MSAS / NES / UPC receiver".

It is beyond the scope of this manual to provide service or repair details. For customer service inquiries, please contact NovAtel Customer Service via any of the methods listed in the *Customer Service* section at the front of this manual.

PREREQUISITES

The MSAS / NES / UPC receiver is a stand-alone fully functional GPS and MSAS receiver. Refer to *Chapter 2* or *Appendix A* for more information on installation requirements and considerations.

The NovAtel MSAS / NES / UPC receiver module utilizes a comprehensive user interface command structure which requires communications through its serial (COM) ports. To utilize the built-in command structure to its fullest potential, it is recommended that some time be taken to review and become familiar with *Chapters 5-7* of this manual before operating the MSAS / NES / UPC receiver.

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 an integer number between 0 and 1023 represents the GPS week. As GPS time started on Sunday January 6, 1980 at 0:00 hours Greenwich Mean Time (GMT), week 1023 ended on Saturday August 21, 1999 at 23:59:59 GMT.

According to the ICD-GPS specifications, the receiver should reset the GPS week number. This means that the week number should not advance to 1024, but start back at 0. However, another way to handle this issue is to extend the number of bits used to represent the GPS week number. This way, the GPS week would be able to increment per usual and would not have to be reset.

Per the GPS system specifications document, NovAtel firmware reset the receiver's GPS week number back to zero. Different manufacturers no doubt handled this situation differently. Therefore, 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.

WHAT'S NEW IN THIS MANUAL

This version of the manual contains documentation for the $CARRIEROFFSET and $PLL_CONFIG commands. The WBCA/B log has also been added. The details of some of the commands and logs have been updated or expanded. The performance specifications given in the appendices have been updated for the disabling of Selective Availability (SA).

1 INTRODUCTION

The MTSAT Satellite-based Augmentation System (MSAS) is a safety-critical system that will enable the Global Navigation Satellite System (GNSS) to meet the International Civil Aviation Organization's navigation performance requirements for various phases of flight. MSAS does this by augmenting the GNSS: providing independent verification of GNSS data, and extending the system's capabilities. The Global Positioning System (GPS) is a principal component of GNSS.

In MSAS, a Multi-functional Transport Satellite (MTSAT) in a geostationary location over Southeast Asia provides communication, navigation and surveillance services to aircraft in the area. The use of this geostationary satellite (GEO) means that conceptually, MSAS has much in common with the Wide Area Augmentation System (WAAS) that will provide GNSS augmentation for North America; in fact, the message format transmitted by the geostationary satellites in the two systems are identical.

MSAS is composed of the space borne MTSAT and one or more of each of the following terrestrial components:

1. Ground Monitor Station (GMS)
    - receives GPS signals
    - sends data to MCS
    - geographically distributed
2. Monitor and Ranging Station (MRS)
    - receives GPS signals
    - receives MTSAT signals and collects range measurement data
    - sends data to MCS
    - geographically distributed
3. Master Control Station (MCS)
    - receives data from GMS and MRS
    - monitors and controls the system
    - calculates correction data
    - calculates the MTSAT's orbit
    - calculates ionospheric delay compensation
    - determines system integrity
    - receives GPS signals
    - receives MTSAT signals and collects range measurement data
    - sends data to NES for uplink to MTSAT for broadcast
4. Navigation Earth Station (NES)
    - receives data from MCS for uplink to MTSAT for broadcast

The data broadcast by the MTSAT is available over a wide area to anyone with a suitable receiver. The GPS L1 frequency (1575.42 MHz) is used, together with GPS-type Coarse/Acquisition (C/A) pseudorandom (PRN) modulation codes. In addition, the phase timing of the code is maintained close to GPS time to provide additional ranging capability, which improves the overall availability, continuity and accuracy of the GPS. The data transmitted from the MTSAT also includes integrity information for each GPS satellite (e.g. orbits and clock corrections), and corrections for ionospheric distortions.

A user requires a receiver that is capable of tracking GPS satellites as well as one or more of the GEO satellites.

THE NOVATEL MSAS & NES / UPC RECEIVER SUBSYSTEMS

NovAtel has three products that will play strategic roles in MSAS:

1. The NovAtel MSAS Receiver Subsystem provides the GPS monitoring function.
2. The NovAtel NES / UPC Receiver Subsystem provides the MTSAT monitoring function.

Figure 1 The NovAtel MSAS & NES / UPC Receiver Subsystems

There are many similarities between the MSAS Receiver Subsystem and the NES / UPC Receiver Subsystem. For example, the user interface - the commands by which you can enter information, and the logs by which you can extract data - is common to the three receivers. Therefore, throughout this manual the three are referred to as the “MSAS / NES / UPC receiver” whenever the text is sufficiently general to refer to either one. However, in those sections of the manual where one is being specifically described, “MSAS receiver” or “NES / UPC receiver” is used.

The NovAtel MSAS / NES / UPC receiver is a high-performance GPS & MSAS receiver that automatically achieves a high level of multipath reduction, without any user intervention. This is particularly important for rooftop installations where signal reflections are likely to result in significant multipath effects. NovAtel has developed a multipath elimination technology that approaches the theoretical limits of multipath-free GPS signal reception. This patented technology, known as “Multipath Estimating Delay-Lock-Loop” (MEDLL), uses a combination of hardware and software techniques which together are capable of reducing the combined effects of pseudorange and carrier-phase multipath errors by as much as 90% compared to a system using Narrow Correlator alone. The MEDLL technology takes advantage of NovAtel’s parallel channel Narrow Correlator sampling techniques. MEDLL uses a proprietary coupled correlator sampling technique combined with “maximum likelihood estimation” techniques to break down the received signals into direct path and reflected path components. MEDLL determines the amplitude, delay, and phase angle of both the direct and multipath signals and analyses the signal with the least delay to determine the direct path. All other signals with greater delay are considered to be multipath components and are removed. To do this, MEDLL utilizes a multi-card configuration. Each L1 GPSCard in the MEDLL receiver is linked to one common RF deck and an OCXO that minimizes inter-channel biases.

The MSAS / NES / UPC receiver also incorporates two L1/L2 GPSCards, which incorporate NovAtel's P-Code Delayed Correlation Technology, providing superior performance even in the presence of P-code encryption. Each GPSCard is an independent GPS receiver.

The MSAS / NES / UPC receiver is packaged in a standard 4U x 19" sub-rack. Easy I/O access is provided by the rear panel's 9-pin D connectors as well as the antenna and external oscillator connectors.

OPERATIONAL OVERVIEW

The NovAtel MSAS / NES / UPC Receiver has three functional blocks (see *Figure 2*):

- MEDLL which receives and minimizes multipath on GPS C/A code and GEOs
- Dual Frequency L1/L2 I
- Dual Frequency L1/L2 II

Figure 2 MSAS / NES / UPC Receiver Functional Block Diagram

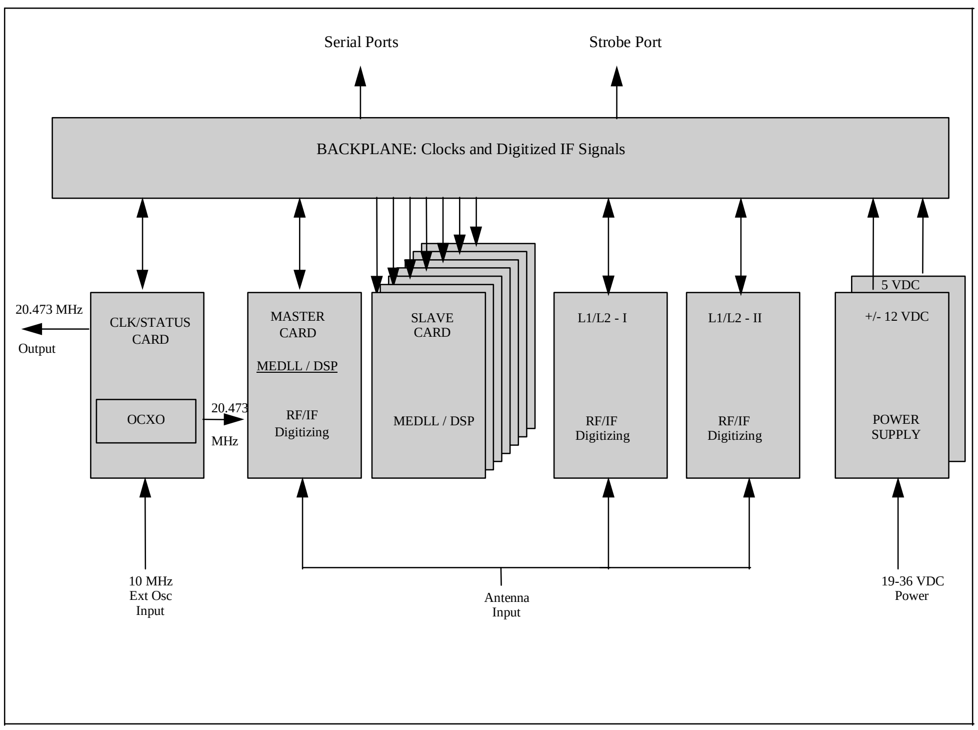


Table 1 shows the filtering bandwidths and integration times of observables.

Table 1 Filtering Bandwidths and Integration Times

Observable	L1		L2	
	Filtering Bandwidth (Hz)	Integration Time	Filtering Bandwidth (Hz)	Integration Time
Pseudorange (DLL)	0.05	1 second	0.05	2 seconds
Carrier Phase	3	20 milliseconds	0.2	500 milliseconds
Instantaneous Doppler	3	20 milliseconds	0.2	500 milliseconds

MEDLL

MEDLL is implemented across a number of standard NovAtel Narrow Correlator 12 channel GPS receivers. Through parallel linking of these separate receiver modules, MEDLL may be configured to behave as a single GPS receiver, capable of simultaneously tracking either 14 GPS satellites and 2 GEOs (default configuration), or 12 GPS satellites and 4 GEOs.

A single incoming RF signal is routed to a Master Card, which down converts the signal to baseband frequency for parallel processing by seven Slave receivers. The baseband signal is then processed by eight parallel digital signal processing sections (Master, plus seven Slaves), through MINOS Application Specific Integrated Circuits (ASICs) and NovAtel patented Narrow Correlation tracking software.

Across the eight processing sections, there are a total of 96 tracking channels. Six channels are dedicated to tracking each GPS or GEO satellite, and these channels are dynamically adjusted around the associated correlation envelope. By a process of continuous comparison of signal measured by each channel, any distortion from the ideal correlation envelope can be detected, tracked, qualified and removed. This process allows the receiver to isolate and eliminate multipath distortions from the received signal.

The Master and Slave receivers are mounted in a standard 19” sub-rack, and are supplied power from an integrated power conditioner. Stable clock signals are derived from a precision Oven Controlled Crystal Oscillator (OCXO). Status indicators on the front panel provide visual confirmation of the health of each electronic sub-assembly within the 19” sub-rack.

Signals are routed to and from the MEDLL receiver via an RF antenna input, power and digital I/O signal connector on the rear of the unit.

The unit is controlled via RS-232 using standard NovAtel commands, and data is output in slightly modified NovAtel output logs. Specific MEDLL logs provide access to the MEDLL processing data.

GEO Processing

Specific channels in the MEDLL and L1/L2-2 groups have the capability to receive and process the GEO MSAS signal. The signal is in-band at L1 and is identified with MSAS-specific PRN numbers. The MSAS message is decoded and separated into its various components. The MSAS message and associated pseudorange is provided as an output.

Dual Frequency L1/L2 I

This functionality is provided by a standard, dual-frequency NovAtel MiLLennium receiver. It is configured to track 12 L1 C/A-code signals (Narrow Correlator), and 12 L2 P-code codeless signals. The output is used to compute ionospheric corrections.

Dual Frequency L1/L2 II

There are several sub-functions within this group:

- 14 channels are configured to track L1 with ‘Wide’ (0.15 chip) Correlator spacing
- 3 L1 and 3 L2 are configured as extra channel pairs for tracking more than 12 satellites
- 2 channels are configured to track L1 C/A code GEOs
- 2 channels are configured to track L2 C/A code GEOs

The ‘Wide Correlation’ C/A code signals are used for integrity checking against MEDLL and L1/L2 I C/A code measurements, and the L1 C/A code and L2 C/A code measurements are used to derive ionospheric corrections for the GEOs.

Other Outputs & Inputs

- A 1PPS pulse from the MEDLL Master is available on the 1PPS connector. An estimate of the NES/UPC time of the 1PPS pulse is provided on the TIME port. The TM1A message is output once every 10 seconds and will lag the 1PPS pulse within approximately 0 to 50 ms.
- A 20.473 MHz output is available for use with an external GEO receiver.
- Three serial ports provide:
  - raw satellite measurements (pseudorange, carrier & time)
  - receiver status data (communications & tracking)
  - raw satellite data (ephemeris & almanac)
  - fast code corrections for signal stability monitoring
- The receiver accepts an external input from a 10MHz atomic clock for synchronization.

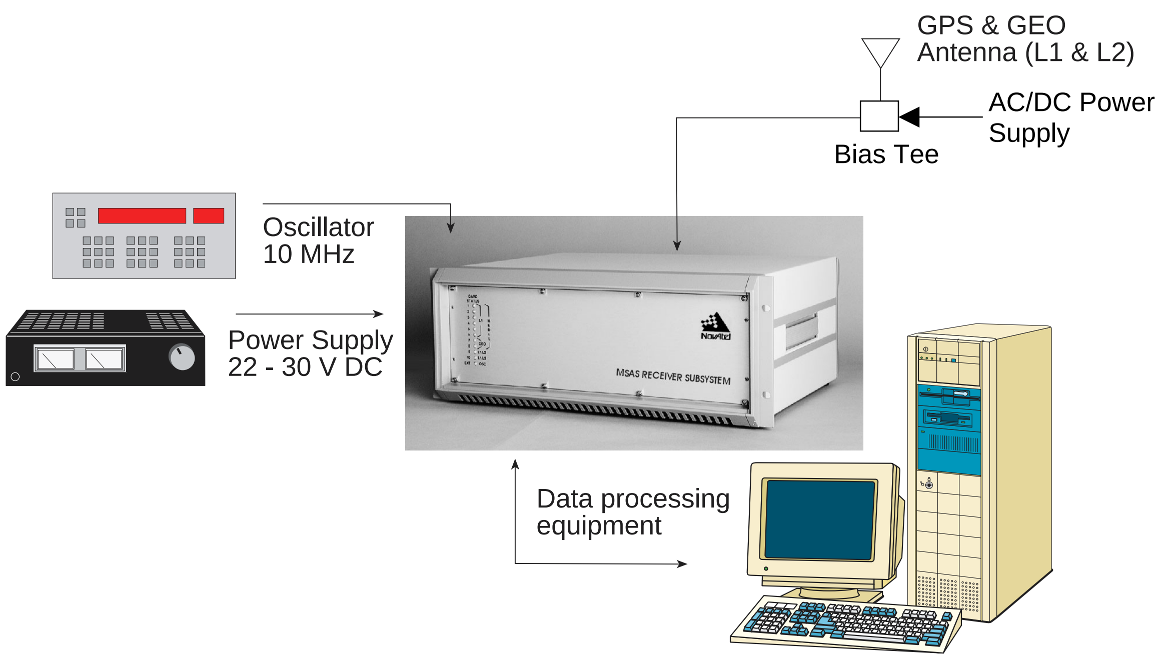
2 INSTALLING THE MSAS RECEIVER

This chapter provides sufficient information to allow you to set up and prepare the MSAS receiver for initial operation. The corresponding information for the NES / UPC receiver is contained in *Appendix A*.

MINIMUM CONFIGURATION

In order for the MSAS receiver to function as a complete system, a minimum equipment configuration is required. This is illustrated in *Figure 3*.

Figure 3 MSAS Minimum System Configuration



The recommended minimum configuration and required accessories are listed below:

- NovAtel MSAS receiver
- User-supplied and powered L1/L2 GPS antenna and LNA
- User-supplied power supply (22-30 V DC, 5 A maximum)
- User-supplied external frequency reference (10 MHz)
- User-supplied interface, such as a PC or other data communications equipment, capable of standard serial communications (RS-232C).
- User-supplied data and RF cables

See *Appendix E* for a list of associated suppliers of MSAS subsystem components.

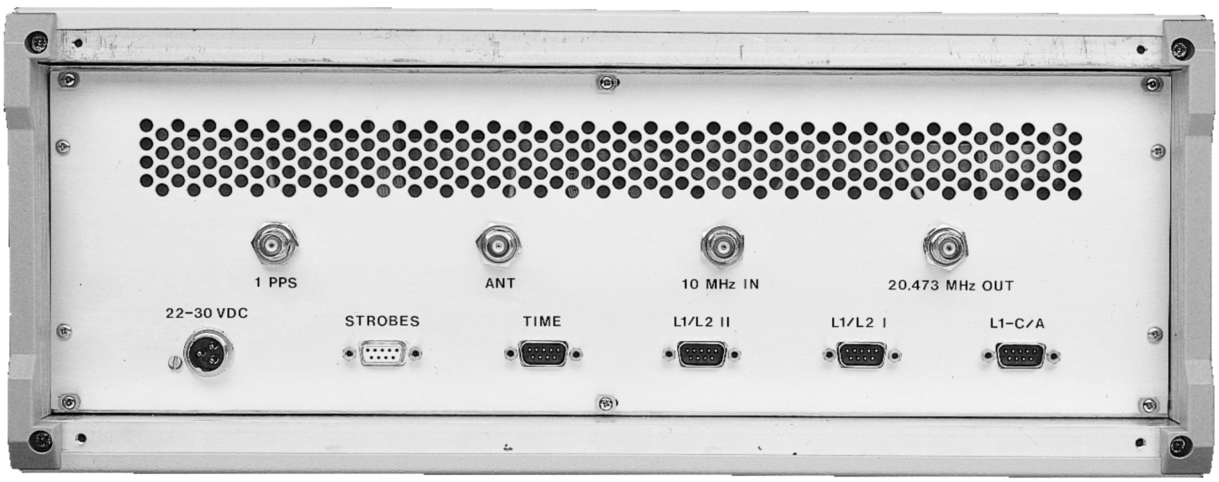
Of course, your intended set-up may differ significantly from this minimum configuration. The MSAS receiver has many features that would not be used in the minimum configuration shown above. This section merely describes the basic system configuration, which you can modify to meet your specific situation.

For the minimum configuration, setting up the MSAS receiver involves the following steps:

1. Connect the external frequency reference to the MSAS receiver (“10 MHz IN” connector)
2. Connect the user interface to the MSAS receiver (“L1-C/A”, “L1/L2 I” and/or “L1/L2 II” connectors)
3. Install the GPS antenna and low-noise amplifier, and make the appropriate connections to the MSAS receiver (“ANT” connector) and a power supply
4. Supply power to the MSAS receiver (“22-30 VDC” connector)

The connections on the rear panel are shown in *Figure 4* below:

Figure 4 Rear Panel of MSAS Receiver

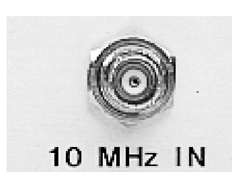


CONNECTING THE EXTERNAL FREQUENCY REFERENCE

The MSAS receiver requires an external, user-supplied frequency reference; this would typically take the form of a high-accuracy oscillator. Please refer to *Appendix B* for the recommended specifications of this device. See *Appendix E* for a list of associated suppliers of MSAS subsystem components.

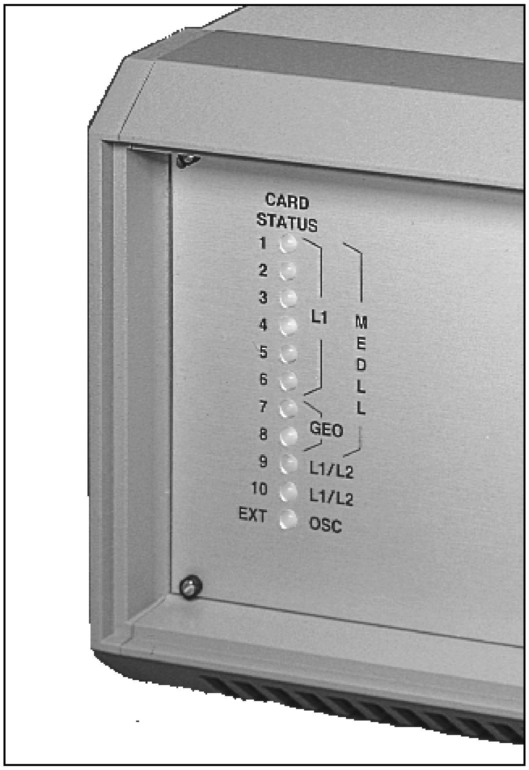
The frequency reference is connected to the 10 MHz BNC female connector on the rear panel of the MSAS receiver. Refer to *Figure 5* below.

Figure 5 10 MHz In (External Frequency Reference) - MSAS



The 11th (bottom) LED on the front panel indicates the status of the connection between the MSAS receiver and the external clock reference. A *clear* LED indicates that no external reference is present, *red* indicates the external clock is not locked (undergoing the locking process, or the signal is not within the capture range), and *green* indicates that the clock is locked and stabilized. Refer to *Figure 6* below.

Figure 6 Lights on Front Panel of MSAS Receiver



CONNECTING DATA COMMUNICATIONS EQUIPMENT

There are four serial ports on the back panel of the MSAS receiver; all are configured for RS-232C protocol. These ports make it possible for external data communications equipment, such as a personal computer, to communicate with the MSAS receiver. Each of these ports has a DE9P connector.

- The L1-C/A, L1/L2 I and L1/L2 II ports (see *Figure 7*) allow two-way communications. Each one is configured as COM1 if you attempt to communicate directly with it. The L1/L2 I and L1/L2 II ports are each connected to an L1/L2 GPSCard within the MSAS receiver unit; the L1-C/A port is connected to the L1-only GPSCard which controls the MEDLL subsystem. Each of these ports can be addressed independently of the other.
- The TIME port (see *Figure 8*) is used for output **only**. Data can be directed to this port by using the "com2" directive when logging data from the MEDLL receiver. In the standard configuration a TM1A log is output at 1 Hz using a data transfer rate of 9600 bps, with one stop bit, one start bit, no parity and no handshaking. The output of the TM1A is triggered by a 1 PPS signal. The exact timing of the output of the first bit of the log is non-deterministic but is limited to less than 100 ms after the triggering 1 PPS signal. The information in the TM1A log refers to the preceding 1 PPS signal that triggered the output of the log.

Figure 7 Pinout for L1-C/A, L1/L2 I, & L1/L2 II Ports - MSAS

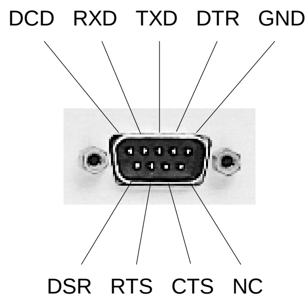
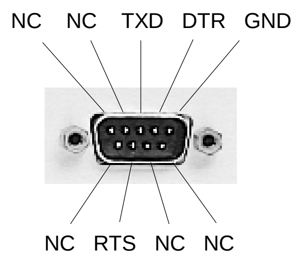


Figure 8 Pinout for TIME Port - MSAS



USING THE 1PPS OUTPUT

The clock signal available on the 1 PPS port (see *Figure 9*) is referenced by the data available on the TIME port. The specifications and electrical characteristics of this signal are described in *Appendix B*. The pulse train is accessed from the BNC female connector on the back of the MSAS receiver.

Upon determination of position-time, the receiver will align the 1PPS to the GPS epoch. From this time onwards the 1PPS triggers every second. By default, it will drift with the external frequency standard.

Immediately on start-up of the receiver, the 1PPS is active (at 1Hz) but it is not aligned to the GPS epoch. The timing of the 1PPS will be adjusted when position-time is known. This means that the 1PPS may occur twice within 1 second when being adjusted. Without CLOCKADJUST enabled, see *Page 30*, the 1PPS is only adjusted once.

1 Hz GPS measurements are taken on the 1PPS. These measurements include pseudorange, carrier phase and Doppler.

Receiver sections of the receiver are synchronized together via an internal TM1A message. This message is sent from the MEDLL receiver section to the L1/L2 - II and L1/L2 - I receiver sections. The message is used to synchronize the time used by all three receiver sections.

Figure 9 1 PPS Output - MSAS

CONNECTING THE GPS ANTENNA

Selecting and installing an appropriate antenna system is crucial to the proper operation of the MSAS receiver. See *Appendix E* for a list of associated suppliers of MSAS subsystem components.

Keep these points in mind when installing the antenna system:

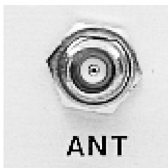
- Ideally, select an antenna location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction.
- Ensure that the antenna is mounted on a secure, stable structure capable of withstanding relevant environmental loading forces (e.g. due to wind or ice).

Use high-quality coaxial cables to minimize signal attenuation. When using active antennas, remember that you also need to connect each low-noise amplifier (LNA) to a suitable power source. The gain of the LNA must be sufficient to compensate for the cabling loss. The MSAS receiver (but not the NES/UPC receiver) requires 5dB more signal power than other NovAtel products.

NOTE: The ANT connector does not provide DC power for an active LNA.

The antenna port on the MSAS receiver has a TNC female connector, as shown in *Figure 10*.

Figure 10 Antenna Input - MSAS

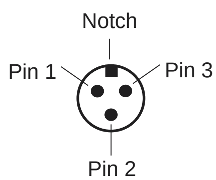


CONNECTING THE EXTERNAL POWER INPUT

The MSAS receiver requires one source of external regulated power. The input can be in the 22-30 V DC range. The receiver draws up to 5 A at start-up, but the steady-state requirement is approximately 3.5 A.

The power-input connector on the MSAS receiver is a 3-position chassis jack. It mates to a 3-position inline plug (see *Appendix E* for a list of associated suppliers of MSAS subsystem components). Pin 1 (+22-30V DC), and Pin 2 (GND) connect to the MSAS receiver's internal power supply, which performs filtering and voltage regulation functions. Pin 3 serves as a protection ground connection. Refer to *Figure 11*.

Figure 11 External Power Connections - MSAS



USING THE 20.473 MHz OUTPUT SIGNAL

The 20.473 MHz output provides a high-stability reference clock signal to another device in the system. It permits the synchronization of another unit to the MSAS receiver. This signal can be accessed by means of the BNC female connector on the MSAS receiver's rear panel (see *Figure 12*).

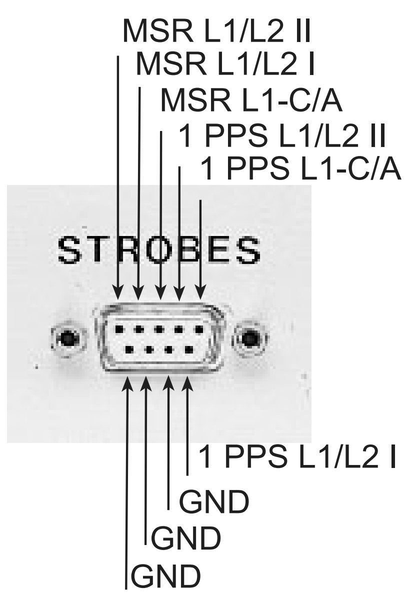
Figure 12 20.473 MHz Output – MSAS

ACCESSING THE STROBE SIGNALS

The MSAS receiver's output strobe lines are available on the rear panel from the DE9S connector (see *Figure 13*). The specifications and electrical characteristics of these signals are described in *Appendix B*. These signals are provided for diagnostic purposes.

The L1/L2 I and L1/L2 II ports are each connected to an L1/L2 GPS receiver within the MSAS receiver unit; the L1-C/A port is connected to the L1 GPS receiver which controls the MEDLL subsystem.

Figure 13 Strobe 9-pin D-Connector Pinout - MSAS



3 OPERATING THE MSAS / NES / UPC RECEIVER

Before operating the MSAS receiver for the first time, ensure that you have followed the installation instructions in *Chapter 2*. Before operating the NES / UPC receiver for the first time, ensure that you have followed the installation instructions in *Appendix A*.

