NovAtel

A Precise Positioning Technology Company

OEMStar™ Firmware Reference Manual

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OEMStar Receiver - Firmware Reference Manual

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#6,608,998 B1
#6,664,923 B1
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Foreword

Congratulations!

Congratulations on purchasing a NovAtel product. Whether you have bought a stand alone OEM card or a packaged receiver you will have also received companion documents to this manual. They will help you get the hardware operational. Afterwards, this text will be your primary OEMStar command and logging reference.

Scope

This manual describes each command and log that the OEMStar receivers are capable of accepting or generating. Sufficient detail is provided so that you should understand the purpose, syntax, and structure of each command or log and be able to effectively communicate with the receiver, thus enabling you to effectively use and write custom interfacing software for specific needs and applications. The manual is organized into chapters which allow easy access to appropriate information about the receiver.

OEMStar products support Satellite Based Augmentation System (SBAS) signal functionality and GLONASS measurements. For more information, pease refer to the *SBAS Overview* section in the *OEMStar Installation and Operation User Manual* and the Knowledge and Learning page in the Support section of our Web site at www.novatel.com. OEMStar supports NMEA and DGPS. If you have any of these options and wish to learn more about them, please refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com, and see their associated sections in this manual. Commands and logs are tagged to be easily recognizable for cards and options. These tags are shown in more detail in the *Conventions* section starting below.

This manual does not address any of the receiver hardware attributes or installation information. Please consult the *OEMStar Installation and Operation User Manual* for technical information about these topics. Furthermore, should you encounter any functional, operational, or interfacing difficulties with the receiver, consult the same manual for NovAtel warranty and support information.

Conventions

This manual covers the full performance capabilities of all the OEMStar receivers. Feature-tagging symbols have been created to help clarify which commands and logs are only available with certain options. The tags are in the title of the command or log and also appear in tables where features are mentioned as footnotes. The tags are described below:

API	Features only available with receivers equipped with API option.
DGPS_Tx	Features only available with receivers equipped with the DGPS_Tx option
DGPS_Tx & GLO	Features only available with receivers equipped with the DGPS_Tx and GLONASS options
GLO	Features only available with receivers equipped with the GLONASS option
RAIM	Features only available with receivers equipped with the RAIM option

SBAS	SBAS messages and commands available when tracking an SBAS satellite[1]

Other conventions used in this document are described below:

✉	Note that provides information to supplement or clarify the accompanying text.
CAUTION:	Caution that a certain action, operation or configuration may result in incorrect or improper use of the product.
WARNING!:	Warning that a certain action, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage.

- Command defaults:
  - The factory defaults for commands are shown in *Section 2.4, Factory Defaults* on *page 47*. Each factory default is also shown after the syntax but before the example of each command description starting on *page 49*.
  - If you use a command without specifying an optional parameter value, OEMStar will use the default value given in the command table.
- The letter H in the Binary Byte or Binary Offset columns of the commands and logs tables represents the header length for that command or log, see *Section 1.1.3, Binary* on *page 19*.
- The number following 0x is a hexadecimal number.
- Default values shown in command tables indicate the assumed values when optional parameters have been omitted. Default values do not imply the factory default settings, see *Chapter 2, page 47* for a list of factory default settings.
- Command descriptions in brackets, [ ] represent parameters that are optional.
- In tables where values are missing they are assumed to be reserved for future use.
- Status words are output as hexadecimal numbers and must be converted to binary format (and in some cases then also to decimal). For an example of this type of conversion, please see the RANGE log, *Table 62 on page 305*.

  Conversions and their binary or decimal results are always read from right to left. For a complete list of hexadecimal, binary and decimal equivalents, please refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.
- ASCII log examples may be split over several lines for readability. In reality only a single [CR][LF] pair is transmitted at the end of an ASCII log.
- Relevant SBAS commands and logs start with WAAS except for RAWWAASFRAME. Generally, the PRN field of the WAASx logs is common, and

1.Refer to the *SELECTCHANCONFIG* command on *page 138* for more information.

indicates the SBAS satellite that the message originated from. Please refer to the RTCA document *RTCA D0-229B, Appendix A Wide Area Augmentation System Signal Specification* for details.

You can download the most up-to-date version of this manual, and any addendums, from our Web site at http://www.novatel.com/support/firmware-software-and-manuals/.

What's New in Rev 5 of this Manual?

The manual has been revised to include information on the following:

- GLONASS-only positioning and timing are now available on the OEMStar. to support this functionality, the SETTIMEBASE command has been added and the SELECTCHANCONFIG command has been revised.
- New channel configurations to support multi-system timing. See the SELECTCHANCONFIG command description for more details.
- RAIM is now a feature available on the OEMStar. To support this functionality, the RAIMMODE command and RAIMSTATUS log have been added to this manual.
- User developed applications (API) is now available on the OEMStar.
- Updated command and log descriptions for: AUTH, VERSION, PPSCONTROL
- Additional new logs: CLOCKMODEL2, PSRDOP2
- Removed logs: PSRVELOCITYTYPE

Prerequisites

As this reference manual is focused on the OEMStar commands and logging protocol, it is necessary to ensure that the receiver has been properly installed and powered up according to the instructions outlined in the companion *OEMStar Installation and Operation User Manual* before proceeding.

Chapter 1 Messages

1.1 Message Types

The receiver handles incoming and outgoing NovAtel data in three different message formats: Abbreviated ASCII, ASCII, and Binary. This allows for a great deal of versatility in the way the OEMStar receivers can be used. All NovAtel commands and logs can be entered, transmitted, output or received in any of the three formats. The receiver also supports RTCA, RTCM, and NMEA format messaging. For more information about message formats, refer to the *OEMStar Installation and Operation User Manual*.

When entering an ASCII or abbreviated ASCII command in order to request an output log, the message type is indicated by the character appended to the end of the message name. ‘A’ indicates that the message is ASCII and ‘B’ indicates that it is binary. No character means that the message is Abbreviated ASCII. When issuing binary commands the output message type is dependent on the bit format in the message’s binary header (see *Binary* on *page 19*).

Table 1, below, describes the field types used in the description of messages.

Table 1: Field Types

Type	Binary Size (bytes)	Description
Char	1	The **char** type is an 8-bit integer in the range -128 to +127. This integer value may be the ASCII code corresponding to the specified character. In ASCII or Abbreviated ASCII this comes out as an actual character.
UChar	1	The **uchar** type is an 8-bit unsigned integer. Values are in the range from +0 to +255. In ASCII or Abbreviated ASCII this comes out as a number.
Short	2	The short type is 16-bit integer in the range -32768 to +32767.
UShort	2	The same as Short except that it is not signed. Values are in the range from +0 to +65535.
Long	4	The **long** type is 32-bit integer in the range -2147483648 to +2147483647.
ULong	4	The same as Long except that it is not signed. Values are in the range from +0 to +4294967295.
Double	8	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. This is IEEE 754.

Continued on the following page

Type	Binary Size (bytes)	Description
Float	4	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. This is IEEE 754.
Enum	4	A 4-byte enumerated type beginning at zero (an unsigned long). In binary, the enumerated value is output. In ASCII or Abbreviated ASCII, the enumeration label is spelled out.
GPSec	4	This type has two separate formats that depend on whether you have requested a binary or an ASCII format output. For binary the output is in milliseconds and is a **long** type. For ASCII the output is in seconds and is a **float** type.
Hex	n	Hex is a packed, fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs.
String	n	String is a variable length array of bytes that is null-terminated in the binary case and additional bytes of padding are added to maintain 4 byte alignment. The maximum byte length for each String field is shown in their row in the log or command tables.

Table 2: Byte Arrangements

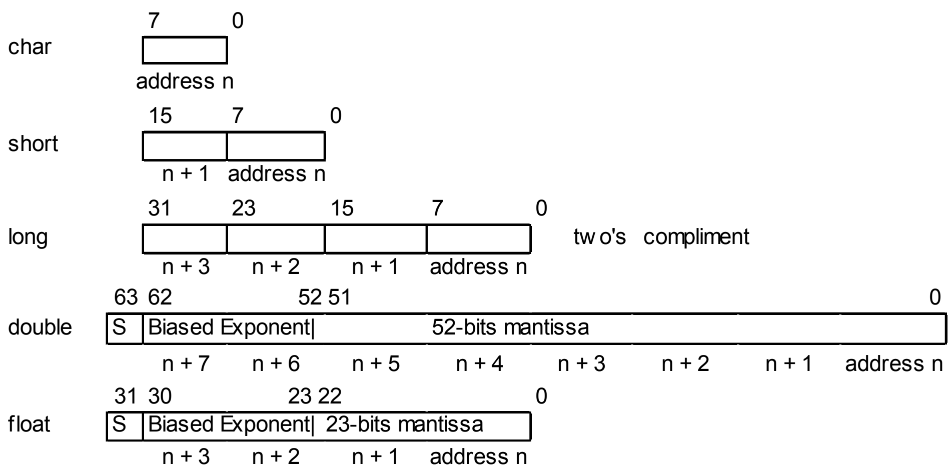

Table 2 shows the arrangement of bytes within each field type when used by IBM PC computers. All data sent to or from the OEMStar receiver, however, is read least significant bit (LSB) first, opposite to what is shown in *Table 2*. Data is then stored in the receiver LSB first. For example, in char type data, the LSB is bit 0 and the most significant bit (MSB) is bit 7. See *Table 62, Channel Tracking Example* on *page 305* for a more detailed example.

1.1.1 ASCII

ASCII messages are readable by both the user and a computer. The structures of all ASCII messages follow the general conventions as noted here:

1. The lead code identifier for each record is '#'.
2. Each log or command is of variable length depending on amount of data and formats.
3. All data fields are delimited by a comma ',' with two exceptions. The first exception is the last header field which is followed by a ‘;’ to denote the start of the data message. The other exception is the last data field, which is followed by a * to indicate end of message data.
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, for example, *1234ABCD[CR][LF]. This value is a 32-bit CRC of all bytes in the log, excluding the '#' identifier and the asterisk preceding the four checksum digits. See *1.7, 32-Bit CRC on page 30* for the algorithm used to generate the CRC.
5. An ASCII string is one field and is surrounded by double quotation marks, for example, “ASCII string”. If separators are surrounded by quotation marks then the string is still one field and the separator will be ignored, for example, “xxx,xxx” is one field. Double quotation marks within a string are not allowed.
6. If the receiver detects an error parsing an input message, it will return an error response message. Please see *Chapter 4, Responses on page 415* for a list of response messages from the receiver.

Message Structure:

header;	data field...,	data field...,	data field...	*xxxxxxxx	[CR][LF]

The ASCII message header structure is described in *Table 3* on the next page.

Table 3: ASCII Message Header Structure

Field #	Field Name	Field Type	Description	Ignored on Input
1	Sync	Char	Sync character. The ASCII message is always preceded by a single '#' symbol.	N
2	Message	Char	This is the ASCII name of the log or command (lists are in *Table 10, page 37* and *Table 40, page 183*).	N
3	Port	Char	This is the name of the port from which the log was generated. The string is made up of the port name followed by an _x where x is a number from 1 to 31 denoting the virtual address of the port. If no virtual address is indicated, it is assumed to be address 0.	Y
4	Sequence #	Long	This is used for multiple related logs. It is a number that counts down from N-1 to 0 where 0 means it is the last one of the set. Most logs only come out one at a time in which case this number is 0.	N
5	% Idle Time	Float	The minimum percentage of time that the processor is idle between successive logs with the same Message ID.	Y
6	Time Status	Enum	This value indicates the quality of the GPS reference time (see *Table 8, GPS Reference Time Status* on *page 27*)	Y
7	Week	Ulong	GPS reference week number.	Y
8	Seconds	GPSec	Seconds from the beginning of the GPS reference week accurate to the millisecond level.	Y
9	Receiver Status	Ulong	This is an eight digit hexadecimal number representing the status of various hardware and software components of the receiver between successive logs with the same Message ID (see *Table 69, Receiver Status* on *page 350*).	Y
10	Reserved	Ulong	Reserved for internal use.	Y
11	Receiver s/w Version	Ulong	This is a value (0 - 65535) that represents the receiver software build number.	Y
12	;	Char	This character indicates the end of the header.	N

Example Log:

```
#RAWEPHEMA,COM1,0,35.0,SATTIME,1364,496230.000,00100000,97b7,2310;
30,1364,496800,8b0550a1892755100275e6a09382232523a9dc04ee6f794a0000090394ee,8b05
50a189aa6ff925386228f97eabf9c8047e34a70ec5a10e486e794a7a,8b0550a18a2effc2f80061c
2fffc267cd09f1d5034d3537affa28b6ff0eb*7a22f279
```

1.1.2 Abbreviated ASCII

This message format is designed to make the entering and viewing of commands and logs by the user as simple as possible. The data is represented as simple ASCII characters separated by spaces or commas and arranged in an easy to understand fashion. There is also no 32-bit CRC for error detection because it is meant for viewing by the user.

Example Command:

```
log com1 loglist
```

Resultant Log:

```
<LOGLIST COM1 0 69.0 FINE 0 0.000 00240000 206d 0
<     4
<          COM1 RXSTATUSEVENTA ONNEW 0.000000 0.000000 NOHOLD
<          COM2 RXSTATUSEVENTA ONNEW 0.000000 0.000000 NOHOLD
<          COM1 LOGLIST ONCE 0.000000 0.000000 NOHOLD
```

As you can see the array of 4 logs are offset from the left hand side and start with ‘<’.

1.1.3 Binary

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

1. Basic format of:

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

   Data — variable

   CRC — 4 bytes

2. The 3 Sync bytes will always be:

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

3. The CRC is a 32-bit CRC (see *1.7, 32-Bit CRC on page 30* for the CRC algorithm) performed on all data including the header.

4. The header is in the format shown in *Table 4, Binary Message Header Structure* on *page 20*.

Table 4: Binary Message Header Structure

Field #	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignored on Input
1	Sync	Char	Hexadecimal 0xAA.	1	0	N
2	Sync	Char	Hexadecimal 0x44.	1	1	N
3	Sync	Char	Hexadecimal 0x12.	1	2	N
4	Header Lgth	Uchar	Length of the header.	1	3	N
5	Message ID	Ushort	This is the Message ID number of the log (see the log descriptions in *Table 41, OEMStar Logs in Order of their Message IDs* on *page 187* for the Message ID values of individual logs).	2	4	N
6	Message Type	Char	Bits 0-4 = Reserved Bits 5-6 = Format 00 = Binary 01 = ASCII 10 = Abbreviated ASCII, NMEA 11 = Reserved Bit 7 = Response bit (see *Section 1.2, page 24*) 0 = Original Message 1 = Response Message	1	6	N
7	Port Address	Uchar	See *Table 4* on *page 19* (decimal values greater than 16 may be used) (lower 8 bits only) [a]	1	7	N [b]
8	Message Length	Ushort	The length in bytes of the body of the message. This does not include the header nor the CRC.	2	8	N

Continued on the following page

Table 4: Binary Message Header Structure (continued)

Field #	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignored on Input
9	Sequence	Ushort	This is used for multiple related logs. It is a number that counts down from N-1 to 0 where N is the number of related logs and 0 means it is the last one of the set. Most logs only come out one at a time in which case this number is 0.	2	10	N
10	Idle Time	Uchar	The time that the processor is idle in the last second between successive logs with the same Message ID. Take the time (0 - 200) and divide by two to give the percentage of time (0 - 100%).	1	12	Y
11	Time Status	Enum	Indicates the quality of the GPS reference time (see *Table 8, GPS Reference Time Status* on *page 27*).	1 [c]	13	N [d]
12	Week	Ushort	GPS reference week number.	2	14	N [d]
13	ms	GPSec	Milliseconds from the beginning of the GPS reference week.	4	16	N [d]
14	Receiver Status	Ulong	32 bits representing the status of various hardware and software components of the receiver between successive logs with the same Message ID (see *Table 69, Receiver Status* on *page 350*)	4	20	Y
15	Reserved	Ushort	Reserved for internal use.	2	24	Y
16	Receiver S/W Version	Ushort	This is a value (0 - 65535) that represents the receiver software build number.	2	26	Y

a. The 8 bit size means that you will only see 0xA0 to 0xBF when the top bits are dropped from a port value greater than 8 bits. For example ASCII port USB1 will be seen as 0xA0 in the binary output.

b. Recommended value is THISPORT (binary 192)

Table 5: Detailed Serial Port Identifiers

ASCII Port Name	Hex Port Value	Decimal Port Value [a]	Description
NO_PORTS	0	0	No ports specified
COM1_ALL	1	1	All virtual ports for COM port 1
COM2_ALL	2	2	All virtual ports for COM port 2
THISPORT_ALL	6	6	All virtual ports for the current port
ALL_PORTS	8	8	All virtual ports for all ports
XCOM1_ALL	9	9	All virtual COM1 ports
XCOM2_ALL	10	10	All virtual COM2 ports
USB1_ALL	d	13	All virtual ports for USB port 1
USB2_ALL	e	14	All virtual ports for USB port 2
USB3_ALL	f	15	All virtual ports for USB port 3
XCOM3_ALL	11	17	All virtual COM3 ports
COM1	20	32	COM port 1, virtual port 0
COM1_1	21	33	COM port 1, virtual port 1
. . .			
COM1_31	3f	63	COM port 1, virtual port 31
COM2	40	64	COM port 2, virtual port 0
. . .			
COM2_31	5f	95	COM port 2, virtual port 31
USB	80	128	USB port, virtual port 0
. . .			
USB_31	9f	159	USB port, virtual port 31
SPECIAL	a0	160	Unknown port, virtual port 0
. . .			
SPECIAL_31	bf	191	Unknown port, virtual port 31
THISPORT	c0	192	Current COM port, virtual port 0
. . .			
THISPORT_31	df	223	Current COM port, virtual port 31
XCOM1	1a0	416	Virtual COM1 port, virtual port 0
XCOM1_1	1a1	417	Virtual COM1 port, virtual port 1
. . .			
XCOM1_31	1bf	447	Virtual COM1 port, virtual port 31
XCOM2	2a0	672	Virtual COM2 port, virtual port 0

Continued on the following page

Table 5: Detailed Serial Port Identifiers (continued)

ASCII Port Name	Hex Port Value	Decimal Port Value [a]	Description
XCOM2_1	2a1	673	Virtual COM2 port, virtual port 1
. . .			
XCOM2_31	2bf	703	Virtual COM2 port, virtual port 31
USB1	5a0	1440	USB port 1, virtual port 0
USB1_1	5a1	1441	USB port 1, virtual port 1
. . .			
USB1_31	5bf	1471	USB port 1, virtual port 31
USB2	6a0	1696	USB port 2, virtual port 0
. . .			
USB2_31	6bf	1727	USB port 2, virtual port 31
USB3	7a0	1952	USB port 3, virtual port 0
. . .			
USB3_31	7bf	1983	USB port 3, virtual port 31
XCOM3	9a0	2464	Virtual COM3 port, virtual port 0
. . .			
XCOM3_31	9bf	2495	Virtual COM3 port, virtual port 31

a. Decimal port values 0 through 16 are only available to the UNLOGALL command (see *page 166*) and cannot be used in the UNLOG command (see *page 165)* or in the binary message header (see *Table 4* on *page 19*).

✉ COM1_ALL, COM2_ALL, THISPORT_ALL, ALL_PORTS, USB1_ALL, USB2_ALL, and USB3_ALL are only valid for the UNLOGALL command.

1.2 Responses

By default, if you input a message you will get back a response. If desired, the INTERFACEMODE command can be used to disable response messages (see *page 100*). The response will be in the exact format that you entered the message (that is, binary input = binary response).

1.2.1 Abbreviated Response

Just the leading '<' followed by the response string, for example:

<OK

1.2.2 ASCII Response

Full header with the message name being identical except ending in an 'R' (for response). The body of the message consists of a 40 character string for the response string, for example:

#ECUTOFFR,COM1,0,57.0,FINESTEERING,1592,329121.246,00000000,b8e2,38640;OK*bb31b3ff

1.2.3 Binary Response

Similar to an ASCII response except that it follows the binary protocols (see *Table 6, Binary Message Response Structure* on *page 25*).

Table 7, Binary Message Sequence on *page 26* is an example of the sequence for requesting and then receiving BESTPOSB. The example is in hex format. When you enter a hex command, you may need to add a '\x' or '0x' before each hex pair, depending on your code (for example, 0xAA0x440x120x1C0x010x000x02 and so on).

Table 6: Binary Message Response Structure

	Field #	Field Name	Field Type	Description	Binary Bytes	Binary Offset
BINARY HEADER	1	Sync	Char	Hexadecimal 0xAA.	1	0
	2	Sync	Char	Hexadecimal 0x44.	1	1
	3	Sync	Char	Hexadecimal 0x12.	1	2
	4	Header Lgth	Uchar	Length of the header.	1	3
	5	Message ID	Ushort	Message ID number	2	4
	6	Message Type	Char	Bit 7 = Response Bit 1 = Response Message	1	6
	7	Port Address	Uchar	See *Table 4* on *page 19*	1	7
	8	Message Length	Ushort	The length in bytes of the body of the message (not the CRC).	2	8
	9	Sequence	Ushort	Normally 0	2	10
	10	Idle Time	Uchar	Idle time	1	12
	11	Time Status	Enum	*Table 8* on *page 27*	1 [a]	13
	12	Week	Ushort	GPS reference week number	2	14
	13	ms	GPSec	Milliseconds into GPS reference week	4	16
	14	Receiver Status	Ulong	*Table 68* on *page 348*	4	20
	15	Reserved	Ushort	Reserved for internal use	2	24
	16	Receiver S/W Version	Ushort	Receiver software build number.	2	26
ID	17	Response ID	Enum	*Table 80, Response Messages* on *page 415*	4	28
HEX	18	Response	Hex	String containing the ASCII response in hex coding to match the ID above (for example, 0x4F4B = OK)	variable	32

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

Table 7: Binary Message Sequence

Direction	Sequence	Data
To Receiver	LOG Command Header	AA44121C 01000240 20000000 1D1D0000 29160000 00004C00 55525A80
	LOG Parameters	20000000 2A000000 02000000 00000000 0000F03F 00000000 00000000 00000000
	Checksum	2304B3F1
From Receiver	LOG Response Header	AA44121C 01008220 06000000 FFB4EE04 605A0513 00004C00 FFFF5A80
	Log Response Data	01000000 4F4B
	Checksum	DA8688EC
From Receiver	BESTPOSB Header	AA44121C 2A000220 48000000 90B49305 B0ABB912 00000000 4561BC0A
	BESTPOSB Data	00000000 10000000 1B0450B3 F28E4940 16FA6BBE 7C825CC0 0060769F 449F9040 A62A82C1 3D000000 125ACB3F CD9E983F DB664040 00303030 00000000 00000000 0B0B0000 00060003
	Checksum	42DC4C48

1.3 GLONASS Slot and Frequency Numbers

OEMStar can track a total of 14 channels (GPS + GLONASS + SBAS), which can include a maximum of 6 GLONASS channels (see *Table 13, OEMStar Channel Configurations* on *page 54*).

When a PRN in a log is in the range 38 to 61, then that PRN represents a GLONASS Slot where the Slot shown is the actual GLONASS Slot Number plus 37.

Similarly, the GLONASS Frequency shown in logs is the actual GLONASS Frequency plus 7.

For example:

```
#SATVISA,COM1,0,53.5,FINESTEERING,1363,234894.000,00000000,0947,2277;
TRUE,TRUE,46,
2,0,0,73.3,159.8,934.926,934.770,
...
43,8,0,-0.4,163.7,4528.085,4527.929,
...
3,0,0,-79.9,264.3,716.934,716.778*b94813d3
```

where 2 and 3 are GPS satellites and 43 is a GLONASS satellite. Its actual GLONASS Slot Number is 6. The SATVIS log shows 43 (6+ 37). Its actual GLONASS frequency is 1. The SATVIS log shows 8 (1+7). See also the SATVIS log on *page 357*.

Refer to the Knowledge and Learning page in the Support section of out Web site at www.novatel.com for more information.

1.4 GPS Reference Time Status

All reported receiver times are subject to a qualifying time status. This status gives you an indication of how well a time is known, see *Table 8*:

Table 8: GPS Reference Time Status

GPS Reference Time Status (Decimal)	GPS Reference Time Status [a] (ASCII)	Description
20	UNKNOWN	Time validity is unknown.
60	APPROXIMATE	Time is set approximately.
80	COARSEADJUSTING	Time is approaching coarse precision.
100	COARSE	This time is valid to coarse precision.
120	COARSESTEERING	Time is coarse set, and is being steered.
130	FREEWHEELING	Position is lost, and the range bias cannot be calculated.
140	FINEADJUSTING	Time is adjusting to fine precision.
160	FINE	Time has fine precision.
170	FINEBACKUPSTEERING	Time is fine set and is being steered by the backup system.
180	FINESTEERING	Time is fine-set and is being steered.
200	SATTIME	Time from satellite. This is only used in logs containing satellite data such as ephemeris and almanac.

a. See also *Section 1.5, Message Time Stamps on page 28*

There are several distinct states that the receiver will go through when CLOCKADJUST is enabled:

- UNKNOWN (initial state)
- COARSESTEERING (initial coarse time set)
- FINESTEERING (normal operating state)
- FINEBACKUPSTEERING (when the back-up system is used for time)
- FREEWHEELING (when range bias becomes unknown)

and when the CLOCKADJUST is disabled:

- UNKNOWN (initial state)
- COARSE (initial coarse time set)

FINE (normal operating state)On start up, and before any satellites are being tracked, the receiver can not possibly know the current time. As such, the receiver time starts counting at GPS reference week 0 and second 0.0. The time status flag is set to UNKNOWN.

If time is input to the receiver using the SETAPPROXTIME command (see *page 144*) or on receipt of an RTCAEPHEM message (see *page 324),* the time status will be APPROXIMATE.

After the first ephemeris is decoded, the receiver time is set to a resolution of ±10 milliseconds. This state is qualified by the COARSE or COARSESTEERING time status flag depending on the state of the CLOCKADJUST switch.

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

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

The final logical time status flag depends on whether CLOCKADJUST is enabled or not, (see *page 60*). If CLOCKADJUST is disabled, the time status flag will never improve on FINE. The time will only be adjusted again to within ±1 microsecond if the range bias gets larger than ±250 milliseconds. If Clock Adjust is enabled, the time status flag will be set to FINESTEERING and the receiver time will be continuously updated (steered) to minimize the receiver range bias.

When the back-up system is used, the time status is set to FINEBACKUPSTEERING. If, for some reason, position is lost and the range bias cannot be calculated, the time status will be degraded to FREEWHEELING.

1.5 Message Time Stamps

All NovAtel format messages generated by OEMStar receivers have a GPS reference time stamp in their header. GPS reference time is referenced to UTC with zero point defined as midnight on the night of January 5 1980. The time stamp consists of the number of weeks since that zero point and the number of seconds since the last week number change (0 to 604,799). GPS reference time differs from UTC time since leap seconds are occasionally inserted into UTC but GPS reference time is continuous. In addition a small error (less than 1 microsecond) can exist in synchronization between UTC and GPS reference time. The TIME log reports both GPS and UTC time and the offset between the two.

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

Other log types (asynchronous and polled) are triggered by an external event and the time in the header may not be synchronized to the current GPS reference time. Logs that contain satellite broadcast data (for example, ALMANAC, GPSEPHEM) have the transmit time of their last subframe in the header. Logs triggered by a mark event (for example, MARKEDPOS, MARKTIME) have the estimated GPS reference time of the mark event in their header. In the header of polled logs (for example, LOGLIST, PORTSTATS, VERSION) is the approximate GPS reference time when their data was generated. However, when asynchronous logs are triggered ONTIME, the time stamp will represent the time the log was generated, not the time given in the data.

1.6 Decoding of the GPS Reference Week Number

The GPS reference week number provided in the raw satellite data is the 10 least significant bits (or 8 least significant bits in the case of the almanac data) of the full week number. When the receiver processes the satellite data, the week number is decoded in the context of the current era and, therefore, is computed as the full week number starting from week 0 or January 6, 1980. Therefore, in all log headers and decoded week number fields, the full week number is given. Only in raw data, such as the *data* field of the RAWALM log or the *subframe* field of the RAWEPHEM log, will the week number remain as the 10 (or 8) least significant bits.

1.7 32-Bit CRC

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

```
#define CRC32_POLYNOMIAL   0xEDB88320L
/* --------------------------------------------------------------------------
Calculate a CRC value to be used by CRC calculation functions.
-------------------------------------------------------------------------- */
unsigned long CRC32Value(int i)
{
   int j;
   unsigned long ulCRC;
   ulCRC = i;
   for ( j = 8 ; j > 0; j-- )
   {
      if ( ulCRC & 1 )
         ulCRC = ( ulCRC >> 1 ) ^ CRC32_POLYNOMIAL;
      else
         ulCRC >>= 1;
   }
   return ulCRC;
}
/* --------------------------------------------------------------------------
Calculates the CRC-32 of a block of data all at once
-------------------------------------------------------------------------- */
unsigned long CalculateBlockCRC32(
   unsigned long ulCount,     /* Number of bytes in the data block */
   unsigned char *ucBuffer ) /* Data block */
{
   unsigned long ulTemp1;
   unsigned long ulTemp2;
   unsigned long ulCRC = 0;
  while ( ulCount-- != 0 )
```

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

The NMEA checksum is an XOR of all the bytes (including delimiters such as ',' but excluding the * and $) in the message output. It is therefore an 8-bit and not a 32-bit checksum.

At the time of writing, logs may not yet be available. Every effort is made to ensure that examples are correct, however, a checksum may be created for promptness in publication. In this case it will appear as ‘9999’.

Example:

BESTPOSA and BESTPOSB from an OEMStar receiver.

ASCII:

```
#BESTPOSA,COM1,0,78.0,FINESTEERING,1427,325298.000,00000000,6145,2748;
SOL_COMPUTED,SINGLE,51.11678928753,-114.03886216575,1064.3470,-16.2708,
WGS84,2.3434,1.3043,4.7300,"",0.000,0.000,7,7,0,0,0,06,0,03*9c9a92bb
```

BINARY:

0xaa, 0x44, 0x12, 0x1c 2a, 0x00, 0x02, 0x20, 0x48, 0x00, 0x00, 0x00, 0x90, 0xb4, 0x93, 0x05, 0xb0, 0xab, 0xb9, 0x12, 0x00, 0x00, 0x00, 0x00, 0x45, 0x61, 0xbc, 0x0a, 0x00, 0x00, 0x00, 0x00, 0x10, 0x00, 0x00, 0x00, 0x1b, 0x04, 0x50, 0xb3, 0xf2, 0x8e, 0x49, 0x40, 0x16, 0xfa, 0x6b, 0xbe, 0x7c, 0x82, 0x5c, 0xc0, 0x00, 0x60, 0x76, 0x9f, 0x44, 0x9f, 0x90, 0x40, 0xa6, 0x2a, 0x82, 0xc1, 0x3d, 0x00, 0x00, 0x00, 0x12, 0x5a, 0xcb, 0x3f, 0xcd, 0x9e, 0x98, 0x3f, 0xdb, 0x66, 0x40, 0x40, 0x00, 0x30, 0x30, 0x30, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0b, 0x0b, 0x00, 0x00, 0x00, 0x06, 0x00, 0x03, 0x***42***, 0x***dc,*** 0x***4c,*** 0x***48***

Below is a demonstration of how to generate the CRC from both ASCII and BINARY messages using the function described above.

When you pass the data into the code that follows, exclude the checksum shown in ***bold italics*** above.

ASCII:

```
#include <iostream.h>
#include <string.h>
void  main()
{
char *i = ”BESTPOSA,COM2,0,77.5,FINESTEERING,1285,160578.000,00000020,5941,11
64;
SOL_COMPUTED,SINGLE,51.11640941570,-114.03830951024,1062.6963,-16.2712,
WGS84,1.6890,1.2564,2.7826,\"\",0.000,0.000,10,10,0,0,0,0,0,0";
unsigned long iLen = strlen(i);
unsigned long CRC = CalculateBlockCRC32(iLen, (unsigned char*)i);
cout << hex << CRC <<endl;
}
```

BINARY:

```
#include <iostream.h>
#include <string.h>
int main()
{
unsigned char buffer[] = {0xAA, 0x44, 0x12, 0x1C 2A, 0x00, 0x02, 0x20, 0x48,
0x00, 0x00, 0x00, 0x90, 0xB4, 0x93, 0x05, 0xB0, 0xAB, 0xB9, 0x12, 0x00, 0x00,
0x00, 0x00, 0x45, 0x61, 0xBC, 0x0A, 0x00, 0x00, 0x00, 0x00, 0x10, 0x00, 0x00,
0x00, 0x1B, 0x04, 0x50, 0xB3, 0xF2, 0x8E, 0x49, 0x40, 0x16, 0xFA, 0x6B, 0xBE,
0x7C, 0x82, 0x5C, 0xC0, 0x00, 0x60, 0x76, 0x9F, 0x44, 0x9F, 0x90, 0x40, 0xA6,
0x2A, 0x82, 0xC1, 0x3D, 0x00, 0x00, 0x00, 0x12, 0x5A, 0xCB, 0x3F, 0xCD, 0x9E,
0x98, 0x3F, 0xDB, 0x66, 0x40, 0x40, 0x00, 0x30, 0x30, 0x30, 0x00, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x00, 0x0B, 0x0B, 0x00, 0x00, 0x00, 0x06, 0x00, 0x03};
unsigned long crc = CalculateBlockCRC32(60, buffer);
cout << hex << crc <<endl;
//Please note that this hex needs to be reversed due to Big Endian order where
the most significant value in the sequence is stored first (at the lowest
storage address). For example, the two bytes required for the hex number 4F52
is stored as 524F.
}
```

Chapter 2 Command

2.1 Command Formats

The receiver accepts commands in 3 formats as described in *Chapter 1*:

- Abbreviated ASCII
- ASCII
- Binary

Abbreviated ASCII is the easiest to use for your input. The other two formats include a CRC for error checking and are intended for use when interfacing with other electronic equipment.

Here are examples of the same command in each format:

Abbreviated ASCII Example:

```
LOG COM1 BESTPOSB ONTIME 1[CR]
```

ASCII Example:

```
LOGA,COM2,0,66.0,UNKNOWN,0,15.917,004c0000,5255,32858;COM1,
BESTPOSB,ONTIME,1.000000,0.000000,NOHOLD*F95592DD[CR]
```

Binary Example:

```
AA44121C 01000240 20000000 1D1D0000 29160000 00004C00 55525A80
20000000 2A000000 02000000 00000000 0000F03F 00000000 00000000
00000000 2304B3F1
```

2.2 Command Settings

There are several ways to determine the current command settings of the receiver:

1. Request an RXCONFIG log (see *page 345*). This log provides a listing of all commands and their parameter settings. It also provides the most complete information, but the size and format do not make it easy to read.
2. For some specific commands, logs are available to indicate all their parameter settings. The LOGLIST log (see *page 267*), shows all active logs in the receiver beginning with the LOG command. The COMCONFIG log (see *page 219*) shows both the COM and INTERFACEMODE commands parameter settings for all serial ports.
3. Request a log of the specific command of interest to show the parameters last entered for that command. The format of the log produced is exactly the same as the format of the specific command with updated header information.

✉ This is very useful for most commands, but for commands that are repeated with different parameters (for example, COM and LOG), this only shows the most recent set of parameters used. To see all sets of parameters try method 1 or 2 above.

Abbreviated ASCII Example:

```
log fix
<FIX COM1 0 45.0 FINE 1114 151898.288 00200000 dbfd 33123
<     NONE -10000.00000000000 -10000.00000000000 -10000.0000
```

2.3 Commands by Function

Table 9 lists the commands by function while *Table 10* on *page 37* is an alphabetical listing of commands (repeated in *Table 11* on *page 42* with the commands in the order of their message IDs). Please see *Section 2.5, Command Reference* on *page 49* for a more detailed description of individual commands which are listed alphabetically.

Table 9: Communications, Control and Status Functions

COMMANDS	DESCRIPTIONS
COMMUNICATIONS, CONTROL AND STATUS	
ANTENNAPOWER	Control power to low-noise amplifier (LNA) of an active antenna
COM	Set COM port configuration
ECHO	Set port echo
FREQUENCYOUT	Set the output pulse train available on VARF
INTERFACEMODE	Set interface type, Receive (Rx)/Transmit (Tx), for a port
LOG	Request a log
MARKCONTROL	Control processing of the mark inputs
PPSCONTROL	Control the PPS output
SEND	Send ASCII message to a port
SENDHEX	Send non-printable characters to a port
UNLOG, UNLOGALL	Remove one or all logs from logging control
GENERAL RECEIVER CONTROL	
AUTH	Add authorization code for new model
DYNAMICS	Tune receiver parameters

Continued on the following page.

GENERAL RECEIVER CONTROL	
FRESET	Reset receiver to factory default
MODEL	Switch receiver to a previously AUTHed model
NVMRESTORE	Restore NVM data after a failure in NVM
RESET	Perform a hardware reset
SAVECONFIG	Save current configuration
STATUSCONFIG	Configure various status mask fields in RXSTATUSEVENT log

POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL	
CSMOOTH	Set amount of carrier smoothing
DATUM	Choose a DATUM name type
ECUTOFF	Set satellite elevation cut-off for solutions
FIX	Constrain receiver height or position
FIXPOSDATUM	Set the position in a specified datum
GGAQUALITY	Customize the GPGGA GPS quality indicator
NMEATALKER	Set the NMEA talker ID
PDPFILTER	Enable, disable or reset the Pseudorange/Delta-Phase (PDP) filter
PDPMODE	Select the PDP mode and dynamics
RAIMMODE	Sets RAIM mode
SBASCONTROL	Set SBAS test mode and PRN
SELECTCHANCONFIG	Change channel configuration
SETIONOTYPE	Set the ionospheric corrections model
SETUTCLEAPSECONDS	Change default UTC Leap Seconds offset
UNDULATION	Set ellipsoid-geoid separation
USERDATUM	Set user-customized datum
USEREXPDATUM	Set custom expanded datum
UTMZONE	Set UTM parameters

SATELLITE TRACKING AND CHANNEL CONTROL	
ASSIGN	Assign individual satellite channel

Continued on the following page.

SATELLITE TRACKING AND CHANNEL CONTROL	
ASSIGNALL	Assign all satellite channels
CNOUPDATE	C/No update rate and resolution
DYNAMICS	Tune receiver parameters
ECUTOFF	Set satellite tracking elevation cut-off
GLOCSMOOTH	Carrier smoothing for GLONASS channels
GLOECUTOFF	Set the GLONASS satellite elevation cut-off angle
LOCKOUT	Prevent the receiver from using a satellite by specifying its PRN
SETAPPROXPOS	Set an approximate position
SETAPPROXTIME	Set an approximate GPS reference time
UNASSIGN	Unassign a previously ASSIGNed channel
UNASSIGNALL	Unassign all previously ASSIGNed channels
UNLOCKOUT	Reinstate a satellite in the solution
UNLOCKOUTALL	Reinstate all previously locked out satellites
WAASECUTOFF	Set SBAS satellite elevation cut-off

WAYPOINT NAVIGATION	
MAGVAR	Set magnetic variation correction
SETNAV	Set waypoints

DIFFERENTIAL BASE STATION	
DGPSEPHEMDELAY	DGPS ephemeris delay
DGPSTXID	DGPS transmit ID
FIX	Constrain receiver height or position
INTERFACEMODE	Set interface type Transmit (Tx), for a port
LOG	Select required differential-output log
POSAVE	Set up position averaging
FIXPOSDATUM	Fix position in a datum
SETRTCM16	Enter ASCII message to be sent in RTCM data stream
SETRTCM36	Enter ASCII message including Russian characters

Continued on the following page

DIFFERENTIAL ROVER STATION	
DGPSEPHEMDELAY	DGPS ephemeris delay
DGPSTIMEOUT	Set maximum age of differential data accepted
INTERFACEMODE	Set interface type, Receive (Rx), for a COM port
POSTIMEOUT	Set the position time out value
PSRDIFFSOURCE	Set the pseudorange correction source
RTKSOURCE	Set the RTK correction source
SBASCONTROL	Set SBAS test mode and PRN
SETAPPROXPOS	Set an approximate position
SETAPPROXTIME	Set an approximate GPS reference time
WAASTIMEOUT	Set maximum age of WAAS data accepted

CLOCK INFORMATION, STATUS, AND TIME	
ADJUST1PPS	Adjust the receiver clock
CLOCKADJUST	Enable/disable adjustments to internal clock and 1PPS output
CLOCKCALIBRATE	Adjust the control parameters of the clock steering loop
CLOCKOFFSET	Adjust for antenna RF cable delay in PPS output
SETAPPROXTIME	Set an approximate time

Table 10: OEMStar Commands in Alphabetical Order

Command	Message ID	Description	Syntax
ADJUST1PPS	429	Adjust the receiver clock	adjust1pps mode [period] [offset]
ANTENNAPOWER	98	Control power to low-noise amplifier of an active antenna	antennapower flag
ASSIGN	27	Assign individual satellite channel to a PRN	assign channel [state] prn [Doppler [Doppler window]]
ASSIGNALL	28	Assign all satellite channels to a PRN	assignall [system] [state] prn [Doppler [Doppler window]]
AUTH	49	Add authorization code for new model	auth [state] part1 part2 part3 part4 part5 model [date]

Continued on the following page.

Command	Message ID	Description	Syntax
CLOCKADJUST	15	Enable clock adjustments	clockadjust switch
CLOCKCALIBRATE	430	Adjust the control parameters of the clock steering loop	clockcalibrate mode [period] [width] [slope] [bandwidth]
CLOCKOFFSET	596	Adjust for antenna RF cable delay in PPS output	clockoffset offset
CNOUPDATE	849	C/No update rate and resolution	cnoupdate rate
COM	4	COM port configuration control	com [port] bps [parity [databits [stopbits [handshake [echo [break]]]]]]
CSMOOTH	269	Set carrier smoothing	csmooth L1time
DATUM	160	Choose a DATUM name type	datum datum
DGPSEPHEMDELAY	142	DGPS ephemeris delay	dgpsephemdelay delay
DGPSTIMEOUT	127	Set maximum age of differential data accepted	dgpstimeout delay
DGPSTXID	144	DGPS transmit ID	dgpstxid type ID
DYNAMICS	258	Tune receiver parameters	dynamics dynamics
ECHO	1247	Set port echo	echo [port] echo
ECUTOFF	50	Set satellite elevation cut-off	ecutoff angle
FIX	44	Constrain to fixed height or position	fix type [param1 [param2 [param3]]]
FIXPOSDATUM	761	Set the position in a specified datum	fixposdatum datum [lat [lon [height]]]
FREQUENCYOUT	232	Sets the output pulse train available on VARF.	frequencyout [switch] [pulsewidth] [period]

Continued on the following page.

Command	Message ID	Description	Syntax
FRESET	20	Clear almanac model, or user configuration data, which is stored in NVM and followed by a receiver reset.	freset [target]
GGAQUALITY	691	Customize the GPGGA GPS quality indicator	ggaquality #entries [pos type1][qual1] [pos type2] [qual2]...
GLOCSMOOTH	830	Carrier smoothing for GLONASS channels	glocsmooth L1time
GLOECUTOFF	735	Set the GLONASS satellite elevation cut-off angle	gloecutoff angle
INTERFACEMODE	3	Set interface type, Receive (Rx)/Transmit (Tx), for ports	interfacemode [port] rxtype txtype [responses]
LOCKOUT	137	Prevent the receiver from using a satellite by specifying its PRN	lockout prn
LOG	1	Request logs from receiver	log [port] message [trigger [period [offset [hold]]]]
MAGVAR	180	Set magnetic variation correction	magvar type [correction [stddev]]
MARKCONTROL	614	Control the processing of the mark inputs	markcontrol signal switch [polarity] [timebias [timeguard]]
MODEL	22	Switch to a previously AUTHed model	model model
NMEATALKER	861	Set the NMEA talker ID	nmeatalker ID
NVMRESTORE	197	Restore NVM data after a failure in NVM	nvmrestore
PDPFILTER	424	Enable, disable or reset the PDP filter	pdpfilter switch
PDPMODE	970	Select the PDP mode and dynamics	pdpmode mode dynamics

Continued on the following page.

Command	Message ID	Description	Syntax
POSAVE	173	Implement position averaging for base station	posave [state] maxtime [maxhstd [maxvstd]]
POSTIMEOUT	612	Sets the position time out value	postimeout sec
PPSCONTROL	613	Control the PPS output	ppscontrol switch [polarity] [rate] [pulse width]
PSRDIFFSOURCE	493	Set the pseudorange correction source	psrdiffsource type ID
RAIMMODE	1285	Set the RAIM mode	raimmode mode [hal [val [pfa]]]
RESET	18	Perform a hardware reset	reset [delay]
SAVECONFIG	19	Save current configuration in non-volatile memory	saveconfig
SBASCONTROL	652	Set SBAS test mode and PRN	sbascontrol keyword [system] [prn] [testmode]
SELECTCHAN-CONFIG	1149	Set channel configuration	selectchanconfig [set]
SEND	177	Send an ASCII message to any of the communications ports	send port data
SENDHEX	178	Send non-printable characters in hexadecimal pairs	sendhex port length data
SETAPPROXPOS	377	Set an approximate position	setapproxpos lat lon height
SETAPPROXTIME	102	Set an approximate GPS reference time	setapproxtime week sec
SETBESTPOS-CRITERIA	839	Set criteria for the BESTPOS log	setbestposcriteria type delay
SETIONOTYPE	711	Set the ionospheric corrections model	setionotype model

Continued on the following page.

Command	Message ID	Description	Syntax
SETNAV	162	Set start and destination waypoints	setnav fromlat fromlon tolat tolon track offset from-point to-point
SETRTCM16	131	Enter an ASCII text message to be sent out in the RTCM data stream	setrtcm16 text
SETRTCM36	880	Enter ASCII message including Russian characters	setrtcm36 extdtext
SETUTCLEAP-SECONDS	1150	Set detault UTC Leap Seconds offset	setutcleapseconds [seconds]
STATUSCONFIG	95	Configure various status mask fields in RXSTATUSEVENT log	statusconfig type word mask
UNASSIGN	29	Unassign a previously ASSIGNed channel	unassign channel
UNASSIGNALL	30	Unassign all previously ASSIGNed channels	unassignall [system]
UNDULATION	214	Choose undulation	undulation option [separation]
UNLOCKOUT	138	Reinstate a satellite in the solution computation	unlockout prn
UNLOCKOUTALL	139	Reinstate all previously locked out satellites	unlockoutall
UNLOG	36	Remove log from logging control	unlog [port] datatype
UNLOGALL	38	Remove all logs from logging control	unlogall [port]
USERDATUM	78	Set user-customized datum	userdatum semimajor flattening dx dy dz rx ry rz scale
USEREXPDATUM	783	Set custom expanded datum	userexpdatum semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev refdate
UTMZONE	749	Set UTM parameters	utmzone command parameter

Continued on the following page.

Command	Message ID	Description	Syntax
WAASECUTOFF	505	Set SBAS satellite elevation cut-off	waasecutoff angle
WAASTIMEOUT	851	Set maximum age of WAAS data accepted	waastimeout mode [delay]

Table 11: OEMStar Commands in Numerical Order

Message ID	Command	Description	Syntax
1	LOG	Request logs from receiver	log [port] message [trigger [period [offset [hold]]]]
3	INTERFACEMODE	Set interface type, Receive (Rx)/Transmit (Tx), for ports	interfacemode [port] rxtype txtype [responses]
4	COM	COM port configuration control	com [port] bps [parity [databits [stopbits [handshake [echo [break]]]]]]
15	CLOCKADJUST	Enable clock adjustments	clockadjust switch
18	RESET	Perform a hardware reset	reset [delay]
19	SAVECONFIG	Save current configuration in non-volatile memory	saveconfig
20	FRESET	Clear almanac model, or user configuration data, which is stored in NVM and followed by a receiver reset.	freset [target]
22	MODEL	Switch to a previously AUTHed model	model model
27	ASSIGN	Assign individual satellite channel to a PRN	assign channel [state] prn [Doppler [Doppler window]]
28	ASSIGNALL	Assign all satellite channels to a PRN	assignall [system] [state] prn [Doppler [Doppler window]]
29	UNASSIGN	Unassign a previously ASSIGNed channel	unassign channel

Continued on the following page.

Message ID	Command	Description	Syntax
30	UNASSIGNALL	Unassign all previously ASSIGNed channels	unassignall [system]
36	UNLOG	Remove log from logging control	unlog [port] datatype
38	UNLOGALL	Remove all logs from logging control	unlogall [port]
44	FIX	Constrain to fixed height or position	fix type [param1 [param2 [param3]]]
49	AUTH	Add authorization code for new model	auth [state] part1 part2 part3 part4 part5 model [date]
50	ECUTOFF	Set satellite elevation cut-off	ecutoff angle
78	USERDATUM	Set user-customized datum	userdatum semimajor flattening dx dy dz rx ry rz scale
95	STATUSCONFIG	Configure various status mask fields in RXSTATUSEVENT log	statusconfig type word mask
98	ANTENNAPOWER	Control power to low-noise amplifier of an active antenna	antennapower flag
102	SETAPPROXTIME	Set an approximate GPS reference time	setapproxtime week sec
127	DGPSTIMEOUT	Set maximum age of differential data accepted	dgpstimeout delay
131	SETRTCM16	Enter an ASCII text message to be sent out in the RTCM data stream	SETRTCM16 text
137	LOCKOUT	Prevent the receiver from using a satellite by specifying its PRN	lockout prn
138	UNLOCKOUT	Reinstate a satellite in the solution computation	unlockout prn

Continued on the following page.

Message ID	Command	Description	Syntax
139	UNLOCKOUTALL	Reinstate all previously locked out satellites	unlockoutall
142	DGPSEPHEM-DELAY	DGPS ephemeris delay	dgpsephemdelay delay
144	DGPSTXID	DGPS transmit ID	dgpstxid type ID
160	DATUM	Choose a DATUM name type	datum datum
162	SETNAV	Set start and destination waypoints	setnav fromlat fromlon tolat tolon track offset from-point to-point
173	POSAVE	Implement position averaging for base station	posave[state] maxtime [maxhstd [maxvstd]]
177	SEND	Send an ASCII message to any of the communications ports	send port data
178	SENDHEX	Send non-printable characters in hexadecimal pairs	sendhex port length data
180	MAGVAR	Set magnetic variation correction	magvar type [correction [stddev]]
197	NVMRESTORE	Restore NVM data after a failure in NVM	nvmrestore
214	UNDULATION	Choose undulation	undulation option [separation]
232	FREQUENCYOUT	Sets the output pulse train available on VARF.	frequencyout [switch] [pulsewidth] [period]
258	DYNAMICS	Tune receiver parameters	dynamics dynamics
269	CSMOOTH	Set carrier smoothing	csmooth L1time
377	SETAPPROXPOS	Set an approximate position	setapproxpos lat lon height
424	PDPFILTER	Enable, disable or reset the PDP filter	pdpfilter switch

Continued on the following page.

Message ID	Command	Description	Syntax
429	ADJUST1PPS	Adjust the receiver clock	adjust1pps mode [period] [offset]
430	CLOCKCALIBRATE	Adjust the control parameters of the clock steering loop	clockcalibrate mode [period] [width] [slope] [bandwidth]
493	PSRDIFFSOURCE	Set the pseudorange correction source	psrdiffsource type ID
505	WAASECUTOFF	Set SBAS satellite elevation cut-off	waasecutoff angle
596	CLOCKOFFSET	Adjust for antenna RF cable delay	clockoffset offset
612	POSTIMEOUT	Sets the position time out	postimeout sec
613	PPSCONTROL	Control the PPS output	ppscontrol switch [polarity] [period] [pulse width]
614	MARKCONTROL	Control the processing of the mark inputs	markcontrol signal switch [polarity] [timebias [timeguard]]
652	SBASCONTROL	Set SBAS test mode and PRN	sbascontrol switch[system] [prn] [testmode]
691	GGAQUALITY	Customize the GPGGA GPS quality indicator	ggaquality #entries [pos type1][qual1] [pos type2] [qual2]...
711	SETIONOTYPE	Set the ionospheric corrections model	setionotype model
735	GLOECUTOFF	Set the GLONASS satellite elevation cut-off	gloecutoff angle
749	UTMZONE	Set UTM parameters	utmzone command parameter
761	FIXPOSDATUM	Set the position in a specified datum	fixposdatum datum [lat [lon [height]]]
783	USEREXPDATUM	Set custom expanded datum	userexpdatum semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev refdate
830	GLOCSMOOTH	Carrier smoothing for GLONASS channels	glocsmooth L1time

Continued on the following page.

Message ID	Command	Description	Syntax
839	SETBESTPOS-CRITERIA	Set criteria for the BESTPOS log	setbestposcriteria type delay
849	CNOUPDATE	C/No update rate and resolution	cnoupdate rate
851	WAASTIMEOUT	Set maximum age of WAAS data accepted	waastimeout mode [delay]
861	NMEATALKER	Set the NMEA talker ID	nmeatalker ID
880	SETRTCM36	Enter ASCII message including Russian chars	setrtcm36 extdtext
970	PDPMODE	Select the PDP mode and dynamics	pdpmode mode dynamics
1149	SELECTCHAN-CONFIG	Set channel configuration	selectchanconfig [set]
1150	SETUTCLEAP-SECONDS	Change default UTC Leap Seconds offset	setutcleapseconds [seconds]
1247	ECHO	Set port echo	echo [port] echo
1285	RAIMMODE	Set RAIM mode	raimmode mode [hal [val [pfa]]]

When the receiver is first powered up, or after a FRESET command, all commands revert to their factory default settings. The SAVECONFIG command can be used to modify the power-on defaults. Use the RXCONFIG log to determine command and log settings.

Ensure that all windows, other than the Console window, are closed in NovAtel's Control and Display Unit (CDU) user interface before you issue the SAVECONFIG command.