From here on, it will be assumed that testing and operation of the MSAS / NES / UPC receiver will be performed while using a personal computer (PC); this will allow the greatest ease and versatility.

PRE-START CHECK LIST

Before turning on power to the MSAS / NES / UPC receiver, ensure that all of the following conditions have been met:

- The external frequency reference is properly installed, connected, powered-up, and stabilized.
- The antenna(s) is (are) properly installed, powered, and connected.
- The PC is properly connected using a null-modem cable, and its communications protocol has been set up to match that of the MSAS / NES / UPC receiver.

Supply power to the MSAS / NES / UPC receiver only after all of the above checks have been made. Note that the warm-up process may take several minutes, depending on ambient temperature. Required start-up time (cold start) is 5 minutes. This is for the OCXO to lock onto the external frequency standard. The green stage of the *Ext. Osc* LED on the front panel indicates that the MSAS / NES / UPC receiver has locked onto the external frequency reference, and is ready for operation. Note that the *Ext. Osc*. LED remains clear if there is no external oscillator present and it glows red when the receiver is trying to lock onto the external frequency reference of a connected external oscillator in the MEDLL receiver section.

It is recommended that you do a complete receiver reset, by sending a RESET command to each receiver section, after 5 minutes, following a cold start. This allows a recalibration of the RF jammer detection algorithm after RF components have warmed up. It also allows the automatic sky search routine to reset.

If this power-up order is not followed, the start-up times will not be achieved. The limiting factor in achieving the start-up times is the external frequency reference becoming stable.

SERIAL PORTS - DEFAULT SETTINGS

Because the MSAS / NES / UPC receiver communicates with the user's PC via serial ports, the units require the same port settings. The communications settings of the PC should match these on the receiver:

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

Once initial communications are established, the port settings for the MSAS / NES / UPC receiver can be changed using the *COM1* command (see *Chapter 5*).

BOOT-UP

The MSAS / NES / UPC receiver's firmware resides in non-volatile memory. Supply power to the unit, wait a few moments for self-boot, and the MSAS / NES / UPC receiver will be ready for command input.

On receiver start-up, the integrity of the random-access memory (RAM) is checked. If the RAM check fails, the receiver waits for operator intervention. If the RAM check completes successfully, the authorization code is verified in order to check the integrity of the software load. If this check fails, an associated message will be output from the receiver (see *Appendix D Information Messages* on *Page 100*). Following the authorization code check, the configuration of the receiver is verified. The default configuration for the receiver model will be applied (see the *Technical Specifications* appendices starting on *Page 86)*. After these checks have been completed, the receiver will output the COM port prompt.

A read-back check of the ASIC and a loop-back test of the COM ports are also included in the start-up BIT sequence to make sure that they are functioning properly. In the event of a failure of either of these checks, the associated bit will be set in the receiver status word (see *Table 10 Additional Information about MSAS / NES / UPC Receiver Self-Test Status Word* on *Page 77*). If it has been determined that the COM port has failed, the COM prompt may not be output, depending on the nature of the failure.

There are two initial start-up indicators to let you know that the MSAS / NES / UPC receiver's serial ports are ready to communicate:

1. Status lights on the MSAS / NES / UPC receiver's front panel (upper ten LEDs) should turn from *red* to *green* to indicate that all cards are healthy. If any one of the LEDs does not turn *green*, then the system should be considered unreliable. If this situation occurs, contact NovAtel Customer Service for assistance.
2. Your external terminal screen will display one of the following prompts:

   Com1> if you are connected to the L1-C/A, L1/L2 I or L1/L2 II serial port.

   Com2> if you are connected to the TIME serial port.

The MSAS / NES / UPC receiver is now ready for command input from any of the three COM1 ports. Data output from the TIME COM2 port is restricted for special use.

INITIAL COMMUNICATIONS WITH THE MSAS / NES / UPC RECEIVER

Communicating with the MSAS / NES / UPC receiver is a straightforward process and is accomplished by issuing desired commands to the COM1 ports from an external serial communications device. For your initial testing and communications, you will probably be using either a remote terminal or a personal computer that is directly connected to a MSAS / NES / UPC receiver's serial port by means of a null modem cable.

To change the default communication settings, such as bit rate, use the *COM1* command (see *Chapter 5*).

It is to your advantage to become thoroughly familiar with *Chapters 5 - 7* of this manual to ensure maximum utilization of the MSAS / NES / UPC receiver's capabilities.

When the MSAS / NES / UPC receiver is first powered up, no activity information is transmitted from the serial ports except for the **COM1>** or **COM2>** prompt described in *Boot-Up, Page 13*.

Commands are directly input to MSAS / NES / UPC receiver using the external terminal. It should be noted that most commands do not echo a response to a command input. Your indicator that the command has actually been accepted is a return of the **COM1>** prompt from MSAS / NES / UPC receiver. Note that *VERSION* is the only command that does provide an echo response other than the port prompt.

Examples:

1. If you type VERSION <Enter> from a terminal, this will cause the MSAS / NES / UPC receiver to echo the firmware version information.
2. An example of a no-echo response to an input command is the FIX POSITION command. It can be input as follows:

   COM1>**fix position 51.113 -114.043 1060** <Enter>

   This example illustrates command input to the COM1 port which sets the MSAS / NES / UPC receiver's position. However, your only confirmation that the command was actually accepted is the return of the **COM1>** prompt.

If a command is erroneously input, the MSAS / NES / UPC receiver will respond with the "Invalid Command Option" response followed by the COM1> prompt.

4 FIRMWARE UPDATES

As described in the Introduction, the MSAS / NES / UPC receiver comprises single and dual frequency GPSCards. All GPSCards store their firmware (program software) in on-board, non-volatile memory. This unique feature allows a receiver's firmware to be updated in the field. Thus, a procedure such as updating software model **WAASMEDLL rev. 5.444** to **WAASMEDLL rev. 5.446** 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 the firmware on the GPSCards, it is recommended that all the cards be updated together. The MEDLL subsystem is updated by means of a serial connection to the host PC using the L1–C/A port, while each of the L1/L2 cards are updated using their respective L1/L2 I and L1/L2 II ports. Therefore three separate operations are required to update the entire MSAS / NES / UPC receiver. However, software provided along with the firmware update may be used to automate this procedure.

NOTE: Updating the firmware versions of these GPSCards is based on approved combinations of MEDLL and L1/L2 software that have been tested to work together. For example, MSAS software release 5.446/4.446 implies that the single-frequency GPSCards in the MEDLL subsystem will be updated to 5.446 revision firmware, while the dual-frequency GPSCards will be updated to 4.446 revision firmware.

When updating to a higher revision level, you will need to transfer the new firmware to the appropriate GPSCard with the aid of the NovAtel-supplied utility program, "**LOADER"**. To update firmware while using LOADER, you will need a personal computer with the following features:

- MS-DOS 6.0 or later
- one available RS-232 serial port
- null-modem cable
- at least 1 MB of available hard drive space

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

1. Contact NovAtel Customer Service
2. Download compressed files
3. Decompress files
4. Run LOADER in one of three modes: Menu, Command Line, or Entire Receiver Update.

CONTACT CUSTOMER SERVICE

The first step in updating the receiver is to contact NovAtel GPS Customer Service via any of the methods described in the *Customer Service* section at the beginning of this manual.

When you call, be sure to have available the MSAS / NES / UPC receiver's **serial number**, and **program revision level**. This information is printed on the rear panel of the MSAS / NES / UPC receiver. You can also verify the information by powering up the receiver and issuing the "VERSION" command for the serial port you are connected to. Remember that the L1-C/A serial port is connected to the L1-only GPSCard controlling the MEDLL subsystem, and the L1/L2 I and L1/L2 II serial ports are each connected to an L1/L2 GPSCard. The firmware for the L1 GPSCard is different than that of the L1/L2 GPSCards.

After conferring with Customer Service to establish the required revision level, (as well as the terms and conditions of your firmware update), Customer Service will issue you up to three **authorization codes** (auth-codes), one for the MEDLL subsystem and one each for the two L1/L2 cards. The auth-code is required to unlock the MSAS / NES / UPC 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 LOADER utility, Customer Service will confirm with you as to the procedures, files, and methods required for using LOADER. As the LOADER and update programs are generally provided in a **compressed file** format, you will also be given a file decompression **password**. The LOADER and update files are available from Customer Service by FTP, e-mail, or diskette.

DOWNLOAD COMPRESSED FILES

Typically, there are two files required when performing software revision updates on a particular GPSCard: LOADER.EXE (the LOADER utility program) and XXX.BIN (the firmware update file). Typical MSAS / NES / UPC firmware files might be named 4446.BIN (for the L1/L2 GPSCards), M5446.BIN (for the MEDLL Master GPSCard) and S5446.BIN (for the MEDLL Slave GPSCards).

To proceed with your program update, you will first need to download the appropriate files from NovAtel's FTP site (ftp://ftp.novatel.ca), or via e-mail (support@novatel.ca). 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 will have differing names; Customer Service will advise you as to the exact names of the files you need. As well, Customer Service will provide you with a file de-compression password.

DECOMPRESS FILES

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

Syntax:

[*filename*] -s[*password*]

Where:

filename:	is the name of the compressed file (excluding the extension)
-s:	is the password command switch
password:	is the password required to allow decompression

Example:

m5446 -s12345678<Enter>

RUN LOADER

LOADER should be copied to the hard drive of your personal computer and run from the command (DOS) prompt. Once LOADER is installed and running, it allows you to select and configure a PC serial port, as well as choose the directory path and file name of the new program software to be transferred to the GPSCard. After the LOADER parameters have been selected and the auth-code entered, the actual file transfer only takes a few minutes, depending on the data transfer rate selected. LOADER also contains built-in terminal software.

LOADER can be run in one of three different modes:

1. Menu mode – contains a graphical interface to facilitate the procedure of updating one GPSCard at a time. This is the preferred method to update individual L1/L2 GPSCards in the MSAS / NES / UPC receiver.
2. Command-Line mode – allows you to update either one GPSCard at a time, or set up a batch process. Use this mode to update the multiple cards within the MEDLL subsystem. Or, use this as an alternate method to update individual L1/L2 GPSCards.

3. Entire Receiver Update mode – use this if you wish to update all of the GPSCards (L1/L2 & MEDLL subsystems) within an entire MSAS / NES / UPC receiver in a single operation.

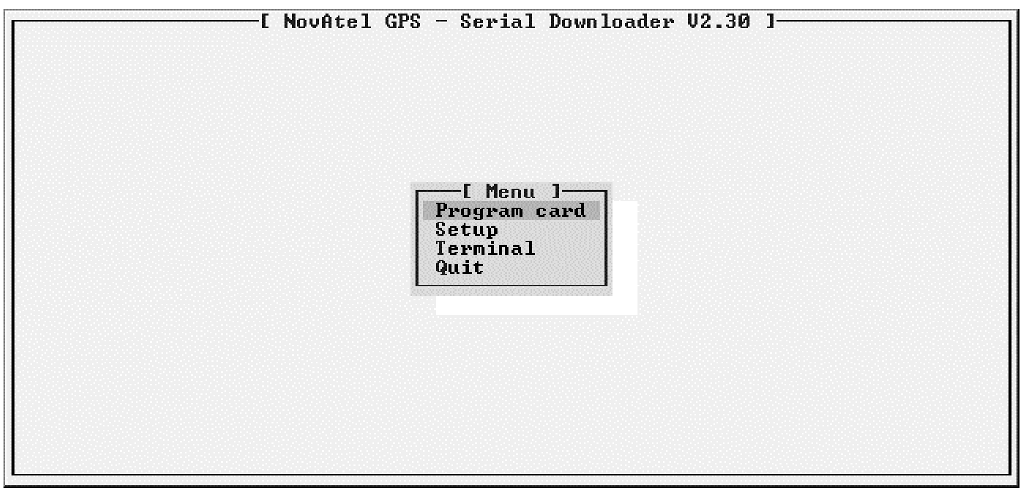
Choose the mode which best suits the task which needs to be done.

MENU MODE

The procedure shown below can be used to update the firmware on either of the two L1/L2 GPSCards in the MSAS / NES / UPC receiver. This procedure will not work to update the MEDLL subsystem firmware; for that, see *Command-Line Mode, Page 18*.

LOADER can operate from the DOS prompt of any directory or drive on your PC. The program is comprised of three parts: *Program Card* (authorization procedure), *Setup* (communications configuration) and *Terminal* (terminal emulator). The main screen is shown in *Figure 14.*

Figure 14 Main Screen of LOADER Program



If you are running LOADER for the first time, be sure to access the *Setup* menu (step 3 below) before proceeding to *Program Card* (step 4 below); otherwise, you can go directly from step 2 below to step 4. To update the firmware on a GPSCard, follow this procedure:

1. Turn off power to the MSAS / NES / UPC receiver.
2. Start LOADER.
3. From the main menu screen, select `Setup` to configure the PC's serial port over which communication will occur (default: COM1), and the data transfer rates for both programming (default: 115 200 bits per second) and terminal emulation (default: 9600 bps). To minimize the time required, select the highest serial bit rate your PC can reliably support. LOADER will verify and save your selections in a file named LOADER.SET, and return to the main menu screen.
4. From the main screen, select `Program Card`.
5. Select the disk drive (e.g. A, B, C, D) in which the update file (e.g. M5446.BIN) is located. Select the path where the update file is located (e.g. C:\MSAS\LOADER\BINFILES); the directory from which you started LOADER is the default path. Select the required update file (e.g. M5446.BIN).
6. At the prompt, enter your update auth-code (e.g. `17b2,32df,6ba0,92b5,e5b9,waasmedll`).

7. When prompted by the program, turn on power to the MSAS / NES / UPC receiver. LOADER will automatically establish communications with it, and begin the file transfer. The time required to transfer the new program data will depend on the bit rate that was selected earlier.
8. When the file transfer is complete, use the terminal emulator in LOADER *(*select `Terminal`*)*, or any other one, to issue the VERSION command; this will verify your new program version number. When using the terminal emulator in LOADER, a prompt does not initially appear; you need to enter the command first, which then produces a response, after which a prompt will appear.
9. Exit LOADER (select `Quit`).

COMMAND-LINE MODE

LOADER may also be used by entering parameters directly at the command prompt. In this mode of operation the filename and authorization code can be specified on the command line. When the program detects a filename and authorization code, it immediately proceeds to read the specified file, authorize it and send it to the MSAS / NES / UPC receiver.

There are two syntactical forms. The first is for updating individual GPSCards, while the second one is for updating the GPSCards in the MEDLL subsystem.

Updating Individual GPSCards

Syntax #1:

LOADER	-f<filename.bin>	-a<auth code>	*-c<card>*	*-p<port>*	*-s<speed>*

Where:

-f<filename.bin> Specifies BIN file to be loaded.

-a<auth code> Specifies authorization code to insert in file.

-c<card> *(optional)* Specifies a target card. This option is used on units with multiple GPSCards to specify which particular card is to be programmed. The default is 1.

-p<port> *(optional)* Specifies the port to use for communications using a value from 1 to 4, where a value of 1 specifies PC COM port 1 (COM1).

-s<speed> *(optional)* Specifies the download communications speed. The speed value can be 9600, 19200, 38400, 57600 or 115200.

-h Requests on-line help.

Examples:

```
loader -h

loader -fc:\work\m5446.bin -a120a,26dc,ae75,a344,9859,waasmedll
```

The second example causes LOADER to read and authorize C:\WORK\M5446.BIN with the specified authorization code, then transfer the update file to the MSAS / NES / UPC receiver using the port settings previously defined. It is important to ensure that no spaces exist in the entry of the authorization code. Ensure that the MSAS / NES / UPC receiver is turned off. Once the program has been started, you are prompted to turn the MSAS / NES / UPC receiver back on, at which point the screen will display the progress.

Updating the GPSCards in the MEDLL Subsystem

A batch file can be used to provide a convenient way to program multiple GPSCards with the same or different loads of software. Rather than having to run LOADER once for each card, you can specify the card number, firmware filename and an optional authorization code in a batch file.

NOTE: This is the only way to update the GPSCards in the MEDLL subsystem of the MSAS / NES / UPC receiver, other than the proposed software that would allow remote reprogramming over a network.

The batch file is a simple ASCII text file and should be formatted as shown in the example below. In this example, Card #1 is to be loaded with software in the M5446.BIN file, and remaining cards with the S5446.BIN file. Cards #2-#8 have no authorization codes. The batch file should be in the same directory as the LOADER program.

Syntax #2:

`LOADER`	`-p<port>`	`-b<batchfile>`

Where:

-b<batchfile> Specifies file with multiple load commands.

-p<port> Specifies the port to use for communications using a value from 1 to 4, where a value of 1 specifies PC COM port 1 (COM1).

-h Requests on-line help.

Examples:

```
loader –h

loader -bmedll.txt
```

In the second example, this would be the listing of the MEDLL.TXT file for a MEDLL subsystem consisting of one master card and seven slave cards:

```
1 m5446.bin 1234,5678,9012,3456,waasmedll
2 s5446.bin
3 s5446.bin
4 s5446.bin
5 s5446.bin
6 s5446.bin
7 s5446.bin
8 s5446.bin
```

The LOADER program will only initialize the number of cards required to complete the programming. Once the cards have been initialized, the screen will show this:

```
Programming card: 1 with M5446.BIN
```

As the card is being programmed, a character to the right of the filename will spin indicating programming activity. When the first card has been programmed, the screen will show this:

```
Programming card: 1 with M5446.BIN     Okay
Erasing card:  2    \
```

This process will continue until all of the requested cards are programmed and the screen will look similar to this:

```
Programming card: 1 with M5446.BIN     Okay
Programming card: 2 with S5446.BIN     Okay
.
.
Programming card: 8 with S5446.BIN     Okay
Done.  Resetting Cards
Initialization took:      27 seconds
   Programming took:     114 seconds
         Total Time:     141 seconds
Press ENTER to exit
```

Once all of the cards have been programmed, they will be reset. Using PC communication software or the terminal emulator in the Menu mode of LOADER, issue the *VERSION* command to verify your new program version number.

ENTIRE RECEIVER UPDATE MODE

If you wish to perform an update of all the GPSCards in a MSAS / NES / UPC receiver, this mode of LOADER will guide you through the process and simplify the operation considerably. Together with the LOADER program and the update files that you received from Customer Service, there will also be a file with a name such as UPDATE.BAT. This is a batch file which runs LOADER in Command Line mode as described above, with all the commands already prepared.

To run the software, you will need to issue the following command:

Syntax:

UPDATE	<serial port>	<data transfer rate>

Where:

<serial port>	Specifies the port to use for communications using a value from 1 to 4, where a value of 1 specifies PC COM port 1 (COM1).
<data transfer rate>	Specifies the data transfer rate which is to be used

Examples:

```
update 2 115200
```

This example instructs the UPDATE utility to upgrade the GPSCard that is connected to the PC's serial port 2 (COM2) at 115,200 bits per second. The utility will prompt you to turn the power to the MSAS / NES / UPC receiver on or off; it will also prompt you to connect your personal computer to a specific port on the MSAS / NES / UPC receiver.

By the time this utility completes its task, you will have connected your computer to the L1-C/A, L1/L2 1, and L1/L2 II ports on the MSAS / NES / UPC receiver and updated all the GPSCards inside.

UPDATING REMOTELY OVER A NETWORK (PROPOSED)

NovAtel has proposed software that would allow an authorized individual to establish communication with a remote MSAS / NES / UPC receiver. Once the communication session is connected, the user would be required to log in before gaining access to the system. Then, the user could connect to any GPSCard within a remote MSAS / NES / UPC unit.

This application would allow an operator, at a central location, to send files and issue commands to GPSCards in remote MSAS / NES / UPC units. This would greatly simplify the updating of a nation-wide system of MSAS / NES / UPC receivers by eliminating the time and expense associated with having someone travel to each site to perform the update.

More information on this subject will be available as details are finalized.

REQUESTING A CARD'S PSN

The LOADER software has the ability to query the Product Serial Number (PSN) through the serial port. Customer Service personnel need a PSN when generating an authorization code. Normally this information can be found by issuing the VERSION command on the card. However, if the software is not operating, it may be difficult to determine the PSN. This option provides a means of reading the PSN electronically through the serial cable.

To activate this feature, issue the following commands:

Syntax:

`LOADER`	*-c<card>*	*-p<port>*	*/?PSN*

Where:

-p<port>	Specifies the port to use for communications using a value from 1 to 4, where a value of 1 specifies PC COM port 1 (COM1).
-c<card>	*(optional)* Specifies a target card. This option is used on units with multiple GPSCards to specify which particular card is to be programmed. The default is 1.
-h	Requests on-line help.

Examples:

```
loader –p2 /?PSN

loader –p1 –c8 /?PSN
```

The first example requests the PSN from the card connected on COM2. The second example requests the PSNs of all 8 receivers connected on COM1.

5 COMMAND DESCRIPTIONS

This chapter describes the commands accepted by the MSAS / NES / UPC receiver. They are listed in alphabetical order.

The MSAS / NES / UPC receiver is capable of responding to many different input commands. You will find that once you become familiar with these commands, the MSAS / NES / UPC receiver offers a wide range in operational flexibility. Commands can be sent to the MSAS / NES / UPC receiver through the L1-C/A, L1/L2 I and L1/L2 II serial ports. Each of these ports can be addressed independently of the other.

You can issue these commands to control the following:

1. Overall status of the MSAS / NES / UPC receiver
2. Input & output functions
3. Configuration of a specific channel of the MSAS / NES / UPC receiver

Table 2 shows the list of commands, clustered according to these three categories; *Table 3* shows the list of commands, arranged alphabetically.

When the MSAS / NES / UPC receiver is first powered up, all commands revert to the factory default settings. Each command description in this chapter also lists its default setting. The RCCA log can be used to view the instantaneous settings of all commands.

The following rules apply when communicating with the card:

1. The commands are not case sensitive.
   - e.g. *VERSION* or *version*
   - e.g. *FIX POSITION* or *fix position*

2. All commands and required entries can be separated by a space or a comma.
   - e.g. *fix,position,51.3455323,-117.289534,1002*
   - e.g. *fix position 51.3455323 -117.289534 1002*
   - e.g. *com1,9600,n,8,1,n,off*
   - e.g. *com1 9600 n 8 1 n off*
   - e.g. *log,com1,frmb,onnew*
   - *e.g.* *log com1 frmb onnew*

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

4. Most command entries do not provide a response to the entered command. The exception to this statement is the *VERSION* command. Otherwise, successful entry of a command is verified by receipt of the COM port prompt (i.e. COM1>).

Table 2 MSAS / NES / UPC Commands by Category

Command	Description	Syntax
Overall status of the MSAS / NES / UPC receiver		
Command	**Description**	**Syntax**
$AGC	Controls selected AGC control mechanism	*(5 different syntactical forms)*
CONFIG	Implements pre-defined configurations	config *keyword*
CSMOOTH	Sets carrier smoothing	csmooth *value,[value2]*
ECUTOFF	Set elevation cutoff angle	ecutoff angle
FIX POSITION	Set antenna coordinates for monitor station	fix position *lat,lon,height,[station_id],[health]*
$JAMMODE	Controls the state of jamming	$jammode *agc,state*
$PLLBW	Set receiver's phase-lock-loop bandwidths	$pllbw *l1_bw,[l2_bw]*
$PLL_CONFIG	Configure receiver's phase-lock-loop	$pll_config *channel,l1_pll_bw,[threshold], [filter_constant],[l2_pll_bw]*
RESET	Performs a hardware reset	reset
$SETFRAMETYPE	Sets the type of navigation frame data output in the FRMA/B log	$setframetype *type*
UNDULATION	Choose undulation	undulation *separation*
UNFIX	Remove all receiver FIX constraints	unfix
VERSION	Current software level	version
Input & output functions		
Command	**Description**	**Syntax**
CLOCKADJUST	Adjust 1PPS continuously	clockadjust *switch*
COM1	Initialize serial port	com1 *baud,parity,databits,stopbits, handshake,echo*
LOG	Choose data logging type	log *port,datatype,trigger,[period,offset]*
UNLOG	Cease logging a data log	unlog *port,datatype*
UNLOGALL	Cease logging all data logs	unlogall
Configuration of a specific channel of the MSAS / NES / UPC receiver		
Command	**Description**	**Syntax**
ASSIGN	Assign a PRN to a channel #	assign *channel,prn,doppler,search_window*
$ASSIGNG2TOPRN	Assign a G2 delay to a PRN	$assigng2toprn *prn,g2_delay*
$CARRIEROFFSET	Adjust receiver to support non-standard carrier wave frequencies	$carrieroffset *rf_deck,carrier_offset*
$CCRATIO	Carrier to Code Ratio	*(3 different syntactical forms)*
$DLLORDER	Controls the filter order of the Delay-Lock Loop	$dllorder *channel,order,[order2]*
$THRESHOLD	Controls signal acquisition and lock thresholds	$threshold *channel,acqui,[lock],[acqui2],[lock2]*
UNASSIGN	Un-assign a channel	unassign *channel*
UNASSIGNALL	Un-assign all channels	unassignall
$UNASSIGNG2TOPRN	Un-assign a G2 delay	$unassigng2toprn *prn*

Table 3 MSAS / NES / UPC Command Summary

Command	Description	Syntax
$AGC	Controls selected AGC control mechanism	*(5 different syntactical forms)*
ASSIGN	Assign a PRN to a channel #	assign *channel,prn,doppler,search_window*
$ASSIGNG2TOPRN	Assign a G2 delay to a PRN	$assigng2toprn *prn,g2_delay*
$CARRIEROFFSET	Adjust receiver to support non-standard carrier wave frequencies	$carrieroffset *rf_deck,carrier_offset*
$CCRATIO	Carrier to Code Ratio	*(3 different syntactical forms)*
CLOCKADJUST	Adjust 1PPS continuously	clockadjust *switch*
COM1	Initialize serial port	com1 *baud,parity,databits,stopbits, handshake,echo*
CONFIG	Implements pre-defined configurations	config *keyword*
CSMOOTH	Sets carrier smoothing	csmooth *value,[value2]*
$DLLORDER	Controls the filter order of the Delay-Lock Loop	$dllorder *channel,order,[order2]*
ECUTOFF	Set elevation cutoff angle	ecutoff angle
FIX POSITION	Set antenna coordinates for monitor station	fix position *lat,lon,height,[station_id],[health]*
$JAMMODE	Controls the state of jamming	$jammode *agc,state*
LOG	Choose data logging type	log *port,datatype,trigger,[period,offset]*
$PLLBW	Set receiver's phase-lock-loop bandwidths	$pllbw *l1_bw,[l2_bw]*
$PLL_CONFIG	Configure receiver's phase-lock-loop	$pll_config *channel,l1_pll_bw,[threshold], [filter_constant],[l2_pll_bw]*
RESET	Performs a hardware reset	reset
$SETFRAMETYPE	Sets the type of navigation frame data output in the FRMA/B log	$setframetype *type*
$THRESHOLD	Controls signal acquisition and lock thresholds	$threshold *channel,acqui,[lock],[acqui2],[lock2]*
UNASSIGN	Un-assign a channel	unassign *channel*
UNASSIGNALL	Un-assign all channels	unassignall
$UNASSIGNG2TOPRN	Un-assign a G2 delay	$unassigng2toprn *prn*
UNDULATION	Choose undulation	undulation *separation*
UNFIX	Remove all receiver FIX constraints	unfix
UNLOG	Cease logging a data log	unlog *port,datatype*
UNLOGALL	Cease logging all data logs	unlogall
VERSION	Current software level	version

$AGC

This command controls the selected AGC control mechanism, which has two primary functions:

1. Perform the analog-to-digital conversions in the receiver's front end
2. Mitigate jamming

NOTE: 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.

There are five syntactical forms, as shown below. See also the $JAMMODE command.