✉ FRESET STANDARD causes all previously stored user configurations saved to non-volatile memory to be erased (including Saved Config, Saved Almanac, and Saved Ephemeris.)

2.4 Factory Defaults

When the receiver is first powered up, or after a FRESET command (see *page 92*), all commands revert to their factory default settings. When you use a command without specifying its optional parameters, it may have a different command default than the factory default. The SAVECONFIG command (see *page 135*) can be used to save these defaults. Use the RXCONFIG log (see *page 345*) to reference many command and log settings.

The factory defaults are:

```
ADJUST1PPS OFF
ANTENNAPOWER ON
CLOCKADJUST ENABLE
CLOCKOFFSET 0
COM COM1 9600 N 8 1 N OFF ON
COM COM2 9600 N 8 1 N OFF ON
CSMOOTH 100
DATUM WGS84
DGPSEPHEMDELAY 120
DGPSTIMEOUT 300
DGPSTXID AUTO "ANY"
DYNAMICS AIR
ECUTOFF 5.0
FIX NONE
FIXPOSDATUM NONE
FREQUENCYOUT DISABLE
GLOCSMOOTH 100
GLOECUTOFF 5.0
INTERFACEMODE COM1 NOVATEL NOVATEL ON
INTERFACEMODE COM2 NOVATEL NOVATEL ON
INTERFACEMODE USB1 NOVATEL NOVATEL ON
INTERFACEMODE USB2 NOVATEL NOVATEL ON
INTERFACEMODE USB3 NOVATEL NOVATEL ON
LOG COM1 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG COM2 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG USB1 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG USB2 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG USB3 RXSTATUSEVENTA ONNEW 0 0 HOLD
MAGVAR CORRECTION 0 0
MARKCONTROL MARK1 ENABLE NEGATIVE 0 0
NMEATALKER gp
```

```
PDPFILTER ENABLE
PDPMODE NORMAL AUTO
POSAVE OFF
POSTIMEOUT 600
PPSCONTROL ENABLE NEGATIVE 1.0 1000
PSRDIFFSOURCE AUTO "ANY"
RAIMMODE DEFAULT
SBASCONTROL DISABLE
SETRTCMRXVERSION V23
SETIONOTYPE AUTO
SETTIMEBASE GPS 0
SETNAV 90.0 0.0 90.0 0.0 0.0 from to
STATUSCONFIG PRIORITY STATUS 0
STATUSCONFIG PRIORITY AUX1 0x00000008
STATUSCONFIG PRIORITY AUX2 0
STATUSCONFIG SET STATUS 0x00000000
STATUSCONFIG SET AUX1 0
STATUSCONFIG SET AUX2 0
STATUSCONFIG CLEAR STATUS 0x00000000
STATUSCONFIG CLEAR AUX1 0
STATUSCONFIG CLEAR AUX2 0
UNDULATION EGM96
USERDATUM 6378137.0 298.2572235628 0.0 0.0 0.0 0.0 0.0 0.0 0.0
USEREXPDATUM 6378137.0 298.25722356280 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
UTMZONE AUTO 0
WAASECUTOFF -5.000000000
```

2.5 Command Reference

When you use a command without specifying its optional parameters, it may have a different command default than the factory default. See *Section 2.4* starting on *page 47* for the factory default settings and the individual commands in the sections that follow for their command defaults.

2.5.1 ADJUST1PPS Adjust the receiver clock

This command is used to manually shift the phase of the clock. The number of pulses per second (PPS) is always set to 1 Hz with this command.

✉ The resolution of the clock synchronization is 50 ns.

To adjust the 1PPS output when the receiver's internal clock is being used and the CLOCKADJUST command is enabled, use the CLOCKOFFSET command on *Page 65*.

If the 1PPS rate is adjusted, the new rate does not start until the next second begins.

The 1PPS is obtained from different receivers in different ways.

If you are using a:

Bare Card	The 1PPS output strobe is on pin# 19 of the OEMStar 20-pin header.
FlexPak-G2™	A DB9F connector on the enclosure provides external access to various I/O strobes to the internal card. This includes the 1PPS output signal, which is accessible on pin #2 of the DB9F connector

Abbreviated ASCII Syntax: **Message ID: 429**

ADJUST1PPS mode [period] [offset]

Factory Default:

adjust1pps off

ASCII Example:

adjust1pps mark continuous 240

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ADUST-1PPS header	-	-	This field contains the command name	-	H	0
2	mode	OFF	0	Disables ADJUST1PPS (default).	Enum	4	H
		MANUAL	1	Immediately shifts the receivers time by the offset field in ns. The period field has no effect in this mode. This command does not affect the clock state			
		MARK[a]	2	Shifts the receiver time to align its 1PPS with the signal received in the MK1I port adjusted by the offset field in ns. The effective shift range is ± 0.5 s.			
		Reserved	3				
		Reserved	4				
3	period	ONCE	0	The time is synchronized only once (default). The ADJUST1PPS command must be re-issued if another synchronization is required.	Enum	4	H+4
		CONTINUOUS	1	The time is continuously monitored and the receiver clock is corrected if an offset of more than 50 ns is detected.			

Continued on the following page

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
4	offset	-2147483648 to +2147483647		Allows the operator to shift the Secondary clock in 50 ns increments. In MANUAL mode, this command applies an immediate shift of this offset in ns to the receiver clock. In MARK and MARKWITHTIME mode, this offset shifts the receiver clock with respect to the time of arrival of the MK1I event. If this offset is zero, the Secondary aligns its 1PPS to that of the signal received in its MK1I port. For example, if this value was set to 50, then the Secondary would set its 1PPS 50 ns ahead of the input signal and if this value was set to -100 then the would set its clock to 100 ns behind the input signal. Typically this offset is used to correct for cable delay of the 1PPS signal.	Long	4	H+8

a. Only the MK1I input can be used to synchronize the 1PPS signal.

2.5.2 ANTENNAPOWER Control power to the antenna

This command enables or disables the supply of electrical power from the internal (refer to the *OEMStar Installation and Operation User Manual* for information about supplying power to the antenna) power source of the receiver to the low-noise amplifier (LNA) of an active antenna.

There are several bits in the Receiver Status (see *Table 69, Receiver Status* on *page 350*) that pertain to the antenna. These bits indicate whether the antenna is powered (internally or externally) and whether it is open circuited or short circuited.

On start-up, the ANTENNAPOWER is set to ON.

Abbreviated ASCII Syntax: **Message ID: 98**

ANTENNAPOWER flag

Factory Default:

antennapower on

ASCII Example:

antennapower off

For the OEMStar card, it is possible to supply power to the LNA of an active antenna from an external source connected to pin 1 of the 20-pin interface header. The receiver card distributes the voltage from the external source to the antenna port via a current limiting circuit. The current limiting circuit of the OEMStar can handle +3.3 to +5.5 VDC at up to 100 mA. This meets the needs of any of NovAtel's GPS antennas.

***WARNING!:*The voltage of +5.5VDC must not be exceeded or it will result in damage to the card.**

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ANTENNAPOWER header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	flag	OFF	0	Disables internal powering of antenna.	Enum	4	H
		ON	1	Enables internal powering of antenna.			

2.5.3 ASSIGN Assign a channel to a PRN

The ASSIGN command should only be used by advanced users.

Assigning a SV channel sets the forced assignment bit in the channel tracking status field which is reported in the RANGE and TRACKSTAT logs

Assigning a PRN to a SV channel does not remove the PRN from the search space of the automatic searcher; only the SV channel is removed (that is, the searcher may search and lock onto this PRN on another channel). The automatic searcher only searches for PRNs 1 to 32 for GPS channels, PRNs 38 to 61 for GLONASS (where available) and PRNs 120 to 138 for SBAS channels.

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 search for a specified satellite at a specified Doppler frequency within a specified Doppler window.

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

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

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

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

Table 12: Channel State

Binary	ASCII	Description
0	IDLE	Set the SV channel to not track any satellites
1	ACTIVE	Set the SV channel active (default)
2	AUTO	Tell the receiver to automatically assign PRN codes to channels
3	NODATA	Tell the receiver to track without navigation data

Abbreviated ASCII Syntax: **Message ID: 27**

ASSIGN channel [state] [prn [Doppler [Doppler window]]]

ASCII Example 1:

assign 0 active 29 0 2000

In example 1, the first SV channel is acquiring satellite PRN 29 in a range from -2000 Hz to 2000 Hz until the satellite signal has been detected.

ASCII Example 2:

assign 11 28 -250 0

SV channel 11 is acquiring satellite PRN 28 at an offset of -250 Hz only.

ASCII Example 3:

assign 11 idle

SV channel 11 is idled and does not attempt to search for satellites.

✉ OEMStar cards can have up to 2 channels available for SBAS dependent on the channel configuration (see *Section 2.5.45, SELECTCHANCONFIG Set channel configuration* on *page 138*).

Table 13: OEMStar Channel Configurations

Configurations	Set	Channels
GPS	1	0 to 13 for GPS L1 channels
GPS/SBAS	2	0 to 11 for GPS L1 channels 12 to 13 for SBAS L1 channels
GPS/GLONASS	3	0 to 9 for GPS L1 channels 10 to 13 for GLONASS L1 channels
	4	0 to 7 for GPS L1 channels 8 to 13 for GLONASS L1 channels
GPS/GLONASS/SBAS	5	0 to 7 for GPS L1 channels 8 to 11 for GLONASS L1 channels 12 to 13 for SBAS L1 channels
	6	0 to 9 for GPS L1 channels 10 to 11 for GLONASS L1 channels 12 to 13 for SBAS L1 channels

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ASSIGN header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively (see *Section 1.1, Message Types* on *page 14)*.	-	H	0
2	channel	See *Table 13, OEMStar Channel Configurations* on *page 54*		Desired SV channel number where channel 0 is the first SV channel. The last channel will be channel 13.	ULong	4	H
3	state	See *Table 12, Channel State* on *page 53*		Set the SV channel state.	Enum	4	H+4
4	prn	GPS: 1-37 SBAS: 120-138 GLONASS: see *Section 1.3* on *page 26*.		Optional satellite PRN code from 1 to 32 for GPS channels, 38 to 61 for GLONASS and 120 to 138 for SBAS channels. If not included in the command line, the state parameter must be set to IDLE.	Long	4	H+8
5	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 of Doppler frequency. (default = 0)	Long	4	H+12
6	Doppler window	0 to 10 000 Hz		Error or uncertainty in the Doppler estimate above. Note: This is a ± value. Example: 500 for ± 500 Hz. (default = 4 500)	ULong	4	H+16

2.5.4 ASSIGNALL Assign all channels to a PRN

✉ The ASSIGNALL command should only be used by advanced users.

This command allows you to override the automatic satellite/channel assignment and reacquisition processes for all receiver channels with manual instructions.

Abbreviated ASCII Syntax: **Message ID: 28**

ASSIGNALL [system][state][prn [Doppler [Doppler window]]]

Table 14: Channel System

Binary	ASCII	Description
0	GPSL1	GPS L1 dedicated SV channels only
2	NONE	No dedicated SV channels
3	ALL	All channels (default)
4	SBASL1	SBAS SV channels only
10	GLOL1	GLONASS L1 dedicated SV channels only

✉ Only GLONASS satellites that are in the almanac are available to assign using a slot number in the ASSIGN command. The possible range is still 38 to 61.

The optional *system* field indicates the channel type the command is to use. For example, the command input `ASSIGNALL GPSL1 IDLE` idles all GPS L1 channels on the receiver (GPSL1 is the system in this case). If the receiver is not using any GPS L1 channels, the command has no effect.

The ASSIGNALL command cannot be used as a method of changing the receiver's channel configuration. For example, changing from all GPS L1 to a GPS L1/GLONASS L1 channel configuration. Channel configuration can only be modified by using the SELECTCHANCONFIG command or purchasing the appropriate software model.

ASCII Example 1:

assignall gpsl1 active 29 0 2000

In example 1, all GPS L1 dedicated SV channels are set to active and trying to acquire PRN 29 in a range from -2000 Hz to 2000 Hz until the satellite signal has been detected.

ASCII Example 2:

assignall gpsl1 28 -250 0

All GPS L1 dedicated SV channels are trying to acquire satellite PRN 28 at -250 Hz only.

ASCII Example 3:

assignall gpsl1 idle

All L1 only dedicated SV channels are idled and are not attempting to search for satellites.

✉ This command is the same as ASSIGN except that it affects **all** SV channels.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ASSIGN-ALL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	system	See *Table 14*		System that SV channel is tracking	Enum	4	H
3	state	See *Table 12, Channel State* on *page 53*		Set the SV channel state	Enum	4	H+4
4	prn	GPS: 1-37 SBAS: 120-138 GLONASS (see *Section 1.3* on *page 26*).		Optional satellite PRN code from 1 to 37 for GPS channels, 38 to 61 for GLONASS and 120 to 138 for SBAS channels. If not included in the command line, the state parameter must be set to idle.	Long	4	H+8
5	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 of Doppler frequency. (default = 0)	Long	4	H+12
6	Doppler window	0 to 10 000 Hz		Error or uncertainty in the Doppler estimate above. This is a ± value (for example, 500 for ± 500 Hz). (default =4500)	ULong	4	H+16

2.5.5 AUTH Add authorization code for new model

This command is used to add or remove authorization codes from the receiver. Authorization codes are used to authorize models of software for a receiver. The receiver is capable of keeping track of 24 authorization codes at one time. The MODEL command can then be used to switch between authorized models. The VALIDMODELS log lists the current available models in the receiver. This simplifies the use of multiple software models on the same receiver.

If there is more than one valid model in the receiver, the receiver either uses the model of the last auth code entered via the AUTH command or the model that was selected by the MODEL command, whichever was done last. Both the AUTH and MODEL commands cause a reset automatically.

Authorization codes are firmware version specific. If the receiver firmware is updated, it is necessary to acquire new authorization codes for the required models. If you wish to update the firmware in the receiver, please contact NovAtel Customer Support.

WARNING!:**Removing an authorization code will cause the receiver to permanently lose this information.**

Abbreviated ASCII Syntax: **Message ID: 49**

AUTH [state] part1 part2 part3 part4 part5 model [date]

Input Examples:

auth add 1234 5678 9abc def0 1234 lxgdmts 990131

auth 1234 5678 9abc def0 1234 lxgdmts

When you want to easily upgrade your receiver without returning it to the factory, our unique field-upgradeable feature allows you buy the equipment that you need today, and upgrade them without facing obsolescence.

When you are ready to upgrade from one model to another, call 1-800-NOVATEL to speak with our Customer Support/Sales Personnel, who can provide the authorization code that unlocks the additional features of your GPS receiver. This procedure can be performed at your work-site and takes only a few minutes.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	AUTH header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	state	REMOVE	0	Remove the authcode from the system.	Enum	4	H
		ADD	1	Add the authcode to the system. (default)			
3	part1	4 digit hexadecimal (0-FFFF)		Authorization code section 1.	ULong	4	H+4
4	part2	4 digit hexadecimal (0-FFFF)		Authorization code section 2.	ULong	4	H+8
5	part3	4 digit hexadecimal (0-FFFF)		Authorization code section 3.	ULong	4	H+12
6	part4	4 digit hexadecimal (0-FFFF)		Authorization code section 4.	ULong	4	H+16
7	part5	4 digit hexadecimal (0-FFFF)		Authorization code section 5.	ULong	4	H+20
8	model	Alpha numeric	Null terminated	Model name of the receiver	String [max. 16]	Vari-able [a]	Vari-able
9	date	Numeric	Null terminated	Expiry date entered as yymmdd in decimal.	String [max. 7]	Vari-able [a]	Vari-able

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

2.5.6 CLOCKADJUST Enable clock adjustments

All oscillators have some inherent drift. By default the receiver attempts to steer the receiver's clock to accurately match GPS reference time. If for some reason this is not desired, this behavior can be disabled using the CLOCKADJUST command. The TIME log can then be used to monitor clock drift.

✉ The CLOCKADJUST command should only be used by advanced users.

When disabled, the range measurement bias errors continue to accumulate with clock drift.

Pseudorange, carrier phase and Doppler measurements may jump if the CLOCKADJUST mode is altered while the receiver is tracking.

When disabled, the time reported on all logs may be offset from GPS reference time. The 1PPS output may also be offset. The amount of this offset may be determined from the TIME log (see *page 359*).

A discussion on GPS reference time may be found in *Section 1.4, GPS Reference Time Status* on *page 27*.

Abbreviated ASCII Syntax: **Message ID: 15**

CLOCKADJUST switch

Factory Default:

clockadjust enable

ASCII Example:

clockadjust disable

✉ The CLOCKADJUST command can be used to calibrate the internal oscillator. Disable the CLOCKADJUST mode in order find out what the actual drift is from the internal oscillator. Watch the CLOCKMODEL log to see the drift rate and adjust the oscillator until the drift stops.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	CLOCKADJUST header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	switch	DISABLE	0	Disallow adjustment of internal clock	Enum	4	H
		ENABLE	1	Allow adjustment of internal clock			

2.5.7 CLOCKCALIBRATE Adjust clock steering parameters

This command is used to adjust the control parameters of the clock steering loop. The receiver must be enabled for clock steering before these values can take effect. Refer to the CLOCKADJUST command (see *page 60*) to enable or disable this feature.

To disable the clock steering process, issue the CLOCKADJUST DISABLE command.

The current values used by the clock steering process are listed in the CLOCKSTEERING log (see *page 215*).

The values entered using the CLOCKCALIBRATE command are saved to non-volatile memory (NVM). To restore the values to their defaults, the FRESET CLKCALIBRATION command must be used. See *Section 2.5.22 on page 94* for more details.

Abbreviated ASCII Syntax: **Message ID: 430**

CLOCKCALIBRATE mode [period] [width] [slope] [bandwidth]

ASCII Example:

clockcalibrate auto

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	CLOCKCALIBRATE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	mode	SET	0	Sets the period, pulsewidth, slope, and bandwidth values into NVM for the internal oscillator.	Enum	4	H
		AUTO	1	Once the receiver time status is fine (see *Table 8* on *page 27*), this forces the receiver to do a clock steering calibration to measure the slope (change in clock drift rate with a 1 bit change in pulse width), and required pulsewidth, to zero the clock drift rate. After the calibration, these values along with the period and bandwidth are entered into NVM and are then used from this point forward on the internal oscillator.			
		OFF	2	Terminates a calibration process currently underway			
3	period	0 to 262144		Signal period in 25 ns steps. Frequency Output = 20,000,000 / Period. (default = 5000)	Ulong	4	H+4
4	pulsewidth	The valid range for this parameter is 10% to 90% of the period.		Sets the initial pulse width that should provide a near zero drift rate from the selected oscillator being steered. The valid range for this parameter is 10% to 90% of the period. The default value is 3040.	Ulong	4	H+8

Continued on the following page

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
5	slope			This value should correspond to how much the clock drift changes with a 1 bit change in the pulsewidth m/s/bit. The default values for the slope used for the internal clock is 2.1. If this value is not known, then its value should be set to 1.0 and the mode should be set to AUTO to force a calibration. Once the calibration process is complete and using a slope value of 1.0, the receiver should be recalibrated using the measured slope and pulsewidth values (see the CLOCKSTEERING log on *page 215*). This process should be repeated until the measured slope value remains constant (less than a 5% change).	Float	4	H+12
6	bandwidth			This is the value used to control the smoothness of the clock steering process. Smaller values result in slower and smoother changes to the receiver clock. Larger values result in faster responses to changes in oscillator frequency and faster start-up clock pull-in. The default value is 0.03 Hz.	Float	4	H+16

2.5.8 CLOCKOFFSET Adjust for delay in 1PPS output

This command can be used to remove a delay in the PPS output. The PPS signal is delayed from the actual measurement time due to two major factors:

- A delay in the signal path from the antenna to the receiver
- An intrinsic delay through the RF and digital sections of the receiver

The second delay is automatically accounted for by the receiver using a nominal value determined for each receiver type. However, since the delay from the antenna to the receiver cannot be determined by the receiver, an adjustment cannot automatically be made. The CLOCKOFFSET command can be used to adjust for this delay.

Abbreviated ASCII Syntax: **Message ID: 596**

CLOCKOFFSET offset

Factory Default:

clockoffset 0

ASCII Example:

clockoffset -15

✉ There may be small variances in the delays for each cable or card. The CLOCKOFFSET command can be used to characterize each setup. For example, for a cable with a delay of 10 ns, the offset can be set to -10 to remove the delay from the PPS output.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	CLOCKOFFSET header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively (see *Section 1.1, Message Types* on *page 14)*.	-	H	0
2	offset	±200		Specifies the offset in nanoseconds	Long	4	H

2.5.9 CNOUPDATE Set the C/No update rate and resolution

This command allows you to set the C/No update rate and resolution.

Abbreviated ASCII Syntax: **Message ID: 849**

CNOUPDATE rate

Factory Default:

cnoupdate default

ASCII Example (rover):

cnoupdate 20hz

✉ Use the CNOUPDATE command for higher resolution C/No measurements, of the incoming GPS signals, at a higher rate. By default, the C/No values are calculated at approximately 4 Hz, but this command allows you to increase that rate to 20 Hz.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	CNO-UPDATE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	rate	DEFAULT	0	C/No update rate: 0 = Turn off C/No enhancement default = 4 Hz (4 bits/s) 1 = 20 Hz C/No updates (20 bits/s)	ENUM	4	H
		20HZ	1				

2.5.10 COM COM port configuration control

This command permits you to configure the receiver's asynchronous serial port communications drivers. The current COM port configuration can be reset to its default state at any time by sending it two hardware break signals of 250 milliseconds each, spaced by fifteen hundred milliseconds (1.5 seconds) with a pause of at least 250 milliseconds following the second break. This will:

- Stop the logging of data on the current port (see UNLOGALL on *page 166)*
- Clear the transmit and receive buffers on the current port
- Return the current port to its default settings (see *page 47* for details)
- Set the interface mode to NovAtel for both input and output (see the INTERFACEMODE command on *page 100*)

See also *Section 2.4, Factory Defaults* on *page 47* for a description of the factory defaults, and the COMCONFIG log on *page 219*.

✉ Baud rates higher than 115,200 bps are not supported by standard PC hardware. Special PC hardware may be required for higher rates, including 230400 bps. Also, some PC's have trouble with baud rates beyond 57600 bps.

Abbreviated ASCII Syntax: **Message ID: 4**

COM [port] bps [parity[databits[stopbits[handshake[echo[break]]]]]]

Factory Default:

com com1 9600 n 8 1 n off on
com com2 9600 n 8 1 n off on

ASCII Example:

com com1,57600,n,8,1,n,off,on

✉ Watch for situations where the COM ports of two receivers are connected together and the baud rates do not match. Data transmitted through a port operating at a slower baud rate may be misinterpreted as break signals by the receiving port if it is operating at a higher baud rate. This is because data transmitted at the lower baud rate is stretched relative to the higher baud rate. In this case, configure the receiving port to have break detection disabled using the COM command.

⚠ ***WARNING!:*****Use the COM command before using the INTERFACEMODE command on each port. Turn break detection off using the COM command to stop the port from resetting because it is interpreting incoming bits as a break command.**

Table 15: COM Serial Port Identifiers

Binary	ASCII	Description
1	COM1	COM port 1
2	COM2	COM port 2
6	THISPORT	The current COM port
8	ALL	All COM ports
9	XCOM1 [a]	Virtual COM1 port
10	XCOM2 [a]	Virtual COM2 port
13	USB1 [b]	USB port 1
14	USB2 [b]	USB port 2
15	USB3 [b]	USB port 3
17	XCOM3 [a]	Virtual COM3 port

a. The XCOM1, XCOM2 and XCOM3 identifiers are not available with the COM command but may be used with other commands. For example, INTERFACEMODE on *Page 100* and LOG on *page 105*.

b. The only other field that applies when a USB port is selected is the echo field. A place holder must be inserted for all other fields to use the echo field in this case.

Table 16: Parity

Binary	ASCII	Description
0	N	No parity (default)
1	E	Even parity
2	O	Odd parity

Table 17: Handshaking

Binary	ASCII	Description
0	N	No handshaking (default)
1	XON	XON/XOFF software handshaking
2	CTS	CTS/RTS hardware handshaking

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	COM header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	port	See *Table 15, COM Serial Port Identifiers* on *page 68*		Port to configure. (default = THISPORT)	Enum	4	H
3	bps/baud	300, 600, 900, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, or 230400		Communication baud rate (bps).	ULong	4	H+4
4	parity	See *Table 16* on *page 68*		Parity	Enum	4	H+8
5	databits	7 or 8		Number of data bits (default = 8)	ULong	4	H+12
6	stopbits	1 or 2		Number of stop bits (default = 1)	ULong	4	H+16
7	handshake	See *Table 17* on *page 68*		Handshaking	Enum	4	H+20
8	echo	OFF	0	No echo (default)	Enum	4	H+24
		ON	1	Transmit any input characters as they are received			
9	break	OFF	0	Disable break detection	Enum	4	H+28
		ON	1	Enable break detection (default)			

2.5.11 CSMOOTH Set carrier smoothing

This command sets the amount of carrier smoothing to be performed on the code measurements. An input value of 100 corresponds to approximately 100 seconds of smoothing. Upon issuing the command, the locktime (amount of continuous tracking in seconds) for all tracking satellites is reset to zero. From this point each code smoothing filter is restarted. The user must wait for at least the length of smoothing time for the new smoothing constant to take full effect. The optimum setting for this command is dependent on your application

There are several considerations when using the CSMOOTH command:

- The attenuation of low frequency noise (multipath) in pseudorange measurements
- The effect of time constants on the correlation of phase and code observations
- The rate of “pulling-in” of the code tracking loop (step response)

The effect of ionospheric divergence on carrier smoothed pseudorange (ramp response)

The primary reason for applying carrier smoothing to the measured pseudoranges is to mitigate the high frequency noise inherent in all code measurements. Adding more carrier smoothing by increasing the CSMOOTH value filters out lower frequency noise, including some multipath frequencies.

There are also some adverse effects of higher CSMOOTH values on some performance aspects of the receiver. Specifically, the time constant of the tracking loop is directly proportional to the CSMOOTH value and affects the degree of dependence between the carrier phase and pseudorange information. Carrier phase smoothing of the code measurements (pseudoranges) is accomplished by introducing data from the carrier tracking loops into the code tracking system. Phase and code data collected at a sampling rate greater than about 3 time constants of the loop are correlated (the greater the sampling rate, the greater the correlation). This correlation is not relevant if only positions are logged from the receiver, but is an important consideration if the data is combined in some other process such as post-mission carrier smoothing. Also, a narrow bandwidth in a feedback loop impedes the ability of the loop to track step functions. Steps in the pseudorange are encountered during initial lock-on of the satellite and when working in an environment conducive to multipath. A low CSMOOTH value allows the receiver to effectively adapt to these situations.

Also, increased carrier smoothing may cause problems when satellite signals are strongly affected by the ionosphere. The rate of divergence between the pseudoranges and phase-derived ranges is greatest when a satellite is low in the sky since the GPS signal must travel through a much “thicker” ionosphere. The tracking error of the receiver is greatest at these times when a lot of carrier smoothing is implemented. In addition, changing periods of ionospheric activity (diurnal changes and the 11-year cycle) influences the impact of large CSMOOTH values. It is important to realize that the advantages of carrier smoothing do not come without some trade-off in receiver performance. The factory default CSMOOTH value of 100 was selected as an optimal compromise of the above considerations. For the majority of applications, this default value should be appropriate. However, the flexibility exists to adjust the parameter for specific applications by users who are familiar with the consequences.