Syntax #1 lets you enable or disable the AGC control mechanism. When enabled, the AGC control mechanism reads the signal distribution and attempts to control the gain of the signal. However, the control mechanism may be disabled (i.e. the feedback loop can be broken) and either a fixed gain applied or the last gain maintained. The default state is 'auto'.

NOTE: When the AGC mode is disabled the receiver status word will report the AGC as 'good' while the control metric used in the feedback loop is within 7.5% of the set point.

Syntax #1:

```
$AGC    agc  keyword  [gain]
```

Syntax	Range Value	Description	Default
$AGC	-	Command	
Agc	L1 or L2	select AGC circuit	
Keyword	AUTO FIX CALIBRATE	- AGC control is set to automatic. - AGC is set to a fixed value. If no gain value is given, the current gain value is used. - Calculates new calibration values for AGC (for example, if antennas are switched without resetting the receiver)	AUTO
Gain	0 to 99,999	Optional parameter. AGC circuit duty cycle (0 = highest gain, 99,999 = lowest gain).	

Examples:

```
$agc l2 fix 2000
$agc l1 calibrate
```

Syntax #2:

```
$AGC    agc  keyword  jamdetect  jamenter  jamexit
```

Syntax	Range Value	Description	Default
$AGC	-	Command	
Agc	L1 or L2	select AGC circuit	
Keyword	DETECTLEVELS	-	
Jamdetect	0.0 to 1.0	The level at which the AGC jam bit is set in the receiver status word.	0.005
Jamenter	0.0 to 1.0	The level at which the signal processing is switched to jam mode. This value is normally higher than 'jamexit'.	0.03
Jamexit	0.0 to 1.0	The level at which the signal processing is switched to normal operation. This value is normally lower than 'jamenter'.	0.01

Example:

```
$agc l1 detectlevels 0.03 0.05 0.04
```

Syntax #3:

`$AGC` `agc` `keyword` `mode` `variance`

Syntax	Range Value	Description	Default
$AGC	-	Command	
agc	L1 or L2	Select AGC circuit	
keyword	VARIANCE	The control set points used in conjunction with the sum of the products of the bin weights and bin ratios to form the AGC control feedback. Negative values allow alternate control strategies to be invoked.	
mode	GAUSSIAN or JAMMED	'Gaussian' is the normal mode (set point = 1.0); 'Jammed' is a jamming mitigation mode (set point = 0.203)	
variance	±1.0		

Example:

```
$agc l2 variance jammed 0.67
```

Syntax #4:

`$AGC` `agc` `keyword` `mode` `bin1` `bin2` `bin3` `bin4` `bin5` `bin6`

Syntax	Range Value	Description	Default
$AGC	-	Command	
Agc	L1 or L2	select AGC circuit	
Keyword	BINVALUES or BINWEIGHTS	Expected ratio of the number of samples in one bin divided by the total of all bins for one time sample. The bin ratios are multiplied by their respective bin weights and summed together to form a control metric. This is used as the feedback in the AGC control loop. Negative values allow alternate control strategies to be invoked. These values are calculated during calibration, but can be overridden using this command. By default, the values for the Gaussian mode are different than those for the jamming mitigation mode.	
Mode	GAUSSIAN or JAMMED	'Gaussian' is the normal mode (set point = 1.0); 'Jammed' is a jamming mitigation mode (set point = 0.203)	
bin1	±10.0 (bin weights) 0.0 to 1.0 (bin values)	Default Gaussian bin weight & bin value: 3.301 & 0.097 Default Jammed bin weight & bin value: 2.063 & 0.002	
bin2	±10.0 (bin weights) 0.0 to 1.0 (bin values)	Default Gaussian bin weight & bin value: 0.920 & 0.161 Default Jammed bin weight & bin value: 0.721 & 0.072	
bin3	±10.0 (bin weights) 0.0 to 1.0 (bin values)	Default Gaussian bin weight & bin value: 0.133 & 0.242 Default Jammed bin weight & bin value: 0.106 & 0.426	
bin4	±10.0 (bin weights) 0.0 to 1.0 (bin values)	Default Gaussian bin weight & bin value: 0.133 & 0.242 Default Jammed bin weight & bin value: 0.106 & 0.426	
bin5	±10.0 (bin weights) 0.0 to 1.0 (bin values)	Default Gaussian bin weight & bin value: 0.920 & 0.161 Default Jammed bin weight & bin value: 0.721 & 0.072	
bin6	±10.0 (bin weights) 0.0 to 1.0 (bin values)	Default Gaussian bin weight & bin value: 3.301 & 0.097 Default Jammed bin weight & bin value: 2.063 & 0.002	

Example:

```
$agc l2 binvalues gaussian 0.12 0.14 0.26 0.26 0.14 0.12
```

Syntax #5:

```
$AGC    agc  keyword  setting
```

Syntax	Range Value	Description	Default
$AGC	-	Command	
Agc	L1 or L2	select AGC circuit	
Keyword	DEADBAND	Enable, disable or set the ratio magnitude of the deviation away from the variance control set point for the dead band control of the AGC.	
Setting	ON	Enable dead band control with the current magnitude setting.	
	OFF	Disable dead band control.	
	0 to 10	Ratio magnitude used to determine the size of the dead band; e.g. a value of 0.2 will allow a variation of ±0.1 in the agc variance value for a control set point of 0.5. Setting this value automatically enables dead band control. Default = 0.06.	

Example:

```
$agc l1 deadband 0.2
```

ASSIGN

At startup, the MSAS / NES / UPC receiver automatically searches for GPS satellites (PRN 1-32). However, the PRN for MSAS GEO satellites must be manually assigned using the ASSIGN command.

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 indicated tracking channel searches for a specified satellite at a specified Doppler frequency within a specified Doppler window. The instruction will remain in effect for the specified channel and PRN, even if the assigned satellite subsequently sets. If the satellite Doppler offset of the assigned channel exceeds that specified by the 'search-window' parameter of the ASSIGN command, the satellite may never be acquired or re-acquired. To cancel the effects of ASSIGN, you must issue the UNASSIGN or UNASSIGNALL command, or reboot the MSAS / NES / UPC receiver.

When using this command, NovAtel recommends that you monitor the *channel tracking status* of the assigned channel and then use the UNASSIGN or UNASSIGNALL commands to cancel the command once the L1 channel has reached channel tracking state 4, the Phase Lock Loop (PLL) state. Refer to *Table 7* in the ETSB log description for an explanation of the various channel states.

NOTES:

1. Assigning a PRN to a channel does not remove the PRN from the search space of the automatic searcher; only the channel is removed.
2. By default, the automatic searcher only searches for the GPS satellites (PRNs 1-32).

See also the $ASSIGNG2TOPRN command.

There are two syntactical forms of this command, as shown.

Syntax #1:

```
ASSIGN  channel  prn  doppler  search_window
```

Syntax	Range Value	Description	Default	Example
ASSIGN	-	Command	unassignall	assign
Channel	0 - highest channel number	Desired channel number from 0 to maximum channel number inclusive		0
Prn	1 - 999	A satellite PRN integer number from 1 to 32 inclusive (for GPS), 120 to 138 inclusive (for SBAS), or 1 to 999 inclusive if PRNs are assigned using the $ASSIGNG2TOPRN command.		29
Doppler	-100,000 to 100,000 Hz	Current Doppler offset of the satellite Note: Satellite motion, receiver antenna motion and receiver clock frequency error must be included in the calculation for Doppler frequency.		0
Search_window	0 - 10,000	Error or uncertainty in the Doppler estimate above in Hz Note: Any positive value from 0 to 10000 will be accepted. Example: 500 implies ± 500 Hz.		2000

Example:

```
assign 0 29 0 2000
```

Syntax #2:

```
ASSIGN  channel  keyword
```

Syntax	Range Value	Description	Default	Example
ASSIGN	-	Command	unassignall	assign
Channel	0 - highest channel number	Desired channel number from maximum channel number inclusive		0
Keyword	IDLE	Idles channel (not case sensitive)		IDLE

Example 1:

```
assign 0,29,0,2000
```

In Example 1, the first channel will try to acquire satellite PRN 29 in a range from -2000 Hz to 2000 Hz until the satellite signal has been detected.

Example 2:

```
assign 11,idle
```

In Example 2, Channel 11 will be idled and will not attempt to search for satellites.

$ASSIGNG2TOPRN

This command allows you to link a satellite PRN with a particular G2 delay. This delay is then added to a user-defined table, which allows up to 100 entries. Hence, when an ASSIGN command is issued, the receiver will check the user-defined table first and if the PRN is listed there, it will use that G2 delay. Otherwise it will use the default values for GPS and MSAS satellites. This command affects the C/A code tracking only.

Use the $UNASSIGNG2TOPRN command to delete a G2 delay assignment for a particular PRN from the user-defined table.

Syntax:

```
$ASSIGNG2TOPRN  prn  G2_delay
```

Syntax	Range Value	Description	Example
$ASSIGNG2TOPRN	-	Command	$assigng2toprn
Prn	1 – 999	PRN Number	32
G2_delay	0 – 1023	C/A code G2 delay	862

Example:

```
$assigng2toprn 32 862
```

$CARRIEROFFSET

This command is used to adjust the operation of the receiver so that it can support non-standard carrier wave frequencies. It is available on the L1/L2 I and II ports only.

NOTE: The $CARRIEROFFSET command is meant for use in very specialized applications. In normal operation, the use of this command can cause the receiver to malfunction.

Syntax:

```
$CARRIEROFFSET  rf_deck  carrier_offset
```

Syntax	Range Value	Description	Example
$CARRIEROFFSET	-	Command	$carrieroffset
RF_Deck	L1 or L2	RD Deck that is receiving a non-standard carrier wave frequency	L1
Carrier_Offset	±10 000.0	Difference between the non-standard carrier frequency and a nominal GPS frequency (L1 = 1575.42 MHz or L2 = 1227.6 MHz) in Hz.	100.0

Example:

```
$carrieroffset L1 100.0
```

$CCRATIO

This command is used to set the number of carrier cycles in each code chip. It is available on the L1/L2 II port only. There are three different syntactical forms permitted.

NOTE: The $CCRATIO is meant for use in very specialized applications. In normal operation, the use of this command can cause the receiver to malfunction.

Syntax #1:

```
$CCRATIO  channel  cycles
```

Syntax	Range Value	Description	Example
$CCRATIO	-	Command	$ccratio
Channel	0 – highest channel number	Desired channel number from 0 to maximum channel available	3
Cycles	1000 – 20,000	Carrier to code ratio in cycles per code chip. This value can be entered with up to 8 decimal places.	1540.0

Example:

```
$ccratio 3 1540.0
```

Syntax #2:

`$CCRATIO channel keyword`

Syntax	Range Value	Description	Example
$CCRATIO	-	Command	$ccratio
Channel	0 - highest channel number	Desired channel number from 0 to maximum channel available	3
Keyword	RESET	Resets specified channel.	reset

Example:

```
$ccratio 3 reset
```

Syntax #3:

`$CCRATIO keyword`

Syntax	Range Value	Description	Example
$CCRATIO	-	Command	$ccratio
Keyword	RESET	Resets all channels	Reset

Example:

```
$ccratio reset
```

CLOCKADJUST

All oscillators have some inherent drift characterization. This command, if enabled, permits software to model these long-term drift characteristics of the clock. The correction is applied to the 1PPS strobe as well. The clock adjustment is performed digitally. As a result, the 1PPS Strobe (on an L1 card) will have a 49 ns jitter on it due to the receiver's attempts to keep it as close as possible to GPS time. Jitter on an L1/L2 card is 50 ns.

CLOCKADJUST must be disabled (which it is by default) if you wish to measure the drift rate of the oscillator using the CLKA/B data log. Under normal conditions, it is recommended that the command be left in a disabled state.

NOTES:

1. If you enable this command, do not disable it after 30 seconds from power-up: unpredictable clock drifts may result.
2. When disabled, the range measurement bias errors will continue to accumulate with clock drift and the 1PPS output form the receiver will drift with the external clock..
3. This feature should only be changed by advanced users.

Syntax:

`CLOCKADJUST switch`

Syntax	Range Value	Description	Default
CLOCKADJUST	-	Command	
switch	Enable or disable	Allows or disallows adjustment to the internal clock	disable

Example:

```
clockadjust disable
```

COM1

This command permits you to configure the serial port's asynchronous driver.

The L1-C/A, L1/L2 I and L1/L2 II ports allow two-way communications. Each one is configured as COM1. Thus, regardless of which of these three ports your data communications equipment is physically connected to, you would enter *COM1* as the command name. It is not possible to alter any of the communications parameters associated with the TIME port.

Syntax:

```
COM1 bps parity databits stopbits handshake echo FIFO
```

Syntax	Value	Description	Default	Example
COM1	-	Command		COM1
bps	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115,200	Specify bit rate	9600	19200
parity	N (none), O (odd) or E (even)	Specify parity	N	E
databits	7 or 8	Specify number of data bits	8	7
stopbits	1 or 2	Specify number of stop bits	1	1
handshake	N (none), XON (Xon/Xoff) or CTS (CTS/RTS)	Specify handshaking	N	N
echo	ON or OFF	Specify echo	OFF	ON
FIFO	ON or OFF	Enable or disable the 16550 UART's transmit FIFO	ON	OFF

Examples:

```
com1 19200,e,7,1,n,on, off
com1 1200,e,8,1,n,on, off
```

CONFIG

This command switches the channel configuration of the L1-C/A code receiver between pre-defined configurations. When the command is issued the receiver resets with the new configuration.

Syntax:

```
CONFIG keyword
```

Syntax	Range	Description	Default
CONFIG	-	Command	
keyword	G14W2	Configures the L1-C/A code portion of the receiver to track up to 14 GPS & 2 GEO satellites	G14W2
	G12W4	Configures the L1-C/A code portion of the receiver to track up to 12 GPS & 4 GEO satellites	

Example:

```
config g14w2
```

CSMOOTH

This command sets the amount of carrier smoothing to be performed on the pseudorange measurements carrier. The 'value' field sets the L1 channel portion and the optional 'value2' field sets the L2 channel portion. An input value of 100 corresponds to approximately 100 seconds of smoothing. Upon issuing the command, the locktime for all tracking satellites is reset to zero, and each pseudorange smoothing filter is restarted. You must wait for at least the length of smoothing time for the new smoothing constant to take full effect. 20 seconds is the default smoothing constant used in the MSAS / NES / UPC receiver. The optimum setting for this command depends on your application and thus cannot be specified.

On port L1-C/A, 'value2' is ignored since the MEDLL subsystem is L1-only.

NOTES:

1. The CSMOOTH command should only be used by advanced users. It may not be suitable for every GPS application. When using CSMOOTH in a differential mode, the same setting should be used at both the monitor and remote station.
2. The lower the smoothing constant, the more noise there will be.

Syntax:

```
CSMOOTH    value  [value2]
```

Syntax	Range Value	Description	Default
CSMOOTH	-	Command	
Value	2 to 1000	L1 carrier smoothing constant (in seconds).	20
Value2	20 to 1000	L2 carrier smoothing constant (in seconds).	20

Example:

```
csmooth 20 500
```

$DLLORDER

This command controls the filter order of the Delay-Lock Loop (DLL). The 'order' field sets the L1 channel portion and the optional 'order2' field sets the L2 channel portion. The 'order2' field, however, is not currently used.

Syntax:

```
$DLLORDER    channel  order  [order2]
```

Syntax	Range Value	Description	Default	Example
$DLLORDER	-	Command		$dllorder
Channel	0 to the highest channel number, or the keyword 'ALL' for all channels.	An individual channel number can be entered or the 'all' keyword can be used if the threshold values apply to all channels.	ALL	0
Order	DEFAULT 1 2	Default DLL order (1st order) Sets DLL to 1st order on L1 channel Sets DLL to 2nd order on L1 channel	1	2
Order2		(not currently used)		

Examples:

```
$dllorder 0 2
$dllorder all 2
```

ECUTOFF

This command sets the elevation cut-off angle for usable satellites. The GPSCard will not start tracking a satellite until it rises above the cutoff angle and, if a satellite being tracked drops below this angle, it will be dropped. Satellites below the cutoff angle will be eliminated from the internal position and clock offset solution computations.

This command permits a negative cutoff angle, which could be used in these situations:

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

NOTES:
1. When ECUTOFF is set to zero (0), the receiver will track all satellites in view including some within a few degrees below the horizon.
2. Care should be taken when using ECUTOFF because the signals received from low-elevation satellites travel along a longer atmospheric path and thus tend to experience greater degradation.
3. If a satellite has been assigned to a specific channel (via the ASSIGN command), the receiver section will continually attempt to track the satellite regardless of the elevation.

Syntax:

```
ECUTOFF angle
```

Syntax	Range Value	Description	Default
ECUTOFF	-	Command	
Angle	-90° to +90°	Value in degrees (relative to the horizon).	-90

Example:

```
ecutoff 5
```

FIX POSITION

Invoking this command will result in the MSAS / NES / UPC receiver position being held fixed. A computation will be done to solve local clock offset, pseudorange, and pseudorange differential corrections. This mode of operation can be used for time transfer applications where the position is fixed and accurate GPS time output is required (refer to *CLKA/B* and *TM1A/B* logs for time data).

The values entered into the FIX POSITION command should reflect the precise position of the antenna's phase centre. Any errors in these coordinates will be propagated into the pseudorange corrections calculated by the receiver.

The height is the distance above the geoid. The MSAS / NES / UPC receiver performs all internal computations based on WGS-84. If you are going to input an ellipsoidal height you must first set the undulation to zero; please refer to the UNDULATION command.

The FIX POSITION command will override any previous FIX POSITION command settings. Use the UNFIX command to disable the FIX POSITION setting.

Syntax:

```
FIX POSITION  lat  lon  height  station_id  RTCM stn health
```

Syntax	Range Value	Description	Default	Example
FIX POSITION	-	Command	unfix	fix position
lat	± 90 (only 8 decimal places are shown in the RCCA log, though higher precision is carried internally)	Latitude (in degrees/decimal degrees) of fixed monitor station antenna in current datum. A negative sign implies South latitude.		51.3455323
lon	± 360 (only 8 decimal places are shown in the RCCA log, though higher precision is carried internally)	Longitude (in degrees) of fixed monitor station antenna in current datum. A negative sign implies West longitude.		-114.289534
height	-1,000 to 20,000,000	Height (in metres) above the geoid of monitor station in current datum.		1201.123
Station_id	(not used in MSAS)	(not used in MSAS)	0000	
RTCM monitor station health	(not used in MSAS)	(not used in MSAS)	0	

Example:

```
fix position 51.3455323,-114.289534,1201.123
```

The above example fixes the position of the receiver with fixed coordinates of:

Latitude	N 51° 20' 43.9163" (WGS-84 or local datum)
Longitude	W 114° 17' 22.3224"
Height above sea level	1201.123 metres

$JAMMODE

This command controls the receiver's ability to switch to a jamming mitigation configuration. By default, jamming mitigation automatically begins as soon as the jamming reaches a certain threshold (that is, if the AGC control mechanism is set to 'auto'). This command allows you to remove this from the AGC's control, and force the jamming mitigation mode to be on or off. The jamming mitigation mode not only controls the gain feedback of the AGC control mechanism, but also the encoding of the data signal for the MINOS.

See also the $AGC command.

NOTE: 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.

Syntax:

```
$JAMMODE  agc  state
```

Syntax	Range Value	Description	Default	Example
$JAMMODE	-	Command		$jammode
Agc	L1 or L2	select AGC circuit		L1
State	ON OFF AUTO	force jamming mitigation mode on force jamming mitigation mode off AGC detects jamming and switches to jamming mitigation mode automatically	auto	ON

Example:

```
$jammode l1 on
```

LOG

Many different types of data can be logged using several different methods of triggering the log events. Every log element can be directed to the COM1 port. The ONTIME trigger option requires the addition of the *period* parameter and optionally allows input of the *offset* parameter. See the beginning of *Chapter 7* for further information about the ASCII and binary data log structures.

The ‘*port*’ parameter is optional. If ‘*port*’ is not specified, ‘*port*’ is defaulted to the port that the command was received on. This feature eliminates the need for you to know which port you are communicating on if you want logs to come back to you on the same port by which you are sending commands.

If the LOG syntax does not include a ‘*trigger*’ type, it will be output only once following execution of the LOG command. If ‘*trigger*’ type is specified in the LOG syntax, the log will continue to be output based on the ‘*trigger*’ specification.

The optional parameter ‘*hold*’ 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 L1-C/A, L1/L2 I and L1/L2 II ports allow two-way communications; each one is configured as COM1. Thus, regardless of which of these three ports your data communications equipment is physically connected to, you would enter *COM1* as the port name. It is not possible to log data to the TIME port.

Specific logs can be disabled using the UNLOG command, whereas all enabled logs will be disabled by using the UNLOGALL command (except for those issued with the ‘*hold*’ parameter).

When the LOG command is ONTIME the software will attempt to output the log with the period chosen. The start of the period is the 1PPS signal. The period is 1 second and, therefore, ONTIME 1 will cause logs to be output as soon as the data is available after the 1PPS. The OFFSET option is used to output the log with the period starting, not from the 1PPS, but at 1PPS plus the offset. The OFFSET option value is limited by the measurement frequency. That is, the software will only output a log after a measurement is taken. The L1/L2 - II and L1/L2 - I measurements are taken every 1PPS. Therefore, you cannot offset the log by 0.5 seconds from the 1PPS because the software will only get data every 1 second (the closest time to 1PPS + 0.5 seconds is 1PPS + 1 second). MEDLL's measurement frequency is 5 Hz. MEDLL's measurement log can be output at 1PPS plus the offset where the offset is one of 0.2, 0.4, 0.6 and 0.8 seconds. If you ask for 1PPS + 0.5 seconds, you will get data at 1PPS + 0.6 seconds. This measurement data is from the 1PPS + 0.6 measurement and not from the time of the 1PPS.

Syntax:

```
LOG [port] datatype [trigger] [period] [offset] [hold]
```

Syntax	Description	Example
LOG	Command	LOG
port	(Optional) COM1 is the only valid entry	COM1
datatype	Enter one of the valid data log names (see *Chapter 7*)	ETSB
trigger	(Optional) Enter one of the following *triggers*: *ONCE* — Immediately logs the selected data to the selected port once. Default if trigger field is left blank. *ONMARK* — Logs the selected data when a MARKIN electrical event is detected. Outputs internal buffers at time of mark – does not extrapolate to mark time. *ONNEW* — Logs the selected data each time the data is new even if the data is unchanged. *ONCHANGED* — Logs the selected data only when the data has changed. *ONTIME [period], [offset]* — Immediately logs the selected data and then periodically logs the selected data at a frequency determined by the *period* and *offset* parameters. The logging will continue until an UNLOG command pertaining to the selected data item is received (see *UNLOG* Command). *CONTINUOUSLY* — Will log the data all the time. The GPSCard will generate a new log when the output buffer associated with the chosen port becomes empty. This may cause unpredictable results if more than one log is assigned to the port. The *continuously* option was designed for use with differential corrections over low bit rate data links. This will provide optimal record generation rates. The next record will not be generated until the last byte of the previous record is loaded into the output buffer of the UART.	ONTIME
Period	(Optional) Use only with the *Ontime* trigger. Units for this parameter are seconds. The selected period may be any value from 0.05 second to 3600 seconds. Selected data is logged immediately and then periodic logging of the data will start at the next even multiple of the period. If a period of 0.20 sec is chosen, then data will be logged when the receiver time is at the 0.20, 0.40, 0.60 and the next (0.80) second marks. If the period is 15 seconds, then the logger will log the data when the receiver time is at even 1/4 minute marks. The same rule applies even if the chosen period is not divisible into its next second or minute marks. If a period of 7 seconds is chosen, then the logger will log at the multiples of 7 seconds less than 60, that is, 7, 14, 21, 28, 35, 42, 49, 56 and every 7 seconds thereafter.	60
Offset	(Optional) Use only with the *Ontime* trigger and with *Period*. Units for this parameter are seconds. It provides the ability to offset the logging events from the above startup rule. If you wished to log data at 1 second after every minute you would set the period to 60 seconds and the offset to 1 second. The default is 0.	1
Hold	(Optional) Prevents a log from being removed when the UNLOGALL command is issued; UNLOG must be used.	

Examples:

```
log com1,etsb,ontime,60,1
log com1 etsb
log etsb ontime 60 1
```

The first example will cause the ETSB log to be sent to COM port 1, recurring every 60 seconds, and offset by 1 second. The second example will cause the ETSB log to be sent only once, by omitting the trigger option. The third example is identical to the first, since all the ports on the MSAS / NES / UPC receiver to which one can issue commands are configured as COM1.

$PLLBW

This command sets the phase-lock-loop bandwidths of the receiver.

NOTES: 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. In Version 4.446, modifying the L2_BW results in the tracking loop gain being set to zero. Instead, use the $PLL_CONFIG command.

Syntax:

```
$PLLBW        L1_BW  [L2_BW]
```

Syntax	Range Value	Description	Default
$pllbw	-	Command	
L1_BW	0.5 Hz to 15 Hz	L1 C/A or L2 C/A phase-lock-loop bandwidth.	3
L2_BW	0.01 Hz to 0.2 Hz	Optional. L2 P (codeless) phase-lock-loop bandwidth. See Note #2 above.	0.2

Example:

```
$pllbw 12
```

$PLL_CONFIG

This command sets the L1 PLL low pass filter bandwidth, L1 PLL error signal variance tracking threshold, L1 PLL error signal variance filter constant, and L2 PLL low pass filter bandwidth for one or all channels.

Use of the $PLL_CONFIG and $PLLBW commands are compatible. However, if the $PLL_CONFIG command is used, the $PLLBW entry in the $RCCA log is replaced with one or more $PLL_CONFIG entries.

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.

Filtering: new value = $e^{-\Delta T \omega} \cdot$(old data) + $(1-e^{-\Delta T \omega}) \cdot$(new data)

Where: ΔT is the PLL sampling rate

$\omega = 4 \times$ filter constant

NOTE: 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.

There are two different syntactical forms, as shown below.

Syntax #1:

`$PLL_CONFIG` `channel` `L1_PLL_BW` `[threshold]` `[filter_constant]` `[L2_PLL_BW]`

Syntax	Range Value	Description	Default
$pll_config	-	Command	
Channel	0 to the highest channel number, or 'ALL' for all channels.	An individual channel number can be entered, or the 'ALL' keyword can be used if the parameter values apply to all channels.	-
L1_PLL_BW	0.5 Hz to 15 Hz	L1 PLL low pass filter bandwidth.	15
Threshold	0 cycles^2 to 1.0 cycles^2	(Optional) L1 PLL error signal variance tracking threshold. Used to detect possible cycle slip conditions and cause the lock time to reset.	0.01
Filter_constant	0.01 Hz to 2.0 Hz	(Optional) L1 PLL error signal variance first order time filtering constant.	1.0
L2_PLL_BW	0.01 Hz to 0.2 Hz	(Optional) L2 PLL low pass filter bandwidth.	0.2

Example:

```
$pll_config 3 1.0 0.5 2.0
```

Syntax #2:

`$PLL_CONFIG` `channel` `keyword`

Syntax	Range Value	Description
$pll_config	-	Command
Channel	0 to the highest channel number, or 'ALL' for all channels.	An individual channel number can be entered, or the 'ALL' keyword can be used if the parameter values apply to all channels.
Keyword	DEFAULT	Causes all four parameters to return to their default value.

Example:

```
$pll_config all default
```

RESET

This command performs a hardware reset. Following a RESET command, the MSAS / NES / UPC receiver will initiate a cold-start bootup. Therefore, the receiver configuration will revert to the factory default.

Syntax:

```
RESET
```

$SETFRAMETYPE

This command controls the type of navigation frame data that is output in the FRMA/B logs.

Syntax:

`$SETFRAMETYPE` `type`

Syntax	Range Value	Description	Default	Example
$SETFRAMETYPE	-	Command		$setframetype
Type	ALL GPS GLONASS WAAS	Individual navigation frame data can be entered or the 'all' keyword can be used if the all types are needed.	ALL	GPS

Example:

```
$setframetype gps
```

$THRESHOLD

This command controls signal acquisition and steady-state-lock signal thresholds. The ‘acquisition’, and ‘lock’ fields must have values. The ‘acquisition2’ and ‘lock2’ fields are used if the channel is L1/L2. In this case, the ‘acquisition’ and ‘lock’ fields set the thresholds for the L1 portion of the channel, and the ‘acquisition2’, and ‘lock2’ fields set the thresholds for the L2 portion of the channel.

The ‘acquisition2’ and ‘lock2’ fields (that is, the L2 portion) may be entered, are reported in the RCCA log, but are not currently used by the receiver.

NOTE: Using this command forces the specified channel to reacquire the satellite.

There are two different syntactical forms, as shown below.

Syntax #1:

```
$THRESHOLD  channel  acqui  [lock]  [acqui2]  [lock2]
```

Syntax	Range Value	Description	Default
$THRESHOLD	-	Command	--
Channel	0 to the highest channel number, or ‘ALL’ for all channels.	An individual channel number can be entered, or the ‘ALL’ keyword can be used if the threshold values apply to all channels.	3
Acqui	30 dBHz to 70 dBHz	Acquisition power threshold.	36
Lock	25 dBHz to 70 dBHz	Steady-state tracking lock threshold.	28
Acqui2	(not currently used)		
lock2	(not currently used)		

Example:

```
$threshold 3 36 28
```

Syntax #2:

```
$THRESHOLD  channel  keyword
```

Syntax	Range Value	Description
$THRESHOLD	-	Command
Channel	0 to the highest channel number, or ‘ALL’.	An individual channel number can be entered or the ‘ALL’ keyword can be used if the threshold values apply to all channels.
Keyword	DEFAULT	Sets the power thresholds to default values.

Example:

```
$threshold all default
```

UNASSIGN

This command cancels a previously issued ASSIGN command and the channel reverts to automatic control. If an L1 channel has reached channel tracking state 4 (PLL, see *Table 7*), the satellite being tracked will not be dropped when the UNASSIGN command is issued, unless it is below the elevation cutoff angle and there are healthy satellites above the elevation cutoff angle that are not already assigned to other channels.

Syntax:

```
UNASSIGN  channel
```

Syntax	Range Value	Description	Default
UNASSIGN	-	Command	unassignall
Channel	0 - highest channel number	Reset channel to automatic search and acquisition mode	

Example:

```
unassign 11
```

UNASSIGNALL

This command cancels all previously issued ASSIGN commands for all channels. Tracking and control for each channel reverts to automatic mode. If any of the L1 channels has reached channel tracking state 4 (PLL, see *Table 7*), the satellites being tracked will not be dropped when the UNASSIGNALL command is issued, unless they are below the elevation cutoff angle and there are healthy satellites above the elevation cutoff angle that are not already assigned to other channels.

Syntax:

```
UNASSIGNALL
```

$UNASSIGNG2TOPRN

This command deletes a G2 delay assignment for a particular PRN from the user-defined table. It reverses a previous $ASSIGNG2TOPRN command. There are two syntactical forms, as shown below.

Syntax #1:

```
$UNASSIGNG2TOPRN  prn
```

Syntax	Range Value	Description	Example
$UNASSIGNG2TOPRN	-	Command	$unassigng2toprn
Prn	1 – 999	PRN Number	101

Example:

```
$unassigng2toprn 101
```

Syntax #2:

```
$UNASSIGNG2TOPRN  keyword
```

Syntax	Range Value	Description	Example
$UNASSIGNG2TOPRN	-	Command	$unassigng2toprn
Keyword	ALL	Keyword - 'all' is the only defined keyword at this time.	all

Example:

```
$unassigng2toprn all
```

UNDULATION

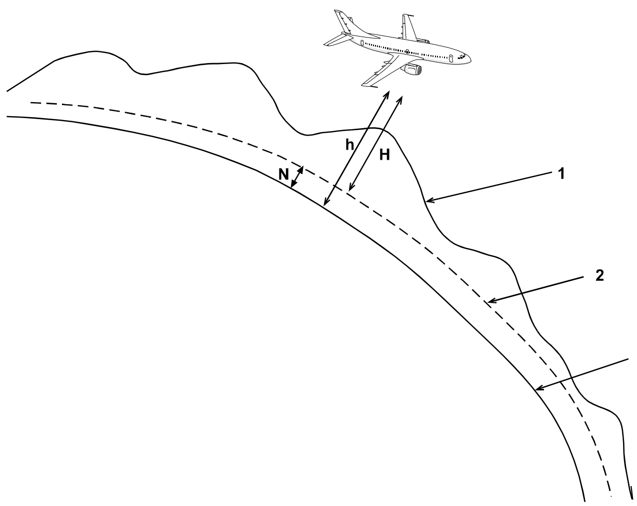
This command permits you to either enter a specific geoidal undulation value or use the internal table of geoidal undulations. The separation values only refer to the separation between the WGS-84 ellipsoid and the geoid at your location, regardless of the datum chosen. When you are going to input the ellipsoidal height using the FIX POSITION command you must first set the UNDULATION to zero.

Figure 15 illustrates the various terms used in describing height relationships. In this figure,

1 = topography
2 = geoid = mean sea level
3 = ellipsoid

N = undulation
h = ellipsoidal height = height above ellipsoid
H = height above mean sea level.

Figure 15 Height Relationships



Syntax:

```
UNDULATION    separation
```

Syntax	Range Value	Description	Default
UNDULATION	-	Command	
Separation	Keyword "table" or a value	Selects the internal table of undulations and ignores any previously entered value. The internal table utilizes a grid (OSU - 89B) of approximately 1.5 degrees x 1.5 degrees. A numeric entry that overrides the internal table, with a value in metres.	table

Examples:

```
undulation table
undulation -5.6
```

UNFIX

This command removes all position constraints invoked with the FIX POSITION command.

Syntax:

```
UNFIX
```

UNLOG

This command permits you to remove a specific log request from the system. It reverses the effect of a particular LOG command.

The [port] parameter is optional. If [port] is not specified, it is defaulted to the port that the command was received on. This feature eliminates the need for you to know which port you are communicating on if you want logs to come back on the same port you are sending commands on.

Syntax:

```
UNLOG  port  datatype
```

Syntax	Range Value	Description	Default
UNLOG	-	Command	unlogall
Port	COM1	COM port from which log originated	
Datatype	any valid log	The name of the log to be disabled	

Example:

```
unlog com1,tm1b
```

UNLOGALL

This command permits you to disable all current logs on the port to which your data communication equipment is connected. It reverses the effects of all LOG commands.

NOTE: This command does not disable logs that have the 'hold' attribute (see description for LOG command). To disable logs with the 'hold' attribute, use the UNLOG command.

Syntax:

```
UNLOGALL
```

VERSION

Use this command to determine the current software version of the GPSCard. The response to the VERSION command is logged to the port from which the command originated.

Syntax:

```
VERSION
```

Response:

```
card type  model#  S/N  MACH rev  SW rev/boot code rev  date
```

Response	Description	Maximum Field Length (bytes)
card type	Card type	5
model #	Model number	16
S/N	Serial number	16
MACH rev	CPLD revision	16
SW	Characters representing software (SW)	2
SW rev/boot code rev	Firmware revision/ boot code revision	16
date	Firmware compile date	12

Example 1 (L1 C/A Port):

```
COM1>version
OEM-2 WAASMEDLL CGC97350052 HW 1  SW 5.446/1.03 Apr 07/2
```

Example 2 (L1/L2 I Port):

```
COM1>version
OEM-3 WAASL2 CGL97360022 HW 3-1 SW 4.446/2.03 Apr 07/02
```

Example 3 (L1/L2 II Port):

```
COM1>version
OEM-3 WAASL2W CGL97420013 HW 3-1 SW 4.446/2.03 Apr 07/02
```

NOTE: Spaces are delimiters in between fields.

6 OUTPUT LOGGING

When logging data from the MSAS / NES / UPC receiver, the logs must be sent to the COM1 serial port; the COM2 port is reserved for special use. Logging to COM2 may interfere with or damage the effective operation of the receiver.

Table 4 shows the list of logs, clustered according to several categories; *Table 5* shows the list of logs, arranged alphabetically.

The data logs available are in NovAtel ASCII and binary format, and are described in *Chapter 7*. They can be logged using several methods of triggering each log event. Each log is initiated using the LOG command. The LOG command and syntax are described in *Chapter 5*; they are of the form ***log*** *port,datatype,trigger,[period,offset,hold]*.

If the LOG syntax does not include a *trigger* type, it will be output only once following execution of the LOG command. If *trigger* type is specified in the LOG syntax, the log will continue to be output based on the *trigger* specification. Specific logs can be disabled using the UNLOG command, whereas all enabled logs will be disabled by using the UNLOGALL command.

Table 4 MSAS / NES / UPC Logs by Category

COMMUNICATIONS, CONTROL & STATUS	
Logs	**Descriptions**
$ACPA/B	AGC Control Parameter Information
$AGCA/B	AGC and A/D Information
CDSA/B	COM port communications status
GENERAL RECEIVER CONTROL & STATUS	
Logs	**Descriptions**
RCCA	Receiver configuration status
RVSA/B	Receiver status
POSITION, PARAMETERS & SOLUTION FILTERING	
Logs	**Descriptions**
DOPA/B	DOP of SVs currently tracking
POSA/B	Position data
SATELLITE TRACKING & CHANNEL CONTROL	
Logs	**Descriptions**
ALMA/B	Current decoded almanac data
DOPA/B	DOP of SVs currently tracking
ETSA/B	Provides channel tracking status information for each of the GPSCard parallel channels
FRMA/B	Framed Navigation Data
IONA/B	Decoded Almanac – Ionospheric Model parameters
RBTA/B	Raw Navigation Bits
REPA/B	Raw Ephemeris
RGEA/B/D	Satellite range measurements
SATA/B	Satellite specific information
SBTA/B	Raw Navigation Symbols
UTCA/B	Decoded Almanac – UTC Time parameters
WBCA/B	Wide Band Carrier Range Corrections
WRCA/B	Wide Band Code Range Corrections
CLOCK INFORMATION, STATUS & TIME	
Logs	**Descriptions**
CLKA/B	Receiver clock offset information
TM1A/B	Time of 1PPS

Table 5 MSAS / NES / UPC Log Summary

NovAtel Format Logs	
Datatype	Description
$ACPA/B	AGC Control Parameter Information
$AGCA/B	AGC and A/D Information
ALMA/B	Decoded Almanac
CDSA/B	Communication and Differential Decode Status
CLKA/B	Receiver Clock Offset Data
DOPA/B	Dilution of Precision
ETSA/B	Extended Channel Tracking Status
FRMA/B	Framed Navigation Data
IONA/B	Decoded Almanac – Ionospheric Model parameters
POSA/B	Computed Position
RBTA/B	Raw Navigation Bits
RCCA	Receiver Configuration
REPA/B	Raw Ephemeris
RGEA/B	Channel Range Measurements
RVSA/B	Receiver status incl. S/W version, # of working channels, CPU idle time, BISTs status, clock status
SATA/B	Satellite Specific Data
SBTA/B	Raw Navigation Symbols
TM1A/B	Time of 1PPS
UTCA/B	Decoded Almanac – UTC Time parameters
WBCA/B	Wide Band Carrier Range Corrections
WRCA/B	Wide Band Code Range Corrections

7 NOVATEL FORMAT DATA LOGS

The MSAS / NES / UPC receiver is capable of generating many NovAtel-format output logs, in either ASCII or binary format.

The following log descriptions are listed in alphabetical order. Each log first lists the ASCII format, then the binary format description.

ASCII LOG STRUCTURE

Log types ending with the letter A are output in ASCII format (e.g., POSA). The structures of all ASCII logs follow the general conventions as noted here:

1. The lead code identifier for each record is '$'.
2. Each log is of variable length depending on amount of data and formats.
3. All data fields are delimited by a comma ',' with the exception of the last data field, which is followed by a '*' to indicate end-of-message data.
4. Each log ends with a hexadecimal number preceded by an asterisk and followed by a line termination using the carriage return and line feed characters, e.g., *xx[CR][LF]. This 8-bit value is an exclusive OR (XOR) of all bytes in the log, excluding the '$' identifier and the asterisk preceding the two checksum digits.

Structure:

`$xxxx,`	`data field...,`	`data field...,`	`data field...`	`*xx`	`[CR][LF]`

BINARY LOG STRUCTURE

The structures of the Binary logs follow the general conventions as noted here:

1. Basic format of:

Sync	3 bytes
Checksum	1 byte
Message ID	4 bytes unsigned integer
Message byte count	4 bytes unsigned integer
Data	x bytes

2. The Sync bytes will always be:

Byte	Hex	Decimal
First	AA	170
Second	44	68
Third	11	17

3. The Checksum is an XOR of all the bytes, including the 12 header bytes with CRC = 00.
4. The Message ID identifies the type of log to follow.
5. The Message byte count equals the total length of the data block including the header.

NOTE: Maximum flexibility for logging data is provided 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. CPU overload can be monitored using the idle time and buffer overload bits from the RVSB log. For further information, please refer to *Table 9, Page 73*.

The following describes the format types used in the description of binary logs.

Type	Size (bytes)	Size (bits)	Description
char	1	8	The **char** type is used to store the integer value of a member of the representable character set. That integer value is the ASCII code corresponding to the specified character.
int	4	32	The size of a signed or unsigned **int** item is the standard size of an integer on a particular machine. On a 32-bit processor (such as the NovAtel GPSCard), the **int** type is 32 bits, or 4 bytes. The **int** types all represent signed values unless specified otherwise. Signed integers are represented in two's-complement form. The most-significant bit holds the sign: 1 for negative, 0 for positive and zero.
double	8	64	The **double** type contains 64 bits: 1 for sign, 11 for the exponent, and 52 for the mantissa. Its range is ±1.7E308 with at least 15 digits of precision.
float	4	32	The **float** type contains 32 bits: 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.

Each byte within an **int** has its own address, and the smallest of the addresses is the address of the int. The byte at this lowest address contains the eight least significant bits of the double word, while the byte at the highest address contains the eight most significant bits. Similarly the bits of a "double" type are stored least significant byte first. This is the same data format used by personal computers.

TIME CONVENTIONS

All logs report GPS time expressed in GPS weeks and seconds into the week. The time reported is not corrected for the local receiver's clock error. To derive the closest GPS time, one must subtract the clock offset shown in the CLKB log (field 4) from GPS time reported.

GPS time is based on an atomic time scale. Universal Time Coordinated (UTC) is also based on an atomic time scale, with an offset of seconds applied to coordinate Universal Time to GPS time. GPS time is designated as being coincident with UTC at the start date of January 6, 1980 (00 hours). GPS time does not count leap seconds, and therefore an offset exists between UTC and GPS time (at this date: approximately 11 seconds). The GPS week consists of 604800 seconds, where 000000 seconds is at Saturday midnight. Each week at this time, the week number increments by one, and the seconds into the week resets to 0.

LOG DESCRIPTIONS

$ACPA/B AGC CONTROL PARAMETER INFORMATION

The ACPA/B log contains AGC related information. This information includes information about the AGC controller bin values, bin weights, variances, and detect levels.

$ACPA

Structure:

```
$ACPA  week  seconds  rec_status  #RF
RF_type  gv1  gv2  gv3  gv4  gv5  gv6  jv1  jv2  jv3  jv4  jv5  jv6
gw1  gw2  gw3  gw4  gw5  gw6  jw1  jw2  jw3  jw4  jw5  jw6  gcv  jcv  jdl  j_in  j_ex
:
data for other RF decks, if required  *xx  [CR][LF]
```

Field	Item	Description	Example
1	$ACPA	Log header	$ACPA
2	week	GPS week number	932
3	seconds	GPS seconds into the week	256586.00
4	rec_status	Self-test status of the receiver (see *Table 9*)	43A00FF
5	# RF	Number of RF decks reported in this message.	2
6	RF_type	0 = GPS L1, 1 = GPS L2, all other numbers are reserved for future use.	0
7	gv1	Expected Gaussian Bin Value 1	0.1037
8	gv2	Expected Gaussian Bin Value 2	0.1781
9	gv3	Expected Gaussian Bin Value 3	0.2375
10	gv4	Expected Gaussian Bin Value 4	0.2370
11	gv5	Expected Gaussian Bin Value 5	0.1569
12	gv6	Expected Gaussian Bin Value 6	0.0868
13	jv1	Expected Jammed Bin Value 1	0.0060
14	jv2	Expected Jammed Bin Value 2	0.1335
15	jv3	Expected Jammed Bin Value 3	0.4221
16	jv4	Expected Jammed Bin Value 4	0.3596
17	jv5	Expected Jammed Bin Value 5	0.0761
18	jv6	Expected Jammed Bin Value 6	0.0028
19	gw1	Gaussian Bin Weight 1	3.3010
20	gw2	Gaussian Bin Weight 2	0.9200
21	gw3	Gaussian Bin Weight 3	0.1330
22	gw4	Gaussian Bin Weight 4	0.1330
23	gw5	Gaussian Bin Weight 5	0.9200
24	gw6	Gaussian Bin Weight 6	3.3010
25	jw1	Jammed Bin Weight 1	2.0630
26	jw2	Jammed Bin Weight 2	0.7210
27	jw3	Jammed Bin Weight 3	0.1060
28	jw4	Jammed Bin Weight 4	0.1060
29	jw5	Jammed Bin Weight 5	0.7210
30	jw6	Jammed Bin Weight 6	2.0630
31	gcv	Gaussian Variance Control Level	1.0000
32	jcv	Jammed Variance Control Level	0.2030
33	jdl	Jam Detect Level	0.0050
34	j_in	Jam Enter Level	0.0300
35	j_ex	Jam Exit Level	0.0100
36...65	….	Next RF Deck if required.	….
Variable	*xx	Checksum	*70
Variable	[CR][LF]	Sentence terminator	[CR][LF]

Example:

$ACPA,932,256586.00,43A00FF,2,0,0.1037,0.1781,0.2375,0.2370,0.1569,0.0868,0.0060,0.1335,0.4221,0.3596,0.0761,
0.0028,3.3010,0.9200,0.1330,0.1330,0.9200,3.3010,2.0630,0.7210,0.1060,0.1060,0.7210,2.0630,1.0000,0.2030,0.0050,
0.0300,0.0100,1,0.0992,0.1720,0.2353,0.2387,0.1636,0.0911,0.0065,0.1300,0.4065,0.3635,0.0898,0.0037,3.3010,0.920
0,0.1330,0.1330,0.9200,3.3010,2.0630,0.7210,0.1060,0.1060,0.0721,2.0630,1.0000,0.2030,0.0050,0.0300,0.0100*70

$ACPB

Format: Message ID = 75
Message byte count = 32 + (r * 120) where r is the # of RF decks.

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Week number	4	Integer	weeks	12
3	Time of week	8	Double	seconds	16
4	Receiver status	4	Integer	Receiver self-test status (see *Table 9*)	24
5	No. of RF decks	4	Integer	number of receiver RF decks	28
6	RF Type	4	Integer	0 = GPS_L1, 1 = GPS_L2, all others are reserved for future use.	32
7	Gaussian Bin Value 1	4	Float		36
8	Gaussian Bin Value 2	4	Float		40
9	Gaussian Bin Value 3	4	Float		44
10	Gaussian Bin Value 4	4	Float		48
11	Gaussian Bin Value 5	4	Float		52
12	Gaussian Bin Value 6	4	Float		56
13	Jammed Bin Value 1	4	Float		60
14	Jammed Bin Value 2	4	Float		64
15	Jammed Bin Value 3	4	Float		68
16	Jammed Bin Value 4	4	Float		72
17	Jammed Bin Value 5	4	Float		76
18	Jammed Bin Value 6	4	Float		80
19	Gaussian Bin Weight 1	4	Float		84
20	Gaussian Bin Weight 2	4	Float		88
21	Gaussian Bin Weight 3	4	Float		92
22	Gaussian Bin Weight 4	4	Float		96
23	Gaussian Bin Weight 5	4	Float		100
24	Gaussian Bin Weight 6	4	Float		104
25	Jammed Bin Weight 1	4	Float		108
26	Jammed Bin Weight 2	4	Float		112
27	Jammed Bin Weight 3	4	Float		116
28	Jammed Bin Weight 4	4	Float		120
29	Jammed Bin Weight 5	4	Float		124
30	Jammed Bin Weight 6	4	Float		128
31	Gaussian Control Variance	4	Float		132
32	Jammed Control Variance	4	Float		136
33	Jam Detect Level	4	Float		140
34	Jam Enter Level	4	Float		144
35	Jam Exit Level	4	Float		148
18...29	Next RF Deck if required	120			152

$AGCA/B AGC AND A/D INFORMATION

The AGCA/B log contains AGC related information. This information includes information about the AGC gain, A/D bin values and AGC control statistics.

$AGCA

Structure:

```
$AGCA | week | seconds | rec_status | # RF
RF_type | bin 1 | bin 2 | bin 3 | bin 4 | bin 5 | bin 6
Gain | 1ms_AGC | 1ms_Chan | bins_rms | gof_bins
:
next RF deck if required | *xx | [CR][LF]
```

Field #	Field type	Data Description	Example
1	$AGCA	Log header	$AGCA
2	week	GPS week number	932
3	seconds	GPS seconds into the week	256542.00
4	rec_status	Self-test status of the receiver (see *Table 9*)	43A00FF
5	# RF	Number of RF decks reported in this message.	2
6	RF_type	0 = GPS_L1, 1 = GPS_L2, all others are reserved for future usage.	0
7	bin 1	A/D Bin 1	0.1022
8	bin 2	A/D Bin 2	0.1813
9	bin 3	A/D Bin 3	0.2380
10	bin 4	A/D Bin 4	0.2363
11	bin 5	A/D Bin 5	0.1558
12	bin 6	A/D Bin 6	0.0864
13	gain	AGC Gain	3125
14	1ms_AGC	Estimate of the receiver noise based on an A/D data histogram. 1 ms noise floor calculated using the A/D bin values.	1557822.00
15	1ms_Chan	Estimate of the receiver noise that is either an AGC estimate or measured power in a 1 ms post correlation accumulation from a searching channel.	1557822.00
16	bins_rms	Estimate of the variance of the receiver noise based on time smoothed A/D data histograms. Root mean squared value of the A/D bins calculated using the expected values as truth.	0.9957
17	gof_stat	The chi-squared test statistic estimating the goodness of fit between a current A/D data histogram to an A/D data histogram that was obtained at start-up by averaging several A/D histogram samples. Goodness of Fit test statistic for the A/D bins.	0.000008
18...29	….	Next RF Deck if required.	….
Variable	*xx	Checksum	*66
Variable	[CR][LF]	Sentence terminator	[CR][LF]

Example:
$AGCA,932,256542.00,43A00FF,2,0,0.1022,0.1813,0.2380,0.2363,0.1558,0.0864,3125,1557822.00,1557822.00,0.9957,0.000008,1,0.0973,0.1722,0.2353,0.2406,0.1637,0.0909,3361,1552060.00,1552060.00,0.9935,0.000042*66

$AGCB

Format: Message ID = 74
Message byte count = 32 + (r * 48) where r is the # of RF decks.

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Week number	4	Integer	weeks	12
3	Time of week	8	Double	seconds	16
4	Receiver status	4	Integer	(See *Table 9*)	24
5	No. of RF decks	4	Integer	number of receiver RF decks	28
6	RF Type	4	Integer	0 = GPS_L1, 1 = GPS_L2, all others are reserved for future usage.	32
7	A/D Bin 1 (Most Neg.)	4	Float	percentage	36
8	A/D Bin 2	4	Float	percentage	40
9	A/D Bin 3	4	Float	percentage	44
10	A/D Bin 4	4	Float	percentage	48
11	A/D Bin 5	4	Float	percentage	52
12	A/D Bin 6 (Most Pos.)	4	Float	percentage	56
13	AGC Gain	4	Integer	0 to 99,999 (0 is max)	60
14	1ms Noise Floor From AGC	4	Float		64
15	1ms Noise Floor From Channels	4	Float		68
16	A/D Bins RMS	4	Float		72
17	A/D Goodness of Fit Test Statistic	4	Float		76
18...29	Next RF Deck if required	48			80

ALMA/B DECODED ALMANAC

This log contains the decoded almanac parameters from sub-frames 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.

The Ionospheric Model parameters (IONA/B) and the UTC Time parameters (UTCA/B) are also provided, following the last almanac record. These cannot be logged individually or independently of the ALMA/B message. They are, however, described separately under their respective names.

For more information on Almanac data, refer to the GPS SPS Signal Specification.

ALMA

Structure:

$ALMA	Prn	ecc	seconds	week	rate-ra	ra	w	M_O	af_0	af_1	cor-mean-motion

A	Incl-angle	health-4	health-5	health-alm	*xx	[CR][LF]

Field #	Field type	Data Description	Example
1	$ALMA	Log header	$ALMA
2	prn	Satellite PRN number for current message	1
3	ecc	Eccentricity	3.55577E-003
4	seconds	Almanac reference time, seconds into the week	32768
5	week	Almanac reference week (GPS week number)	745
6	rate-ra	Rate of right ascension, radians	-7.8860E-009
7	ra	Right ascension, radians	-6.0052951E-002
8	w	Argument of perigee, radians	-1.1824254E+000
9	M_O	Mean anomaly, radians	1.67892137E+000
10	a_{f0}	Clock aging parameter, seconds	-1.8119E-005
11	a_{f1}	Clock aging parameter, seconds/second	-3.6379E-012
12	cor-mean-motion	Corrected mean motion, radians/second	1.45854965E-004
13	A	Semi-major axis, metres	2.65602281E+007
14	incl-angle	Angle of inclination, radians	9.55576E-001
15	health-4	Anti-spoofing and SV config from sub-frame 4, page 25	1
16	health-5	SV health, 6 bits/SV (sub-frame 4 or 5, page 25)	0
17	health-alm	SV health, 8 bits (almanac)	0
18	*xx	Checksum	*20
19	[CR][LF]	Sentence terminator	[CR][LF]
:			
1 - 19	$ALMA	Last satellite PRN almanac message	

1 - 11	$IONA	Ionospheric Model Parameters	
1 - 11	$UTCA	UTC Time Parameters	

Example:

$ALMA,**1**,3.55577E-003,32768,745,-7.8860E-009,-6.0052951E-002,-1.1824254E+000,
1.67892137E+000,-1.8119E-005,-3.6379E-012,1.45854965E-004,2.65602281E+007,
9.55576E-001,1,0,0*20[CR][LF]
:
$ALMA,**31**,4.90665E-003,32768,745,-8.0460E-009,3.05762855E+000,6.14527459E-001,
1.69958217E+000,6.67572E-006,3.63797E-012,1.45861888E-004,2.65593876E+007,
9.61664E-001,1,0,0*13[CR][LF]

ALMB

Format: Message ID = 18 Message byte count = 120

Field #	Field Type		Bytes	Format	Units	Offset
1 (header)	Sync		3			0
	Checksum		1			3
	Message ID		4			4
	Message byte count		4			8
2	Satellite PRN number		4	integer	dimensionless	12
3	Eccentricity		8	double	dimensionless	16
4	Almanac ref. time		8	double	seconds	24
5	Almanac ref. week		4	integer	weeks	32
6	Omegadot - rate of right ascension		8	double	radians/second	36
7	Right ascension		8	double	radians	44
8	Argument of perigee	w	8	double	radians	52
9	Mean anomaly	Mo	8	double	radians	60
10	Clock aging parameter	a_{f0}	8	double	seconds	68
11	Clock aging parameter	a_{f1}	8	double	seconds/second	76
12	Corrected mean motion		8	double	radians/second	84
13	Semi-major axis	A	8	double	metres	92
14	Angle of inclination		8	double	radians	100
15	Sv health from sub-frame 4		4	integer		108
16	Sv health from sub-frame 5		4	Integer		112
17	Sv health from almanac		4	Integer		116

CDSA/B COMMUNICATION AND DIFFERENTIAL DECODE STATUS

The MSAS / NES / UPC receiver maintains a running count of a variety of status indicators of the data link. This log outputs a report of those indicators.