Abbreviated ASCII Syntax: **Message ID: 269**

CSMOOTH L1time

Factory Default:

csmooth 100

Abbreviated ASCII Example:

csmooth 500

The CSMOOTH command should only be used by advanced GPS users. The shorter the carrier smoothing the more noise there will be. If you are at all unsure please call NovAtel Customer Support Department, see the *Customer Support* section at the start of the *OEMStar Installation and Operation User Manual.*

It may not be suitable for every GPS application. When using CSMOOTH in differential mode, the same setting should be used at both the base and rover station.

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Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	CSMOOTH header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	L1time	2-2000		L1 carrier smoothing time constant, in seconds	Ulong	4	H
3	Reserved						

2.5.12 DATUM Choose a datum name type

This command permits you to select the geodetic datum for operation of the receiver. If not set, the factory default value is WGS84. See the USERDATUM command for user definable datums. The datum you select causes all position solutions to be based on that datum.

The transformation for the WGS84 to Local used in the OEMStar is the Bursa-Wolf transformation or reverse Helmert transformation. In the Helmert transformation, the rotation of a point is counter clockwise around the axes. In the Bursa-Wolf transformation, the rotation of a point is clockwise. Therefore, the reverse Helmert transformation is the same as the Bursa-Wolf.

See *Table 18* on *page 73* for a complete listing of all available predefined datums. The offsets in the table are from your local datum to WGS84.

Abbreviated ASCII Syntax: **Message ID: 160**

DATUM datum

Factory Default:

datum wgs84

ASCII Example:

datum csrs

Also, as an example, you can achieve spatial integrity with Government of Canada maps and surveys if the coordinates are output using the CSRS datum (Datum ID# 64).

Table 18 on *page 73* contains the internal ellipsoid and transformation parameters used in the receiver. The values contained in these tables were derived from the following DMA reports:

1. TR 8350.2 Department of Defense World Geodetic System 1984 and Relationships with Local Geodetic Systems - Revised March 1, 1988.
2. TR 8350.2B Supplement to Department of Defense World Geodetic System 1984 Technical Report - Part II - Parameters, Formulas, and Graphics for the Practical Application of WGS84 - December 1, 1987.
3. TR 8350.2 Department of Defense World Geodetic System 1984 National Imagery and Mapping Agency Technical Report, Third Addition, Amendment 1 - January 3, 2000

By default, NovAtel receivers output positions in WGS84, with the following additional information to consider:

Single: Uses WGS84

WAAS: Corrects to WGS84

EGNOS: Corrects to International Terrestrial Reference System which is compatible with WGS84

PSRDIFF: Unknown, as the rover does not know how the user fixed the base position, but must be close to WGS84

Table 18: Reference Ellipsoid Constants

ELLIPSOID	ID CODE	a (metres)	1/f	f
Airy 1830	AW	6377563.396	299.3249646	0.00334085064038
Modified Airy	AM	6377340.189	299.3249646	0.00334085064038
Australian National	AN	6378160.0	298.25	0.00335289186924
Bessel 1841	BR	6377397.155	299.1528128	0.00334277318217
Clarke 1866	CC	6378206.4	294.9786982	0.00339007530409
Clarke 1880	CD	6378249.145	293.465	0.00340756137870
Everest (India 1830)	EA	6377276.345	300.8017	0.00332444929666
Everest (Brunei & E.Malaysia)	EB	6377298.556	300.8017	0.00332444929666
Everest (W.Malaysia & Singapore)	EE	6377304.063	300.8017	0.00332444929666
Geodetic Reference System 1980	RF	6378137.0	298.257222101	0.00335281068118
Helmert 1906	HE	6378200.0	298.30	0.00335232986926
Hough 1960	HO	6378270.0	297.00	0.00336700336700
International 1924	IN	6378388.0	297.00	0.00336700336700
Parameters of the Earth	PZ-90.02	6378136.0	298.26	0.00335280374302
South American 1969	SA	6378160.0	298.25	0.00335289186924
World Geodetic System 1972	WD	6378135.0	298.26	0.00335277945417
World Geodetic System 1984	WE	6378137.0	298.257223563	0.00335281066475

Table 19: Datum Transformation Parameters

Datum ID#	NAME	DX [a]	DY [b]	DZ [b]	DATUM DESCRIPTION	ELLIPSOID
1	ADIND	-162	-12	206	This datum has been updated, see ID# 65 [b]	Clarke 1880
2	ARC50	-143	-90	-294	ARC 1950 (SW & SE Africa)	Clarke 1880
3	ARC60	-160	-8	-300	This datum has been updated, see ID# 66 [c]	Clarke 1880
4	AGD66	-133	-48	148	Australian Geodetic Datum 1966	Australian National
5	AGD84	-134	-48	149	Australian Geodetic Datum 1984	Australian National
6	BUKIT	-384	664	-48	Bukit Rimpah (Indonesia)	Bessel 1841
7	ASTRO	-104	-129	239	Camp Area Astro (Antarctica)	International 1924
8	CHATM	175	-38	113	Chatham 1971 (New Zealand)	International 1924
9	CARTH	-263	6	431	Carthage (Tunisia)	Clarke 1880
10	CAPE	-136	-108	-292	CAPE (South Africa)	Clarke 1880
11	DJAKA	-377	681	-50	Djakarta (Indonesia)	Bessel 1841
12	EGYPT	-130	110	-13	Old Egyptian	Helmert 1906
13	ED50	-87	-98	-121	European 1950	International 1924
14	ED79	-86	-98	-119	European 1979	International 1924
15	GUNSG	-403	684	41	G. Segara (Kalimantan - Indonesia)	Bessel 1841
16	GEO49	84	-22	209	Geodetic Datum 1949 (New Zealand)	International 1924
17	GRB36	375	-111	431	**Do not use.** Use ID# 76 instead. [d]	Airy 1830
18	GUAM	-100	-248	259	Guam 1963 (Guam Island)	Clarke 1866
19	HAWAII	89	-279	-183	**Do not use.** Use ID# 77 or ID# 81 instead. [d]	Clarke 1866
20	KAUAI	45	-290	-172	**Do not use.** Use ID# 78 or ID# 82 instead. [d]	Clarke 1866

Table 19: Datum Transformation Parameters (continued)

Datum ID#	NAME	DX [a]	DY [b]	DZ [b]	DATUM DESCRIPTION	ELLIPSOID
21	MAUI	65	-290	-190	**Do not use.** Use ID# 79 or ID# 83 instead. [d]	Clarke 1866
22	OAHU	56	-284	-181	**Do not use.** Use ID# 80 or ID# 84 instead. [d]	Clarke 1866
23	HERAT	-333	-222	114	Herat North (Afghanistan)	International 1924
24	HJORS	-73	46	-86	Hjorsey 1955 (Iceland)	International 1924
25	HONGK	-156	-271	-189	Hong Kong 1963	International 1924
26	HUTZU	-634	-549	-201	This datum has been updated, see ID# 68 [c]	International 1924
27	INDIA	289	734	257	**Do not use.** Use ID# 69 or ID# 70 instead. [c]	Everest (EA)
28	IRE65	506	-122	611	**Do not use.** Use ID# 71 instead. [d]	Modified Airy
29	KERTA	-11	851	5	Kertau 1948 (West Malaysia and Singapore)	Everest (EE)
30	KANDA	-97	787	86	Kandawala (Sri Lanka)	Everest (EA)
31	LIBER	-90	40	88	Liberia 1964	Clarke 1880
32	LUZON	-133	-77	-51	**Do not use.** Use ID# 72 instead. [d]	Clarke 1866
33	MINDA	-133	-70	-72	This datum has been updated, see ID# 73 [c]	Clarke 1866
34	MERCH	31	146	47	Merchich (Morocco)	Clarke 1880
35	NAHR	-231	-196	482	This datum has been updated, see ID# 74 [c]	Clarke 1880
36	NAD83	0	0	0	N. American 1983 (Includes Areas 37-42)	GRS-80
37	CANADA	-10	158	187	N. American Canada 1927	Clarke 1866
38	ALASKA	-5	135	172	N. American Alaska 1927	Clarke 1866
39	NAD27	-8	160	176	N. American Conus 1927	Clarke 1866
40	CARIBB	-7	152	178	This datum has been updated, see ID# 75 [c]	Clarke 1866
41	MEXICO	-12	130	190	N. American Mexico	Clarke 1866

Table 19: Datum Transformation Parameters (continued)

Datum ID#	NAME	DX [a]	DY [b]	DZ [b]	DATUM DESCRIPTION	ELLIPSOID
42	CAMER	0	125	194	N. American Central America	Clarke 1866
43	MINNA	-92	-93	122	Nigeria (Minna)	Clarke 1880
44	OMAN	-346	-1	224	Oman	Clarke 1880
45	PUERTO	11	72	-101	Puerto Rica and Virgin Islands	Clarke 1866
46	QORNO	164	138	-189	Qornoq (South Greenland)	International 1924
47	ROME	-255	-65	9	Rome 1940 Sardinia Island	International 1924
48	CHUA	-134	229	-29	South American Chua Astro (Paraguay)	International 1924
49	SAM56	-288	175	-376	South American (Provisional 1956)	International 1924
50	SAM69	-57	1	-41	South American 1969	S. American 1969
51	CAMPO	-148	136	90	S. American Campo Inchauspe (Argentina)	International 1924
52	SACOR	-206	172	-6	South American Corrego Alegre (Brazil)	International 1924
53	YACAR	-155	171	37	South American Yacare (Uruguay)	International 1924
54	TANAN	-189	-242	-91	Tananarive Observatory 1925 (Madagascar)	International 1924
55	TIMBA	-689	691	-46	This datum has been updated, see ID# 85 [c]	Everest (EB)
56	TOKYO	-128	481	664	This datum has been updated, see ID# 86 [c]	Bessel 1841
57	TRIST	-632	438	-609	Tristan Astro 1968 (Tristan du Cunha)	International 1924
58	VITI	51	391	-36	Viti Levu 1916 (Fiji Islands)	Clarke 1880
59	WAK60	101	52	-39	This datum has been updated, see ID# 67 [c]	Hough 1960
60	WGS72	0	0	4.5	World Geodetic System - 72	WGS72
61	WGS84	0	0	0	World Geodetic System - 84	WGS84
62	ZANDE	-265	120	-358	Zanderidj (Surinam)	International 1924

Table 19: Datum Transformation Parameters (continued)

Datum ID#	NAME	DX [a]	DY [b]	DZ [b]	DATUM DESCRIPTION	ELLIPSOID
63	USER	0	0	0	User Defined Datum Defaults	User [a]
64	CSRS	-0.9833	1.9082	0.4878	Canadian Spatial Ref. System (epoch 2005.0)	GRS-80
65	ADIM	-166	-15	204	Adindan (Ethiopia, Mali, Senegal & Sudan) [c]	Clarke 1880
66	ARSM	-160	-6	-302	ARC 1960 (Kenya, Tanzania) [c]	Clarke 1880
67	ENW	102	52	-38	Wake-Eniwetok (Marshall Islands) [c]	Hough 1960
68	HTN	-637	-549	-203	Hu-Tzu-Shan (Taiwan) [c]	International 1924
69	INDB	282	726	254	Indian (Bangladesh) [d]	Everest (EA)
70	INDI	295	736	257	Indian (India, Nepal) [d]	Everest (EA)
71	IRL	506	-122	611	Ireland 1965 [d]	Modified Airy
72	LUZA	-133	-77	-51	Luzon (Philippines excluding Mindanoa Is.) [dd]	Clarke 1866
73	LUZB	-133	-79	-72	Mindanoa Island [c]	Clarke 1866
74	NAHC	-243	-192	477	Nahrwan (Saudi Arabia) [c]	Clarke 1880
75	NASP	-3	142	183	N. American Caribbean [c]	Clarke 1866
76	OGBM	375	-111	431	Great Britain 1936 (Ordinance Survey) [d]	Airy 1830
77	OHAA	89	-279	-183	Hawaiian Hawaii [d]	Clarke 1866
78	OHAB	45	-290	-172	Hawaiian Kauai [d]	Clarke 1866
79	OHAC	65	-290	-190	Hawaiian Maui [d]	Clarke 1866
80	OHAD	58	-283	-182	Hawaiian Oahu [d]	Clarke 1866
81	OHIA	229	-222	-348	Hawaiian Hawaii [d]	International 1924
82	OHIB	185	-233	-337	Hawaiian Kauai [d]	International 1924
83	OHIC	205	-233	-355	Hawaiian Maui [d]	International 1924

Table 19: Datum Transformation Parameters (continued)

Datum ID#	NAME	DX [a]	DY [b]	DZ [b]	DATUM DESCRIPTION	ELLIPSOID
84	OHID	198	-226	-347	Hawaiian Oahu [d]	International 1924
85	TIL	-679	669	-48	Timbalai (Brunei and East Malaysia) 1948 [c]	Everest (EB)
86	TOYM	-148	507	685	Tokyo (Japan, Korea and Okinawa) [c]	Bessel 1841

a. The DX, DY and DZ offsets are from your local datum to WGS84.
b. The updated datum have the new x, y and z translation values updated to the latest numbers. The old datum values can still be used for backwards compatibility.
c. Use the corrected datum only (with the higher ID#) as the old datum is incorrect.
d. The original LUZON values are the same as for LUZA but the original has an error in the code.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	DATUM header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Datum Type	See *Table 19*.		The datum to use (default is WGS84)	Enum	4	H

2.5.13 DGPSEPHEMDELAY DGPS ephemeris delay

The DGPSEPHEMDELAY command is used to set the ephemeris delay when operating as a base station. The ephemeris delay sets a time value by which the base station continues to use the old ephemeris data. A delay of 120 to 300 seconds typically ensures that the rover stations have collected updated ephemeris. After the delay period is passed, the base station begins using new ephemeris data.

The factory default of 120 seconds matches the RTCM standard.

✉ The RTCA Standard stipulates that a base station shall wait five minutes after receiving a new ephemeris before transmitting differential corrections to rover stations that are using the RTCA standard. This time interval ensures that the rover stations have received the new ephemeris, and have computed differential positioning based upon the same ephemeris. Therefore, for RTCA base stations, the recommended ephemeris delay is 300 seconds.

Abbreviated ASCII Syntax: **Message ID: 142**

DGPSEPHEMDELAY delay

Factory Default:

dgpsephemdelay 120

ASCII Example (base):

dgpsephemdelay 120

✉ When using differential corrections, the rover receiver must use the same set of broadcast ephemeris parameters as the base station generating the corrections. The Issue of Ephemeris Data (IODE) parameter is transmitted as part of the differential correction so that the rover can guarantee that its and the base station ephemerides match. The DGPSEPHEMDELAY parameter should be large enough to ensure that the base station is not using a new set of ephemerides that has not yet been received at the rover receiver.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	DGPSEPHEMDELAY header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	delay	0 to 600 s		Minimum time delay before new ephemeris is used	ULong	4	H

2.5.14 DGPSTIMEOUT Set maximum age of differential data

This command is used to set the maximum age of pseudorange differential data to use when operating as a rover station. Pseudorange differential data received that is older than the specified time is ignored. See DGPSEPHEMDELAY on *page 79* to set the ephemeris changeover delay for base stations.

✉ The RTCA Standard for SCAT-I stipulates that the maximum age of differential correction messages cannot be greater than 22 seconds. Therefore, for RTCA rover users, the recommended DGPS delay setting is 22.

Abbreviated ASCII Syntax: **Message ID: 127**

DGPSTIMEOUT delay

Factory Default:

dgpstimeout 300

ASCII Example (rover):

dgpstimeout 60

✉ DGPSTIMEOUT applies to local pseudorange differential (RTCA and RTCM) corrections as if they were from a local base station. This also applies to pseudorange differential positioning using RTK corrections.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	DGPSTIMEOUT header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	delay	2 to 1000 s		Maximum pseudorange differential age	ULong	4	H

2.5.15 DGPSTXID DGPS transmit ID

This command sets the station ID value for the receiver when it is transmitting corrections. This allows for the easy identification of which base station was the source of the data.

Abbreviated ASCII Syntax: **Message ID: 144**

DGPSTXID type ID

Factory Default:

dgpstxid auto "any"

ASCII Examples:

dgpstxid rtcm 2 - using an rtcm type and id

dgpstxid rtca d036 - using an rtca type and id

How long do I need to sit on a 10 km baseline? How long you need to occupy stations for a 10 km baseline depends on the system you are using and what type of accuracies you require. For a DGPS system using only L1 C/A-code data, all you require is a single epoch of common data. Typically, you would log a few minutes worth of data. The type of accuracy you can expect out of this system is in the 1 metre range.

The term optimal conditions refers to observing six or more healthy satellites being tracked with a geometric dilution of precision - GDOP value of less than 5 and relatively low multi-path. Note that the above situations apply to both real-time and post-processed solutions with minor differences.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	DGPSTXID header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	See *Table 26.*		ID Type	Enum	4	H
3	ID	String [max. 5] or "ANY"		ID string ANY type defaults: RTCM - 0 RTCA - AAAA These range values are in affect: 0 ≤ RTCM ID ≤ 1023 RTCA: any four character string containing only alpha (a-z) or numerical characters (0-9)	String [max. 5]	Variable[a]	Variable

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

2.5.16 DYNAMICS Tune receiver parameters

This command adjusts the receiver dynamics to that of your environment. It is used to optimally tune receiver parameters.

The DYNAMICS command adjusts the Tracking State transition time-out value of the receiver (see *Table 60, Tracking State* on *page 304)*. When the receiver loses the position solution (see *Table 44, Solution Status* on *page 197*) it attempts to steer the tracking loops for fast reacquisition (5 s time-out by default). The DYNAMICS command allows you to adjust this time-out value.

easing the steering time. The three states 0, 1, and 2 set the time-out to 5, 10, or 20 s respectively.

✉ The DYNAMICS command should only be used by advanced users. The default of AIR should **not** be changed except under very specific conditions.

The DYNAMICS command affects satellite reacquisition. The constraint of its filter with FOOT is very tight and is appropriate for a user on foot. A sudden tilted or up and down movement, for example while a tractor is moving slowly along a track, may trip the filter to reset and cause the position to jump. AIR should be used in this case.

Abbreviated ASCII Syntax: **Message ID: 258**

DYNAMICS dynamics

Factory Default:

dynamics air

Example:

dynamics foot

Table 20: User Dynamics

Binary	ASCII	Description
0	AIR	Receiver is in an aircraft or a land vehicle, for example a high speed train, with velocity greater than 110 km/h (30 m/s). This is also the most suitable dynamic for a jittery vehicle at any speed (see also *Note #2* above).
1	LAND	Receiver is in a stable land vehicle with velocity less than 110 km/h (30 m/s)
2	FOOT	Receiver is being carried by a person with velocity less than 11 km/h (3 m/s)

✉ Qualifying North American Solar Challenge cars annually weave their way through 1000’s of miles between the US and Canada. GPS keeps them on track through many intersections on secondary highways and gives the Calgary team constant intelligence on the competition’s every move. In this case, with average speeds of 46 miles/hour and at times a jittery vehicle, air is the most suitable dynamic.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	DYNAMICS header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	dynamics	See *Table 20*		Receiver dynamics based on your environment	Enum	4	H

2.5.17 ECHO Sets port echo

This command sets a port to echo.

This command also acts as a collection response ether and can be used as a log.

Abbreviated ASCII Syntax: **Message ID: 1247**

ECHO [port] echo

Factory Default:

echo com1 off

echo com2 off

echo usb1 off

echo usb2 off

echo usb3 off

ASCII Example:

```
echo com1 on
```

Field #	Field Type	ASCII Value	Binary Value	Data Description	Format	Binary Bytes	Binary Offset
1	ECHO Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0
2	port	See *Table 15*[a]		Port to configure. (default = THISPORT)	Enum	4	H
3	echo	OFF	0	Sets port echo to off	Enum	4	H+4
		ON	1	Sets port echo to on			

a. XCOM ports are not supported.

2.5.18 ECUTOFF Set satellite elevation cut-off

This command sets the elevation cut-off angle for tracked satellites. The receiver does not start automatically searching for a satellite until it rises above the cut-off angle. Tracked satellites that fall below the cut-off angle are no longer tracked unless they were manually assigned (see the ASSIGN command).

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

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

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

---

✉ Care must be taken when using ECUTOFF because the signals from lower elevation satellites are traveling through more atmosphere and are therefore degraded. Use of satellites below 5 degrees is not recommended.

This command does not affect the tracking of SBAS or GLONASS satellites.

Abbreviated ASCII Syntax: **Message ID: 50**

ECUTOFF angle

Factory Default:

ecutoff 5.0

ASCII Example:

ecutoff 10.0

✉ A low elevation satellite is a satellite the receiver tracks "just" above the horizon. Generally, a satellite is considered low elevation if it is anywhere between 0 and 15 degrees above the horizon. Low elevation satellites are usually setting or rising.

There is no difference in the data transmitted from a low elevation satellite to that transmitted from a higher elevation satellite. However, differences in the signal path of a low elevation satellite make their use less desirable. Low elevation satellite signals are noisier due to the increased amount of atmosphere they must travel through. In addition, signals from low elevation satellites don't fit the assumption that a GPS signal travels in air nearly the same as in a vacuum. As such, using low elevation satellites in the solution results in greater position inaccuracies.

The elevation cut-off angle is specified with ECUTOFF to ensure that noisy, low elevation satellite data below the cut-off is not used in computing a position. If post-processing data, it is still best to collect all data (even that below the cut-off angle). Experimenting with different cut-off angles can then be done to provide the best results. In cases where there are not enough satellites visible, a low elevation satellite may actually help in providing a useful solution.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ECUTOFF header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	angle	±90.0 degrees		Elevation cut-off angle relative to horizon	Float	4	H

2.5.19 FIX Constrain to fixed height or position

This command fixes various parameters of the receiver such as height or position. For various applications, fixing these values can assist in improving acquisition times and accuracy of position or corrections. For example, fixing the position and height is a requirement for differential base stations as it provides a truth position to base the differential corrections from.

If you enter a FIXPOSDATUM command (see *page 91*) the FIX command is then issued internally with the FIXPOSDATUM command values translated to WGS84. It is the FIX command that appears in the RXCONFIG log. If the FIX or the FIXPOSDATUM command are used, their newest values overwrite the internal FIX values.

NovAtel strongly recommends that the FIX POSITION entered be good to within a few metres. This level of accuracy can be obtained from a receiver using single point positioning once 5 or 6 satellites are being tracked.

PDPFILTER DISABLE command must be sent for FIX command to take effect.

FIX POSITION should only be used for base station receivers. Applying FIX POSITION to a rover, switches it from DGPS mode to a fixed position mode. Applying FIX POSITION to the rover does not speed up ambiguity resolution.

You can fix the position of the receiver using latitude, longitude and height in Mean Sea Level (MSL) or ellipsoidal parameters depending on the UNDULATION setting. The factory default for the UNDULATION setting is TABLE where the height entered in the FIX command is set as MSL height. If you change the UNDULATION setting to USER 0, the height entered in the FIX command is set as ellipsoidal height (see *page 161*).

Error checking is done on the entered fixed position. If less than 3 measurements are available, the solution status indicates PENDING. While the status is PENDING, the fixed position value is not used internally (for example, for updating the clock model, or controlling the satellite signal search). Once 3 or more measurements are available, error checking is performed. If the error check passes, the solution status changes to SOL_COMPUTED, and the fixed position is used internally. At the first level of error, when the fixed position is off by approximately 25-50 m, the output position log indicates INTEGRITY_WARNING in the solution status field, but the fixed position value is still used internally. If the error reaches the second level, a few km, the receiver does not use the fixed position at all and indicates INVALID_FIX in the solution status. Note that a fixed position obtained from the POSAVE function is treated the same way in the error checking as one entered manually.

Abbreviated ASCII Syntax: **Message ID: 44**

FIX type [param1 [param2 [param3]]]

Factory Default:

fix none

ASCII Example:

fix height 4.567

✉ In order to maximize accuracy of a DGPS survey, you must fix the base station coordinates to their known position using the FIX [lat][lon][hgt] command. This ensures the accuracy of their corrections.

Table 21: Fix Types

ASCII Name	Binary Value	Description
NONE	0	Unfix. Clears any previous FIX commands.
AUTO	1	Configures the receiver to fix the height at the last calculated value if the number of satellites available is insufficient for a 3-D solution. This provides a 2-D solution. Height calculation resumes when the number of satellites available allows a 3-D solution.
HEIGHT	2	Configures the receiver in 2-D mode with its height constrained to a given value. This command is used mainly in marine applications where height in relation to mean sea level may be considered to be approximately constant. The height entered using this command is referenced to the mean sea level, (see the BESTPOS log on *page 195*) and is in metres. The receiver is capable of receiving and applying differential corrections from a base station while FIX HEIGHT is in effect. The FIX HEIGHT command overrides any previous FIX HEIGHT or FIX POSITION command.
POSITION	3	Configures the receiver with its position fixed. This command is used when it is necessary to generate differential corrections. For both pseudorange and differential corrections, this command must be properly initialized before the receiver can operate as a GPS base station. Once initialized, the receiver computes differential corrections for each satellite being tracked. The computed differential corrections can then be output to rover stations by utilizing any of the following receiver differential corrections data log formats: RTCM or RTCA. See the *OEMStar Installation and Operation User Manual* for information about using the receiver for differential applications. The values entered into the FIX POSITION command should reflect the precise position of the base station antenna phase center. Any errors in the FIX POSITION coordinates directly bias the corrections calculated by the base receiver. The receiver performs all internal computations based on WGS84 and the datum command is defaulted as such. The datum in which you choose to operate (by changing the DATUM command) is internally converted to and from WGS84. Therefore, all differential corrections are based on WGS84, regardless of your operating datum. The FIX POSITION command overrides any previous FIX HEIGHT or FIX POSITION command settings.

Table 22: FIX Parameters

ASCII Type Name	Parameter 1	Parameter 2	Parameter 3
NONE	Not used	Not used	Not used
AUTO	Not used	Not used	Not used
HEIGHT	Default MSL height [a] [b] (-1000 to 20000000 m)	Not used	Not used
POSITION	Lat (-90 to 90 degrees) where a '-' sign denotes south and a '+' sign denotes north	Lon (-360 to 360 degrees) where a '-' sign denotes west and a '+' sign denotes east	Default MSL height [a] [b] (-1000 to 20000000 m)
Velocity			

a. For more information about height, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

b. See also *Note #4* on *page 88*

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	FIX header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	See *Table 21* on *page 89*		Fix type	Enum	4	H
3	param1	See *Table 22*		Parameter 1	Double	8	H + 4
4	param2			Parameter 2	Double	8	H + 12
5	param3			Parameter 3	Double	8	H + 20

2.5.20 FIXPOSDATUM Set position in a specified datum

This command sets the position by referencing the position parameters through a specified datum. The position is transformed into the same datum as that in the receiver's current setting. The FIX command, see *page 88*, is then issued internally with the FIXPOSDATUM command values. It is the FIX command that appears in the RXCONFIG log. If the FIX or the FIXPOSDATUM command are used, their newest values overwrite the internal FIX values.