Parity and framing errors will occur if poor transmission lines are encountered or if there is an incompatibility in the data protocol. If errors occur, you may need to confirm the bit rate, number of data bits, number of stop bits, and parity of both the transmit and receiving ends. Overrun errors will occur if more characters are sent to the UART that can be removed by the on-board microprocessor.

CDSA

Structure:

$CDSA	week	seconds	xon1	cts1	parity1	overrun1	framing1	rx1	tx1
Xon2	cts2	parity2	overrun2	framing2	rx2	tx2			
Rtca crc	rtcaa chk	rtca good	rtcm par	rtcma chk	rtcm good	dcsa chk	dcsa good	dcsb chk	dcsb good
Res'd	res'd	res'd	*xx	[CR][LF]					

Field #	Field type	Data Description	Example
1	$CDSA	Log header	$CDSA
2	week	GPS week number	787
3	seconds	GPS seconds into the week	500227
4	xon1	Flag to indicate that the com1 is using XON/XOFF handshaking protocol and port has received an XOFF and will wait for an XON before sending any more data.	0
5	cts1	Flag to indicate that com1 is using CTS/RTS handshake protocol and CTS line port has been asserted. The port will wait for the line to de-assert before sending any more data.	0
6	parity1	A running count of character parity errors from the UART of COM1	0
7	overrun1	A running count of UART buffer overrun errors of COM1	0
8	framing1	A running count of character framing error from the UART of COM1	0
9	rx1	A running count of the characters received from COM1	0
10	tx1	A running count of the characters sent out COM1	9
11	xon2	Flag to indicate that the COM2 is using XON/XOFF handshaking protocol and port has received an XOFF and will wait for an XON before sending any more data.	0
12	cts2	Flag to indicate that COM2 is using CTS/RTS handshake protocol and CTS line port has been asserted. The Port will wait for the line to de-assert before sending any more data.	0
13	parity2	A running count of character parity errors from the UART of COM2	0
14	overrun2	A running count of UART buffer overrun errors of COM2	0
15	framing2	A running count of character framing error from the UART of COM2	0
16	rx2	A running count of the characters received from COM2	0
17	tx2	A running count of the characters sent out COM2	9
18	rtcacrc †	A running count of RTCA CRC failures	0
19	rtcaachk †	A running count of invalid ASCII $RTCA,....,*xx records indicating that the ASCII checksum "xx" failed.	0
20	rtcagood †	A running count of RTCA records that pass error checking	0
21	rtcmpar †	A running count of 30 bit RTCM parity failures	0
22	rtcmachk †	A running count of invalid ASCII $RTCM,....,*xx records indicating that the ASCII checksum "xx" failed.	0
23	rtcmgood †	A running count of RTCM records that pass error checking	0
24	dcsachk †	A running count of invalid ASCII $DCSA,....,*xx records	0
25	dcsagood †	A running count of DCSA records that pass error checking	0
26	dcsbchk †	A running count of invalid binary DCSB records	0
27	dcsbgood †	A running count of DCSB records that pass error checking	0
28		Reserved for future use	0
29		Reserved for future use	0
30		Reserved for future use	0
31	*xx	Checksum	*33
32	[CR][LF]	Sentence terminator	[CR][LF]

Note: † Fields 18-27 will be 0 if differential corrections are not used.

Example:

$CDSA,787,500227,0,0,0,0,0,0,9,0,0,0,0,0,0,9,0,0,0,0,0,0,0,0,0,0,0,0,0*33[CR][LF]

CDSB

Format: Message ID = 39 Message byte count = 128

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer		8
2	Week number	4	integer	weeks	12
3	Time of week	4	integer	seconds	16
4	Xon COM1	4	integer	1 or 0	20
5	CTS COM1	4	integer	1 or 0	24
6	Parity errors COM1	4	integer	Total count	28
7	Overrun errors COM1	4	integer	Total count	32
8	Framing error COM1	4	integer	Total count	36
9	Bytes received in COM1	4	integer	Total count	40
10	Bytes sent out COM1	4	integer	Total count	44
11	Xon COM2	4	integer	1 or 0	48
12	CTS COM2	4	integer	1 or 0	52
13	Parity errors COM2	4	integer	Total count	56
14	Overrun errors COM2	4	integer	Total count	60
15	Framing error COM2	4	integer	Total count	64
16	Bytes received in COM2	4	integer	Total count	68
17	Bytes sent out COM2	4	integer	Total count	72
18	RTCA CRC fails †	4	integer	Total count	76
19	RTCAA checksum fails †	4	integer	Total count	80
20	RTCA records passed †	4	integer	Total count	84
21	RTCM parity fails †	4	integer	Total count	88
22	RTCMA checksum fails †	4	integer	Total count	92
23	RTCM records passed †	4	integer	Total count	96
24	DCSA checksum fails †	4	integer	Total count	100
25	DCSA records passed †	4	integer	Total count	104
26	DCSB checksum fails †	4	integer	Total count	108
27	DCSB records passed †	4	integer	Total count	112
28	Reserved	4	integer	Total count	116
29	Reserved	4	integer	Total count	120
30	Reserved	4	integer	Total count	124

† Fields 18-27 will be 0 if differential corrections are not used.

CLKA/B RECEIVER CLOCK OFFSET DATA

This log is used to monitor the state of the receiver time. Its values will depend on the CLOCKADJUST command. If CLOCKADJUST is enabled, then the offset and drift times will approach zero. If not enabled, then the offset will grow at the oscillator drift rate. Disabling CLOCKADJUST and monitoring the CLKA/B log will allow you to determine the error in your GPSCard 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 one must subtract the clock offset (field #4 of the CLKA log) from the reported GPS time.

Field #6 is the output of a Gauss-Markov Selective Availability clock dither estimator. This value reflects both the collective SA-induced short-term drift of the satellite clocks, when SA is active, as well as any range bias discontinuities that would normally affect the clock model's offset and drift states. With SA off, this value is much smaller than the example shown.

The CLKA/B log is not synchronous to the 1PPS.

Clock model status is not related to clock type. There is no effect on the validity of the clock model data when the CLOCKADJUST command is set to DISABLE. The clock model is valid when the ‘cm status’ is equal to 0. The receiver must be tracking at least four satellites for the clock model to make the transition from an invalid state (-20 to -1) to a valid state (0). The clock model will remain valid for a short period if the number of satellites being tracked drops below four.

The internal units of the clock model’s three states (offset, drift and GM state) are meters, meters per second, and meters. When scaled to time units for the output log, these become seconds, seconds per second, and seconds, respectively.

CLKA

Structure:

$CLKA	week	seconds	offset	drift	G-M state	offset std	drift std	cm status
*xx	[CR][LF]							

Field #	Field type	Data Description	Example
1	$CLKA	Log header	$CLKA
2	week	GPS week number	637
3	seconds	GPS seconds into the week	511323.00
4	offset	Receiver clock offset (s). 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)	-4.628358547E-003
5	drift	Receiver clock drift (s/s). A positive drift implies that the receiver clock is running faster than GPS Time.	-2.239751396E-007
6	G-M state	The output value of the Gauss-Markov Selective Availability clock dither estimator (s).	2.061788299E-006
7	offset std	Standard deviation of receiver clock offset (s).	5.369997167E-008
8	drift std	Standard deviation of receiver drift (s/s)	4.449097711E-009
9	cm status	Receiver Clock Model Status (0 = valid, -20 to -1 imply that the model is in the process of stabilization)	0
10	*xx	Checksum	*7F
11	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$CLKA,841,499296.00,9.521895494E-008,-2.69065747E-008,2.061788299E-006,
9.642598169E-008,8.685638908E-010,0*4F
```

CLKB

Format: Message ID = 02 Message byte count = 68

Field #	Field Type	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	s	16
4	Clock offset	8	double	s	24
5	Clock drift	8	double	s/s	32
6	SA Gauss-Markov state	8	double	s	40
7	StdDev clock offset	8	double	s	48
8	StdDev clock drift	8	double	s/s	56
9	Clock model status	4	integer	0 = good, -1 to -20 = bad	64

DOPA/B DILUTION OF PRECISION

The dilution of precision data is calculated using the geometry of only those satellites that are currently being tracked and used in the position solution by the GPSCard and updated once every 60 seconds or whenever a change in the constellation occurs. Therefore, the total number of data fields output by the log is variable, depending on the number of satellites being tracked. Twelve is the maximum number of satellite PRNs contained in the list.

NOTE: Satellites that are locked out using the LOCKOUT command, although still shown in the PRN list), are significantly de-weighted in the DOP calculation.

DOPA

Structure:

`$DOPA` `week` `sec` `gdop` `pdop` `htdop` `hdop` `tdop` `#sats` `prns` `*xx` `[CR][LF]`

Field #	Field type	Data Description	Example
1	$DOPA	Log header	$DOPA
2	week	GPS week number	637
3	sec	GPS seconds into the week	512473.00
4	gdop	Geometric dilution of precision - assumes 3-D position and receiver clock offset (all 4 parameters) are unknown	2.9644
5	pdop	Position dilution of precision - assumes 3-D position is unknown and receiver clock offset is known	2.5639
6	htdop	Horizontal position and time dilution of precision	2.0200
7	hdop	Horizontal dilution of precision	1.3662
8	tdop	Time dilution of precision - assumes 3-D position is known and only receiver clock offset is unknown	1.4880
9	#sats	Number of satellites used in position solution (0-12)	6
10...	prns	PRN list of SV PRNs tracking (1-32), null field until first position solution available	18,6,11,2,16,19
variable	*xx	Checksum	*29
variable	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$DOPA,637,512473.00,2.9644,2.5639,2.0200,1.3662,1.4880,6,18,6,11,2,16,19
*29[CR][LF]
```

DOPB

Format: Message ID = 07 Message byte count = 68+(sats*4)

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	gdop	8	double		24
5	pdop	8	double		32
6	htdop	8	double		40
7	hdop	8	double		48
8	tdop	8	double		56
9	Number of satellites used	4	integer		64
10	1st PRN	4	integer		68
11...	Next satellite PRN Offset = 68 + (sats*4) where sats = 0 to (number of sats-1)				

ETSA/B EXTENDED TRACKING STATUS

These logs provide channel tracking status information for each of the GPSCard parallel channels.

NOTE: This log is intended for status display only; since some of the data elements are not synchronized together, they are not to be used for measurement data. Please use the *RGEA/B/C, SATA/B,* and *SVDA/B* logs to obtain synchronized data for post processing analysis.

If both the L1 and L2 signals are being tracked for a given PRN, two entries with the same PRN will appear in the range logs. As shown in *Table 7* (Channel Tracking Status word), these entries can be differentiated by bit 19, which is set if there are multiple observables for a given PRN, and bit 20, which denotes whether the observation is for L1 or L2. This is to aid in parsing the data.

ETSA

Structure:

```
$ETSA week seconds sol status # obs
prn ch tr-status dopp C/No residual locktime psr reject code
:
prn ch tr-status dopp C/No residual locktime psr reject code *xx [CR][LF]
```

Field #	Field type	Data Description	Example
1	$ETSA	Log header	$ETSA
2	week	GPS week number	850
3	seconds	GPS seconds into the week (receiver time, not corrected for clock error, CLOCKADJUST enabled)	332087.00
4	sol status	Solution status (see *Table 6*)	0
5	# obs	Number of observations to follow	24
6	prn	Satellite PRN number (1-32) (channel 0)	7
7	ch tr-status	Hexadecimal number indicating channel tracking status (See *Table 7*)	00082E04
8	dopp	Instantaneous carrier Doppler frequency (Hz)	-613.5
9	C/No	Carrier to noise density ratio (dB-Hz)	54.682
10	residual	Residual from position filter (m)	27.617
11	locktime	Number of seconds of continuous tracking (no cycle slips)	12301.4
12	psr	Pseudorange measurement (m)	20257359.57
13	reject code	Indicates whether the range is valid (code = 0) or not (see *Table 8*)	0
14-21 .. 94-101	.. .. ..	next observation .. last observation	
102	*xx	Checksum	*19
103	[CR][LF]	Sentence terminator	[CR][LF]

Example (carriage returns have been added between observations for clarity):

```
$ETSA,850,332087.00,0,24,
7,00082E04,-613.5,54.682,27.617,12301.4,20257359.57,0,
7,00582E0B,-478.1,46.388,0.000,11892.0,20257351.96,13,
5,00082E14,3311.2,35.915,1.037,1224.4,24412632.47,0,
5,00582E1B,2580.4,39.563,0.000,1186.7,24412629.40,13,
9,00082E24,1183.1,53.294,-29.857,7283.8,21498303.67,0,
9,00582E2B,921.9,44.422,0.000,7250.2,21498297.13,13,
2,00082E34,-2405.2,50.824,-20.985,19223.6,22047005.47,0,
2,00582E3B,-1874.1,41.918,0.000,19186.7,22046999.44,13,
4,00082E44,3302.8,47.287,7.522,3648.1,22696783.36,0,
4,00582E4B,2573.6,37.341,0.000,3191.2,22696778.15,13,
14,00082E54,2132.7,41.786,-22.388,541.3,25117182.07,0,
14,00582E5B,1661.7,33.903,0.000,500.7,25117179.63,13,
26,00082E64,-3004.3,43.223,2.928,14536.2,25074382.19,0,
26,00582E6B,-2340.9,33.019,0.000,14491.7,25074378.01,13,
15,00082E74,-3037.7,43.669,0.508,12011.5,24104788.88,0,
15,00582E7B,-2367.0,34.765,0.000,11842.4,24104781.53,13,
24,00082E84,3814.0,37.081,7.511,95.7,25360032.49,0,
24,00582E8B,2972.0,24.148,0.000,5.2,25360030.13,13,
28,00082A90,-9800.9,0.000,0.000,0.0,0.00,9,
28,00382A90,-7637.0,0.000,0.000,0.0,0.00,9,
3,000822A0,-3328.3,0.000,0.000,0.0,0.00,9,
3,005828A0,-2593.5,0.000,0.000,0.0,0.00,9,
27,000822B0,-3851.7,0.000,0.000,0.0,0.00,9,
27,005828B0,-3001.7,0.000,0.000,0.0,0.00,9
*41[CR][LF]
```

ETSB

Format: Message ID = 48
Message byte count = 32 + (n*52) where n is number of channels in receiver

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer		8
2	Week number	4	integer	weeks	12
3	Time of week	8	double	seconds	16
4	Solution status	4	integer	(See *Table 6*)	24
5	No. of channels	4	integer	number of channels in receiver	28
6	PRN number (chan 0)	4	integer		32
7	Channel tracking status	4	integer	(See *Table 7*)	36
8	Doppler	8	double	Hz	40
9	C/N_0 (db-Hz)	8	double	db/Hz	48
10	Residual	8	double	metres	56
11	Locktime	8	double	seconds	64
12	Pseudorange	8	double	metres	72
13	Rejection code	4	integer	(See *Table 8*)	80
14 ...	Offset = 32 + (chan * 52) where chan varies from 0 - highest channel number				

Table 6 GPSCard Solution Status

Value	Description
0	Solution computed
1	Insufficient observations
2	No convergence
3	Singular AtPA Matrix
4	Covariance trace exceeds maximum (trace > 1000 m)
5	Test distance exceeded (maximum of 3 rej if distance > 10 Km)
6	Not yet converged from cold start

Higher numbers are reserved for future use

Table 7 Channel Tracking Status Bits

N 7 | N 6 | N 5 | N 4 | N 3 | N 2 | N 1 | N 0 <- <- Nibble Number

Bit	Description	Range Values	Hex.
lsb = 0	Tracking state	0 - 11 See below	1
1			2
2			4
3			8
4	Channel number	0 - n (0 = first, n = last) (n depends on GPSCard model)	10
5			20
6			40
7			80
8			100
9	Phase lock flag	1 = Lock, 0 = Not locked	200
10	Parity known flag	1 = Known, 0 = Not known	400
11	Code locked flag	1 = Lock, 0 = Not locked	800
12	Correlator spacing	0 - 7 See below	1000
13			2000
14			4000
15	Satellite system	0=GPS 3= Pseudolite GPS 1=GLONASS 4-7 Reserved 2=WAAS	8000
16			10000
17			20000
18	Antenna	1 = Secondary, 0 = Primary	40000
19	Grouping	1 = Grouped, 0 = Not grouped	80000
20	Frequency	1 = L2, 0 = L1	100000
21	Code type	0 = C/A 2 = P-codeless 1 = P 3 = Reserved	200000
22			400000
23	Forward error correction	1 = FEC enabled, 0 = no FEC	800000
24 : 29	Reserved		
30	External range	1 = Ext. range, 0 = Int. range	
31	Channel assignment	1 = Forced, 0 = Automatic	

Table 7, Bits 0 - 3 : Channel Tracking State

State	Description	State	Description
0	L1 Idle	6	L1 Steering
1	L1 Sky search	7	L1 Frequency-lock loop
2	L1 Wide frequency band pull-in	8	L2 Idle
3	L1 Narrow frequency band pull-in	9	L2 P-code alignment
4	L1 Phase-lock loop	10	L2 Search
5	L1 Re-acquisition	11	L2 Phase-lock loop

Higher numbers are reserved for future use

Table 7, Bits 12-14 : Correlator Spacing

State	Description
0	Unknown: this only appears in versions of software previous to x.4x, which didn't use this field
1	Standard correlator: spacing = 1 chip
2	Narrow Correlator: spacing < 1 chip
3	MET: uses Early-Late Slope Technique to improve Narrow Correlator performance in reducing errors due to multipath
4	Reserved for future use
5	MEDLL: decomposes the incoming signal into direct-path and reflected-path components to reduce errors due to multipath

Higher numbers are reserved for future use

Table 8 Range Reject Codes

Value	Description
0	Observations are good
1	Bad satellite health is indicated by ephemeris data
2	Old ephemeris due to data not being updated during last 3 hours
3	Eccentric anomaly error during computation of the satellite's position
4	True anomaly error during computation of the satellite's position
5	Satellite coordinate error during computation of the satellite's position
6	Elevation error due to the satellite being below the cutoff angle
7	Misclosure too large due to excessive gap between estimated and actual positions
8	No differential correction is available for this particular satellite
9	Ephemeris data for this satellite has not yet been received
10	Invalid IODE due to mismatch between differential stations
11	Locked Out: satellite is excluded by user (LOCKOUT command)
12	Low Power: satellite rejected due to low signal/noise ratio
13	L2 measurements are not currently used in the filter

Higher numbers are reserved for future use

FRMA/B FRAMED RAW NAVIGATION DATA

This message contains the raw framed navigation data. An individual message is sent for each PRN being tracked. The message is updated with each new frame, therefore it is best to log the data with the 'onnew' trigger activated.

FRMA

`$FRMA` `week` `seconds` `prn` `cstatus` `# of bits` `framed raw data`

`*xx` `[CR][LF]`

Field #	Field type	Data Description	Example
1	$FRMA	Log header	$FRMA
2	week	GPS week number	845
3	seconds	GPS seconds into the week	238623.412
4	prn	PRN of satellite from which data originated	120
5	cstatus	Channel Tracking Status	80811F14
6	# of bits	Number of bits transmitted in the message. 250 for WAAS, 300 for GPS and 85 for GLONASS.	250
7	framed raw data	One field of raw framed navigation data.	9AFE5354656C2053796E63 68726F6E696369747920202 02020202020B0029E40*3F
8	*xx	Checksum	*42
9	[CR][LF]	Sentence terminator	[CR][LF]

FRMB

Format: Message ID = 54 Message byte count = 40

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	PRN number	4	integer	1-999	24
5	Channel Status	4	integer	n/a	28
6	Number of Bits	4	integer	250 for WAAS 300 for GPS 85 for GLONASS	32
7	Data Sub-frame	4 [1]	char	N/A	36

[1] Up to 3 bytes of padding are added to the end of the data sub-frame to ensure 4-byte alignment.

IONA/B IONOSPHERIC MODEL PARAMETERS

The Ionospheric Model parameters (IONA/B) are provided following the last almanac records when an ALMA/B message has been logged. The IONA/B message cannot be logged individually or independently of the ALMA/B message.

For more information on Almanac data, refer to the GPS SPS Signal Specification.

IONA

Structure:

$IONA	act	a1ot	a2ot	a3ot	bct	b1ot	b2ot	b3ot	*xx	[CR][LF]

Field #	Field type	Data Description	Example
1	$IONA	Log header	$IONA
2	act	Alpha constant term, seconds	1.0244548320770265E-008
3	a1ot	Alpha 1st order term, sec/semicircle	1.4901161193847656E-008
4	a2ot	Alpha 2nd order term, sec/(semic.)^2	-5.9604644775390610E-008
5	a3ot	Alpha 3rd order term, sec/(semic.)^3	-1.192092895507812E-007
6	bct	Beta constant term, seconds	8.8064000000000017E+004
7	b1ot	Beta 1st order term, sec/semicircle	3.2768000000000010E+004
8	b2ot	Beta 2nd order term, sec/(semic.)^2	-1.966080000000001E+005
9	b3ot	Beta 3rd order term, sec/(semic.)^3	-1.966080000000001E+005
10	*xx	Checksum	*02
11	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$IONA,1.0244548320770265E-008,1.4901161193847656E-008,-5.960464477539061E-008,
-1.192092895507812E-007,8.8064000000000017E+004,3.2768000000000010E+004,
-1.966080000000001E+005,-1.966080000000001E+005*02[CR][LF]
```

IONB

Format Message ID = 16 Message byte count = 76

Field #	Field Type	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Alpha constant term	8	double	seconds	12
3	Alpha 1st order term	8	double	sec/semicircle	20
4	Alpha 2nd order term	8	double	sec/(semic.)^2	28
5	Alpha 3rd order term	8	double	sec/(semic.)^3	36
6	Beta constant term	8	double	seconds	44
7	Beta 1st order term	8	double	sec/semic	52
8	Beta 2nd order term	8	double	sec/(semic.)^2	60
9	Beta 3rd order term	8	double	sec/(semic.)^3	68

POSA/B COMPUTED POSITION

This log will contain the last valid position and time calculated referenced to the antenna phase centre. The position is in geographic coordinates in degrees based on your specified datum (default is WGS-84). The height is referenced to mean sea level. The receiver time is in GPS weeks and seconds into the week. The estimated standard deviations of the solution and current filter status are also included.

POSA

Structure:

```
$POSA | week | seconds | lat | lon | hgt | undulation | datum ID | lat std | lon std
hgt std | sol status | *xx | [CR][LF]
```

Field #	Field type	Data Description	Example
1	$POSA	Log header	$POSA
2	week	GPS week number	637
3	seconds	GPS seconds into the week	511251.00
4	lat	Latitude of position in current datum, in degrees (DD.dddddddd). A negative sign implies South latitude	51.11161847
5	lon	Longitude of position in current datum, in degrees (DDD.dddddddd). A negative sign implies West longitude	-114.03922149
6	hgt	Height of position in current datum, in metres above mean sea level (MSL)	1072.436
7	undulation	Geoidal separation, in metres, where positive is above spheroid and negative is below spheroid	-16.198
8	datum ID	Current datum ID #	61
9	lat std	Standard deviation of latitude solution element, in metres	26.636
10	lon std	Standard deviation of longitude solution element, in metres	6.758
11	hgt std	Standard deviation of height solution element, in metres	78.459
12	sol status	Solution status as listed in *Table 6*	0
13	*xx	Checksum	*12
14	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$POSA,637,511251.00,51.11161847,-114.03922149,1072.436,-16.198,61,26.636,
6.758,78.459,0*12[CR][LF]
```

POSB

Format: Message ID = 01 Message byte count = 88

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	Latitude	8	double	degrees (+ is North, - is South)	24
5	Longitude	8	double	degrees (+ is East, - is West)	32
6	Height	8	double	metres with respect to MSL	40
7	Undulation	8	double	metres	48
8	Datum ID	4	integer		56
9	StdDev of latitude	8	double	metres	60
10	StdDev of longitude	8	double	metres	68
11	StdDev of height	8	double	metres	76
12	Solution status	4	integer		84

RBTA/B SATELLITE BROADCAST DATA: RAW BITS

This message contains the satellite broadcast data in raw bits before FEC decoding or any other processing. An individual message is sent for each PRN being tracked. For a given satellite, the message number increments by one each time a new message is generated. This data matches the SBTA/B data if the message numbers are equal. The data must be logged with the 'onnew' trigger activated to prevent loss of data.

RBTA

Structure:

```
$RBTA | week | seconds | prn | ch tr-status | message # | # of bits
raw bits | *xx | [CR][LF]
```

Field #	Field type	Data Description	Example
1	$RBTA	Log header	$RBTA
2	week	GPS week number	883
3	seconds	GPS seconds into the week	413908.000
4	prn	PRN of satellite from which data originated	115
5	ch tr-status	Channel Tracking Status (see *Table 7*)	80812F14
6	message #	Message sequence number	119300
7	# of bits	Number of bits transmitted in the message. At present, always equals 256 bits.	256
8	raw bits	256 bits compressed into a 32 bytes. Hence, 64 hex characters are output.	30FB30FB30FB30F878DA62194000F18322931B 9EBDBC1CBC9324B68FBDAEBE8A
9	*xx	Checksum	*42
10	[CR][LF]	Sentence terminator	[CR][LF]

RBTB

Format: Message ID = 52 Message byte count = 72

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	PRN number	4	integer	1-999	24
5	Channel Tracking Status	4	integer	n/a	28
6	Message #	4	integer	n/a	32
7	# of Bits	4	integer	n/a	36
8	Raw Bits	32	char	n/a	40

RCCA RECEIVER CONFIGURATION

This log outputs a list of all current GPSCard command settings. Observing this log is a good way to monitor the receiver's configuration settings. If these messages are logged directly after powering up the receiver, they will contain the default configuration settings.

NOTES: 1. The RCCA log output from each of the L1-C/A, L1/L2 I, and L1/L2 II ports will be different. This is because each GPSCard which controls a port has a unique configuration.

2. Each line is followed by a carriage return ([CR][LF]).

Caution! The receiver may lose lock on MSAS signals while logging RCCA records. As a result, data may be lost while RCCA is logging.

RCCA

Example (from the L1/L2 I port):

```
$RCCA,COM1,9600,N,8,1,N,OFF,ON*2B
$RCCA,COM1_DTR,HIGH*70
$RCCA,COM1_RTS,HIGH*67
$RCCA,ACCEPT,COM1,COMMANDS*5B
$RCCA,COM2,9600,N,8,1,N,OFF,ON*28
$RCCA,COM2_DTR,HIGH*73
$RCCA,COM2_RTS,HIGH*64
$RCCA,ACCEPT,COM2,COMMANDS*58
$RCCA,UNDULATION,TABLE*56
$RCCA,DATUM,WGS84*15
$RCCA,USERDATUM,6378137.000,298.257223563,0.000,0.000,0.000,0.000,0.000,0.000,0.000*6A
$RCCA,SETNAV,DISABLE*5C
$RCCA,MAGVAR,0.000*33
$RCCA,DYNAMICS,AIR*4F
$RCCA,UNASSIGNALL*64
$RCCA,UNLOCKOUTALL*20
$RCCA,RESETHEALTHALL*37
$RCCA,UNFIX*73
$RCCA,ANTENNAPOWER OFF*50
$RCCA,SETDGPSID,ALL*1D
$RCCA,RTCMRULE,6CR*32
$RCCA,RTCM16T,*48
$RCCA,CSMOOTH,20.00,20.00*7E
$RCCA,ECUTOFF,0.00*45
$RCCA,FREQUENCY_OUT,DISABLE*12
$RCCA,EXTERNALCLOCK,OCXO*5D
$RCCA,CLOCKADJUST,DISABLE*12
$RCCA,SETTIMESYNC,ENABLE*42
$RCCA,SETL1OFFSET,0.000000*3F
$RCCA,MESSAGES,COM1,ON*56
$RCCA,MESSAGES,COM2,OFF*1B
$RCCA,MESSAGES,CONSOLE,ON*71
$RCCA,DGPSTIMEOUT,60.00,120.00*51
$RCCA,POSAVE,DISABLE*59
$RCCA,CONFIG,L1L2*1A
$RCCA,DIFF_PROTOCOL,DISABLED*47
$RCCA,LOG,COM1,POSB,ONTIME,1.00*0E
$RCCA,LOG,COM1,MKPB,ONNEW*6E
```

REPA/B RAW EPHEMERIS

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

Ephemeris data whose time of ephemeris is older than six hours will not be shown.