Abbreviated ASCII Syntax: **Message ID: 761**

FIXPOSDATUM datum lat lon height

Factory Default:

fixposdatum none

ASCII Example:

fixposdatum user 51.11633810554 -114.03839550586 1048.2343

✉ You can use the FIXPOSDATUM command in a survey to fix the position with values from another known datum, rather than transforming them into WGS84 yourself.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	FIXPOSDATUM header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	datum	See *Table 18* on *page 73*		Datum ID	Enum	4	H
3	lat	±90		Latitude (degrees)	Double	8	H + 4
4	lon	±360		Longitude (degrees)	Double	8	H + 12
5	height	-1000 to 20000000		Mean sea level (MSL) height (m) [a]	Double	8	H + 20

a. For more information about height, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

2.5.21 FREQUENCYOUT Set output pulse train available on VARF

This command sets the output pulse train available on the variable frequency (VARF) pin. The output waveform is coherent with the 1PPS output (see the usage note and *Figure 1* below).

Figure 1, below, shows how the chosen pulse width is frequency locked but not necessarily phase locked.

Abbreviated ASCII Syntax: **Message ID: 232**

FREQUENCYOUT [switch] [pulsewidth] [period]

Factory Default:

frequencyout disable

ASCII Example:

frequencyout enable 1 2

This example generates a 50% duty cycle 10 MHz square wave.

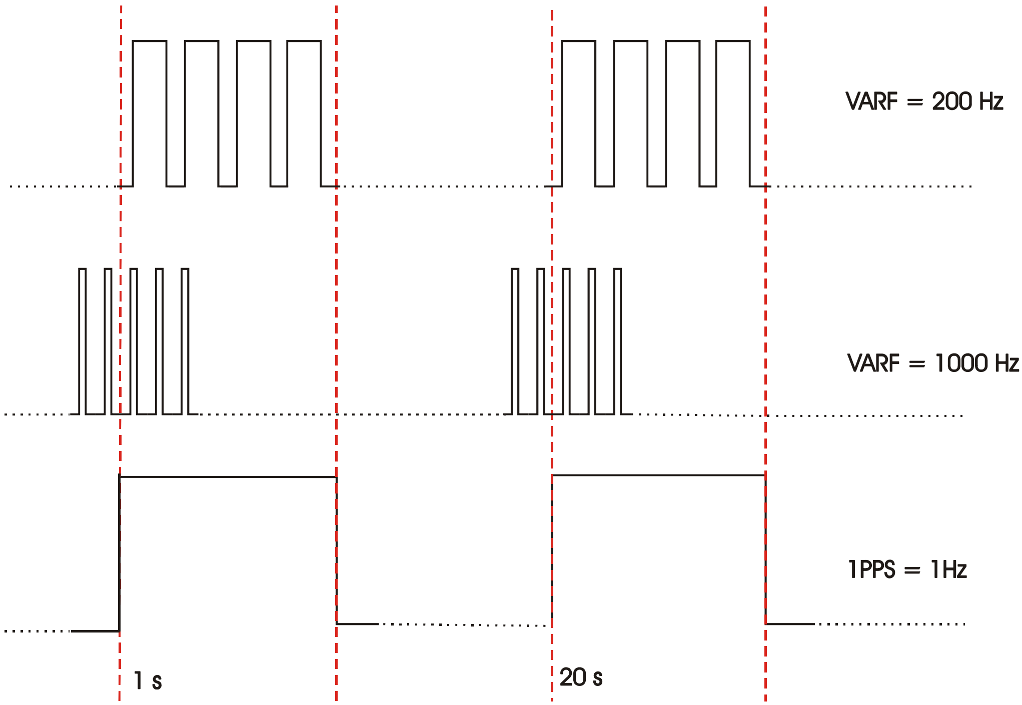


Figure 1: Pulse Width and 1PPS Coherency

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	FREQUENCYOUT header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	switch	DISABLE	0	Disable causes the output to be fixed low (default)	Enum	4	H
		ENABLE	1	Enables customized frequency output			
3	pulsewidth	(0 to 262143)		Number of 50 ns steps for which the output is high. Duty cycle = pulsewidth / period. Must be less than or equal to the period. (default = 0). If pulsewidth is the same as the period, the output is a high DC signal. If pulsewidth is 1/2 the period, then the output is a square wave. If the pulsewidth is set to 0, the output is held LOW.	Ulong	4	H+4
4	period	(0 to 262143)[a]		Signal period in 50 ns steps. Frequency Output = 20,000,000 / Period (default = 0)	Ulong	4	H+8

a. Periods of 1 or 0 produce special cases on the VARF output. If the period is 1 then the output is held at a constant HIGH or LOW depending on the value of the PULSEWIDTH field. If PULSEWIDTH is 1 the output is HIGH, if PULSEWIDTH is 0 the output is LOW. If the period is set to 0 then the output is held LOW.

2.5.22 FRESET Clear selected data from NVM and reset

This command clears data which is stored in non-volatile memory. Such data includes the almanac, ephemeris, and any user-specific configurations. The commands, ephemeris, and almanac related data, excluding the subscription information, can be cleared by using the `STANDARD` target. The model can only be cleared by using the `MODEL` target. The receiver is forced to hardware reset. In addition, values entered using the `CLOCKCALIBRATE` command can only be cleared by using the `STANDARD` target.

`FRESET STANDARD` (which is also the default) causes any commands, ephemeris, GPS almanac and SBAS almanac data (`COMMAND, GPSALMANAC, GPSEPHEM` and `SBASALMANAC` in *Table 23*) previously saved to NVM to be erased.

Abbreviated ASCII Syntax: **Message ID: 20**

FRESET [target]

Input Example:

freset command

If you are receiving no data or random data from your receiver, try these before contacting NovAtel:

- Verify that the receiver is tracking satellites
- Check the integrity and connectivity of power and data cables
- Verify the baud rate settings of the receiver and terminal device (your PC, data logger, or laptop)
- Switch COM ports
- Issue a FRESET command

Table 23: FRESET Target

Binary	ASCII	Description
0	STANDARD	Resets commands, ephemeris, and almanac (default).
1	COMMAND	Resets the stored commands (saved configuration)
2	GPSALMANAC	Resets the stored GPS almanac
3	GPSEPHEM	Resets the stored GPS ephemeris
4	GLOEPHEM	Resets the stored GLONASS ephemeris
5	MODEL	Resets the currently selected model
11	CLKCALIBRATION	Resets the parameters entered using the CLOCKCALIBRATE command
20	SBASALMANAC	Resets the stored SBAS almanac
21	LAST_POSITION	Resets the position using the last stored position
31	GLOALMANAC	Resets the stored GLONASS almanac

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	FRESET header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	target	See *Table 23*		What data is to be reset by the receiver	Enum	4	H

2.5.23 GGAQUALITY Customize the GPGGA GPS quality indicator

This command allows you to customize the NMEA GPGGA GPS quality indicator (see also the GPGGA log on *page 241*).

Abbreviated ASCII Syntax: **Message ID: 691**

GGAQUALITY #entries [pos type1][qual1] [pos type2] [qual2]...

Input Example 1:

ggaquality 1 waas 2

Makes the WAAS solution type show 2 as the quality indicator.

Input Example 2:

ggaquality 0

Sets all the quality indicators back to the default.

✉ Some solution types (see *Table 43, Position or Velocity Type* on *page 196*) store a quality indicator. For example, WAAS has an indicator of 9. This command can be used to customize an application to have unique indicators for each solution type.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	GGAQUALITY header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	#entries	0-20		The number of position types that are being re-mapped (20 max.)	Ulong	4	H+4
3	pos type1	See *Table 43, Position or Velocity Type* on *page 196*		The 1st position type that is being re-mapped	Enum	4	H+8
4	qual1	See *page 241*		The number that appears in the GPGGA log for the 1st position type	Ulong	4	H+12
5	pos type2	See *Table 43* on *page 196*		The 2nd position type that is being re-mapped, if applicable	Enum	4	H+16
6	qual2	See *page 241*		The number that appears in the GPGGA log for the 2nd solution type, if applicable	Ulong	4	H+20
...	Next solution type and quality indicator set, if applicable				Variable		

2.5.24 GLOCSMOOTH GLONASS channel carrier smoothing GLO

This command sets the amount of carrier smoothing to be performed on the code measurements. An input value of 100 corresponds to approximately 100 seconds of smoothing. Upon issuing the command, the locktime for continuous tracking of all GLONASS satellites is reset to zero. From this point each code smoothing filter is restarted. The user must wait for at least the length of smoothing time for the new smoothing constant to take full effect. The optimum setting for this command is dependent on your application.

Abbreviated ASCII Syntax: **Message ID: 830**

GLOCSMOOTH L1time

Factory Default:

glocsmooth 100

Abbreviated ASCII Example:

glocsmooth 200

The GLOCSMOOTH command should only be used by advanced GNSS users. The shorter the carrier smoothing, the more noise there will be. If you are at all unsure please e-mail NovAtel Customer Support (support@novatel.ca).

When used in differential mode, the same setting should be used at both the base and rover stations.

OEMStar receivers use the default setting of 100 s. The GLOCSMOOTH and CSMOOTH values for the OEMStar are best left at their defaults (100) unless you are certain that your application requires different values.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	GLO-CSMOOTH header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	L1 t const	2 to 2000		L1 time constant	Ulong	4	H
3	Reserved						

2.5.25 GLOECUTOFF Set GLONASS satellite elevation cut-off GLO

This command sets the elevation cut-off angle for tracked GLONASS satellites. The receiver does not start automatically searching for a satellite until it rises above the cut-off angle. Tracked satellites that fall below the cut-off angle are no longer tracked unless they were manually assigned (see the ASSIGN command).

In either case, satellites below the GLOECUTOFF angle are eliminated from the internal position and clock offset solution computations. See also the ECUTOFF command on page 86for more information about elevation cut-off commands.

Abbreviated ASCII Syntax: **Message ID: 735**

GLOECUTOFF angle

Factory Default:

gloecutoff 5.0

ASCII Example:

gloecutoff 0

✉ For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	GLO-ECUTOFF header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	angle	±90.0 degrees		Elevation cut-off angle relative to horizon	Float	4	H

2.5.26 INTERFACEMODE Set receive or transmit modes for ports

This command allows the user to specify what type of data a particular port on the receiver can transmit and receive. The receive type tells the receiver what type of data to accept on the specified port. The transmit type tells the receiver what kind of data it can generate. For example, you would set the receive type on a port to RTCA in order to accept RTCA differential corrections.

It is also possible to disable or enable the generation or transmission of command responses for a particular port. Disabling of responses is important for applications where data is required in a specific form and the introduction of extra bytes may cause problems, for example RTCA or RTCM. Disabling a port prompt is also useful when the port is connected to a modem or other device that responds with data the receiver does not recognize.

When INTERFACEMODE *port* NONE NONE OFF is set, the specified port are disabled from interpreting any input or output data. Therefore, no commands or differential corrections are decoded by the specified port. When GENERIC is set for a port, it is also disabled but data can be passed through the disabled port and be output from an alternative port using the pass-through logs, and PASSUSB. See *page 280* for details on these logs and the *Operation* chapter, in the *OEMStar Installation and Operation User Manual*, for information about pass-through logging (see also the COMCONFIG log on *page 219*).

***WARNING!*:If you intend to use the COM command, ensure you do so before the INTERFACEMODE command on each port. The COM command can remove the INTERFACEMODE command setting if the baud rate is changed after the interface mode is set. You can also turn break detection off using the COM command (see *page 67*) to stop the port from resetting because it is interpreting incoming bits as a break command.**

Abbreviated ASCII Syntax: **Message ID: 3**

INTERFACEMODE [port] rxtype txtype [responses]

Factory Default:

interfacemode com1 novatel novatel on

interfacemode com2 novatel novatel on

interfacemode usb1 novatel novatel on

interfacemode usb2 novatel novatel on

interfacemode usb3 novatel novatel on

ASCII Example 1:

interfacemode com1 rtca novatel on

ASCII Example 2:

interfacemode com2 rtcm none

✉ *Are NovAtel receivers compatible with others on the market?*

All GPS receivers output two solutions: position and time. The manner in which they output them makes each receiver unique. Most geodetic and survey grade receivers output the position in electronic form (typically RS-232), which makes them compatible with most computers and data loggers. All NovAtel receivers have this ability. However, each manufacturer has a unique way of formatting the messages. A NovAtel receiver is not directly compatible with a Trimble or Ashtech receiver (which are also incompatible with each other) unless everyone uses a generic data format.

But there are several generic data formats available. For position and navigation output there is the NMEA format. Real-time differential corrections use RTCM or RTCA format. Receiver code and phase data use RINEX format. NovAtel and all other major manufacturers support these formats and can work together using them.

You must understand your post-processing and real-time software requirements. Good software supports a generic standard while poor software locks you into one brand of GPS equipment. For the most flexibility, insist on generic data format support for all hardware and software solutions.

Table 24: Serial Port Interface Modes

Binary Value	ASCII Mode Name	Description
0	NONE	The port accepts/generates nothing. The port is disabled.
1	NOVATEL	The port accepts/generates NovAtel commands and logs
2	RTCM	The port accepts/generates RTCM corrections
3	RTCA	The port accepts/generates RTCA corrections
4	CMR	The port accepts CMR corrections
6	Reserved	
8	RTCMNOCR	RTCM with no CR/LF appended [a]
10	TCOM1	INTERFACEMODE tunnel modes. To configure a full duplex tunnel, configure the baud rate on each port. Once a tunnel is established, the baud rate does not change. Special characters, such as a BREAK condition, do not route across the tunnel transparently and the serial port is altered (see the COM command on *page 67)*. Only serial ports may be in a tunnel configuration: COM1 or COM2 may be used. For example, configure a tunnel at 115200 bps between COM1 and COM2: COM COM2 115200 COM COM1 115200 INTERFACEMODE COM2 TCOM1 NONE OFF INTERFACEMODE COM1 TCOM2 NONE OFF The tunnel is fully configured to receive/transmit at a baud rate of 115200 bps.
11	TCOM2	
14	RTCMV3	The port accepts RTCM Version 3.0 corrections
15	NOVATELBINARY	The port only accepts/generates binary messages. If an ASCII command is entered when the mode is set to binary only, the command is ignored. Only properly formatted binary messages are responded to and the response is a binary message.
16-17	Reserved	
18	GENERIC	The port accepts/generates nothing. SEND/SENDHEX commands from another port generate data on this port. Any incoming data on this port can be seen with PASSCOM logs on another port (see *page 280).*
19	Reserved	

a. An output interfacemode of RTCMNOCR is identical to RTCM but with the CR/LF appended. An input interfacemode of RTCMNOCR is identical to RTCM and functions with or without the CR/LF.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	INTERFACEMODE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	port	See *Table 15, COM Serial Port Identifiers* on *page 68*		Serial port identifier (default = THISPORT)	Enum	4	H
3	rxtype	See *Table 24, Serial Port Interface Modes* on *page 102*		Receive interface mode	Enum	4	H+4
4	txtype			Transmit interface mode	Enum	4	H+8
5	responses	OFF	0	Turn response generation off	Enum	4	H+12
		ON	1	Turn response generation on (default)			

2.5.27 LOCKOUT Prevent the receiver from using a satellite

This command prevents the receiver from using a satellite by de-weighting its range in the solution computations. Note that the LOCKOUT command does not prevent the receiver from tracking an undesirable satellite. This command must be repeated for each satellite to be locked out.

See also the UNLOCKOUT and UNLOCKOUTALL commands.

Abbreviated ASCII Syntax: **Message ID: 137**

LOCKOUT prn

Input Example:

lockout 8

✉ The LOCKOUT command allows you to remove one or more satellites from the solution while leaving other satellites available.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	LOCKOUT header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	prn	GPS: 1-37 SBAS: 120-138 GLONASS (see *Section 1.3* on *page 26*).		A single satellite PRN number to be locked out	Ulong	4	H

2.5.28 LOG Request logs from the receiver

Many different types of data can be logged using several different methods of triggering the log events. Every log element can be directed to any combination of the two COM ports and three USB ports. The ONTIME trigger option requires the addition of the *period* parameter. See *Chapter 3, Data Logs on page 175* for further information and a complete list of data log structures. The *LOG* command tables in this section show the binary format followed by the ASCII command format.

The optional parameter [hold] prevents a log from being removed when the UNLOGALL command, with its defaults, is issued. To remove a log which was invoked using the [hold] parameter requires the specific use of the UNLOG command (see *page 165*). To remove all logs that have the [hold] parameter, use the UNLOGALL command with the *held* field set to 1 (see *page 166*).

The [port] parameter is optional. If [port] is not specified, [port] is defaulted to the port that the command was received on.

✉ OEMStar receivers can handle 30 logs at a time. If you attempt to log more than 30 logs at a time, the receiver responds with an Insufficient Resources error.

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

Polled log types do not allow fractional offsets or ONTIME rates faster than 1Hz.

Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

Only the MARKPOS or MARKTIME logs, and ‘polled’ log types are generated ‘on the fly’ at the exact time of the mark. Synchronous and asynchronous logs output the most recently available data.

If you do use the ONTIME trigger with asynchronous logs, the time stamp in the log does not necessarily represent the time the data was generated, but rather the time when the log is being transmitted.

Abbreviated ASCII Syntax: **Message ID: 1**

LOG [port] message [trigger [period [offset [hold]]]]

Factory Default:

log com1 rxstatuseventa onnew 0 0 hold

log com2 rxstatuseventa onnew 0 0 hold

log usb1 rxstatuseventa onnew 0 0 hold

log usb2 rxstatuseventa onnew 0 0 hold

log usb3 rxstatuseventa onnew 0 0 hold

Abbreviated ASCII Example 1:

log com1 bestpos ontime 7 0.5 hold

The above example shows BESTPOS logging to COM port 1 at 7 second intervals and offset by 0.5 seconds (output at 0.5, 7.5, 14.5 seconds and so on). The [hold] parameter is set so that logging is not disrupted by the UNLOGALL command.

To send a log only one time, the trigger option can be ignored.

Abbreviated ASCII Example 2:

log com1 bestpos once 0.000000 0.000000 nohold

See *Section 2.1, Command Formats* on *page 33* for additional examples.

In CDU there are two ways to initiate data logging to the receiver's serial ports. You can either enter the LOG command in the *Console* window, or use the interface provided in the *Logging Control* window. Ensure the Power Settings on your PC are not set to go into Hibernate or Standby modes. Data is lost if one of these modes occurs during a logging session.

Field	Field Name	Binary Value	Description	Field Type	Binary Bytes	Binary Offset
1	LOG (binary) header	See *Table 4, Binary Message Header Structure* on *page 20*	This field contains the message header.	-	H	0
2	port	See *Table 5, Detailed Serial Port Identifiers* on *page 22*	Output port	Enum	4	H
3	message	Any valid message ID	Message ID of log to output	UShort	2	H+4
4	message type	Bits 0-4 = Reserved Bits 5-6 = Format 00 = Binary 01 = ASCII 10 = Abbrev. ASCII, NMEA 11 = Reserved Bit 7 = Response Bit (see *page 24*) 0 = Original Message 1 = Response Message	Message type of log	Char	1	H+6
5	Reserved			Char	1	H+7
6	trigger	0 = ONNEW	Does not output current message but outputs when the message is updated (not necessarily changed)	Enum	4	H+8
		1 = ONCHANGED	Outputs the current message and then continue to output when the message is changed			
		2 = ONTIME	Output on a time interval			
		3 = ONNEXT	Output only the next message			
		4 = ONCE	Output only the current message			
		5 = ONMARK	Output when a pulse is detected on the mark 1 input, MK1I [a] [b]			

Continued on the next page

Field	Field Name	Binary Value	Description	Field Type	Binary Bytes	Binary Offset
7	period	Valid values for the high rate logging are 0.1, 0.2, 0.25 and 0.5. For logging slower than 1Hz any integer value is accepted.	Log period (for ONTIME trigger) in seconds [c]	Double	8	H+12
8	offset	A valid value is any integer smaller than the period. These decimal values, on their own, are also valid: 0.1, 0.2, 0.25 or 0.5	Offset for period (ONTIME trigger) in seconds. If you wished to log data at 1 second after every minute you would set the period to 60 and the offset to 1	Double	8	H+20
9	hold	0 = NOHOLD	Allow log to be removed by the UNLOGALL command	Enum	4	H+28
		1 = HOLD	Prevent log from being removed by the default UNLOGALL command			

a. Refer to the *Technical Specifications* appendix in the *OEMStar Installation and Operation User Manual* for more details on the MK1I pin. ONMARK only applies to MK1I. Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

b. Once the 1PPS signal has hit a rising edge, for both MARKPOS and MARKTIME logs, a resolution of both measurements is 49 ns. As for the ONMARK trigger for other logs that measure latency, for example RANGE and position log such as BESTPOS, it takes typically 20-30 ms (50 ms maximum) for the logs to output information from the 1PPS signal. Latency is the time between the reception of the 1PPS pulse and the first byte of the associated log. See also the MARKPOS and MARKTIME logs starting on *page 270*.

c. See *Appendix A* in the *OEMStar Installation and Operation User Manual* for the maximum raw measurement rate to calculate the minimum period. If the value entered is lower than the minimum measurement period, the value is ignored and the minimum period is used.

Field	Field Name	ASCII Value	Description	Field Type
1	LOG (ASCII) header	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII or ASCII respectively.	-
2	port	See *Table 15, COM Serial Port Identifiers* on *page 68*	Output port (default = THISPORT)	Enum
3	message	Any valid message name, with an optional A or B suffix.	Message name of log to output	Char [ ]
4	trigger	ONNEW	Output when the message is updated (not necessarily changed)	Enum
		ONCHANGED	Output when the message is changed	
		ONTIME	Output on a time interval	
		ONNEXT	Output only the next message	
		ONCE	Output only the current message. (default)	
		ONMARK	Output when a pulse is detected on the mark 1 input, MK1I (see *Footnotes a* and *b* on *page 108*)	
5	period	Any positive double value larger than the receiver's minimum raw measurement period	Log period (for ONTIME trigger) in seconds (default = 0) (see *Footnote c* on *page 108*)	Double
6	offset	Any positive double value smaller than the period.	Offset for period (ONTIME trigger) in seconds. If you wished to log data at 1 second after every minute you would set the period to 60 and the offset to 1 (default = 0)	Double
7	hold	NOHOLD	Allow log to be removed by the UNLOGALL command (default)	Enum
		HOLD	Prevent log from being removed by the UNLOGALL command	

2.5.29 MAGVAR Set a magnetic variation correction

The receiver computes directions referenced to True North. Use this command (magnetic variation correction) if you intend to navigate in agreement with magnetic compass bearings. The correction value entered here causes the "bearing" field of the NAVIGATE log to report bearing in degrees Magnetic. The receiver computes the magnetic variation correction if you use the auto option (see *Figure 2, Illustration of Magnetic Variation & Correction on page 111)*.

The receiver calculates values of magnetic variation for given values of latitude, longitude and time using the International Geomagnetic Reference Field (IGRF) 2005 spherical harmonic coefficients and IGRF time corrections to the harmonic coefficients. The model is intended for use up to the year 2010. The receiver will compute for years beyond 2010 but accuracy may be reduced.

How does the GPS determine what Magnetic North is? Do the satellites transmit a database, or some kind of look-up chart to determine the declination for your given latitude and longitude? How accurate is it?

Magnetic North refers to the location of the Earth's Magnetic North Pole. Its position is constantly changing in various cycles over centuries, years, and days. These rates of change vary and are not well understood. However, we are able to monitor these changes.

True North refers to the earth's celestial pole, that is, at 90° north latitude or the location where the lines of longitude converge. This position is always the same and does not vary.

The locations of these two poles do not coincide. Thus, a relationship is required between these two values for users to relate GPS bearings to their compass bearings. This value is called the magnetic variation correction or declination.

GPS does not determine where Magnetic North is nor do the satellites provide magnetic correction or declination values. However, OEMStar receivers store this information internally in look-up tables so that when you specify that you want to navigate with respect to Magnetic North, this internal information is used. These values are also available from various information sources such as the United States Geological Survey (USGS). The USGS produces maps and has software which enables you to determine these correction values. By identifying your location (latitude and longitude), you can obtain the correction value.

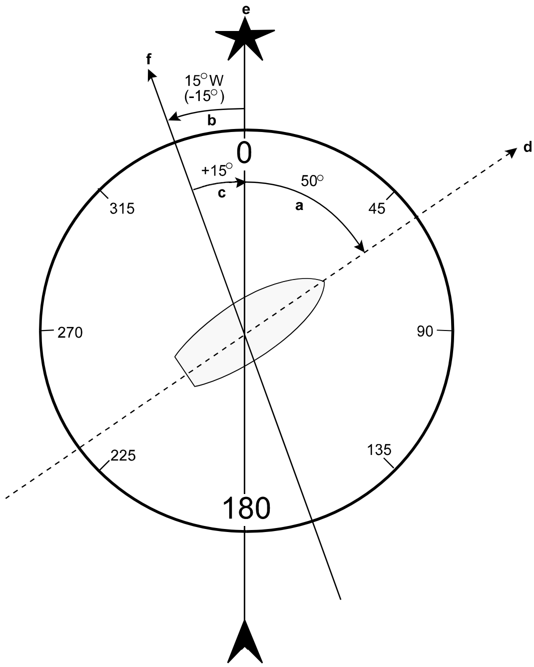


Figure 2: Illustration of Magnetic Variation & Correction

Reference	Description
a	True Bearing
b	Local Magnetic Variation
c	Local Magnetic Variation Correction (inverse of magnetic variation)
a + c	Magnetic Bearing
d	Heading: 50° True, 60° Magnetic
e	True North
f	Local Magnetic North

Abbreviated ASCII Syntax: **Message ID: 180**

MAGVAR type [correction] [std dev]

Factory Default:

magvar correction 0 0

ASCII Example 1:

magvar auto

ASCII Example 2:

magvar correction 15 0

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	MAGVAR header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	AUTO	0	Use IGRF corrections	Enum	4	H
		CORRECTION	1	Use the correction supplied			
3	correction	± 180.0 degrees		Magnitude of correction (Required field if type = Correction)	Float	4	H+4
4	std_dev	± 180.0 degrees		Standard deviation of correction (default = 0)	Float	4	H+8

2.5.30 MARKCONTROL Control processing of mark inputs

This command provides a means of controlling the processing of the mark 1 (MK1I) input for the OEMStar. Using this command, the mark inputs can be enabled or disabled, the polarity can be changed, and a time offset and guard against extraneous pulses can be added.

The MARKPOS and MARKTIME logs (see their descriptions starting on *page 270*) have their outputs (and extrapolated time tags) pushed into the future (relative to the MKI event) by the amount entered into the time bias field. In almost all cases, this value is set to 0, which is also the default setting.

Abbreviated ASCII Syntax: **Message ID: 614**

MARKCONTROL signal switch [polarity] [timebias [timeguard]]

Factory Default:

markcontrol mark1 enable negative 0 0

ASCII Example:

markcontrol mark1 enable negative 50 100

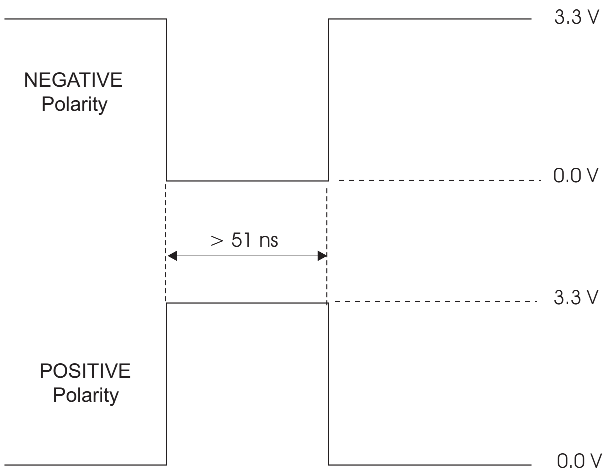


Figure 3: TTL Pulse Polarity

✉ You may have a user point device, such as a video camera device. Connect the device to the receiver's I/O port. Use a cable that is compatible to both the receiver and the device. A MARKIN pulse can be a trigger from the device to the receiver (see also the MARKPOS and MARKTIME logs starting on *page 270*).

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	MARKCONTROL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	signal	MARK1	0	Specifies which mark input the command should be applied to. Set to MARK1 for the MK1I input. The MARK1 input has a 10K pull-up resistor to 3.3 V and is leading edge triggered.	Enum	4	H
3	switch	DISABLE	0	Disables or enables processing of the mark input signal for the input specified. If DISABLE is selected, the mark input signal is ignored. The factory default is ENABLE.	Enum	4	H+4
		ENABLE	1				
4	polarity	NEGATIVE	0	Optional field to specify the polarity of the pulse to be received on the mark input. See *Figure 3* for more information. If no value is specified, the default NEGATIVE is used.	Enum	4	H+8
		POSITIVE	1				
5	timebias	Any valid long value		Optional value to specify an offset, in nanoseconds, to be applied to the time the mark input pulse occurs. If no value is supplied, the default value of 0 is used.	Long	4	H+12
6	timeguard	Any valid ulong value larger than the receiver's minimum raw measurement period [a]		Optional field to specify a time period, in milliseconds, during which subsequent pulses after an initial pulse are ignored. If no value is supplied, the default value of 0 is used.	ULong	4	H+16

a. See *Appendix A* in the *OEMStar Installation and Operation User Manual* for the maximum raw measurement rate to determine the minimum period. If the value entered is lower than the minimum measurement period, the value is ignored and the minimum period is used.

2.5.31 MODEL Switch to a previously authorized model

This command is used to switch the receiver between models previously added with the AUTH command. When this command is issued, the receiver saves this model as the active model. The active model is now used on every subsequent start-up. The MODEL command causes an automatic reset.

Use the VALIDMODELS log to output a list of available models for your receiver. The VALIDMODELS log is described on *page 366*. Use the VERSION log to output the active model (see *page 367)*.

> If you switch to an expired model, the receiver will reset and enter into an error state. You will need to switch to a valid model to continue.

Abbreviated ASCII Syntax: **Message ID: 22**

MODEL model

Input Example:

model lxgmts

> NovAtel receivers use the concept of models to enable different levels of functionality in the receiver firmware. For example, a receiver may be purchased with a GPS-only enabled version of firmware and be easily upgraded at a later time to a more feature-intensive model. All that is required to upgrade is an authorization code for the higher model and the AUTH command (see *page 58*). Reloading the firmware or returning the receiver for service to upgrade the model is not required. Upgrades are available from NovAtel Customer Support at 1-800-NOVATEL.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	MODEL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	model	Max 16 character null-terminated string (including the null)		Model name	String [max. 16]	Vari-able[a]	Vari-able

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

2.5.32 NMEATALKER Set the NMEA talker ID

This command allows you to alter the behavior of the NMEA talker ID. The talker is the first 2 characters after the $ sign in the log header of the GPGLL, GPGRS, GPGSA, GPGST, GPGSV, GPRMB, GPRMC, GPVTG, and GPZDA log outputs.

The default GPS NMEA messages (`nmeatalker gp`) include specific information about only the GPS satellites and have a 'GP' talker solution even when GLONASS satellites are present. The `nmeatalker auto` command changes this behavior so that the NMEA messages include all satellites in the solution, and the talker ID changes according to those satellites.

If `nmeatalker` is set to `auto`, and there are both GPS and GLONASS satellites in the solution, two sentences with the GN talker ID are output. The first sentence contains information about the GPS, and the second sentence on the GLONASS, satellites in the solution.

If `nmeatalker` is set to `auto` and there are only GLONASS satellites in the solution, the talker ID of this message is GL.

Abbreviated ASCII Syntax: **Message ID: 861**

NMEATALKER [ID]

Factory Default:

nmeatalker gp

ASCII Example:

nmeatalker auto

✉ The NMEATALKER command only affects NMEA logs that are capable of a GPS output. For example, GLMLA is a GLONASS-only log and its output will always use the GL talker. *Table 25* on *page 117* shows the NMEA logs and whether they use GPS (GP), GLONASS (GL) or combined (GN) talkers with `nmeatalker auto`.

Table 25: NMEA Talkers

Log	Talker IDs
GLMLA	GL
GPALM	GP
GPGGA	GP
GPGLL	GP or GN
GPGRS	GP or GN
GPGSA	GP or GN
GPGST	GP or GN
GPGSV	GP and GL
GPRMB	GP or GN
GPRMC	GP or GN
GPVTG	GP or GN
GPZDA	GP

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	NMEA-TALKER header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	ID	GP	0	GPS only	Enum	4	H
		AUTO	1	GPS or GLONASS			

2.5.33 NVMRESTORE Restore NVM data after an NVM failure

This command restores non-volatile memory (NVM) data after a NVM Fail error. This failure is indicated by bit 13 of the receiver error word being set (see also *RXSTATUS, page 347* and *RXSTATUSEVENT, page 355*). If corrupt NVM data is detected, the receiver remains in the error state and continues to flash an error code on the Status LED until the NVMRESTORE command is issued (refer to the chapter on *Built-In Status Tests* in the *OEMStar Installation and Operation User Manual* for further explanation).

If you have more than one auth-code and the saved model is lost then the model may need to be entered using the MODEL command or it is automatically saved in NVM on the next start-up. If the almanac was lost, a new almanac is automatically saved when the next complete almanac is received (after approximately 15 minutes of continuous tracking). If the user configuration was lost it has to be re-entered by the user. This could include communication port settings.

✉ The factory default for the COM ports is 9600, n, 8, 1.

After entering the NVMRESTORE command and resetting the receiver, the communications link may have to be re-established at a different baud rate from the previous connection.

Abbreviated ASCII Syntax: **Message ID: 197**

NVMRESTORE

✉ The possibility of NVM failure is extremely remote, however, if it should occur it is likely that only a small part of the data is corrupt. This command is used to remove the corrupt data and restore the receiver to an operational state. The data lost could be the user configuration, almanac, model, or other reserved information.

2.5.34 PDPFILTER Command to enable, disable or reset the PDP filter

This command enables, disables or resets the Pseudorange/Delta-Phase (PDP) filter. The main advantages of the Pseudorange/Delta-Phase (PDP) implementation are:

- Smooths a jumpy position
- Bridges outages in satellite coverage (the solution is degraded from normal but there is at least a reasonable solution without gaps)

✉ For channel configurations that include GPS, PDP is enabled by default on the OEMStar.

With PDP enabled (default), the BESTPOS log is not updated until the receiver has achieved FINESTEERING.

PDP and GL1DE are disabled for GLONASS-only applications.

Enable the PDP filter to output the PDP solution in BESTPOS, BESTVEL and NMEA logs.

Refer to the *OEMStar Installation and Operation Manual*, available from our Web site at www.novatel.com through *Support | Firmware/Software and Manuals | Manuals and Documentation Updates*, for more information about configuring your receiver for PDP or GL1DE® operation. To use GL1DE, you must have the GL1DE option enabled. Contact Customer Support for further information.

GL1DE Position Filter

GL1DE is a mode of the PDP[1] filter which optimizes the position for consistency over time rather than absolute accuracy. This is ideally in clear sky conditions where the user needs a tight, smooth, and consistent output. The GL1DE filter works best with WAAS. The PDP filter is smoother than a least squares fit but is still noisy in places. The GL1DE filter produces a very smooth solution with consistent rather than absolute position accuracy. There should be less than 1 cm difference typically from epoch to epoch. GL1DE also works in single point and DGPS modes (see also the PDPMODE command on *page 121* and the *PDPPOS*, *PSRVEL* and *PSRXYZ* logs starting on *page 284*).

Abbreviated ASCII Syntax: **Message ID: 424**

PDPFILTER switch

Factory Default:

pdpfilter enable

ASCII Example:

pdpfilter disable

1. Refer also to our application note on *Pseudorange/Delta-Phase (PDP)*, available on our Web site as APN-038 at http://www.novatel.com/support/knowledge-and-learning/.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	PDPFILTER header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	switch	DISABLE	0	Enable/disable/reset the PDP filter. A reset clears the filter memory so that the pdp filter can start over.	Enum	4	H
		ENABLE	1				
		RESET	2				

2.5.35 PDPMODE Select the PDP mode and dynamics

This command allows you to select the mode and dynamics of the PDP filter.

✉ You must issue a PDPFILTER ENABLE command before the PDPMODE command (see also *Section 2.5.34* on *page 119*).

If you choose RELATIVE mode (GL1DE) while in WAAS mode, you must force the iono type to GRID in the SETIONOTYPE command. To use GL1DE, you must have the GL1DE option enabled. Contact Customer Support for further information. See also *Section 2.5.51* starting on *page 147* for details on the SETIONOTYPE command.

PDP functionality has been disabled for GLO only channel configurations.

Abbreviated ASCII Syntax: **Message ID: 970**

PDPMODE mode dynamics

Factory Default:

pdpmode normal auto

ASCII Example:

pdpmode relative dynamic

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	PDPMODE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	mode	NORMAL	0	In relative mode, GL1DE performance is optimized to obtain a consistent error in latitude and longitude over time periods of 15 minutes or less rather than to obtain the smallest absolute position error (see also *GL1DE Position Filter* on *page 119*).	Enum	4	H
		RELATIVE	1				
3	dynamics	AUTO	0	Auto detect dynamics mode	Enum	4	H+4
		STATIC	1	Static mode			
		DYNAMIC	2	Dynamic mode			

2.5.36 POSAVE Implement base station position averaging

This command implements position averaging for base stations. Position averaging continues for a specified number of hours or until the estimated averaged position error is within specified accuracy limits. Averaging stops when the time limit or the horizontal standard deviation limit or the vertical standard deviation limit is achieved. When averaging is complete, the FIX POSITION command is automatically invoked.

If you initiate differential logging, then issue the POSAVE command followed by the SAVECONFIG command, the receiver averages positions after every power-on or reset, and then invokes the FIX POSITION command to enable it to send differential corrections.

If this command is used, its command default state is ON and as such you only need to specify the state if you wish to disable position averaging (OFF). In *Example 1* below, `POSAVE 24 1 2` is the same as:

1. POSAVE ON 24 1 2

2. `PDPFILTER DISABLE` must be sent to OEMStar for POSAVE command to take effect.

Abbreviated ASCII Syntax: **Message ID: 173**

POSAVE [state] maxtime [maxhstd [maxvstd]]

Factory Default:

posave off

ASCII Example 1:

posave 24 1 2

ASCII Example 2:

posave off

The POSAVE command can be used to establish a new base station in any form of survey or DGPS data collection by occupying a site and averaging the position until either a certain amount of time has passed, or position accuracy has reached a user-specified level. User-specified requirements can be based on time, or horizontal or vertical quality of precision.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	POSAVE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	state	ON	1	Enable or disable position averaging (default = ON)	Enum	4	H
		OFF	0				
3	maxtime	0.01 - 100 hours		Maximum amount of time that positions are to be averaged. Only becomes optional if: State = OFF	Float	4	H+4
4	maxhstd	0 - 100 m		Desired horizontal standard deviation (default = 0)	Float	4	H+8
5	maxvstd	0 - 100 m		Desired vertical standard deviation (default = 0)	Float	4	H+12

2.5.37 POSTIMEOUT Sets the position time out

This commands allows you to set the position type time out value for the position calculation in seconds.

In position logs, for example BESTPOS or PSRPOS, when the position time out expires, the *Position Type* field is set to NONE. Other field values in these logs remain populated with the last available position data. Also, the position is no longer used in conjunction with the almanac to determine what satellites are visible.

Abbreviated ASCII Syntax: **Message ID: 612**

POSTIMEOUT sec

Factory Default:

postimeout 600

ASCII Example:

postimeout 1200.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	POSTIMEOUT header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	sec	0-86400		Time out in seconds (default = 600 s)	Ulong	4	H

2.5.38 PPSCONTROL Control the PPS output

This command provides a method for controlling the polarity, pulse width and period of the PPS output on the OEMStar. You can also disable the PPS output using this command. The pulse width defaults to 1000 microseconds.

The leading edge of the 1PPS pulse is always the trigger/reference:

```
PPSCONTROL ENABLE NEGATIVE
```

generates a normally high, active low pulse with the falling edge as the reference, while:

```
PPSCONTROL ENABLE POSITIVE
```

generates a normally low, active high pulse with the rising edge as the reference.

Abbreviated ASCII Syntax: **Message ID: 613**

PPSCONTROL switch [polarity] [period] [pulse width]

Factory Default:

ppscontrol enable negative 1.0 1000

ASCII Example:

ppscontrol enable positive 0.5

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	PPSCONTROL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	switch	DISABLE	0	Controls output of PPS pulse. ENABLE allows PPS pulse regardless of time status[a]. ENABLE_FINETIME allows PPS output only when time status is FINE, FINESTEERING, or FINEBACKUPSTEERING Default: ENABLE.	Enum	4	H+4
		ENABLE	1				
		ENABLE_ FINETIME	2				
3	polarity	NEGATIVE	0	Optional field to specify the polarity of the pulse to be generated on the PPS output. See *Figure 3* for more information. If no value is supplied, the default NEGATIVE is used.	Enum	4	H+8
		POSITIVE	1				
4	period	0.05, 0.1, 0.2, 0.25, 0.5, 1.0, 2.0, 3.0,...20.0		Optional field to specify the period of the pulse, in seconds. If no value is supplied, the default value of 1.0 is used.	Double	8	H+12
5	pulse width	Any positive value less than half of the period		Optional field to specify the pulse width of the PPS signal in microseconds. If no value is supplied, the default value of 0 is used which refers to 1000 microseconds. This value must always be less than half the period. Default:1000.	ULong	4	H+20

a. Time status can be obtained from the log header. See *Section 1.1* on *page 14*.

2.5.39 PSRDIFFSOURCE Set the pseudorange correction source

This command lets you identify from which base station to accept differential corrections. This is useful when the receiver is receiving corrections from multiple base stations (see also the RTKSOURCE command on *page 133*).

When a valid PSRDIFFSOURCE command is received, the current correction is removed immediately rather than in the time specified in DGPSTIMEOUT.

PSRDIFFSOIURCE is disabled for GLO only.

Abbreviated ASCII Syntax: **Message ID: 493**

PSRDIFFSOURCE type ID

Factory Default:

psrdiffsource auto "any"

ASCII Examples:

1. Select only SBAS:
   rtksource none
   psrdiffsource sbas
   sbascontrol enable auto
2. Enable PSRDIFF from RTCM, with a fall-back to SBAS:
   rtksource rtcm any
   psrdiffsource rtcm any
   sbascontrol enable auto
3. Select NONE:
   rtksource none
   psrdiffsource none

Since several errors affecting signal transmission are nearly the same for two receivers near each other on the ground, a base at a known location can monitor the errors and generate corrections for the rover to use. This method is called Differential GPS, and is used by surveyors to obtain millimetre accuracy.

Major factors degrading GPS signals, which can be removed or reduced with differential methods, are the atmosphere, ionosphere, satellite orbit errors and satellite clock errors. Errors not removed include receiver noise and multipath.

Table 26: DGPS Type

Binary	ASCII	Tag	Description
0	RTCM [c]		RTCM ID: 0 ≤ RTCM ID ≤ 1023 **or** ANY
1	RTCA [c]		RTCA ID: A four character string containing only alpha (a-z) or numeric characters (0-9) **or** ANY
2	CMR [a c]		CMR ID: 0 ≤ CMR ID ≤ 31 **or** ANY
5	SBAS [b c]	SBAS	In the PSRDIFFSOURCE command, when enabled, SBAS, such as WAAS, EGNOS and MSAS, forces the use of SBAS as the pseudorange differential source. SBAS is able to simultaneously track two SBAS satellites, and incorporate the SBAS corrections into the position to generate differential-quality position solutions. An SBAS-capable receiver permits anyone within the area of coverage to take advantage of its benefits.
6	RTK		This command allows received RTK corrections to be used to generate a DGPS solution.
10	AUTO [b c]		In the PSRDIFFSOURCE command, AUTO means the first received RTCM or RTCA message has preference over an SBAS message. In the RTKSOURCE command, AUTO means that the NovAtel DGPS filter is enabled. The NovAtel DGPS filter selects the first received RTCM, RTCA, RTCMV3 or CMR message.
11	NONE [b c]		Disables all differential correction types
12	Reserved		
13	RTCMV3 [a]		RTCM Version 3.0 ID: 0 ≤ RTCMV3 ID ≤ 4095 **or** ANY

a. Available only with the RTKSOURCE command (see *page 133*)

b. ID parameter is ignored.

c. All PSRDIFFSOURCE entries fall back to SBAS (except NONE) for backwards compatibility

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	PSRDIFFSOURCE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	See *Table 26*		ID Type. All types may revert to SBAS (if enabled) or SINGLE position types. See also *Table 43, Position or Velocity Type* on *page 196.* [a]	Enum	4	H
3	ID	Char [5] or ANY		ID string	Char[5]	8 [b]	H+4

a. If you choose ANY, the receiver ignores the ID string. Specify a Type when you are using base station IDs.

b. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

2.5.40 RAIMMODE Configures RAIM mode RAIM

This command is used to configure RAIM operation. This command uses RTCA MOPS characteristics which defines the positioning accuracy requirements for airborne lateral navigation (LNAV) and vertical navigation (VNAV) at 3 stages of flight:

1. En route travel
2. Terminal (within range of air terminal)
3. Non-precision approach

In order to ensure that the required level of accuracy is available in these phases of flight, MOPS requires the computation of protection levels (HPL and VPL). MOPS has the following definitions that apply to NovAtel's RAIM feature:

Horizontal Protection Level (HPL): is a radius of the circle in the horizontal plane, with its center being at the true position that describes the region that is assured to contain the indicated horizontal position. It is horizontal region where the missed alert and false alert requirements are met using autonomous fault detection.

Vertical Protection Level (VPL): is a half the length of the segment on the vertical axis with its center being at the true position that describes the region that is assured to contain the indicated vertical position when autonomous fault detection is used.

Horizontal Alert Limit (HAL): a radius of the circle in the horizontal plane, with its center being at the true position that describes the region that is required to contain the indicated horizontal position with the required probability.

Vertical Alert Limit (VAL): half of the length of the segment on the vertical axis with its center being at the true position that describes the region that is required to contain the indicated vertical position with certain probability.

Probability of False Alert (P_{fa}): A false alert is defined as the indication of a positioning failure when a positioning failure has not occurred (as a result of false detection). A false alert would cause a navigation alert.

Detection strategy

NovAtel's RAIM detection strategy uses the weighted least-squares detection method. This method computes a solution using a least-squares adjustment (LSA) and is based on the sum of squares of weighted residuals. It is a comparison between a root sum of squares of residuals and a decision threshold to determine a pass/fail decision.

Isolation strategy

NovAtel RAIM uses the maximum residual method. Logically it is implemented as a second part of Fault Detection and Exclusion (FDE) algorithm for LSA detection method. Weighted LSA residuals are standardized individually and the largest residual is compared to a decision threshold. If it is more than the threshold, the observation corresponding to this residual is declared faulty.

Abbreviated ASCII Syntax: **Message ID: 1285**

RAIMMODE mode [hal [val [pfa]]]

Factory Default:

raimmode default

Input Example:

raimmode user 100 100 0.01

raimmode terminal

Field #	Field Type	ASCII Value	Binary Value	Data Description	Format	Binary Bytes	Binary Offset
1	RAIMMODE Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0
2	MODE	See *Table 27* on *page 131*.			-	4	H
3	HAL	5 ≤ HAL ≤ 9999.99		Horizontal alert limit (m) (Default = 0.0)	Double	8	H+4
4	VAL	5 ≤ VAL ≤ 9999.99		Vertical alert limit (m) (Default = 0.0)	Double	8	H+12
5	PFA	$(P_{fa})= 1e^{-7} \leq P_{fa} \leq 0.25$		Probability of false alert (Default = 0.0)	Double	8	H+20

Table 27: RAIM Mode Types

Binary	ASCII	Description
0	DISABLE	Do not do integrity monitoring of least squares solution
1	USER	User will specify alert limits and probability of false alert
2	DEFAULT	Use OEMV (NovAtel) RAIM (default)
3	APPROACH	Default numbers for non-precision approach navigation mode are used - HAL = 556 m (0.3 nm), VAL = 50 m for LNAV/VNAV
4	TERMINAL	Default numbers for terminal navigation mode are used - HAL = 1855 m (1 nm), no VAL requirement
5	ENROUTE	Default numbers for en-route navigation mode are used - HAL = 3710m (2 nm), no VAL requirement

2.5.41 RESET Perform a hardware reset

This command performs a hardware reset. Following a RESET command, the receiver initiates a cold-start boot up. Therefore, the receiver configuration reverts either to the factory default, if no user configuration was saved, or the last SAVECONFIG settings (see also the FRESET and SAVECONFIG commands on *pages 94* and *135* respectively).

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

Abbreviated ASCII Syntax: **Message ID: 18**

RESET [delay]

Example

reset 120

The RESET command can be used to erase any unsaved changes to the receiver configuration.

Unlike the FRESET command, the RESET command does not erase data stored in the NVM, such as Almanac and Ephemeris data

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RESET header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	delay			Seconds to wait before resetting. (default = 0)	Ulong	4	H

2.5.42 RTKSOURCE Set the RTK correction source

This command lets you identify from which base station to accept RTCM, RTCMV3, RTCA, and CMR differential corrections. This is useful when the receiver is receiving corrections from multiple base stations (see also the PSRDIFFSOURCE command on *page 127*).

OEMStar uses all differential corrections to acquire a DGPS solution only. RTK positioning is not available on the OEMStar receiver.

The GLONASS option is necessary for the OEMStar to compute a DGPS solution using GLONASS corrections.

Abbreviated ASCII Syntax: **Message ID: 494**

RTKSOURCE type ID

Factory Default:

rtksource auto "any"

ASCII Examples:

1. Specify the format before specifying the base station IDs:
   rtksource rtcmv3 5
   rtksource rtcm 6

   The RTKSOURCE command supports both RTCM and RTCMV3 while the PSRDIFFSOURCE commands supports only RTCM.

2. Select only SBAS:
   rtksource none
   psrdiffsource none
   sbascontrol enable auto

3. Enable PSRDIFF from RTCM, with a fall-back to SBAS:
   rtksource rtcm any
   psrdiffsource rtcm any
   sbascontrol enable auto

Consider an agricultural example where a farmer has his own RTCM base station set up but, either due to obstructions or radio problems, might occasionally experience a loss of corrections. By specifying a fall back to SBAS, the farmer could set up his receiver to use transmitted RTCM corrections when available, but fall back to SBAS.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKSOURCE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	See *Table 26, DGPS Type* on *page 128*		ID Type [a]	Enum	4	H
3	ID	Char [5] or ANY		ID string	Char[5]	8 [b]	H+4

a. If you choose ANY, the receiver ignores the ID string. Specify a Type when you are using base station IDs.

b. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

2.5.43 SAVECONFIG Save current configuration in NVM

This command saves the user's present configuration in non-volatile memory. The configuration includes the current log settings, FIX settings, port configurations, and so on. Its output is in the RXCONFIG log (see *page 345* and the FRESET command on *page 94*).

***WARNING!*:If you are using this command in CDU, ensure that you have all windows other than the Console window closed. Otherwise, log commands used for the various windows are saved as well. This will result in unnecessary data being logged.**

Abbreviated ASCII Syntax: **Message ID: 19**

SAVECONFIG

2.5.44 SBASCONTROL Set SBAS test mode and PRN SBAS

This command allows you to dictate how the receiver handles Satellite Based Augmentation System (SBAS) corrections. The receiver automatically switches to Pseudorange Differential (RTCM or RTCA) if the appropriate corrections are received, regardless of the current setting.

OEMStar has SBAS control disabled by default. To enable, send command `SBASCONTROL ENABLE AUTO 0 NONE`.

SBASCONTROL is not available on non-SBAS configurations and will return an error.

*CAUTION:*If SBAS is enabled and your receiver is outside of the corrections grid, you may experience larger positional errors caused by applying incorrect correction data.

When in AUTO mode, if the receiver is outside the defined satellite system's corrections grid, it reverts to ANY mode and chooses a system based on other criteria.

The receiver must have a channel configuration that has SBAS channels.

Also see the `SELECTCHANCONFIG` command an *page 138.*

Once tracking satellites from one system in ANY or AUTO mode, it does not track satellites from other systems. This is because systems such as WAAS, EGNOS and MSAS do not share broadcast information and have no way of knowing each other are there.

The "testmode" parameter in the example is to get around the test mode of these systems. EGNOS at one time used the IGNOREZERO test mode. At the time of printing, ZEROTOTWO is the correct setting for all SBAS, including EGNOS, running in test mode. On a simulator, you may want to leave this parameter off or specify NONE explicitly.

When you use the SBASCONTROL command to direct your receiver to use a specific correction type, the receiver begins to search for and track the relevant GEO PRNs for that correction type only.

You can force your receiver to track a specific PRN using the ASSIGN command. You can also force it to use the corrections from a specific SBAS PRN using the SBASCONTROL command.

Disable stops the corrections from being used.

Abbreviated ASCII Syntax: **Message ID: 652**

SBASCONTROL switch [system] [prn] [testmode]

Factory Default:

sbascontrol disable

Abbreviated ASCII Example 1:

sbascontrol enable auto 0 none

✉ NovAtel's OEMStar receivers work with SBAS systems including EGNOS (Europe), MSAS (Japan) and WAAS (North America).