REPA

Structure:

```
$REPA | prn | subframe1 | subframe2 | subframe3 | *xx | [CR][LF]
```

Field #	Field type	Data Description	Example
1	$REPA	Log header	$REPA
2	prn	PRN of satellite from which data originated	14
3	subframe1	Sub-frame 1 of ephemeris data (60 hex characters)	8B09DC17B9079DD7007D5DE404A9B2D 04CF671C6036612560000021804FD
4	subframe2	Sub-frame 2 of ephemeris data (60 hex characters)	8B09DC17B98A66FF713092F12B359D FF7A0254088E1656A10BE2FF125655
5	subframe3	Sub-frame 3 of ephemeris data (60 hex characters)	8B09DC17B78F0027192056EAFFDF2724C 9FE159675A8B468FFA8D066F743
6	*xx	Checksum	*57
7	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$REPA,14,8B09DC17B9079DD7007D5DE404A9B2D04CF671C6036612560000021804FD,
8B09DC17B98A66FF713092F12B359DFF7A0254088E1656A10BE2FF125655,
8B09DC17B78F0027192056EAFFDF2724C9FE159675A8B468FFA8D066F743*57[CR][LF]
```

REPB

Format: Message ID = 14 Message byte count = 108

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	PRN number	4	integer	1-32	12
3-4-5	Ephemeris data	90	char	data [90]	16
	Filler bytes	2	char		106

RGEA/B CHANNEL RANGE MEASUREMENTS

RGEA/B contain the channel range measurements for the currently observed satellites. These logs contain all of the extended tracking status bits. The receiver self-test status word also indicates L2, OCXO and new almanac status.

It is important to ensure that the receiver clock has been set and can be monitored by the bits in the *rec-status* field. Large jumps in range as well as 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 *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 both the L1 and L2 signals are being tracked for a given PRN, two entries with the same PRN will appear in the range logs. As shown in *Table 7* for the Channel Tracking Status word, these entries can be differentiated by bit 19, which is set if there are multiple observables for a given PRN, and bit 20, which denotes whether the observation is for L1 or L2. This is to aid in parsing the data.

RGEA

Structure:

```
$RGEA  week  seconds  # obs  rec status
prn  psr  psr std  adr  adr std  dopp  S/No  locktime  ch tr-status
:
prn  psr  psr std  adr  adr std  dopp  S/No  locktime  ch tr-status
*xx  [CR][LF]
```

Field #	Field type	Data Description	Example
1	$RGEA	Log header	$RGEA
2	week	GPS week number	845
3	seconds	GPS seconds into the week (receiver time, not corrected for clock error)	511089.00
4	# obs	Number of satellite observations with information to follow	14
5	rec status	Receiver self-test status (see *Table 9*)	000B20FF
6	prn	Satellite PRN number (1-32) of range measurement	4
7	psr	Pseudorange measurement (m)	23907330.296
8	psr std	Pseudorange measurement standard deviation (m)	0.119
9	adr	Carrier phase, in cycles (accumulated Doppler range)	-125633783.992
10	adr std	Estimated carrier phase standard deviation (cycles)	0.010
11	dopp	Instantaneous carrier Doppler frequency (Hz)	3714.037
12	C/N_0	Signal to noise density ratio $C/N_0 = 10[\log_{10}(S/N_0)]$ (dB-Hz)	44.8
13	locktime	Number of seconds of continuous tracking (no cycle slipping)	1928.850
14	ch tr-status	Channel tracking status: hexadecimal number indicating phase lock, channel number and channel state as shown in *Table 7*	82E04
15-23		Next PRN range measurement	
...		Next PRN range measurement	
variable	*xx	Checksum	*30
variable	[CR][LF]	Sentence terminator	[CR][LF]

Example (carriage returns have been added between observations for clarity):

```
$RGEA,845,511089.00,14,000B20FF
4,23907330.296,0.119,-125633783.992,0.010,3714.037,44.8,1928.850,82E04,
4,23907329.623,1.648,-97896180.284,0.013,2894.285,35.0,1746.760,582E0B,
2,21298444.942,0.040,-111954153.747,0.006,-1734.838,54.2,17466.670,82E14,
2,21298444.466,0.637,-87236867.557,0.006,-1351.607,43.3,17557.260,582E1B,
9,22048754.383,0.063,-115874135.450,0.006,2174.006,50.4,5489.100,82E24,
9,22048754.424,0.641,-90291443.071,0.006,1694.238,43.2,5489.100,582E2B,
15,23191384.847,0.261,-121887295.980,0.017,-2069.744,38.0,9924.740,82E34,
15,23191384.663,0.596,-94977002.452,0.010,-1612.587,43.8,9881.830,582E3B,
26,24063897.737,0.199,-126477739.189,0.014,-2654.682,40.3,12821.640,82E54,
26,24063898.913,1.043,-98553986.239,0.013,-2068.380,39.0,12793.280,582E5B,
7,20213352.139,0.037,-106237901.461,0.005,439.943,55.0,10313.040,82E74,
7,20213351.196,0.498,-82782498.454,0.007,343.020,45.4,9977.400,582E7B,
27,24393726.829,0.123,-128229016.323,0.012,-4047.338,44.5,22354.119,82E94,
27,24393728.057,1.805,-99918535.513,0.013,-3153.559,34.2,22301.830,582E9B
*30
```

RGEB

Format: Message ID = 32 Message byte count = 32 + (obs x 44)

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer		8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	s	16
4	Number of observations (obs)	4	integer		24
5	Receiver self-test status	4	integer		28
6	PRN	4	integer		32
7	Pseudorange	8	double	m	36
8	StdDev pseudorange	4	float	m	44
9	Carrier phase – accumulated Doppler range	8	double	cycles	48
10	StdDev – accumulated Doppler range	4	float	cycles	56
11	Doppler frequency	4	float	Hz	60
12	C/N_0	4	float	dB-Hz	64
13	Locktime	4	float	s	68
14	Channel Tracking status	4	integer		72
15...	Next PRN offset = 32 + (obs x 44)				

Table 9 Receiver Self-Test Status Codes

N7 N 6 N 5 N 4 N 3 N 2 N 1 N 0 |<- <- Nibble Number

Bit	Description	Range Values	Hex Value
lsb = 0	ANTENNA	1 = good, 0 = bad	00000001
1	L1 PLL	1 = good, 0 = bad	00000002
2	RAM	1 = good, 0 = bad	00000004
3	ROM	1 = good, 0 = bad	00000008
4	DSP	1 = good, 0 = bad	00000010
5	L1 AGC	1 = good, 0 = bad	00000020
6	COM 1	1 = good, 0 = bad	00000040
7	COM 2	1 = good, 0 = bad	00000080
8	WEEK	1 = not set, 0 = set	00000100
9	NO COARSETIME	1 = not set, 0 = set	00000200
10	NO FINETIME	1 = not set, 0 = set	00000400
11	L1 JAMMER	1 = present, 0 = normal	00000800
12	BUFFER COM 1	1 = overrun, 0 = normal	00001000
13	BUFFER COM 2	1 = overrun, 0 = normal	00002000
14	BUFFER CONSOLE	1 = overrun, 0 = normal	00004000
15	CPU OVERLOAD	1 = overload, 0 = normal	00008000
16	ALMANAC SAVED IN NVM	1 = yes, 0 = no	00010000
17	L2 AGC	1 = good, 0 = bad	00020000
18	L2 JAMMER	1 = present, 0 = normal	00040000
19	L2 PLL	1 = good, 0 = bad	00080000
20	OCXO PLL	1 = good, 0 = bad	00100000
21	SAVED ALMA. NEEDS UPDATE	1 = yes, 0 = no	00200000
22	ALMANAC INVALID	1 = invalid, 0 = valid	00400000
23	POSITION SOLUTION INVALID	1 = invalid, 0 = valid	00800000
24	POSITION FIXED	1 = yes, 0 = no	01000000
25	CLOCK MODEL INVALID	1 = invalid, 0 = valid	02000000
26	CLOCK STEERING DISABLED	1 = disabled, 0 = enabled	04000000
27	RESERVED		
28-31	RESERVED		

GPSCard examples:

OEM2:	All OK = 0000 0000 0000 0000 0000 0000 1111 1111 (binary) = 000000FF (hexadecimal)
MiLLennium:	All OK = 0000 0000 0000 1010 0000 0000 1111 1111 (binary) = 000B00FF (hexadecimal) ; osc. = VCTCXO

Notes:

1. Bit 3: For MSAS / NES / UPC, "ROM" includes all forms of non-volatile memory.
2. Bits 2, 3, 4, 6, 7: these are set only once when the GPSCard is first powered up. All other bits are set by internal test processes each time the RVSB log is output.
3. Bits 12-15: Flag is reset to 0 five minutes after the last overrun/overload condition has occurred.
4. Bits 17-20: These bits are always set to 0 for OEM2 GPSCards

Receiver Status – Detailed Bit Descriptions of Self-Test Word

What follows is a detailed description of each bit setting in the Receiver Self-Test Status word (see *Table 9*). Additional information is also included in *Table 10*, below.

Bit 0 Antenna

1 This bit will be set good if the antenna is drawing the appropriate amount of current from the GPSCard jack.
0 OEM2: If the antenna connections are shorted together, open, or otherwise not an drawing appropriate current, then this bit will be clear (0) indicating a possible antenna port problem.
OEM3: If the antenna connections are shorted together, then this bit will be clear (0) indicating a possible antenna port problem.

Bit 1 L1 PLL
1 When the L1 RF down-converter passes self-test, the bit will be set to 1.
0 If a fault is detected in the L1 RF down-converter, this bit is set to 0.

Bit 2 RAM
1 When this bit is set to 1, the receiver's RAM has passed the self-test requirements.
0 If the bit has been set to 0, then RAM test has failed; please contact NovAtel Customer Service.

Bit 3 ROM (Note: "ROM" includes all forms of non-volatile memory (NVM))
1 When this bit is set to 1, the receiver's ROM test has passed the self test requirements.
0 A zero bit indicates the receiver has failed the ROM test.

Bit 4 DSP
1 This bit will be set to 1 when the digital signal processors (DSP) have passed the self-test requirements.
0 If this bit is set to 0, one or both of the DSP chips has failed self-test; please contact NovAtel Customer Service.

Bit 5 L1 AGC
1 When set to 1, the L1AGC circuits are operating within normal range of control.
0 This bit will be set clear if the L1AGC is operating out of normal range. Failure of this test could be the result of various possibilities, such as: bad antenna LNA, excessive loss in the antenna cable, faulty RF down-converter, or a pulsating or high power jamming signal causing interference. If this bit is continuously set clear, and you cannot identify an external cause for the failed test, please contact NovAtel Customer Service.

Bit 6 COM 1
1 When set to 1, the COM1 UART has passed the self-test requirements.
0 If set to 0, the COM1 UART has failed self-test and cannot be used for reliable communications.

Bit 7 COM 2
1 When set to 1, the COM2 UART has passed the self-test requirements.
0 If set to 0, the COM2 UART has failed self-test and cannot be used for reliable communications.

Bits 8, 9, 10 Week / No Coarsetime / No Finetime

0 These bits indicate the state of the receiver's time and are set only once, generally in the first few minutes of operation, in the presence of adequate numbers of satellite signals to compute position and time.

1 If these bits are not all set to zero, then the observation data, pseudorange, carrier phase, and Doppler measurements may jump as the clock adjusts itself.

Bit 11 L1 Jammer Detection

0 Normal operation is indicated when this bit is 0.

1 If set to 1, the receiver has detected a high power signal causing interference. When this happens, the receiver goes into a special anti-jamming mode where it re-maps the A/D decode values as well as special L1AGC feedback control. These adjustments help to minimize the loss that will occur in the presence of a jamming signal. You should monitor this bit, and if set to 1, do your best to remedy the cause of the jamming signal. Nearby transmitters or other electronic equipment could be the cause of interference; you may find it necessary to relocate your antenna position if the problem persists.

Bits 12, 13, 14 Buffer COM 1 / COM 2 / Console

0 Normal operation is indicated by a 0 value.

1 These bits are set to 1 when any of the 8-Kbyte output buffers has reached an over-run condition (COM1, COM2, or console). Over-run is caused by requesting more log data than can be taken from the GPSCard because of bit rate limitations or slow communications equipment. If this happens, the new data attempting to be loaded into the buffer will be discarded. The receiver will not load a partial data record into an output buffer. The flag resets to 0 five minutes after the last overrun occurred.

Bit 15 CPU Overload

0 Normal operation is indicated by a 0 value.

1 A value of 1 indicates that the CPU is being over-taxed. Requesting an excessive amount of information from the receiver may cause this. If this condition is occurring, limit redundant data logging or change to using binary data output formats, or both. You should attempt to tune the logging requirements to keep the idle time above 20% for best operation. If the average idle % drops below 10% for prolonged periods of time (2-5 seconds), critical errors may result in internal data loss and the over-load bit will be set to 1. You can monitor the CPU % idle time by using the RVSA log message. The flag resets to 0 five minutes after the last overload occurred.

NOTE: As the amount of CPU power becomes limited, the software will begin to slow down the position calculation rate. If the CPU becomes further limited, the software will begin to skip range measurement processing. Priority processing goes to the tracking loops.

Bit 16 Almanac Saved

0 Almanac not saved in non-volatile memory.

1 Almanac saved in non-volatile memory.

Bit 17 L2AGC (on an OEM2 GPSCard: this bit is unused, i.e. it would be set to 0 = bad)

1 For an L1/L2 MiLLennium GPSCard: When set to 1, the L2AGC circuits are operating within normal range of control.

0 For an L1/L2 MiLLennium GPSCard: This bit will be set clear if the L2AGC is operating out of normal range. Failure of this test could be the result of various possibilities, such as: bad antenna LNA, excessive loss in the antenna cable, faulty RF down-converter, or a pulsating or high power jamming signal causing interference. If this bit is continuously set clear, and you cannot identify an external cause for the failed test, please contact NovAtel Customer Service.

Bit 18 L2Jammer Detection (on an OEM2 GPSCard: this bit is unused, i.e. it would be set to 0 = normal)

0 For the L1/L2 MiLLennium GPSCard: Normal operation is indicated when this bit is 0.

1 For the L1/L2 MiLLennium GPSCard: If set to 1, the receiver has detected a high power signal causing interference. When this happens, the receiver goes into a special anti-jamming mode where it re-maps the A/D decode values as well as special L2AGC feedback control. These adjustments help to minimize the loss that will occur in the presence of a jamming signal. You should monitor this bit, and if set to 1, do your best to remedy the cause of the jamming signal. Nearby transmitters or other electronic equipment could be the cause of interference; you may find it necessary to relocate your antenna position if the problem persists.

Bit 19 L2PLL (on an OEM2 GPSCard: this bit is unused, i.e. it would be set to 0 = bad)

1 For an L1/L2 MiLLennium GPSCard: When the L2 RF down-converter passes self-test, the bit will be set to 1.

0 For an L1/L2 MiLLennium GPSCard: If a fault is detected in the L2 RF down-converter, this bit is set to 0.

Bit 20 OCXOPLL (on an OEM2 GPSCard: this bit is unused, i.e. it would be set to 0 = bad)

1 For an L1/L2 MiLLennium GPSCard: When the OCXOPLL bit passes self-test, the bit will be set to 1.

0 For the L1/L2 MiLLennium GPSCard: If a fault is detected in the OCXOPLL bit, this bit is set to 0.

Bit 21 Saved Almanac Needs Update

1 When the almanac received is newer that the one currently stored in NVM (non-volatile memory), the bit will be set to 1.

0 This bit will be set to 0 if an almanac has not been received that is newer than the one stored in memory.

Bit 22 Almanac Invalid

1 No almanac in use

0 Valid almanac in use

Bit 23 Position Solution Invalid

1 Position solution is not valid

0 Valid position computed

Bit 24 Position Fixed

1 A fix position command has been accepted

0 Position has not been fixed

Bit 25 Clock Model Invalid

1 Clock model has not stabilised

0 Clock model is valid

Bit 26 Clock Steering Disabled

1 Clockadjust disable command has been accepted

0 Clockadjust is enabled

Table 10 Additional Information about MSAS / NES / UPC Receiver Self-Test Status Word

The bits have been place into 4 categories. They are:

1. **Not Used in MSAS / NES / UPC Rx:** The user can ignore this bit.
2. **Diagnostics:** This bit does not need to be continually monitored by the user but can provide useful information if a problem is detected.
3. **Checked at Startup:** This test is done at power-up of the receiver. This should show 'valid' status before continuing.
4. **Continuous Monitoring:** This bit should be continually monitored by the user. It either indicates a problem or a change of status.

Bit	Description	Category	Comments
0	ANTENNA	Not Used In MSAS / NES / UPC Rx	No antenna power provided by the receiver.
1	L1 PLL	Diagnostics	This bit is unreliable, but can be used for diagnostics if a problem is detected.
2	RAM	Checked at Startup	
3	ROM	Checked at Startup	
4	DSP	Checked at Startup	
5	L1 AGC	Diagnostics	Indicates the AGC has been adjusted. If there is a problem it will show up in the C/No and ranges residuals.
6	COM 1	Checked at Startup	
7	COM 2	Checked at Startup	
8	WEEK	Continuous Monitoring	
9	NO COARSETIME	Continuous Monitoring	
10	NO FINETIME	Continuous Monitoring	
11	L1 JAMMER	Continuous Monitoring	Indicates there may be a jammer present on L1.
12	BUFFER COM1	Continuous Monitoring	
13	BUFFER COM2	Continuous Monitoring	
14	BUFFER CONSOLE	Continuous Monitoring	
15	CPU OVERLOAD	Continuous Monitoring	
16	ALMANAC SAVE IN NVM	Not Used In MSAS / NES / UPC Rx	
17	L2 AGC	Diagnostics	L1/L2 ports only.
18	L2 JAMMER	Continuous Monitoring	L1/L2 ports only.
19	L2 PLL	Diagnostics	L1/L2 ports only. This bit is unreliable, but can be used for diagnostics if a problem is detected.
20	OCXO PLL	Continuous Monitoring	L1/L2 ports only.
21	SAVED ALMA NEEDS UPDATE	Not Used In MSAS / NES / UPC Rx	
22	ALMANAC INVALID	Continuous Monitoring	
23	POSITION SOLITION INVALID	Continuous Monitoring	
24	POSITION FIXED	Continuous Monitoring	
25	CLOCK MODEL INVALID	Continuous Monitoring	
26	CLOCK STEERING DISABLED	Continuous Monitoring	
27-31	RESERVED		

RVSA/B RECEIVER STATUS

This log conveys various status parameters of the receiver system. If the system is a multiple-GPSCard unit with a master card, certain parameters are repeated for each individual GPSCard. If the system is composed of only one GPSCard, then only the parameters for that unit are listed.

Note that the number of satellite channels (the number of satellites the receiver is capable of tracking) is not necessarily the same as the number of signal channels. This is because one L1/L2 satellite channel requires two signal channels. Therefore the 12-channel MiLLennium GPSCard will report 24 signal channels in this field. This number represents the maximum number of channels reporting information in logs such as ETSA/B and RGEA/B/C.

RVSA

Structure:

```
$RVSA week seconds sat_chan sig_chan num reserve
idle status
:
idle status
*xx [CR][LF]
```

Field #	Field type	Data Description	Example
1	$RVSA	Log header	$RVSA
2	week	GPS week number	847
3	seconds	GPS seconds into the week.	318923.00
4	sat_chan	Number of satellite channels	12
5	sig_chan	Number of signal channels	24
6	num	Number of cards	1
7	reserve	Reserved field	
8	idle	First GPSCard: CPU idle time (percent)	16.00
9	status	First GPSCard: Self-test status (see *Table 9*)	000B00FF
10 - 11		Next GPSCard: CPU idle time & self-test status	
...		Next GPSCard: CPU idle time & self-test status	
variable	*xx	Checksum	*42
variable	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$RVSA,847,318923.00,12,24,1,,16.00,000B00FF*42[CR][LF]
```

RVSB

Format: Message ID = 56 Message byte count = 28 + (8 x number of cards)

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer		8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	s	16
4	Number of satellite channels	1	char		24
5	Number of signal channels	1	char		25
6	Number of cards	1	char		26
7	Reserved	1	byte		27
8	CPU idle time	4	float	percent	28
9	Self-test status	4	integer		32
8 & 9 are repeated for each card	Next Card offset = 28 + (8 x card number)				

NOTE: For Field 9, self-test bits 2, 3, 4, 6, & 7 are set only once (when the GPSCard is first powered up). All other bits are set by internal test processes each time the RVSB log is output .

SATA/B SATELLITE SPECIFIC DATA

This log provides satellite specific data for satellites actually being tracked. The record length is variable and depends on the number of satellites.

Satellite data from this log is valid on output unless the values in the azimuth and elevation fields (#7 and #8) are both zero.

Each satellite being tracked has a reject code indicating whether it is used in the solution, or the reason for its rejection from the solution. The reject value of 0 indicates the observation is being used in the position solution. Values of 1 through 11 indicate the observation has been rejected for the reasons specified in *Table 8*.

SATA

Structure:

```
$SATA  week  Seconds  sol status  # obs
prn  azimuth  elevation  residual  reject code
:
prn  azimuth  elevation  residual  reject code  *xx  [CR][LF]
```

Field #	Field type	Data Description	Example
1	$SATA	Log header	$SATA
2	week	GPS week number	637
3	seconds	GPS seconds into the week	513902.00
4	sol status	Solution status as listed in *Table 6*	0
5	# obs	Number of satellite observations with information to follow:	7
6	prn	Satellite PRN number (1-32)	18
7	azimuth	Satellite azimuth from user position with respect to True North, in degrees	168.92
8	elevation	Satellite elevation from user position with respect to the horizon, in degrees	5.52
9	residual	Satellite range residual from position solution for each satellite, in metres	9.582
10	reject code	Indicates that the range is being used in the solution (code 0) or that it was rejected (code 1-11), as shown in *Table 8*	0
11...	..	Next PRN	
variable	*xx	Checksum	*1F
variable	[CR][LF]	Sentence terminator	[CR][LF]

Example:

$SATA,637,513902.00,0,7,**18**,168.92,5.52,9.582,0,**6**,308.12,55.48,0.737,0,
15,110.36,5.87,16.010,0,**11**,49.63,40.29,-0.391,0,
2,250.05,58.89,-12.153,0,**16**,258.55,8.19,-20.237,0,
19,118.10,49.46,-14.803,0*1F[CR][LF]

SATB

Format: Message ID = 12 Message byte count = 32 + (obs*32)

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	Solution status	4	integer		24
5	Number of observations (obs)	4	integer		28
6	PRN	4	integer		32
7	Azimuth	8	double	degrees	36
8	Elevation	8	double	degrees	44
9	Residual	8	double	metres	52
10	Reject code	4	integer		60
11...	Next PRN offset = 32 + (obs * 32) where obs varies from 0 to (obs-1)				

SBTA/B SATELLITE BROADCAST DATA: RAW SYMBOLS

This message contains the satellite broadcast data in raw symbols before FEC decoding or any other processing. An individual message is sent for each PRN being tracked. For a given satellite, the message number increments by one each time a new message is generated. This data matches the RBTA/B data if the message numbers are equal. The data must be logged with the 'onnew' trigger activated to prevent loss of data.

SBTA

Structure:

`$SBTA` `week` `seconds` `prn` `cstatus` `message #` `# of symbols`

`raw symbols` `*xx` `[CR][LF]`

Field #	Field type	Data Description	Example
1	$SBTA	Log header	$SBTA
2	week	GPS week number	883
3	seconds	GPS seconds into the week	413908.000
4	prn	PRN of satellite from which data originated	120
5	cstatus	Channel Tracking Status	80812F14
6	message #	Message sequence number	119300
7	# of symbols	Number of symbols transmitted in the message. At present, always equals 256 bits.	256
8	raw symbols	256 symbols compressed into a 128 bytes, i.e. 4 bits/symbol. Hence, 256 hex characters are output. If FEC decoding is enabled, soft symbols are output with values ranging from -3 to 3. Otherwise 1's and 0's are output.	EE33EEEE33333E33EE33EEEE33333E33EE33EEEE3333 3E33EE33EEEE33333EEEE3333EEE33E33E3EE33EEE3E EEE33EE3E3EEEEEEEEEEEEEE3333EEE33EEEEE33EE 3EEE3E3EE3EE33EEE33E333EE3333E3E3333E33E3333 EEEEE333EE3E3333EE3EE3EE33EE3EE3EE3E33E33E3 EEE33333E3333E33E3E333E3E33333E3EEE3E3E
9	*xx	Checksum	*4C
10	[CR][LF]	Sentence terminator	[CR][LF]

SBTB

Format: Message ID = 53 Message byte count = 168

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	PRN number	4	integer	1-999	24
5	Channel Status	4	integer	n/a	28
6	Message #	4	integer	n/a	32
7	# of Symbols	4	integer	n/a	36
8	Raw Symbols	128	char	n/a	40

TM1A/B TIME OF 1PPS

This log provides the time of the GPSCard 1PPS in GPS week number and seconds into the week. It also includes the receiver clock offset, the standard deviation of the receiver clock offset and clock model status. This log will output at a maximum rate of 1 Hz.

TM1A

Structure:

`$TM1A | week | seconds | offset | offset std | utc offset | cm status | *xx | [CR][LF]`

Field #	Field type	Data Description	Example
1	$TM1A	Log header	$TM1A
2	week	GPS week number	794
3	seconds	GPS seconds into the week at the epoch coincident with the 1PPS output strobe (receiver time)	414634.999999966
4	offset	Receiver clock offset, in seconds. 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)	-0.000000078
5	offset std	Standard deviation of receiver clock offset, in seconds	0.000000021
6	utc offset	This field represents the offset of GPS time from UTC time, computed using almanac parameters. To reconstruct UTC time, algebraically subtract this correction from field 3 above (GPS seconds). UTC time = GPS time – (utc offset)	-9.999999998
7	cm status	Receiver Clock Model Status where 0 is valid and values from -20 to -1 imply that the model is in the process of stabilization	0
8	*xx	Checksum	*57
9	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$TM1A,794,414634.999999966,-0.000000078,0.000000021,-9.999999998,0*57[CR][LF]
```

TM1B

Format: Message ID = 03 Message byte count = 52

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	Clock offset	8	double	seconds	24
5	StdDev clock offset	8	double	seconds	32
6	UTC offset	8	double	seconds	40
7	Clock model status	4	integer	0 = good, -1 to -20 = bad	48

UTCA/B UTC TIME PARAMETERS

The UTC time parameters (UTCA/B) are provided following the last almanac records when an ALMA/B message has been logged. The UTCA/B message cannot be logged individually or independently of the ALMA/B message.

For more information on Almanac data, refer to the GPS SPS Signal Specification.

UTCA

Structure:

```
$UTCA | pct | p1ot | data-ref | wk#-utc | wk#-lset | delta-time | lsop | day #-lset
*xx | [CR][LF]
```

Field #	Field type	Data Description	Example
1	$UTCA	Log header	$UTCA
2	pct	Polynomial constant term, seconds	-2.235174179077148E-008
3	p1ot	Polynomial 1st order term, seconds/second	-1.243449787580175E-014
4	data-ref	UTC data reference time, seconds	32768
5	wk #-utc	Week number of UTC reference, weeks	745
6	wk #-lset	Week number for leap sec effect time, weeks	755
7	delta-time	Delta time due to leap sec, seconds	9
8	lsop	For use when leap sec on past, seconds	10
9	day #-lset	Day number for leap sec effect time, days	5
10	*xx	Checksum	*37
11	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$UTCA,-2.235174179077148E-008,-1.243449787580175E-014,32768,745,755,9,10,5*37
[CR][LF]
```

UTCB

Format: Message ID = 17 Message byte count = 52

Field #	Field Type	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Polynomial constant term	8	double	seconds	12
3	Polynomial 1st order term	8	double	seconds/second	20
4	UTC data reference time	4	integer	seconds	28
5	Week number UTC reference	4	integer	weeks	32
6	Week number for leap sec effect time	4	integer	weeks	36
7	Delta time due to leap sec	4	integer	seconds	40
8	For use when leap sec on past	4	integer	seconds	44
9	Day number for leap sec effect time	4	integer	days	48

WBCA/B WIDE BAND CARRIER RANGE CORRECTION

This message contains the wide band carrier range correction data. A correction is generated for each PRN being tracked and these are grouped together into a single log. Internally, the correction for each satellite is updated asynchronously at a 1 Hz rate. Therefore, logging this message at a rate higher than 1 Hz will result in duplicate data being output. Each carrier range correction is statistically independent and is derived from the previous 1 second of data.

WBCA

Structure:

```
$WBCA  week  seconds  # obs
prn  ch tr-status  tr-BW  wide band carrier range correction
:
prn  ch tr-status  tr-BW  wide band carrier range correction  *xx  [CR][LF]
```

Field #	Field type	Data Description	Example
1	$WRCA	Log header	$WBCA
2	week	GPS week number	637
3	seconds	GPS seconds into the week	513902.00
4	# obs	Number of satellite observations with information to follow:	7
5	prn	Satellite PRN number	18
6	ch tr-status	Channel Tracking Status: Hexadecimal number indicating phase lock, channel number and channel state as shown in *Table 7*	E04
7	tr-BW	PLL tracking loop bandwidth in Hz	15.000
8	wide band carrier correction	Wide band carrier range correction in cycles	0.00123
9...	..	Next PRN	
Variable	*xx	Checksum	*1F
Variable	[CR][LF]	Sentence terminator	[CR][LF]

WBCB

Format: Message ID = 97 Message byte count = 28 + (obs*16)

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	Number of observations (obs)	4	integer		24
5	PRN	4	integer		28
6	Channel Tracking Status, see *Table 7*	4	-	-	32
7	PLL tracking loop bandwidth	4	float	Hz	36
8	Wide Band Range Carrier Correction	4	float	cycles	40
9...	Next PRN offset = 28 + (obs*16)				

WRCA/B WIDE BAND CODE RANGE CORRECTION

This message contains the wide band code range correction data. A correction is generated for each PRN being tracked and these are grouped together into a single log. Internally, the correction for each satellite is updated asynchronously at a 1 Hz rate. Therefore, logging this message at a rate higher than 1 Hz will result in duplicate data being output. Each code range correction is statistically independent and is derived from the previous 1 second of data.

Subtracting the wide band range correction from the pseudorange value of the RGE log, see *Page 71*, effectively produces uncorrelated pseudorange measurements.

WRCA

Structure:

```
$WRCA | week | seconds | # obs
prn | ch tr-status | tr-BW | wide band code range correction
:
prn | ch tr-status | tr-BW | wide band code range correction | *xx | [CR][LF]
```

Field #	Field type	Data Description	Example
1	$WRCA	Log header	$WRCA
2	week	GPS week number	637
3	seconds	GPS seconds into the week	513902.00
4	# obs	Number of satellite observations with information to follow:	7
5	prn	Satellite PRN number	18
6	ch tr-status	Channel Tracking Status: Hexadecimal number indicating phase lock, channel number and channel state as shown in *Table 7*	E04
7	tr-BW	DLL tracking loop bandwidth in Hz	0.050
8	wide band code range correction	Wide band code range correction in metres	1.323
9...	..	Next PRN	
Variable	*xx	Checksum	*1F
Variable	[CR][LF]	Sentence terminator	[CR][LF]

WRCB

Format: Message ID = 67 Message byte count = 28 + (obs*16)

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	char		0
	Checksum	1	char		3
	Message ID	4	integer		4
	Message byte count	4	integer	bytes	8
2	Week number	4	integer	weeks	12
3	Seconds of week	8	double	seconds	16
4	Number of observations (obs)	4	integer		24
5	PRN	4	integer		28
6	Channel Tracking Status	4	-	-	32
7	DLL tracking loop bandwidth	4	float	Hz	36
8	Wide Band Code Range Correction	4	float	metres	40
9...	Next PRN offset = 28 + (obs*16)				

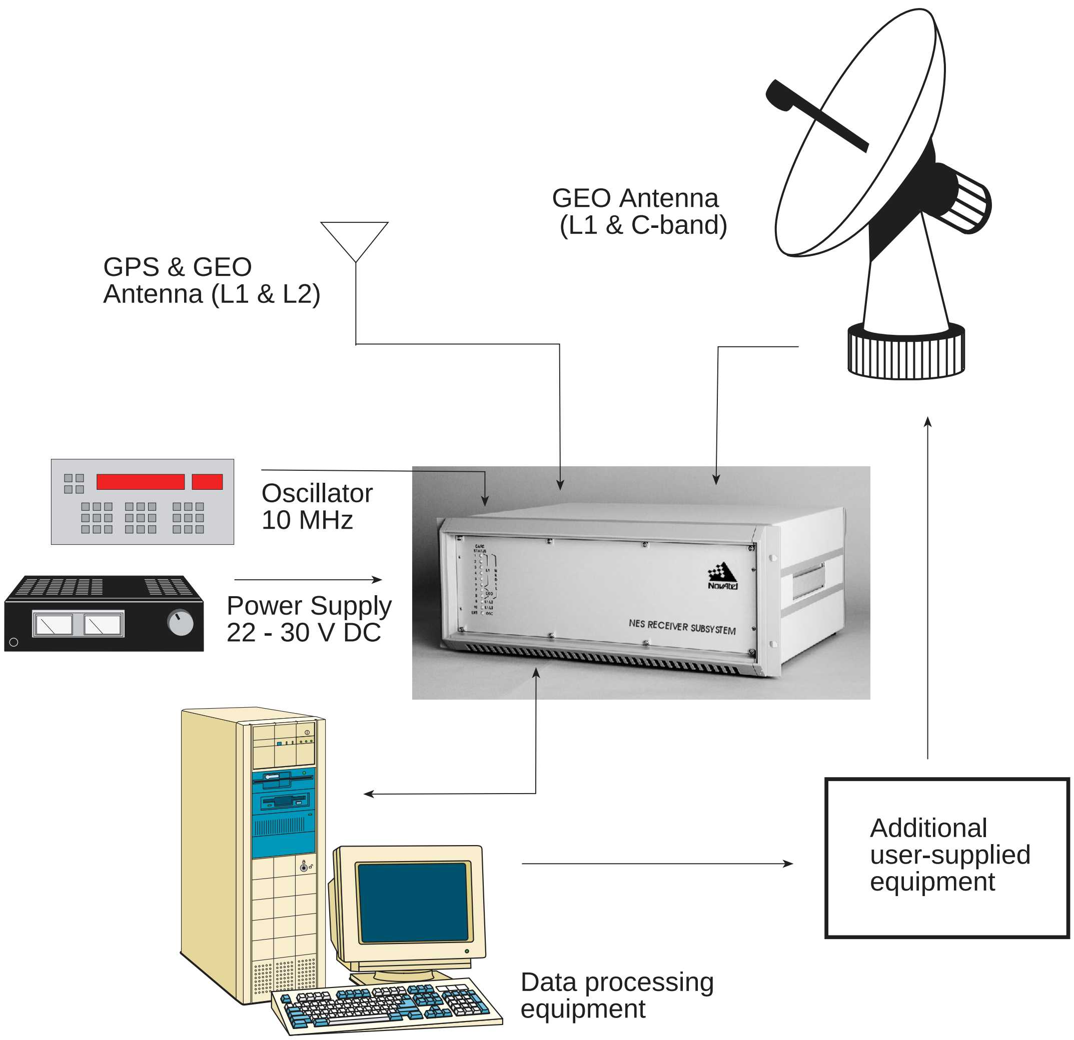
A INSTALLING THE NES / UPC RECEIVER

This chapter provides sufficient information to allow you to set up and prepare the NES / UPC receiver for initial operation. The corresponding information for the MSAS receiver is contained in *Chapter 2*.

MINIMUM CONFIGURATION

In order for the NES / UPC receiver to function as a complete system, a minimum equipment configuration is required. This is illustrated in *Figure 16*.

Figure 16 NES / UPC Minimum System Configuration



The recommended minimum configuration and required accessories are listed below:

- NovAtel NES / UPC receiver
- User-supplied and powered L1 or L1/L2 GPS antenna and LNA
- User-supplied and powered L1 / C-band dish antenna and LNA
- User-supplied power supply (22-30 V DC, 5 A maximum)
- User-supplied external frequency reference (10 MHz)
- User-supplied interface, such as a PC or other data communications equipment, capable of standard serial communications (RS-232C).
- User-supplied data and RF cables

See *Appendix E* for a list of associated suppliers of NES / UPC subsystem components.

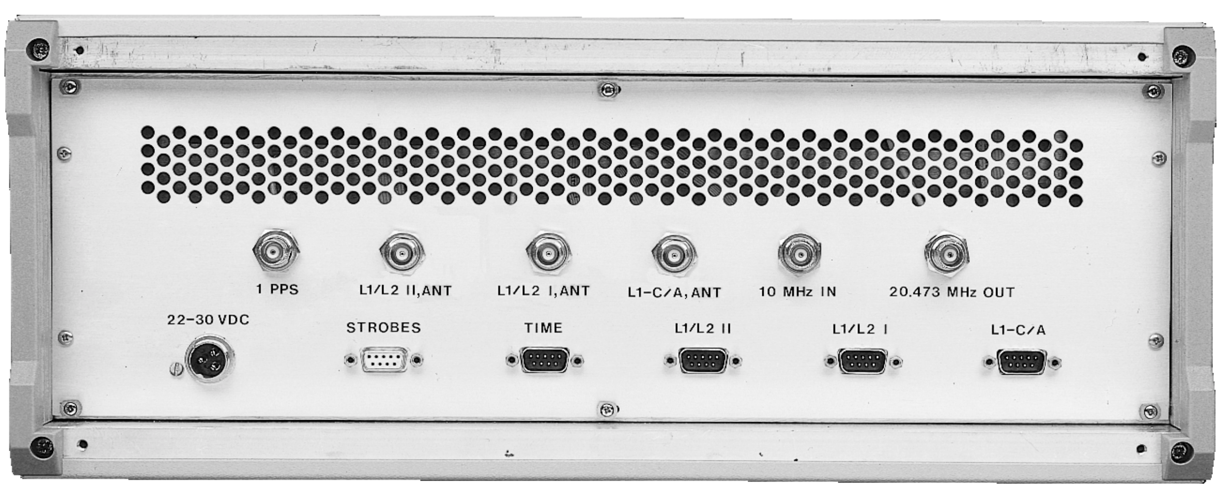
Of course, your intended set-up may differ significantly from this minimum configuration. The NES / UPC receiver has many features that would not be used in the minimum configuration shown above. This section merely describes the basic system configuration, which you can modify to meet your specific situation.

For the minimum configuration, setting up the NES / UPC receiver involves the following steps:

1. Connect the external frequency reference to the NES / UPC receiver (“10 MHz IN” connector)
2. Connect the user interface to the NES / UPC receiver (“L1-C/A”, “L1/L2 I” and/or “L1/L2 II” connectors)
3. Install the GPS antennas and low-noise amplifiers, and make the appropriate connections to the NES / UPC receiver and power supplies. For the minimum configuration, an L1-only or L1/L2 antenna would be connected to the “L1-C/A, ANT” connector, and the GEO dish antenna would be connected to the “L1/L2 II, ANT” connector.
4. Supply power to the NES / UPC receiver (“22-30 VDC” connector)

The connections on the rear panel are shown in *Figure 17* below:

Figure 17 Rear Panel of NES / UPC Receiver

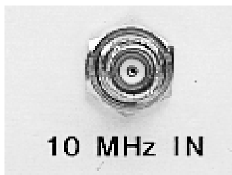


CONNECTING THE EXTERNAL FREQUENCY REFERENCE

The NES / UPC receiver requires an external, user-supplied frequency reference; this would typically take the form of a high-accuracy oscillator. Please refer to *Appendix C* for the recommended specifications of this device. See *Appendix E* for a list of associated suppliers of NES / UPC subsystem components.

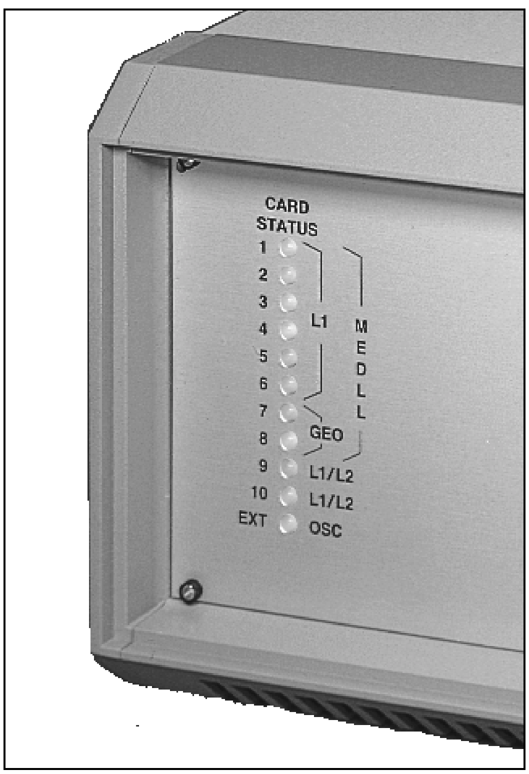
The frequency reference is connected to the 10 MHz BNC female connector on the rear panel of the NES / UPC receiver. Refer to *Figure 18* below.

Figure 18 10 MHz In (External Frequency Reference) - NES / UPC



The 11th (bottom) LED on the front panel indicates the status of the connection between the NES / UPC receiver and the external clock reference. A *clear* LED indicates that no external reference is present, *red* indicates the external clock is not locked (undergoing the locking process, or the signal is not within the capture range), and *green* indicates that the clock is locked and stabilized. Refer to *Figure 19* below.

Figure 19 Lights on Front Panel of NES / UPC Receiver



CONNECTING DATA COMMUNICATIONS EQUIPMENT

There are four serial ports on the back panel of the NES / UPC receiver; all are configured for RS-232C protocol. These ports make it possible for external data communications equipment - such as a personal computer - to communicate with the NES / UPC receiver. Each of these ports has a DE9P connector.

- The L1-C/A, L1/L2 I and L1/L2 II ports (see *Figure 20*) allow two-way communications. Each one is configured as COM1 if you attempt to communicate directly with it. The L1/L2 I and L1/L2 II ports are each connected to an L1/L2 GPSCard within the NES / UPC receiver unit; the L1-C/A port is connected to the L1-only GPSCard which controls the MEDLL subsystem. Each of these ports can be addressed independently of the other.
- The TIME port (see *Figure 21*) is used for output **only**. Data can be directed to this port by using the "com2" directive when logging data from the MEDLL receiver. In the standard configuration a TM1A log is output at 1 Hz using a data transfer rate of 9600 bps, with one stop bit, one start bit, no parity and no handshaking. The output of the TM1A is triggered by a 1 PPS signal. The exact timing of the output of the first bit of the log is non-deterministic but is limited to less than 100 ms after the triggering 1 PPS signal. The information in the TM1A log refers to the preceding 1 PPS signal that triggered the output of the log.

Figure 20 Pinout for L1-C/A, L1/L2 I, & L1/L2 II Ports - NES / UPC

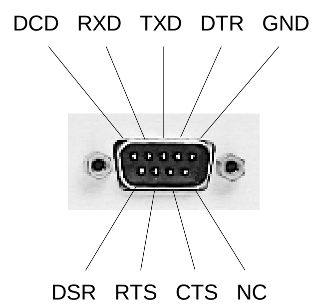
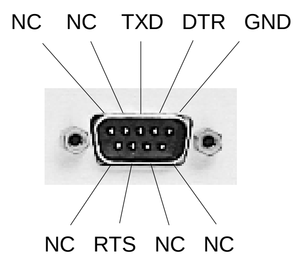


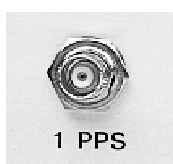
Figure 21 Pinout for TIME Port - NES / UPC



USING THE 1PPS OUTPUT

The clock signal available on the 1 PPS port (see *Figure 22*) is referenced by the data available on the Time port. The specifications and electrical characteristics of this signal are described in *Appendix C*. The pulse train is accessed from the BNC female connector on the back of the NES / UPC receiver.

Figure 22 1 PPS Output - NES / UPC



CONNECTING THE ANTENNAS

Selecting and installing appropriate antenna systems is crucial to the proper operation of the NES / UPC receiver. See *Appendix E* for a list of associated suppliers of NES / UPC subsystem components.

For the minimum configuration, an L1-only or L1/L2 antenna would be connected to the “L1-C/A, ANT” connector, and the L1 / C-band GEO dish antenna would be connected to the “L1/L2 II, ANT” connector. The “L1/L2 I, ANT” connector would accommodate an optional antenna.

Keep these points in mind when installing the antenna systems:

- Ideally, select an antenna location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction.
- Ensure that the antenna is mounted on a secure, stable structure capable of withstanding relevant environmental loading forces (e.g. due to wind or ice).

Use high-quality coaxial cables to minimize signal attenuation. When using active antennas, remember that you also need to connect each low-noise amplifier (LNA) to a suitable power source. The gain of the LNA must be sufficient to compensate for the cabling loss.

NOTE: These connectors do not provide DC power for an active LNA.

The antenna ports on the NES / UPC receiver have TNC female connectors, as shown in *Figure 23*.

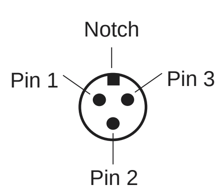
Figure 23 Antenna Input - NES / UPC

CONNECTING THE EXTERNAL POWER INPUT

The NES / UPC receiver requires one source of external regulated power. The input can be in the 22-30 V DC range. The receiver draws up to 5 A at start-up, but the steady-state requirement is approximately 3.5 A.

The power-input connector on the NES / UPC receiver is a 3-position chassis jack. It mates to a 3-position inline plug (see *Appendix E* for a list of associated suppliers of NES / UPC subsystem components). Pin 1 (+22-30V DC), and Pin 2 (GND) connect to the NES / UPC receiver’s internal power supply, which performs filtering and voltage regulation functions. Pin 3 serves as a protection ground connection. Refer to *Figure 24*.

Figure 24 External Power Connections - NES / UPC



USING THE 20.473 MHz OUTPUT SIGNAL

The 20.473 MHz output provides a high-stability reference clock signal to another device in the system. It permits the synchronization of another unit to the NES / UPC receiver. This signal can be accessed by means of the BNC female connector on the NES / UPC receiver's rear panel (see *Figure 25*).

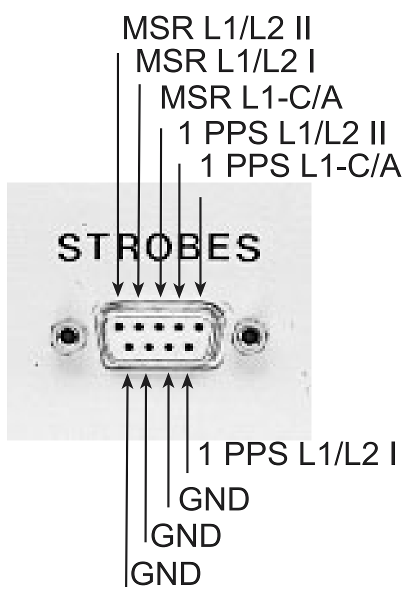
Figure 25 20.473 MHz Output - NES / UPC

ACCESSING THE STROBE SIGNALS

The NES / UPC receiver's output strobe lines are available on the rear panel from the DE9S connector (see *Figure 26*). The specifications and electrical characteristics of these signals are described in *Appendix C*. These signals are provided for diagnostic purposes.

The L1/L2 I and L1/L2 II ports are each connected to an L1/L2 GPS receiver within the NES / UPC receiver unit; the L1-C/A port is connected to the L1 GPS receiver which controls the MEDLL subsystem.

Figure 26 Strobe 9-pin D-Connector Pinout - NES / UPC



B MSAS RECEIVER - TECHNICAL SPECIFICATIONS

PHYSICAL		
Size		448.8 x 361 x 183.5 mm (without the 19” mounting brackets)
Weight		10.2 kg
ENVIRONMENTAL		
Operating Temperature		-25° C to +55° C with 1 m^3 / minute air flow
Storage Temperature		-40° C to +85° C
Humidity		10-80%
Altitude		3,000 metres [May operate above 3,000 m in a controlled environment, however is not certified as such.]
POWER INPUT		
Connector		3-position chassis jack
Voltage		22-30 V DC
Current		maximum 3.5 A continuous; peak 5.0 A
MSAS RECEIVER SUBSYSTEM PERFORMANCE (Subject To GPS System Characteristics)		
Frequency		L1(1575.42 MHz), L2 (1227.6 MHz)
Code tracked		GPS L1-C/A Code, GPS L2 P Codeless, MSAS GEO L1-C/A Code, GPS SVN (PRN 1-32), and GEO SVN (PRN 120-138)
Satellite Tracking Channels	MEDLL	14 L1-C/A, 2 L1-C/A MSAS or 12 L1-C/A, 4 L1-C/A MSAS
	L1/L2 I	12 L1-C/A (Narrow) / L2 (Codeless)
	L1/L2 II[1]	14 L1-C/A (Wide), 3 L1-C/A (Narrow) / L2 (Codeless) or 2 L1-C/A MSAS (Wide), 2 L2-C/A MSAS (Wide)
Position Accuracy Stand-alone		5 metres CEP (SA off), GDOP < 2
Time Accuracy (relative)		50 nanoseconds (SA off)
Pseudorange Measurement Accuracy	MEDLL (C/A)	10 cm RMS, C/N_0 > 44 dBHz, BW = 0.05
	L1 (C/A, Narrow)	10 cm RMS, C/N_0 > 44 dBHz, BW = 0.05
	L1 (C/A, Wide)	1 m RMS, C/N_0 > 44 dBHz, BW = 0.05
	L2	50 cm RMS, C/N_0 > 30 dBHz, BW = 0.05
Single Channel Phase Accuracy	L1	3 mm RMS, C/No > 44 dBHz, Loop BW = 15Hz
	L2	5 mm RMS, C/No > 30 dBHz, Loop BW = 0.2Hz

[1] GPS Narrow is a dot product discriminator with a 0.1 correlator spacing.
GPS Wide is an early-late discriminator with a 0.15 correlator spacing.
MSAS Wide is a dot product discriminator with a 1.0 correlator spacing.

Raw Data Availability Rate	MEDLL	5 phase and code measurements per second (200mSec)
	L1/L2-I	1 phase and code measurements per second
	L1/L2-II	1 phase and code measurements per second
	Time	1 message per 10 seconds
	Almanac data	< 15 minutes after reset
Time to First Fix		100 seconds (95%) with stabilized internal and external oscillators. 15 minutes maximum from start of cold receiver. No initial time, almanac or position required.
Re-acquisition	L1 & MEDLL	5 seconds C/No = 44 dB-Hz, 10 seconds C/No = 38 dB-Hz
	L2	45 seconds C/No = 41 dB-Hz, 60 seconds C/No = 35 dB-Hz
	GEO	10 seconds C/No = 44 dB-Hz
Height Measurements		Up to 18,288 metres (60,000 feet) maximum [In accordance with export licensing, the card is restricted to less than 60,000 feet.]
INPUT/OUTPUT DATA INTERFACE		
Serial		Bit rates: 300, 1200, 4800, 9600, 19200, 57600, 115200 bps, user selectable Default: 9600 bps (L1–C/A, L1/L2 I, L1/L2 II, TIME)
Connector		DE9P
Electrical format		RS-232C
OUTPUT STROBES		
1PPS Output		A one-pulse-per-second Time Sync output. This is a normally high, active low pulse (200 µs for MEDLL, 1 ms for L1/L2 I and L1/L2 II) where the falling edge is the reference.
Measure Out		1 or 5 pulses-per-second output, normally high, active low where the pulse width is 200 µs for MEDLL and 1 ms for L1/L2 I and L1/L2 II. The falling edge is the receiver's measurement strobe. (Rate is model-dependent.)
Connector		DE9S
The electrical specifications of the strobe signals are as follows:		
Output	Voltage	(High) > 2.0 VDC (Low) < 0.55 VDC
	Minimum load impedance	1 KΩ
ANTENNA INPUT		
Connector		TNC female
Frequency		L1(1575.42 MHz), L2 (1227.6 MHz)
Power		Power to the LNA is supplied by the user
Noise Power Spectral Density		-140 dBm/Hz to -160 dBm/Hz
Maximum C/N_0		65 dB-Hz
10 MHz INPUT		
Connector		BNC female
Capture range		10 MHz ± 5 Hz
Locking time	Temp.: -25° C	20 minutes
	Temp.: -10° C	10 minutes
	Temp.: 0° C	5 minutes
	Temp.: 50° C	1 minute
Sensitivity		+9 dBm to +20 dBm into 50 Ω

RECOMMENDED EXTERNAL FREQUENCY REFERENCE SPECIFICATIONS			
Frequency		10.000 MHz	
Short Term Stability (Allen Variance)		2×10^{-11}, 1 second	
Accuracy Over Operating Temp. Range		$\pm 5 \times 10^{-12}$	
RF Output Power		+13 dBm into 50 Ω	
Output Waveform		Sine wave	
	Harmonics:	-40 dBc	
	Spurious:	-80 dBc	
Phase Noise	@10 Hz:	-120 dBc/Hz	
	@100 Hz:	-140 dBc/Hz	
	@1 kHz:	-150 dBc/Hz	
RF Output Connector		BNC Female	
20.473 MHz OUTPUT			
Connector		BNC female	
Frequency		20.473 MHz (locked)	
		20.473MHz ± 65 Hz (unlocked)	
Output level		minimum 500 mV pp, 50 Ω	
1PPS OUTPUT			
Connector		BNC female	
Signal description		A one-pulse-per-second Time Sync output. This is a normally high, active low pulse (200 µs) where the falling edge is the reference.	
Output level	Voltage	(High)	> 2.0 VDC
		(Low)	< 0.55 VDC
	Minimum load impedance		1 KΩ

DEFAULT CHANNEL ASSIGNMENTS – MSAS RECEIVER SUBSYSTEM									
Port	**Channel**	**SV Type**	**Code**	**DLL Type**	**Frame**	**Nav Type**	**Symbol Rate**	**FEC**	**Sky Search**
L1-C/A	0	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	1	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	2	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	3	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	4	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	5	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	6	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	7	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	8	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	9	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	11	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	12	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	13	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	14	MSAS	L1 C/A	MEDLL	MSAS	MSAS	500	Yes	Idle
	15	MSAS	L1 C/A	MEDLL	MSAS	MSAS	500	Yes	Idle

Port	Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
L1/L2 I	0	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	1	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	2	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	3	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	4	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	5	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	6	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	7	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	8	GPS	L1 C/A, L2 P	Narrow Corr	GPS	GPS	50	No	Automatic
	9	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	10	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic
	11	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Automatic

Port	Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
L1/L2 II	0	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	1	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	2	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	3	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	4	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	5	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	6	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	7	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	8	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	9	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	10	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	11	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	12	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	13	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	14	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Idle
	15	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Idle
	16	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Idle
					OR				
	17	MSAS	L1 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle
	18	MSAS	L1 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle
	19	MSAS	L2 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle
	20	MSAS	L2 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle

On the L1/L2 II port, it is possible to use <u>either</u> Channels 0-16 <u>or</u> Channels 17-20, but not both.