Table 28: System Types

ASCII	Binary	Description
NONE	0	Don’t use any SBAS satellites
AUTO	1	Automatically determine satellite system to use (default)
ANY	2	Use any and all SBAS satellites found
WAAS	3	Use only WAAS satellites
EGNOS	4	Use only EGNOS satellites
MSAS	5	Use only MSAS satellites

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SBASCONTROL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	keyword	DISABLE	0	Receiver does not use the SBAS corrections it receives (default)	Enum	4	H
		ENABLE	1	Receiver uses the SBAS corrections it receives			
3	system	See *Table 28* on *page 136*		Chooses the SBAS that the receiver uses	Enum	4	H+4
4	prn	0		Receiver uses any PRN (default)	ULong	4	H+8
		120-138		Receiver uses SBAS corrections only from this PRN			
5	testmode	NONE	0	Receiver interprets Type 0 messages as they are intended (as do not use) (default)	Enum	4	H+12
		ZEROTOTWO	1	Receiver interprets Type 0 messages as Type 2 messages			
		IGNOREZERO	2	Receiver ignores the usual interpretation of Type 0 messages (as do not use) and continues			

2.5.45 SELECTCHANCONFIG Set channel configuration

✉ The SELECTCHANCONFIG command should only be used by advanced users.

This command changes the channel configuration used on the OEMStar receiver. It causes an immediate software reset. The list of available channel configurations can be obtained from the CHANCONFIGLIST log described on page 210.

✉ Configurations containing GLONASS channels are only available when the OEMStar has the GLONASS option.

See *Section 3.3.7,CHANCONFIGLIST All available channel configurations* on *page 210* for a list of available channel configurations.

Message ID: 1149

Abbreviated ASCII Syntax:

SELECTCHANCONFIG [set]

Factory Default (without GLONASS option):

selectchanconfig 2

Factory Default (with GLONASS option):

selectchanconfig 3

Abbreviated ASCII Example:

selectchanconfig 2

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SELECTCHANCONFIG header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	set	See *Table 29, OEMStar Channel Configuration Sets* on *page 139*.		Channel configuration set	ULONG	4	H

Table 29: OEMStar Channel Configuration Sets

Binary	ASCII	Description
1	1	14 GPS L1 channels
2	2	12 GPS L1 channels 2 SBAS L1 channels
3	3	10 GPS L1 channels 4 GLONASS L1 channels
4	4	8 GPS L1 channels 6 GLONASS L1 channels
5	5	8 GPS L1 channels 4 GLONASS L1 channels 2 SBAS L1 channels
6	6	10 GPS L1 channels 2 GLONASS L1 channels 2 SBAS L1 channels
7	7	7 GPS L1 channels 7 GLONASS L1 channels
8	8	14 GLONASS L1 channels

7 GPS L1 + 7 GLONASS L1 channel configuration is recommended for timing-only applications.

Table 30: OEMStar Channel Configurations

Configurations	Set	Description
GPS	1	0 to 13 for GPS L1 channels
GPS/SBAS	2	0 to 11 for GPS L1 channels 12 to 13 for SBAS L1 channels
GPS/GLONASS	3	0 to 9 for GPS L1 channels 10 to 13 for GLONASS L1 channels
GPS/GLONASS	4	0 to 7 for GPS L1 channels 8 to 13 for GLONASS L1 channels
GPS/GLONASS/ SBAS	5	0 to 7 for GPS L1 channels 8 to 11 for GLONASS L1 channels 12 to 13 for SBAS L1 channels (see note in *Table 29*)
GPS/GLONASS/ SBAS	6	0 to 9 for GPS L1 channels 10 to 11 for GLONASS L1 channels 12 to 13 for SBAS L1 channels
GPS/GLONASS	7	0 to 6 for GPS L1 channels 7 to 13 for GLONASS L1 channels
GLONASS	8	0 to 13 GLONASS L1 channels

2.5.46 SEND Send an ASCII message to a COM port

This command is used to send ASCII printable data from any of the COM or USB ports to a specified communications port. This is a one-time command, therefore the data message must be preceded by the SEND command and followed by <CR> each time you wish to send data. If the data string contains delimiters (that is, spaces, commas, tabs, and so on), the entire string must be contained within double quotation marks. Carriage return and line feed characters (for example, 0x0D, 0x0A) are appended to the sent ASCII data.

Example Scenario:

Assume that you are operating receivers as base and rover stations. It could also be assumed that the base station is unattended but operational and you wish to control it from the rover station. From the rover station, you could establish the data link and command the base station receiver to send differential corrections.

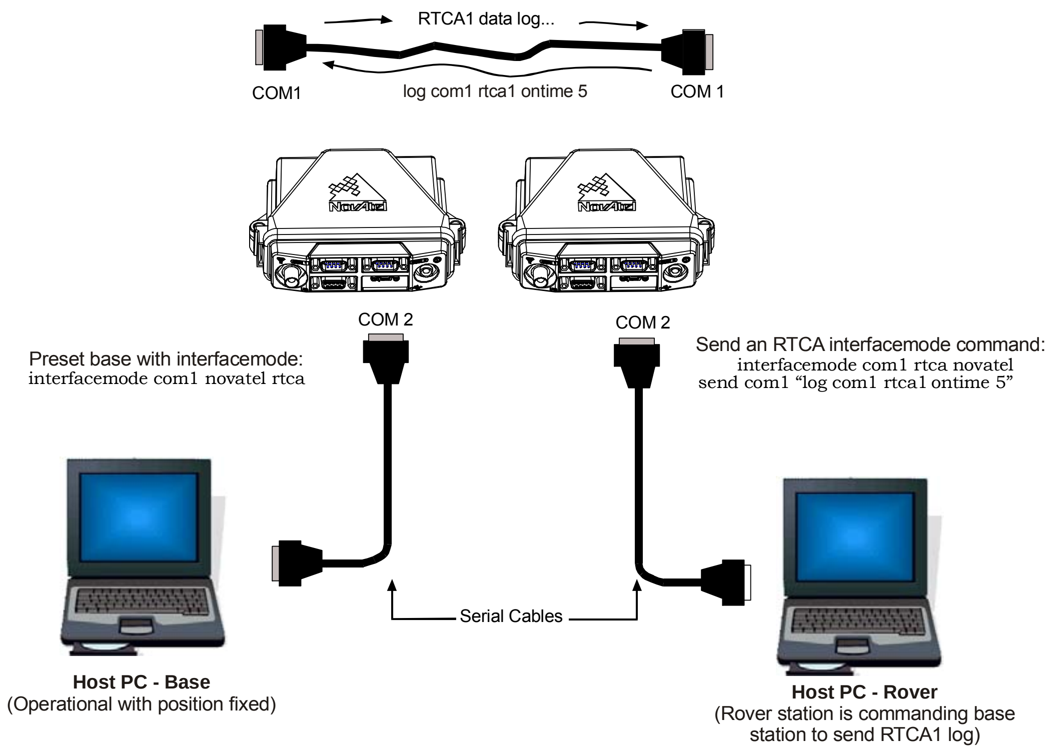


Figure 4: Using the SEND Command

Abbreviated ASCII Syntax: **Message ID: 177**

SEND port data

ASCII Example

send com1 “log com1 rtca1 ontime 5”

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SEND header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	port	See *Table 15, COM Serial Port Identifiers* on *page 68*		Output port	Enum	4	H
3	message	Max 100 character string (99 typed visible chars and a null char added by the firmware automatically)		ASCII data to send	String [max. 100]	Vari-able [a]	Vari-able

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

2.5.47 SENDHEX Send non-printable characters in hex pairs

This command is like the SEND command except that it is used to send non-printable characters expressed as hexadecimal pairs. Carriage return and line feed characters (for example, 0x0D, 0x0A) will **not** be appended to the sent data and so must be explicitly added to the data if needed.

Abbreviated ASCII Syntax: **Message ID: 178**

SENDHEX port length data

Input Example:

sendhex com1 6 143ab5910d0a

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SENDHEX header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	port	See *Table 15, COM Serial Port Identifiers* on *page 68*		Output port	Enum	4	H
3	length	0 - 700		Number of hex pairs	ULong	4	H+4
4	message	limited to a 700 maximum string (1400 pair hex) by command interpreter buffer even number of ASCII characters from set of 0-9, A-F no spaces are allowed between pairs of characters		Data	String [max. 700]	Vari-able[a]	Vari-able

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

2.5.48 SETAPPROXPOS Set an approximate position

This command sets an approximate latitude, longitude, and height in the receiver. Estimating these parameters, when used in conjunction with an approximate time (see the SETAPPROXTIME command on *page 144*), can improve satellite acquisition times and time to first fix. For more information about TTFF and Satellite Acquisition, please refer to the Knowledge and Learning page in the Support section on our Web site at www.novatel.com.

The horizontal position entered should be within 200 km of the actual receiver position. The approximate height is not critical and can normally be entered as zero. If the receiver cannot calculate a valid position within 2.5 minutes of entering an approximate position, the approximate position is ignored.

The approximate position is not visible in any position logs. It can be seen by issuing a SETAPPROXPOS log. See also the SATVIS log on *page 357*.

Abbreviated ASCII Syntax: **Message ID: 377**

SETAPPROXPOS lat lon height

Input Example:

setapproxpos 51.116 -114.038 0

✉ For an example on the use of this command, please see the SETAPPROXTIME command on *page 144*.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETAPPROXPOS header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Lat	± 90 degrees		Approximate latitude	Double	8	H
3	Lon	± 360 degrees		Approximate longitude	Double	8	H+8
4	Height	-1000 to +20000000 m		Approximate height	Double	8	H+16

2.5.49 SETAPPROXTIME Set an approximate GPS reference time

This command sets an approximate time in the receiver. The receiver uses this time as a system time until a GPS coarse time can be acquired. This can be used in conjunction with an approximate position (see the SETAPPROXPOS command on *page 143*) to improve time to first fix. For more information about TTFF and Satellite Acquisition, please refer to the Knowledge and Learning page in the Support section on our Web site at www.novatel.com.

The time entered should be within 10 minutes of the actual GPS reference time.

If the week number entered does not match the broadcast week number, the receiver resets.

See also the SATVIS log on *page 357*.

Abbreviated ASCII Syntax: **Message ID: 102**

SETAPPROXTIME week sec

Input Example:

setapproxtime 1105 425384

Upon power-up, the receiver does not know its position or time, and therefore, cannot use almanac information to aid satellite acquisition. You can set an approximate GPS reference time using the SETAPPROXTIME command or RTCAEPHEM message. The RTCAEPHEM message contains GPS reference week and seconds and the receiver uses that GPS reference time if the time is not yet known. Several logs provide base station coordinates and the receiver uses them as an approximate position allowing it to compute satellite visibility. Alternately, you can set an approximate position by using the SETAPPROXPOS command.

Approximate time and position must be used in conjunction with a current almanac to aid satellite acquisition. See the table below for a summary of OEMStar commands and logs used to inject an approximated time or position into the receiver:

Approximate	Command	Log
Time	SETAPPROXTIME	RTCAEPHEM
Position	SETAPPROXPOS	

Base station aiding can help in these environments. A set of ephemerides can be injected into a rover station by broadcasting the RTCAEPHEM message from a base station. This is also useful in environments where there is frequent loss of lock (GPS ephemeris is three frames long within a sequence of five frames. Each frame requires 6 s of continuous lock to collect the ephemeris data. This gives a minimum of 18 s and a maximum of 36 s continuous lock time.) or, when no recent ephemerides (new or stored) are available.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETAPPROXTIME header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	week	0-9999		GPS reference week number	Ulong	4	H
3	sec	0-604801		Number of seconds into GPS reference week	Double	8	H+4

2.5.50 SETBESTPOSCRITERIA Selection criteria for BESTPOS

Use this command to set the criteria for the BESTPOS log. It allows you to select between 2D and 3D standard deviation to obtain the best position from the BESTPOS log. It also allows you to specify the number of seconds to wait before changing the position type. This delay provides a single transition that ensures position types do not skip back and forth. See also BESTPOS on *page 195*.

Abbreviated ASCII Syntax: **Message ID: 839**

SETBESTPOSCRITERIA type delay

Factory Default:

setbestposcriteria pos3d 0

Example:

setbestposcriteria pos2d 5

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SET-BESTPOS-CRITERIA header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	See *Table 31*		Select a 2D or 3D standard deviation type to obtain the best position from the BESTPOS log default = 3D	Enum	4	H
3	delay	0 to 100 s		Set the number of seconds to wait before changing the position type default = 0	Ulong	4	4

Table 31: Selection Type

ASCII	Binary	Description
POS3D	0	3D standard deviation (default)
POS2D	1	2D standard deviation

2.5.51 SETIONOTYPE Enable ionospheric models

Set which ionospheric corrections model the receiver should use.

L1-only automatically use SBAS ionospheric grid corrections, if available. The corrections model with the previous ASCII name of BROADCAST is now called KLOBUCHAR to reflect the actual model used.

Abbreviated ASCII Syntax: **Message ID: 711**

SETIONOTYPE model

Factory Default:

setionotype auto

ASCII Example:

setionotype klobuchar

For more information about PDP or GL1DE positioning filters, refer to the *OEMStar Installation and Operation User Manual*, available on our Web site at www.novatel.com.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETIONO-TYPE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	model	See *Table 32,* below		Choose an ionospheric corrections model (default = NONE)	Enum	4	H

Table 32: Ionospheric Correction Models

ASCII	Binary	Description
NONE	0	Don't use ionospheric modeling
KLOBUCHAR	1	Use the broadcast Klobuchar model
GRID	2	Use the SBAS model
AUTO	4	Automatically determine the ionospheric model to use

2.5.52 SETNAV Set start and destination waypoints

This command permits entry of one set of navigation waypoints (see *Figure* on *page 148*). The origin (FROM) and destination (TO) waypoint coordinates entered are considered on the ellipsoidal surface of the current datum (default WGS84). Once SETNAV has been set, you can monitor the navigation calculations and progress by observing the NAVIGATE log messages.

Track offset is the perpendicular distance from the great circle line drawn between the FROM lat-lon and TO lat-lon waypoints. It establishes the desired navigation path, or track, that runs parallel to the great circle line, which now becomes the offset track, and is set by entering the track offset value in metres. A negative track offset value indicates that the offset track is to the left of the great circle line track. A positive track offset value (no sign required) indicates the offset track is to the right of the great circle line track (looking from origin to destination). See *Figure 5* for clarification.

Consider the case of setting waypoints in a deformation survey along a dam. The surveyor enters the From and To point locations on either side of the dam using the SETNAV command. They then use the NAVIGATE log messages to record progress and show them where they are in relation to the *From* and *To* points

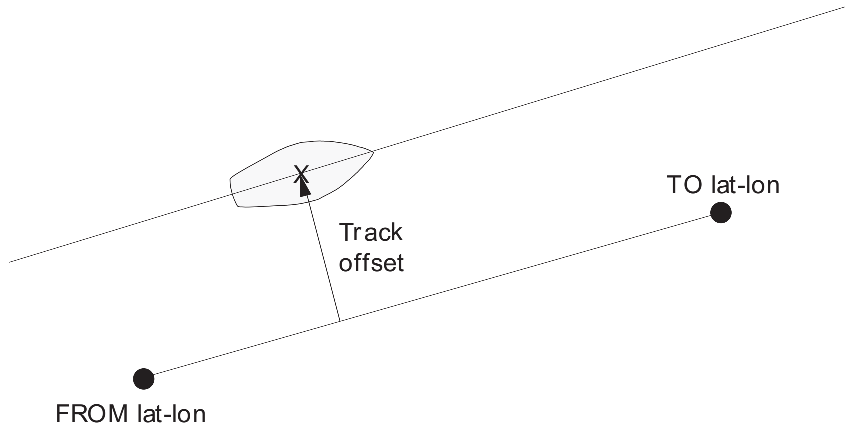


Figure 5: Illustration of SETNAV Parameters

Abbreviated ASCII Syntax: **Message ID: 162**

SETNAV fromlat fromlon tolat tolon track offset from-point to-point

Factory Default:

setnav 90.0 0.0 90.0 0.0 0.0 from to

ASCII Example:

setnav 51.1516 -114.16263 51.16263 -114.1516 -125.23 from to

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETNAV header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	fromlat	± 90 degrees		Origin latitude in units of degrees/decimal degrees. A negative sign for South latitude. No sign for North latitude.	Double	8	H
3	fromlon	± 180 degrees		Origin longitude in units of degrees/decimal degrees. A negative sign for West longitude. No sign for East longitude.	Double	8	H+8
4	tolat	± 90 degrees		Destination latitude in units of degrees/decimal degrees	Double	8	H+16
5	tolon	± 180 degrees		Destination longitude in units of degrees/decimal degrees	Double	8	H+24
6	track offset	± 1000 km		Waypoint great circle line offset (in kilometres); establishes offset track; positive indicates right of great circle line; negative indicates left of great circle line.	Double	8	H+32
7	from-point	5 characters maximum		ASCII station name	String [max. 5]	Variable [a]	Variable
8	to-point	5 characters maximum		ASCII station name	String [max. 5]	Variable [a]	Variable

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

2.5.53 SETRTCMRXVERSION Set the RTCM standard input expected

Use this command to enable interpreting the received RTCM corrections as following RTCM 2.2 or 2.3 standards.

✉ For RTCM correction message types, see *Table 24, Serial Port Interface Modes* on *page 102*.

Abbreviated ASCII Syntax: **Message ID: 1216**

SETRTCMRXVERSION version

Factory Default:

setrtcmrxversion v23

Input Example:

setrtcmrxversion v23

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETRTCMRXVERSION header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	version	v23	0	RTCM version 2.3	-	4	0
		v22	1	RTCM version 2.2	-		0

2.5.54 SETRTCM16 Enter ASCII text for RTCM data stream

The RTCM type 16 message allows ASCII text to be transferred from a base station to rover receivers. The SETRTCM16 command is used to define the ASCII text at the base station. The text defined by the SETRTCM16 command can be verified in the RXCONFIG log. Once the ASCII text is defined it can be broadcast periodically by the base station with the command "log port RTCM16 ONTIME interval".

This command limits the input message length to a maximum of 90 ASCII characters. If the message string contains any delimiters (that is, spaces, commas, tabs, and so on) the entire string must be contained in double quotation marks.

Abbreviated ASCII Syntax: **Message ID: 131**

SETRTCM16 text

Input Example:

setrtcm16 “base station will shut down in 1 hour”

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETRTCM16 header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	text	Maximum 90 character string		The text string	String [max. 90]	Vari-able[a]	Vari-able

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

2.5.55 SETRTCM36 Enter ASCII text with Russian characters GLO

The RTCM Type 36 message is the GLONASS equivalent of the RTCM Type 16 message except that the RTCM36 message can contain characters from an extended character set including Russian characters. *Table 33* on *page 153* provides the standard decimal and hex codes to use when transmitting Cyrillic characters to provide Russian language messages. Codes from 0 to 127 correspond to standard ASCII codes.

To support the 8-bit character data in the ASCII version, 8-bit characters are represented as \xnn (or \dnnn) which are the hexadecimal (or decimal) values of the characters. A "\" is represented as "\\".

In the RTCMDATA36 and RTCM36T logs, the ascii output displays the 8-bit characters in the decimal \dnnn representation. However, in the SETRTCM36 command, you can enter the 8-bit characters using the \x or \d prefix.

✉ This command limits the input message length to a maximum of 90 ASCII characters. If the message string contains any delimiters (that is, spaces, commas, tabs, and so on) the entire string must be contained in double quotation marks.

Abbreviated ASCII Syntax: **Message ID: 880**

SETRTCM36 extdtext

Input Example:

To set the message "QUICK ШТОРМ", enter any of the following commands (color added, or grayscale in printed versions, to aid understanding):

setrtcm36 "quick \d166\d146\d174\d144\d140"

setrtcm36 "quick \xa6\x92\xae\x90\x8c "

setrtcm36 "\x51\x55\x49\x43\x4b\x20\xa6\x92\xae\x90\x8c "

setrtcm36 "\x51\x55\x49\x43\x4b\xa6\x92\xae\x90\x8c "

The corresponding RTCMDATA36A log (see *page 340*) looks like:

```
#RTCMDATA36A,COM1,0,64.5,FINESTEERING,1399,237113.869,00500000,
F9F5,35359;36,0,5189,0,0,6,11,"QUICK\D166\D146\D174\D144\D140"
*8BDEAE71
```

Similarly, the corresponding RTCM36T message (see *page 326*) looks like:

```
#RTCM36TA,COM1,0,77.5,FINESTEERING,1399,237244.454,00000000,
2E54,35359;"QUICK \D166\D146\D174\D144\D140"*4AA7F340
```

✉ Similar to the RTCM type 16 message, the SETRTCM36 command is used to define the ASCII text at the base station and can be verified in the RXCONFIG log. Once the ASCII text is defined it can be broadcast periodically by the base station with the command, for example "log port RTCM36 ONTIME 10". The received ASCII text can be displayed at the rover by logging RTCM36T.

Table 33: Russian Alphabet Characters (Ch) in Decimal (Dec) and Hexadecimal (Hex)

Hex Code	Dec Code	Ch	Hex Code	Dec Code	Ch	Hex Code	Dec Code	Ch	Hex Code	Dec Code	Ch
80	128	А	90	144	Р	A0	160	а	B0	176	р
81	129	Б	91	145	С	A1	161	б	B1	177	с
82	130	В	92	146	Т	A2	162	в	B2	178	т
83	131	Г	93	147	У	A3	163	г	B3	179	у
84	132	Д	94	148	Ф	A4	164	д	B4	180	ф
85	133	Е	95	149	Х	A5	165	е	B5	181	х
86	134	Ж	96	150	Ц	A6	166	ж	B6	182	ц
87	135	З	97	151	Ч	A7	167	з	B7	183	ч
88	136	И	98	152	Ш	A8	168	и	B8	184	ш
89	137	Й	99	153	Щ	A9	169	й	B9	185	щ
8A	138	К	9A	154	Ъ	AA	170	к	BA	186	ъ
8B	139	Л	9B	155	Ы	AB	171	л	BB	187	ы
8C	140	М	9C	156	Ь	AC	172	м	BC	188	ь
8D	141	Н	9D	157	Э	AD	173	н	BD	189	э
8E	142	О	9E	158	Ю	AE	174	о	BE	190	ю
8F	143	П	9F	159	Я	AF	175	п	BF	191	я

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETRTCM36 header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	extdtext	Maximum 90 character string		The RTCM36 text string	String [max. 90]	Variable[a]	Variable

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

2.5.56 SETTIMEBASE Sets primary and backup systems for time base.

This command configures the primary and backup steering system(s) for timing. The primary system is the system that the receiver steers the clock to. Upon startup, the primary system must be present long enough to steer the clock to be valid once, otherwise, the backup system cannot be used. The backup system is used whenever the primary system is not present.

Abbreviated ASCII Syntax: **Message ID: 1237**

SETTIMEBASE primarysystem number of backups [system[backupsystem timeout]]

Factory Default:

For GLONASS-only receiver:

settimebase glonass 0

For GPS capable receiver:

settimebase gps 1 auto 0

Input Example:

settimebase gps 1 glonass 30

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETTIMEBASE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	primarysystem	See *Table 34* on *page 155*		The primary system for steering the receiver clock	Enum	4	H
3	number of backups	0 or 1		The number of records to follow (see *Table 34* on *page 155* for the message options).	Ulong	4	H+4
4	system	See *Table 34* on *page 155*		The system to be used for backup	Enum	4	H+8
5	backup system timeout	0 to +4294967295		Duration that the backup system is used to steer the clock. 0 means ongoing	Ulong	4	H+12

Table 34: System Used for Timing

Binary	ASCII	Description
0	GPS	GPS timing system
1	GLONASS	GLONASS timing system

2.5.57 SETUTCLEAPSECONDS Change default UTC Leap Seconds offset

The SETUTCLEAPSECONDS command should only be used by advanced users. The UTC leap seconds offset is used to calculate the UTC time. Changing the default affects the UTC time stamp in applicable logs, for example, in the GPGGA log.

This command changes the default UTC Leap Seconds offset used by the OEMStar receiver. This default is only in use when there is no valid GPS almanac available. A GPS almanac can be obtained by allowing the receiver to track GPS satellites for approximately 15 minutes.

Message ID: 1150

Abbreviated ASCII Syntax:

SETUTCLEAPSECONDS [seconds]

Factory Default:

none

Abbreviated ASCII Example 1:

setutcleapseconds 15

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETUTCLEAPSECONDS header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	seconds	0 to 0xFFFFFFFF		Channel configuration set	ULONG	4	H

2.5.58 STATUSCONFIG Configure RXSTATUSEVENT mask fields

This command is used to configure the various status mask fields in the RXSTATUSEVENT log (see *page 355*). These masks allow you to modify whether various status fields generate errors or event messages when they are set or cleared.

Receiver Errors automatically generate event messages. These event messages are output in RXSTATUSEVENT logs. It is also possible to have status conditions trigger event messages to be generated by the receiver. This is done by setting/clearing the appropriate bits in the event set/clear masks. The set mask tells the receiver to generate an event message when the bit becomes set. Likewise, the clear mask causes messages to be generated when a bit is cleared. If you wish to disable all these messages without changing the bits, simply UNLOG the RXSTATUSEVENT logs on the appropriate ports. Refer also to the *Built in Status Tests* chapter in the *OEMStar Installation and Operation User Manual*.

✉ The receiver gives the user the ability to determine the importance of the status bits. In the case of the receiver status, setting a bit in the priority mask causes the condition to trigger an error. This causes the receiver to idle all channels, set the ERROR strobe line, flash an error code on the status LED, turn off the antenna (LNA power), and disable the RF hardware, the same as if a bit in the receiver error word is set. Setting a bit in an auxiliary status priority mask causes that condition to set the bit in the Receiver Status word corresponding to that auxiliary status.

Abbreviated ASCII Syntax: **Message ID: 95**

STATUSCONFIG type word mask

Factory Default:

statusconfig priority status 0

statusconfig priority aux1 0x00000008

statusconfig priority aux2 0

statusconfig set status 0x00000000

statusconfig set aux1 0

statusconfig set aux2 0

statusconfig clear status 0x00000000

statusconfig clear aux1 0

statusconfig clear aux2 0

ASCII Example:

statusconfig set status 0028a51d

Table 35: Mask Types

ASCII	Binary	Description
PRIORITY	0	Replace the Priority mask
SET	1	Replace the Set mask
CLEAR	2	Replace the Clear mask

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	STATUSCONFIG header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	type	See *Table 35*		Type of mask to replace	Enum	4	H
3	word	STATUS	1	Receiver Status word	Enum	4	H+4
		AUX1	2	Auxiliary 1 Status word			
4	mask	8 digit hexadecimal		The hexadecimal bit mask	Ulong	4	H+8

2.5.59 UNASSIGN Unassign a previously assigned channel

This command cancels a previously issued ASSIGN command and the SV channel reverts to automatic control (the same as ASSIGN AUTO).

Abbreviated ASCII Syntax: **Message ID: 29**

UNASSIGN channel

Input Example:

unassign 11

✉ Issuing the UNASSIGN command to a channel that was not previously assigned by the ASSIGN command will have no effect.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UNASSIGN header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	channel	See *Table 13, OEMStar Channel Configurations* on *page 54*		Reset SV channel to automatic search and acquisition mode	ULong	4	H
3	state	See *Table 12, Channel State* on *page 53*		Set the SV channel state (currently ignored)	Enum	4	H+4

2.5.60 UNASSIGNALL Unassign all previously assigned channels

This command cancels all previously issued ASSIGN commands for all SV channels (same as ASSIGNALL AUTO). Tracking and control for each SV channel reverts to automatic mode. See ASSIGN AUTO for more details.