C NES / UPC RECEIVER - TECHNICAL SPECIFICATIONS

PHYSICAL		
Size		448.8 x 361 x 183.5 mm (without the 19" mounting brackets)
Weight		10.2 kg
ENVIRONMENTAL		
Operating Temperature		-25° C to +55° C with 1 m^3 / minute air flow
Storage Temperature		-40° C to +85° C
Humidity		10-80%
Altitude		3,000 metres [May operate above 3,000 m in a controlled environment, however is not certified as such.]
POWER INPUT		
Connector		3-position chassis jack
Voltage		22-30 V DC
Current		maximum 3.5 A continuous; peak 5.0 A
NES / UPC RECEIVER SUBSYSTEM PERFORMANCE (Subject To GPS System Characteristics)		
Frequency		L1(1575.42 MHz), L2 (1227.6 MHz)
Code tracked		GPS L1-C/A Code, GPS L2 P Codeless, MSAS GEO L1-C/A Code, GPS SVN (PRN 1-32), and GEO SVN (PRN 120-138)
Satellite Tracking Channels	MEDLL	14 L1-C/A, 2 L1-C/A MSAS or 12 L1-C/A, 4 L1-C/A MSAS
	L1/L2 I [1]	14 L1-C/A (Wide), 3 L1-C/A (Narrow) / L2 (Codeless) or 2 L1-C/A MSAS (Wide), 2 L2-C/A MSAS (Wide)
	L1/L2 II [1]	14 L1-C/A (Wide), 3 L1-C/A (Narrow) / L2 (Codeless) or 2 L1-C/A MSAS (Wide), 2 L2-C/A MSAS (Wide)
Position Accuracy Stand-alone		5 metres CEP (SA off), GDOP < 2
Time Accuracy (relative)		50 nanoseconds (SA off)
Pseudorange Measurement Accuracy	MEDLL (C/A)	10 cm RMS, C/N_0 > 44 dBHz, BW = 0.05
	L1 (C/A, Narrow)	10 cm RMS, C/N_0 > 44 dBHz, BW = 0.05
	L1 (C/A, Wide)	1 m RMS, C/N_0 > 44 dBHz, BW = 0.05
	L2	50 cm RMS, C/N_0 > 30 dBHz, BW = 0.05
Single Channel Phase Accuracy	L1	3 mm RMS, C/No > 44 dBHz, Loop BW = 15Hz
	L2	5 mm RMS, C/No > 30 dBHz, Loop BW = 0.2Hz

[1] GPS Narrow is a dot product discriminator with a 0.1 correlator spacing.
GPS Wide is an early-late discriminator with a 0.15 correlator spacing.
MSAS Wide is a dot product discriminator with a 1.0 correlator spacing.

Raw Data Availability Rate	MEDLL	5 phase and code measurements per second (200mSec)
	L1/L2-I	1 phase and code measurements per second
	L1/L2-II	1 phase and code measurements per second
	Time	1 message per 10 seconds
	Almanac data	< 15 minutes after reset
Time to First Fix		100 seconds (95%) with stabilized internal and external oscillators. 15 minutes maximum from start of cold receiver. No initial time, almanac or position required.
Re-acquisition	L1 & MEDLL	5 seconds C/No = 44 dB-Hz, 10 seconds C/No = 38 dB-Hz
	L2	45 seconds C/No = 41 dB-Hz, 60 seconds C/No = 35 dB-Hz
	GEO	10 seconds C/No = 44 dB-Hz
Height Measurements		Up to 18,288 metres (60,000 feet) maximum [In accordance with export licensing, the card is restricted to less than 60,000 feet.]
INPUT/OUTPUT DATA INTERFACE		
Serial		Bit rates: 300, 1200, 4800, 9600, 19200, 57600, 115200 bps, user selectable Default: 9600 bps (L1–C/A, L1/L2 I, L1/L2 II, TIME)
Connector		DE9P
Electrical format		RS-232C
OUTPUT STROBES		
1PPS Output		A one-pulse-per-second Time Sync output. This is a normally high, active low pulse (200 µs for MEDLL, 1 ms for L1/L2 I and L1/L2 II) where the falling edge is the reference.
Measure Out		1 or 5 pulses-per-second output, normally high, active low where the pulse width is 200 µs for MEDLL and 1 ms for L1/L2 I and L1/L2 II. The falling edge is the receiver's measurement strobe. (Rate is model-dependent.)
Connector		DE9S
The electrical specifications of the strobe signals are as follows:		

Output	Voltage	(High)	> 2.0 VDC
		(Low)	< 0.55 VDC
	Minimum load impedance		1 KΩ

ANTENNA INPUT		
Connectors		TNC female
Frequency		L1(1575.42 MHz), L2 (1227.6 MHz)
Power		Power to the LNA is supplied by the user
Noise Power Spectral Density		-145 dBm/Hz to -165 dBm/Hz
Maximum C/N_0		65 dB-Hz
10 MHz INPUT		
Connector		BNC female
Capture range		10 MHz ± 5 Hz
Locking time	Temp.: -25° C	20 minutes
	Temp.: -10° C	10 minutes
	Temp.: 0° C	5 minutes
	Temp.: 50° C	1 minutes
Sensitivity		+9 dBm to +20 dBm into 50 Ω

RECOMMENDED EXTERNAL FREQUENCY REFERENCE SPECIFICATIONS		
Frequency		10.000 MHz
Short Term Stability (Allen Variance)		$2x10^{-11}$, 1 second
Accuracy Over Operating Temp. Range		±5 x 10^{-12}
RF Output Power		+13 dBm into 50 Ω
Output Waveform		Sine wave
Harmonics:		-40 dBc
Spurious:		-80 dBc
Phase Noise	@10 Hz:	-120 dBc/Hz
	@100 Hz:	-140 dBc/Hz
	@1 kHz:	-150 dBc/Hz
RF Output Connector		BNC Female

20.473 MHz OUTPUT	
Connector	BNC female
Frequency	20.473 MHz (locked) 20.473MHz ± 65 Hz (unlocked)
Output level	minimum 500 mV pp, 50 Ω

1PPS OUTPUT			
Connector		BNC female	
Signal description		A one-pulse-per-second Time Sync output. This is a normally high, active low pulse (200 µs) where the falling edge is the reference.	
Output level	Voltage	(High)	> 2.4 VDC
		(Low)	< 0.55 VDC
	Minimum load impedance		50 Ω

DEFAULT CHANNEL ASSIGNMENTS – NES / UPC RECEIVER SUBSYSTEM

Port	Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
L1-C/A	0	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	1	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	2	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	3	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	4	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	5	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	6	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	7	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	8	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	9	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	11	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	12	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	13	GPS	L1 C/A	MEDLL	GPS	GPS	50	No	Automatic
	14	MSAS	L1 C/A	MEDLL	MSAS	MSAS	500	Yes	Idle
	15	MSAS	L1 C/A	MEDLL	MSAS	MSAS	500	Yes	Idle

Port	Channel	SV Type	Code	DLL Type	Frame	Nav Type	Symbol Rate	FEC	Sky Search
L1/L2 I	0	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
&	1	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
L1/L2 II	2	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	3	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	4	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	5	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	6	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	7	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	8	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	9	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	10	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	11	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	12	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	13	GPS	L1 C/A	Wide Corr.	GPS	GPS	50	No	Automatic
	14	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Idle
	15	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Idle
	16	GPS	L1 C/A, L2 P	Narrow Corr.	GPS	GPS	50	No	Idle
				OR					
	17	MSAS	L1 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle
	18	MSAS	L1 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle
	19	MSAS	L2 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle
	20	MSAS	L2 C/A	Wide Corr.	MSAS	MSAS	500	Yes	Idle

On the L1/L2 I and L1/L2 II ports, it is possible to use either Channels 0-16 or Channels 17-20, but not both.

D INFORMATION MESSAGES

While operating the MSAS / NES / UPC receiver, there may be additional messages output by the receiver that you may observe. This information is in addition to typical log data as described in this manual, and falls into two categories:

Type 1: Messages that occur as a result of an operational error within the receiver, over which you have no control. These appear in typical NovAtel log format.

Type 2: Messages that occur in response to your input. These are not in typical log format.

The following sections describe these messages.

TYPE 1 INFORMATION MESSAGES

As mentioned, Type 1 information messages indicate that there is a problem with the operation of the on-board firmware. To date, the only Type 1 messages in use are the !ERRA and the !MSGA logs.

If you receive the !ERRA message, it may be useful to reload the software using the correct authorization code; see *Table 11* for a list of !ERRA message types. Each of these messages causes a "severity fatal" condition to be set, causing the card to be reset. To reload the software, power down the receiver and follow the procedure outlined in *Chapter 4*. Under certain of the error conditions, the card will reset itself and resolve the difficulty.

If, after verifying that the software has been correctly loaded, and the receiver cannot reset itself to function normally, contact NovAtel Customer Service.

The !MSGA log would be output if the software is a time-limited version. The log will provide the expiry date of the software. See *Table 12* for a list of !MSGA message types.

!ERRA

`!ERRA` `type` `severity` `error string` `opt desc` `*xx` `[CR][LF]`

Field #	Field type	Data Description	Example
1	!ERRA	Log header	!ERRA
2	type	Log type, numbered 0 - 999 (see *Table 11*)	1
3	severity	Only one is defined to date: severity_fatal (number = 0); causes the receiver to be reset	0
4	error string	Error message (see *Table 11*)	Authorization code invalid
5	*opt desc*	Optional additional description	
6	*xx	Checksum	*22
7	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
!ERRA,1,0,Authorization Code Invalid,*22[CR][LF]
```

Table 11 Type 1 !ERRA Messages

Log type	Error String
0	Unknown ERRA Type
1	Authorization Code Invalid
2	No Authorization Code Found
3	Invalid Expiry In Authorization Code
4	Unable To Read ESN
6	Card Has Stopped Unexpectedly
7	Incorrect Number of Cards Found
8	Software Version Mismatch

!MSGA

`!MSGA` `type` `message` `opt desc` `*xx` `[CR][LF]`

Field #	Field type	Data Description	Example
1	!MSGA	Log header	!MSGA
2	type	Log type, numbered from 1000 (see *Table 12*)	1001
3	message	Message (see *Table 12*)	Authorization Code is Time Limited
4	opt. description	Optional description	Model 3951R expires on 960901
5	*xx	Checksum	*6C
6	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
!MSGA,1001,Authorization Code Is Time Limited, Model 3951R Expires on 960901
*6C[CR][LF]
```

Table 12 Type 1 !MSGA Messages

Log type	Message String
1000	Unknown MSGA Type
1001	Authorization Code Is Time Limited

TYPE 2 INFORMATION MESSAGES

The following is a list of information messages that are generated by the Command Interpreter in the receiver in response to your input. This list is not necessarily complete, but it is the most accurate one available at the time of publication.

Table 13 Type 2 Information Messages

Error Message	Meaning
All OK	No errors to report.
Argument Must Be Hexadecimal (0-9,A-F) Pairs	An argument which is not hexadecimal was entered.
Argument Must Be Numeric	An argument which is not numeric was entered.
Authorization Changes Not Available On This Card	An attempt has been made to change the Authorization Code on a card which is not an OEM card.
Authorization Code Entered Incorrectly	The checksum is incorrect for the Authorization Code. The Authorization Code was most likely entered incorrectly.
Authorization Code Is Invalid	The existing Authorization Code is invalid. Please contact NovAtel GPS customer service for a new Authorization Code.
Can't Change Authorization Code	The existing Authorization Code cannot be changed. Please contact NovAtel GPS customer service for assistance.
Clock Model not set TM1A rejected	The clock model status in a $TM1A command is invalid. The $TM1A command is rejected when the clock model has not been set.
CLOCK_ADJUST Command Not Available On This Model	The CLOCKADJUST command is not available on this model.
Complete Almanac not received yet - try again later	The almanac cannot be saved because a complete almanac has not yet been received. A SAVEALMA command should be performed at a later time when a complete almanac has been received.
Data Too Large To Save To NVM	The configuration data being saved is too large.
Differential Corrections Not Available On This Model	This model does not have the ability to send or receive differential corrections.
EXTERNALCLOCK Command Not Available On This Model	The EXTERNALCLOCK command is not available on this model.
FREQUENCY_OUT Command Not Available On This Model	The FREQUENCY_OUT command is not available on this model.
FROM port name too LONG	The FROM port name in a SETNAV command is too long.
Invalid $ALMA CheckSum	The checksum of a $ALMA command is invalid.
Invalid $DCSA CheckSum	The checksum of a $DCSA command is invalid.
Invalid $IONA CheckSum	The checksum of a $IONA command is invalid.
Invalid $PXYA CheckSum	The checksum of a $PXYA command is invalid.
Invalid $REPA CheckSum	The checksum of a $REPA command is invalid.
Invalid $RTCA CheckSum/CRC	The CRC of a $RTCA command is invalid.
Invalid $RTCM CheckSum	The checksum of a $RTCA command is invalid.
Invalid $TM1A CheckSum	The checksum of a $TM1A command is invalid.
Invalid $UTCA CheckSum	The checksum of a $UTCA command is invalid.
Invalid $VXYA CheckSum	The checksum of a $VXYA command is invalid.
Invalid ADJUSTCLOCK Option	An invalid CLOCKADJUST switch has been entered.
Invalid Baud Rate	The bit rate in a COM1 command is invalid.
Invalid Carrier Smoothing Constant	The carrier smoothing constant of the CSMOOTH command is invalid.
Invalid Channel Number	An invalid channel number has been entered in a command such as ASSIGN.
Invalid Coarse Modulus Field	The coarsemod argument of the FREQUENCY_OUT command is invalid.
Invalid Command CRC	The received command has an invalid checksum.
Invalid Command Name	An invalid command name has been received.
Invalid Command Option	One or more arguments of a command are invalid.
Invalid Coordinates	Invalid coordinates received in a command such as $PVCA, $PXYA, etc.

Invalid Datatype	The data type in an ACCEPT command is invalid.
Invalid Datum Offset	The datum offset in a USERDATUM command is invalid.
Invalid DATUM Option	An option in a DATUM command is invalid.
Invalid Datum Rotation	The datum rotation angle in a USERDATUM command is invalid.
Invalid Degree Field	An invalid degree field has been entered in a command such as FIX POSITION or SETNAV.
Invalid DGPS time-out value	An invalid timeout value was entered in the DGPSTIMEOUT command.
Invalid Doppler	An invalid Doppler has been entered in an ASSIGN command.
Invalid Doppler Window	An invalid Doppler window has been entered in an ASSIGN command.
Invalid DTR choice	An invalid option was entered in the COMn_DTR command.
Invalid DTR Toggle Option	The active option in the COMn_ DTR command is invalid.
Invalid DTR Toggle Setup Time (0-1000)	The lead time option in the COMn_ DTR command is invalid.
Invalid DTR Toggle Terminate Time (0-1000)	The tail time option in the COMn_ DTR command is invalid.
Invalid DYNAMICS Option	The option in a DYNAMICS command is invalid.
Invalid Echo Option	The echo option in a COM1 command is invalid.
Invalid Elevation Cutoff Angle	The elevation cutoff angle in an ECUTOFF command is invalid.
Invalid ERRMSG Flag	The option (on/off) specified in a MESSAGE command is invalid.
Invalid ERRMSG Port	The port specified in a MESSAGE command is invalid.
Invalid EXTERNALCLOCK Option	An invalid external clock was entered in the EXTERNALCLOCK command.
Invalid EXTERNALCLOCK USER Argument(s)	An invalid argument was entered in the EXTERNALCLOCK command.
Invalid Fine Modulus Field	The finemod argument of the FREQUENCY_OUT command is invalid.
Invalid FIX Option	An option other than height, position or velocity was specified in a FIX command.
Invalid Flattening	The flattening in a USERDATUM command is invalid.
Invalid Handshake Option	The handshake option in a COM1 command is invalid.
Invalid HEALTH Override	An invalid health has been entered in a SETHEALTH or FIX command.
Invalid Height	The height in a FIX HEIGHT command is invalid.
Invalid Logger Datatype	An invalid log has been specified in a LOG/UNLOG command.
Invalid Logger Offset	An invalid offset has been specified in a LOG command.
Invalid Logger Period	An invalid period has been specified in a LOG command.
Invalid Logger Port Option	An invalid port number has been specified in a LOG/UNLOG command.
Invalid Logger Trigger	An invalid trigger has been specified in a LOG command.
Invalid Magnetic Variation	The magnetic variation in a MAGVAR command is invalid.
Invalid Number of $ALMA Arguments	The number of arguments in a $ALMA command is invalid.
Invalid Number of $DCSA Arguments	The number of arguments in a $DCSA command is invalid.
Invalid Number of $IONA Arguments	The number of arguments in a $IONA command is invalid.
Invalid Number of $PXYA Arguments	The number of arguments in a $PXYA command is invalid.
Invalid Number of $REPA Arguments	The number of arguments in a $REPA command is invalid.
Invalid Number of $TM1A Arguments	The number of arguments in a $TM1A command is invalid.
Invalid Number of $UTCA Arguments	The number of arguments in a $UTCA command is invalid.
Invalid Number of $VXYA Arguments	The number of arguments in a $VXYA command is invalid.
Invalid Number of Arguments	A command has been received which has an invalid number of arguments.
Invalid Number of Databits	The number of data bits in a COM1 command is invalid.
Invalid Number of StopBits	The number of stop bits in a COM1 command is invalid.
Invalid Parity Option	The parity in a COM1 command is invalid.
Invalid Port	The port in a SEND command is invalid.
Invalid Port number	The port number in an ACCEPT command is invalid.
Invalid PPS Modulus Field	The ppsmod argument of the FREQUENCY_OUT command is invalid.
Invalid RINEX Option	An option of a RINEX command is invalid.
Invalid RTCA option	An invalid RTCA rule has been entered.
Invalid RTCA station Name (\XXXX\)	The RTCA station name in a FIX POSITION message is invalid.
Invalid RTCM Bit Rule	An invalid RTCM rule has been entered.

Invalid RTCM station Name (0..1023)	The RTCM station name in a FIX POSITION message is invalid.
Invalid RTCM16T string length - maximum 90	The RTCM16T string exceeds 90 characters.
Invalid RTS choice	An invalid option was entered in the COMn_RTS command.
Invalid RTS Toggle Option	The active option in the COMn_RTS command is invalid.
Invalid RTS Toggle Setup Time (0-1000)	The lead time option in the COMn_RTS command is invalid.
Invalid RTS Toggle Terminate Time (0-1000)	The tail time option in the COMn_RTS command is invalid.
Invalid Satellite Number	An invalid satellite number has been entered in an ASSIGN, SETHEALTH, LOCKOUT or UNLOCKOUT command.
Invalid Scaling	The scale value in a USERDATUM command is invalid.
Invalid Seconds Into Week in TM1A	The time in a $TM1A command is invalid.
Invalid SemiMajor Axis	The semi-major axis in a USERDATUM command is invalid.
Invalid Standard Deviation Limit (0.1-100 m)	A standard deviation in a POSSE command is invalid.
Invalid Symbol Period 1,2,4,5,10,20	The symbol period is invalid for an ASSIGN on a pseudolite channel.
Invalid Time Limit (0.1-100 hours)	The averaging time in a POSAVE command is invalid.
Invalid Token	This error should never occur. If it does, please contact NovAtel GPS customer service.
Invalid Track Offset	The track offset in the SETNAV command is invalid.
Invalid Velocity	An invalid velocity has been received, either in a FIX VELOCITY command, or in a command such as $PVCA, $PVCB.
Invalid Week Number in TM1A	The week in a $TM1A command is invalid.
MET Command Not Available On This Model	The MET command is not available on this model.
Model Invalid	The Authorization Code has an invalid Model. Please contact NovAtel GPS customer service for assistance.
NVM Error - Unable To Save	The SAVE operation did not complete successfully.
RINEX string too LONG	Indicates that the entered RINEX command is too long.
RT20 Logs Not Available On This Model	This model does not have the ability to send or receive RT20 differential corrections.
RTCM9 Logs Not Available On This Model	This model does not have the ability to send or receive RTCM9 logs.
SAVE Command Not Available On This Model	A SAVE operation was attempted which is not available on this model.
Save Complete	The SAVE operation completed successfully.
SETCLOCK disabled TM1A rejected	The $TM1A command is rejected because the user has not enabled clock synchronization using the SETCLOCK command.
Standard Deviation not allowed with small time limits	In a POSAVE command, a standard deviation cannot be entered with a small time. Enter a larger averaging time if standard deviations are desired.
TO Portname too LONG	The TO port name in a SETNAV command is too long.
User Defined DATUM Not Set	This error should not occur. By default the user defined DATUM is set to WGS-84. If you get this error message, please contact NovAtel GPS customer service.
Valid Option but Missing Process	This message indicates an error in the software. A command option is valid but software cannot process it

E ASSOCIATED SUPPLIERS

The following is a list of associated suppliers of MSAS / NES / UPC subsystem components. NovAtel does not endorse any of these suppliers and in no way assumes any responsibility for or liabilities associated with any of these suppliers. The Customer assumes sole and full responsibility for selection of suppliers for MSAS / NES / UPC receiver accessories.

Accessory	Supplier (s)	
Antenna Subsystem	P/N 2220NW Micro Pulse Inc. 409 Calle San Pablo Camarillo, CA 93012 USA	Attn: Tom Koster Phone: 1-805-389-3446 ext 225 Fax: 1-805-389-3448 E-mail: tomk@micropulse.com
MSAS / NES / UPC Receiver	MSAS: P/N 01016637 NES / UPC: P/N 01016638 DX Antenna Co. Ltd. 3rd Floor, Hanei Building No. 2 No. 1-10-1, Shinjuku Shinjuku-Ku Tokyo 160, Japan	Attn: Mr. Hideyuki Torimoto Ph: +81 (0)3-3341-5448 Fax: +81 (0)3-3341-1980 Email: LDP06265@niftyserve.or.jp
Atomic Clock	P/N FTS 4040A/RS/003 (Raytheon WAAS standard) Datum Frequency & Time Systems 34 Tozer Road Beverly, MA 01915-5510 USA	Attn: David Briggs Phone: 1-978- 927-8220 Fax: 1-978- 927-4099 E-mail: marketing@ftsdatum.com
Power connector: 3-position inline plug to mate to the one on the MSAS / NES / UPC receiver	P/N 25-723-0 MODE Electronics Ltd. 6879 Royal Oak Avenue Burnaby, BC Canada V5J 4J3 Phone: 1-604-435-6633 or 1-800-663-4992 Fax: 1-604-435-8890 E-mail: info@mode-elec.com Web site: http://www.mode-elec.com	The same MODE product can also be ordered from: Farnell Electronics Inc. 18 Technology Drive, #200 Irvine, California USA 92718 Phone: 1-714-727-4001 Fax: 1-714-727-2109 Web site: http://www.farnell.com.
MSAS System Supplier	NEC Corporation 1-10, Nisshincho, Fuchu,Tokyo 183 Japan	Attn: Takashi Nishimura Phone: +81-423-33-1180 Fax: +81-423-33-1970 Email: nisimura@ras.dnp.fc.nec.co.jp
WAAS System Supplier	Raytheon Systems Company Loc. FU, Bldg. TC16, M/S B108 1801 Hughes Drive PO Box 3310 Fullerton, CA 92634-3310	Attn: Elaine Brereton Phone: 1-714-446-2556 Fax: 1-714-446-3203 E-mail: ebrereton@ccgate.hac.com

INDEX

1 PPS port, 9, 89
1PPS, 5, 9, 23, 24, 45, 46, 82, 89, 93, 94, 97, 98
20.473 MHz output, 5, 11, 91, 94, 98
accumulated Doppler, 72, 73
almanac, 5, 45, 53, 54, 65, 71, 76, 82, 83, 93, 97, 102
antenna, 3, 4, 6, 7, 10, 12, 23, 24, 28, 33, 34, 66, 74, 75, 76, 77, 87, 90
antenna phase centre, 33, 66
ASCII format, 47
auth-code, 15, 16, 18
azimuth, 80
batch file, 19, 20
binary format, 44, 47
C/N0, 60, 61, 72, 73, 77, 92, 93, 96, 97
carrier phase, 71, 72, 75
carrier smoothing, 23, 24, 32, 102
carrier to code ratio, 29
case sensitive, 22, 28
channel, 2, 4, 22, 23, 24, 27, 28, 29, 30, 31, 32, 39, 40, 45, 59, 60, 61, 71, 72, 78, 84, 85, 102, 104
channel configuration, 31
channel state, 27, 72, 84, 85
checksum, 47, 55, 56, 102
clock drift, 30, 57, 58
clock model status, 57, 82, 102
clock offset, 33, 45, 48, 57, 58, 82
COM1, 8, 13, 14, 17, 22, 31, 35, 36, 42, 43, 44, 55, 56, 69, 77, 89
COM2, 13, 20, 44, 55, 56, 69, 77
comma, 22, 47
communications settings, 12
Doppler, 27, 28, 60, 61, 72, 73, 75, 103
echo response, 13
elevation, 23, 24, 33, 39, 40, 51, 80, 84, 85, 103
elevation cut-off, 33
external frequency reference, 6, 7, 12, 87
external power input, 10, 90
front panel, viii, 4, 8, 12, 13, 88
G2 delay, 23, 24, 28, 29, 40
GDOP, 58, 92, 96
GEO, 1, 4, 5, 27, 31, 87, 90, 92, 93, 96, 97
GPS time, xi, 1, 48, 57, 82
Ground Uplink Station, 2
HDOP, 58
health, 4, 23, 24, 34, 53, 54, 63, 103
HTDOP, 58
idle time, 46, 48, 75, 78, 79
ionospheric, 1, 4, 53, 65, 83
jamming, 23, 24, 25, 26, 34, 74, 75, 76
L1/L2 I, 3, 4, 7, 8, 9, 11, 13, 15, 20, 22, 29, 31, 35, 43, 69, 87, 89, 90, 91, 92, 93, 95, 96, 97, 99
L1/L2 II, 3, 4, 7, 8, 9, 11, 13, 15, 20, 22, 29, 31, 35, 43, 69, 87, 89, 90, 91, 92, 93, 95, 96, 97, 99
L1-C/A, 7, 8, 9, 11, 13, 15, 20, 22, 31, 32, 35, 69, 87, 89, 90, 91, 92, 94, 96, 98
LNA, 6, 10, 87, 90, 93, 97
LOADER, 15, 16, 17, 18, 19, 20
LOADER.SET, 17
locktime, 32, 60, 72
MEDLL, ii, 3, 4, 8, 11, 15, 16, 17, 18, 19, 32, 62, 89, 91, 92, 93, 94, 96, 97, 98
non-volatile memory, 13, 15, 74, 75, 76
PDOP, 58
phase lock, 72, 84, 85
port, serial, 13
position constraints, 41
receiver clock offset, 57, 58, 82
receiver self-test status, 71, 72
reject code, 60, 79, 80
residual, 60, 80
self-test, 50, 72, 73, 74, 76, 78, 79
signal thresholds, 39
space, 15, 22, 27, 48
status, receiver, 13
strobe lines, 11, 91
subframes, 53
TDOP, 58
time, start-up, 12
Time port, 9, 89
tracking status, 27, 45, 59, 60, 61, 71, 72
Type 1 information messages, 100, 101
Type 2 Information Messages, 100, 102
Universal Time Coordinated (UTC) time, 45, 46, 48, 53, 82, 83
updating firmware, 15, 16, 18, 20
upgrading, 15
UTC, 53, 83
UTC offset, 82

NovAtel Inc.
1120 - 68 Avenue N.E.
Calgary, Alberta, Canada T2E 8S5

GPS Hotline (Canada & U.S.A.): 1 800 NOVATEL
Phone: 1 403 295 4900
Fax: 1 403 295 4901

E-mail: support@novatel.ca
Web site: http://www.novatel.ca

Recyclable

Printed in Canada
on recycled paper