Abbreviated ASCII Syntax: **Message ID: 30**

UNASSIGNALL [system]

Input Example:

unassignall gpsl1

Issuing the UNASSIGNALL command has no effect on channels that were not previously assigned using the ASSIGN command.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UNASSIGNALL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	system	See *Table 14, Channel System* on *page 56*		System that the SV channel is tracking	Enum	4	H

These command examples are only applicable to specific receiver models and/or channel configurations.

1. The following command applies to receiver models tracking only L1 frequencies:

   `assignall sbasl1 idle`

2. The following command applies to receiver models tracking GLONASS L1 frequencies:

   `assignall glol1,52,-250,0`

If you use the *system* field with this command and the receiver has no channels configured with that channel system, the command has no effect on the receiver's tracking state.

2.5.61 UNDULATION Choose undulation

This command permits you to either enter a specific geoidal undulation value or use the internal table of geoidal undulations. In the *option* field, the EGM96 table provides ellipsoid heights at a 0.25° by 0.25° spacing while the OSU89B is implemented at a 2° by 3° spacing. In areas of rapidly changing elevation, you could be operating somewhere within the 2° by 3° grid with an erroneous height. EGM96 provides a more accurate model of the ellipsoid which results in a denser grid of heights. It is more accurate because the accuracy of the grid points themselves has also improved from OSU89B to EGM96. For example, the default grid (EGM96) is useful where there are underwater canyons, steep drop-offs or mountains.

The undulation values reported in the BESTPOS, BESTUTM, MARKPOS, and PSRPOS logs are in reference to the ellipsoid of the chosen datum.

Abbreviated ASCII Syntax: **Message ID: 214**

UNDULATION option [separation]

Factory Default:

undulation egm96

ASCII Example 1:

undulation osu89b

ASCII Example 2:

undulation user -5.599999905

Refer to the application note *APN-006 Geoid Issue*, available at

http://www.novatel.com/support/knowledge-and-learning/

for a description of the relationships in *Figure 6*.

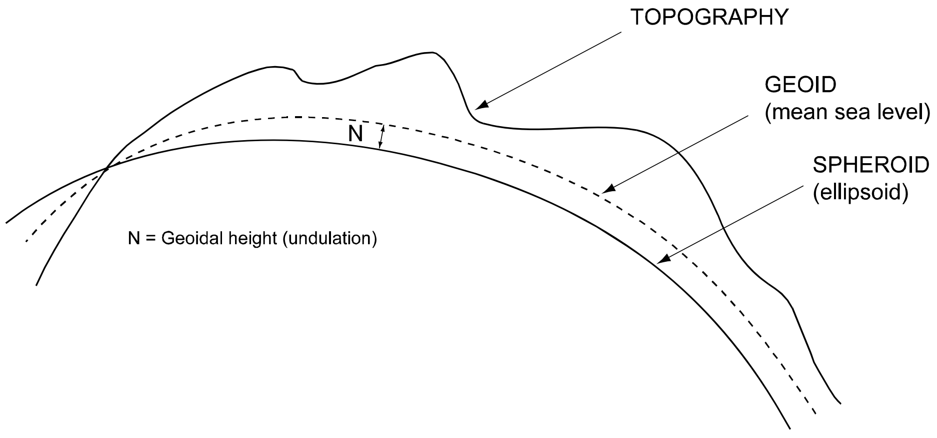


Figure 6: Illustration of Undulation

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UNDULATION header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	option	TABLE	0	Use the internal undulation table (same as EGM96)	Enum	4	H
		USER	1	Use the user specified undulation value			
		OSU89B	2	Use the OSU89B undulation table			
		EGM96	3	Use global geoidal height model EGM96 table (default)			
3	separation	± 1000.0 m		The undulation value (required for the USER option)	Float	4	H+4

2.5.62 UNLOCKOUT Reinstate a satellite in the solution

This command allows a satellite which has been previously locked out (LOCKOUT command) to be reinstated in the solution computation. If more than one satellite is to be reinstated, this command must be reissued for each satellite reinstatement.

Abbreviated ASCII Syntax: **Message ID: 138**

UNLOCKOUT prn

Input Example:

unlockout 8

✉ The UNLOCKOUT command allows you to reinstate a satellite while leaving other locked out satellites unchanged.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UNLOCKOUT header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	prn	GPS: 1-37 SBAS: 120-138 GLONASS: see *Section 1.3* on *page 26*.		A single satellite PRN number to be reinstated	Ulong	4	H

2.5.63 UNLOCKOUTALL Reinstate all previously locked out satellites

This command allows all satellites which have been previously locked out (LOCKOUT command) to be reinstated in the solution computation.

Abbreviated ASCII Syntax: **Message ID: 139**

UNLOCKOUTALL

Input Example:

unlockoutall

The UNLOCKOUTALL command allows you to reinstate all satellites currently locked out.

Field	Field Name	Binary Value	Description	Field Type	Binary Bytes	Binary Offset
1	UNLOG (binary) header	(See *Table 4, Binary Message Header Structure* on *page 20*)	This field contains the message header.	-	H	0
2	port	See *Table 4* on *page 19* (decimal values greater than 16 may be used)	Port to which log is being sent (default = THISPORT)	Enum	4	H
3	message	Any valid message ID	Message ID of log to output	UShort	2	H+4
4	message type	Bits 0-4 = Reserved Bits 5-6 = Format 00 = Binary 01 = ASCII 10 = Abbreviated ASCII, NMEA 11 = Reserved Bit 7 = Response Bit (see *Section 1.2 on page 24*) 0 = Original Message 1 = Response Message	Message type of log	Char	1	H+6
5	Reserved			Char	1	H+7

2.5.64 UNLOG Remove a log from logging control

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

The [*port*] parameter is optional. If [*port*] is not specified, it is defaulted to the port on which the command was received. This feature eliminates the need for you to know which port you are communicating on if you want logs to be removed on the same port as this command.

Abbreviated ASCII Syntax: **Message ID: 36**

UNLOG [port] datatype

Input Example:

unlog com1 bestposa

unlog bestposa

✉ The UNLOG command allows you to remove one or more logs while leaving other logs unchanged.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UNLOG (ASCII) header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	port	See *Table 4 on page 19* (decimal values greater than 16 may be used)		Port to which log is being sent (default = THISPORT)	Enum	4	H
3	message	Message Name	N/A	Message Name of log to be disabled	ULong	4	H+4

2.5.65 UNLOGALL Remove all logs from logging control

If [*port*] is specified this command disables all logs on the specified port only. All other ports are unaffected. If [*port*] is not specified this command defaults to the ALL_PORTS setting.

Abbreviated ASCII Syntax: **Message ID: 38**

UNLOGALL [port]

Input Example:

unlogall com2_15

The UNLOGALL command allows you to remove all log requests currently in use.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UNLOGALL header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	port	See *Table 4* on *page 19* (decimal values greater than 16 may be used)		Port to clear (default = ALL_PORTS)	Enum	4	H
3	held	FALSE	0	Does not remove logs with the HOLD parameter (default)	Enum	4	H+4
		TRUE	1	Removes previously held logs, even those with the HOLD parameter			

2.5.66 USERDATUM Set user-customized datum

This command permits entry of customized ellipsoidal datum parameters. This command is used in conjunction with the DATUM command (see *page 72*). If used, the command default setting for USERDATUM is WGS84.

When the USERDATUM command is entered, the USEREXPDATUM command (see *page 169*) is then issued internally with the USERDATUM command values. It is the USEREXPDATUM command that appears in the RXCONFIG log. If the USEREXPDATUM or the USERDATUM command are used, their newest values overwrite the internal USEREXPDATUM values.

The transformation for the WGS84 to Local used in the OEMStar is the Bursa-Wolf transformation or reverse Helmert transformation. In the Helmert transformation, the rotation of a point is counter clockwise around the axes. In the Bursa-Wolf transformation, the rotation of a point is clockwise. Therefore, the reverse Helmert transformation is the same as the Bursa-Wolf.

Abbreviated ASCII Syntax: **Message ID: 78**

USERDATUM semimajor flattening dx dy dz rx ry rz scale

Factory Default:

userdatum 6378137.0 298.2572235628 0.0 0.0 0.0 0.0 0.0 0.0 0.0

ASCII Example:

userdatum 6378206.400 294.97869820000 -12.0000 147.0000 192.0000 0.0000 0.0000 0.0000 0.000000000

✉ You can use the USERDATUM command in a survey to fix the position with values from another known datum so that the GPS calculated positions are reported in the known datum rather than WGS84.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	USERDATUM header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	semimajor	6300000.0 - 6400000.0 m		Datum Semi-major Axis (a) in metres	Double	8	H
3	flattening	290.0 - 305.0		Reciprocal Flattening, 1/f = a/(a-b)	Double	8	H+8
4	dx	± 2000.0		Datum offsets from local to WGS84. These are the translation values between the user datum and WGS84 (internal reference).	Double	8	H+16
5	dy	± 2000.0			Double	8	H+24
6	dz	± 2000.0			Double	8	H+32
7	rx	± 10.0 radians		Datum rotation angle about X, Y and Z. These values are the rotation from your local datum to WGS84. A positive sign is for counter clockwise rotation and a negative sign is for clockwise rotation.	Double	8	H+40
8	ry	± 10.0 radians			Double	8	H+48
9	rz	± 10.0 radians			Double	8	H+56
10	scale	± 10.0 ppm		Scale value is the difference in ppm between the user datum and WGS84	Double	8	H+64

2.5.67 USEREXPDATUM Set custom expanded datum

Like the USERDATUM command, this command allows you to enter customized ellipsoidal datum parameters. However, USEREXPDATUM literally means user expanded datum allowing you to enter additional datum information such as velocity offsets and time constraints. The 7 expanded parameters are rates of change of the initial 7 parameters. These rates of change affect the initial 7 parameters over time relative to the Reference Date provided by the user.

This command is used in conjunction with the datum command (see *page 72*). If you use this command without specifying any parameters, the command defaults to WGS84. If you enter a USERDATUM command (see *page 167*), the USEREXPDATUM command is then issued internally with the USERDATUM command values. It is the USEREXPDATUM command that appears in the RXCONFIG log. If the USEREXPDATUM or the USERDATUM command are used, their newest values overwrite the internal USEREXPDATUM values.

Abbreviated ASCII Syntax: **Message ID: 783**

USEREXPDATUM semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev refdate

Factory Default:

userexpdatum 6378137.0 298.25722356280 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

ASCII Example:

```
USEREXPDATUM 6378137.000 298.25722356280 0.000000000
0.000000000 0.000000000 0.000000000 0.000000000 0.000000000
0.000000000 0.000000000 0.000000000 0.000000000 0.000000000
0.000000000 0.000000000 0.000000000 0.000000000
```

You can use the USEREXPDATUM command in a survey to fix the position with values from another known datum so that the GPS calculated positions are reported in the known datum rather than WGS84. For example, it is useful for places like Australia, where the continent is moving several centimetres a year relative to WGS84. With USEREXPDATUM you can also input the velocity of the movement to account for drift over the years.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	USEREXPDATUM header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	semimajor	6300000.0 - 6400000.0 m		Datum semi-major axis (a) in metres	Double	8	H
3	flattening	290.0 - 305.0		Reciprocal Flattening, 1/f = a/(a-b)	Double	8	H+8
4	dx	± 2000.0 m		Datum offsets from local to WGS84. These are the translation values between the user datum and WGS84 (internal reference).	Double	8	H+16
5	dy	± 2000.0 m			Double	8	H+24
6	dz	± 2000.0 m			Double	8	H+32
7	rx	± 10.0 radians		Datum rotation angle about X, Y and Z. These values are the rotation from your local datum to WGS84. A positive sign is for counter clockwise rotation and a negative sign is for clockwise rotation.	Double	8	H+40
8	ry	± 10.0 radians			Double	8	H+48
9	rz	± 10.0 radians			Double	8	H+56
10	scale	± 10.0 ppm		Scale value is the difference in ppm between the user datum and WGS84	Double	8	H+64
11	xvel	± 2000.0 m/yr		Velocity vector along X-axis	Double	8	H+72
12	yvel	± 2000.0 m/yr		Velocity vector along Y-axis	Double	8	H+80
13	zvel	± 2000.0 m/yr		Velocity vector along Z-axis	Double	8	H+88
14	xrvel	± 10.0 radians/ yr		Change in the rotation about X over time	Double	8	H+96
15	yrvel	± 10.0 radians/ yr		Change in the rotation about Y over time	Double	8	H+104
16	zrvel	± 10.0 radians/ yr		Change in the rotation about Z over time	Double	8	H+112
17	scalev	± 10.0 ppm/yr		Change in scale from WGS84 over time	Double	8	H+120
18	refdate	0.0 year		Reference date of parameters Example: 2005.00 = Jan 1, 2005 2005.19 = Mar 11, 2005	Double	8	H+128

2.5.68 UTMZONE Set UTM parameters

This command sets the UTM persistence, zone number or meridian. Please refer to http://earth-info.nga.mil/GandG/coordsys/grids/referencesys.html for more information and a world map of UTM zone numbers.

✉ The latitude limits of the UTM System are 80°S to 84°N, so if your position is outside this range, the BESTUTM log outputs a northing, easting, and height of 0.0, along with a zone letter of "*" and a zone number of 0, so that it is obvious that the data in the log is dummy data.

If the latitude band is X, then the Zone number should not be set to 32, 34 or 36. These zones were incorporated into other zone numbers and do not exist.

Abbreviated ASCII Syntax: **Message ID: 749**

UTMZONE command parameter

Factory Default:

utmzone auto 0

ASCII Example 1:

utmzone set 10

ASCII Example 2:

utmzone current

✉ The UTM grid system is displayed on all National Topographic Series (NTS) of Canada maps and United States Geological Survey (USGS) maps. On USGS 7.5-minute quadrangle maps (1:24,000 scale), 15-minute quadrangle maps (1:50,000, 1:62,500, and standard-edition 1:63,360 scales), and Canadian 1:50,000 maps the UTM grid lines are drawn at intervals of 1,000 metres, and are shown either with blue ticks at the edge of the map or by full blue grid lines. On USGS maps at 1:100,000 and 1:250,000 scale and Canadian 1:250,000 scale maps a full UTM grid is shown at intervals of 10,000 metres.

Table 36: UTM Zone Commands

Binary	ASCII	Description
0	AUTO	UTM zone default that automatically sets the central meridian and does not switch zones until it overlaps by the set persistence. This a spherical approximation to the earth unless you are at the equator. (default = 0) (m)
1	CURRENT	Same as UTMZONE AUTO with infinite persistence of the current zone. The parameter field is not used.
2	SET	Sets the central meridian based on the specified UTM zone. A zone includes its western boundary, but not its eastern boundary, Meridian. For example, zone 12 includes (108°W, 114°W] where 108° < longitude ≤ 114°.
3	MERIDIAN	Sets the central meridian as specified in the parameter field. In BESTUTM, the zone number is output as 61 to indicate the manual setting (zones are set by pre-defined central meridians not user-set ones).

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	UTMZONE header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	command	See *Table 36*			Enum	4	H
3	parameter				Enum	4	H+4

2.5.69 WAASECUTOFF Set SBAS satellite elevation cut-off SBAS

This command sets the elevation cut-off angle for SBAS satellites. The receiver does not start automatically searching for an SBAS satellite until it rises above the cut-off angle. Tracked SBAS satellites that fall below the WAASECUTOFF angle are no longer tracked unless they are manually assigned (see the ASSIGN command).

✉ This command does not affect the tracking of GPS satellites. Similarly, the ECUTOFF command does not affect SBAS satellites.

Abbreviated ASCII Syntax: **Message ID: 505**

WAASECUTOFF angle

Factory Default:

waasecutoff -5.000000000

ASCII Example:

waasecutoff 10.0

✉ This command permits a negative cut-off angle. It could be used in these situations:

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

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	WAASECUTOFF header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	angle	±90.0 degrees		Elevation cut-off angle relative to horizon (default = -5.0)	Float	4	H

2.5.70 WAASTIMEOUT Set WAAS position time out SBAS

This command is used to set the amount of time the receiver remain in an SBAS position if it stops receiving SBAS corrections. See the DGPSEPHEMDELAY command on *page 79* to set the ephemeris change-over delay for base stations.

Abbreviated ASCII Syntax: **Message ID: 851**

WAASTIMEOUT mode [delay]

Factory Default:

waastimeout auto

ASCII Example (rover):

waastimeout set 100

When the time out mode is AUTO, the time out delay is 180 s.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	WAAS-TIMEOUT header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	mode	See *Table 37* below		Time out mode (default = AUTO)	Enum	4	H
3	delay	2 to 1000 s		Maximum SBAS position age (default = 180 s)	Double	8	H+4
4	Reserved				Double	8	H+12

Table 37: SBAS Time Out Mode

Binary	ASCII	Description
0	Reserved	
1	AUTO	Set the default value (180 s)
2	SET	Set the delay in seconds

Chapter 3 Data Logs

3.1 Log Types

Refer to the LOG command, page 105, for details on requesting logs.

The receiver is capable of generating many different logs. These logs are divided into the following three types: Synchronous, asynchronous, and polled. The data for synchronous logs is generated on a regular schedule. Asynchronous data is generated at irregular intervals. If asynchronous logs were collected on a regular schedule, they would not output the most current data as soon as it was available. The data in polled logs is generated on demand. An example would be RXCONFIG. It would be polled because it changes only when commanded to do so. Therefore, it would not make sense to log this kind of data ONCHANGED, or ONNEW. The following table outlines the log types and the valid triggers to use:

Table 38: Log Type Triggers

Type	Recommended Trigger	Illegal Trigger
Synch	ONTIME	ONNEW, ONCHANGED
Asynch	ONCHANGED	-
Polled	ONCE or ONTIME [a]	ONNEW, ONCHANGED

a. Polled log types do not allow fractional offsets and cannot do ontime rates faster than 1Hz.

See *Section 1.5, Message Time Stamps on page 28* for information about how the message time stamp is set for each type of log.

✉ OEMStar receivers can handle 30 logs at a time. If you attempt to log more than 30 logs at a time, the receiver responds with an Insufficient Resources error.

The following logs do not support the ONNEXT trigger: GPSEPHEM, RAWEPHEM, RAWGPSSUBFRAME, RAWWAASFRAME, RXSTATUSEVENT and WAAS9.

Asynchronous logs should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.

Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

Before the output of fields for ASCII and Binary logs, there is an ASCII or binary header respectively. See also *Table 3, ASCII Message Header Structure* on *page 17* and *Table 4, Binary Message Header Structure* on *page 20*. There is no header information before Abbreviated ASCII output, see *page 19*.

3.1.1 Log Type Examples

For polled logs, the receiver only supports an offset that is:

- smaller than the logging period
- an integer

The following are valid examples for a polled log:

```
log comconfig ontime 2 1
log portstats ontime 4 2
log version once
```

For polled logs, the following examples are invalid:

`log comconfig ontime 1 2`	[offset is larger than the logging period]
`log comconfig ontime 4 1.5`	[offset is not an integer]

For synchronous and asynchronous logs, the receiver supports any offset that is:

- smaller than the logging period
- a multiple of the minimum logging period

For example, if the receiver supports 10 Hz logging, the minimum logging period is 1/10 Hz or 0.1 s. The following are valid examples for a synchronous, or asynchronous log, on a receiver that can log at rates up to 10 Hz:

`log bestpos ontime 1`	*[1 Hz]*
`log bestpos ontime 1 0.1`	
`log bestpos ontime 1 0.90`	
`log avepos ontime 1 0.95`	
`log avepos ontime 2`	*[0.5 Hz]*
`log avepos ontime 2 1.35`	
`log avepos ontime 2 1.75`	

For synchronous and asynchronous logs, the following examples are invalid:

`log bestpos ontime 1 0.08`	[offset is not a multiple of the minimum logging period]
`log bestpos ontime 1 1.05`	[offset is larger than the logging period]

3.2 Logs By Function

Table 39, starting on the following page, lists the logs by function while *Table 40* starting on *Page 183* is an alphabetical listing of logs (repeated in *Table 41* starting on *Page 187* with the logs in the order of their message IDs).

Table 39: Logs By Function R

GENERAL RECEIVER CONTROL AND STATUS		
Logs	**Descriptions**	**Type**
COMCONFIG	Current COM port configuration	Polled
LOGLIST	List of system logs	Polled
PASSCOM1, PASSXCOM1, PASSUSB1	Pass-through log, also PASSCOM2, PASSXCOM2, PASSXCOM3, PASSUSB2 and PASSUSB3	Asynch
PORTSTATS	COM and, if applicable, USB port statistics	Polled
RXCONFIG	Receiver configuration status	Polled
RXSTATUS	Self-test status	Asynch
RXSTATUSEVENT	Status event indicator	Asynch
VALIDMODELS	Model and expiry date information for receiver	Asynch
VERSION	Receiver hardware and software version numbers	Polled
POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL		
AVEPOS	Position averaging log	Asynch
BESTPOS	Best position data	Synch
BESTUTM	Best available UTM data	Synch
BESTXYZ	Cartesian coordinates position data	Synch
GPGGA	NMEA, fix and position data	Synch
GPGLL	NMEA, position data	Synch
GPGSA	NMEA, DOP information	Synch

Continued on the following page.

POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL		
GPGRS	NMEA, range residuals	Synch
GPGST	NMEA, measurement noise statistics	Synch
IONUTC	Ionospheric and UTC model information	Asynch
MARKPOS	Position at time of mark input event	Asynch
MARKTIME	Time of mark input event	Asynch
PSRDOP	DOP of SVs currently tracking	Asynch
PSRDOP2	Pseudorange Least Squares DOP	Asynch
RAIMSTATUS	RAIM status	Synch
WAYPOINT NAVIGATION		
Logs	**Descriptions**	**Type**
BESTPOS	Best position data	Synch
BESTVEL	Velocity data	Synch
GPRMB	NMEA, waypoint status	Synch
GPRMC	NMEA, navigation information	Synch
GPVTG	NMEA, track made good and speed	Synch
NAVIGATE	Navigation waypoint status	Synch
PSRPOS	Pseudorange position	Synch
PSRVEL	Pseudorange velocity	Synch

Continued on the following page.

CLOCK INFORMATION, STATUS, AND TIME		
CLOCKMODEL	Range bias information	Synch
CLOCKMODEL2	Clock bias	Sync
CLOCKSTEERING	Clock steering status	Asynch
GLOCLOCK	GLONASS clock information	Asynch
GPZDA	NMEA, UTC time and data	Synch
PSRTIME	Time offsets from the pseudorange filter	Synch
TIME	Receiver time information	Synch
POST PROCESSING DATA		
GPSEPHEM	Decoded GPS ephemeris information	Asynch
IONUTC	Ionospheric and UTC model information	Asynch
RAWEPHEM	Raw ephemeris	Asynch
RANGE	Satellite range information	Synch
RANGECMP	Compressed version of the RANGE log	Synch
TIME	Receiver clock offset information	Synch
SATELLITE TRACKING AND CHANNEL CONTROL		
ALMANAC	Current decoded almanac data	Asynch
CHANCONFIGLIST	All available channel configurations	Asynch
GLMLA	NMEA GLONASS almanac data	Asynch
GLOALMANAC	GLONASS almanac data	Asynch
GLOEPHEMERIS	GLONASS ephemeris data	Asynch
GLORAWALM	Raw GLONASS almanac data	Asynch
GLORAWEPHEM	Raw GLONASS ephemeris data	Asynch

Continued on the following page.

SATELLITE TRACKING AND CHANNEL CONTROL		
GLORAWFRAME	Raw GLONASS frame data	Asynch
GLORAWSTRING	Raw GLONASS string data	Asynch
GPALM	NMEA, almanac data	Asynch
GPGSA	NMEA, SV DOP information	Synch
GPGSV	NMEA, satellite-in-view information	Synch
GPSEPHEM	Decoded GPS ephemeris information	Asynch
PSRDOP	DOP of SVs currently tracking	Asynch
PSRDOP2	Pseudorange Least Squares DOP	Asynch
RANGE	Satellite range information	Synch
SATELLITE TRACKING AND CHANNEL CONTROL		
Logs	**Descriptions**	**Type**
RAWALM	Raw almanac	Asynch
RAWEPHEM	Raw ephemeris	Asynch
RAWGPSSUBFRAME	Raw subframe data	Asynch
RAWGPSWORD	Raw navigation word	Asynch
RAWWAASFRAME	Raw SBAS frame data	Asynch
SATVIS	Satellite visibility	Synch
SATXYZ	SV position in ECEF Cartesian coordinates	Synch
TRACKSTAT	Satellite tracking status	Synch
WAAS0	Remove PRN from the solution	Asynch
WAAS1	PRN mask assignments	Asynch
WAAS2	Fast correction slots 0-12	Asynch
WAAS3	Fast correction slots 13-25	Asynch

Continued on the following page.

SATELLITE TRACKING AND CHANNEL CONTROL		
Logs	**Descriptions**	**Type**
WAAS4	Fast correction slots 26-38	Asynch
WAAS5	Fast correction slots 39-50	Asynch
WAAS6	Integrity message	Asynch
WAAS7	Fast correction degradation	Asynch
WAAS9	GEO navigation message	Asynch
WAAS10	Degradation factor	Asynch
WAAS12	SBAS network time and UTC	Asynch
WAAS17	GEO almanac message	Asynch
WAAS18	IGP mask	Asynch
WAAS24	Mixed fast/slow corrections	Asynch
SATELLITE TRACKING AND CHANNEL CONTROL		
Logs	**Descriptions**	**Type**
WAAS25	Long-term slow satellite corrections	Asynch
WAAS26	Ionospheric delay corrections	Asynch
WAAS27	SBAS service message	Asynch
WAASCORR	SBAS range corrections used	Synch
DIFFERENTIAL BASE STATION		
ALMANAC	Current almanac information	Asynch
BESTPOS	Best position data	Synch
BESTVEL	Velocity data	Synch
GPGGA	NMEA, position fix data	Synch
PSRPOS	Pseudorange position	Synch
PSRVEL	Pseudorange velocity	Synch

Continued on the following page.

DIFFERENTIAL BASE STATION		
RANGE	Satellite range information	Synch
RANGECMP	Compressed version of the RANGE log	Synch
REFSTATION	Base station position and health	Asynch
RTCADATA1	Differential GPS corrections	Synch
RTCADATAEPHEM	Ephemeris and time information	Synch

RTCA or RTCM data logs, for example RTCADATA1 and RTCMDATA1. See also *Table 40*, that follows, for a complete list of logs in alphabetical order.

Table 40: OEMStar Logs in Alphabetical Order

NovAtel Format Logs		
Datatype	**Message ID**	**Description**
ALMANAC	73	Current almanac information
AVEPOS	172	Position averaging
BESTPOS	42	Best position data
BESTUTM	726	Best available UTM data
BESTVEL	99	Velocity data
BESTXYZ	241	Cartesian coordinate position data
CHANCONFIGLIST	1148	All available channel configurations
CLOCKMODEL	16	Current clock model matrices
CLOCKMODEL2	1170	Clock bias
CLOCKSTEERING	26	Clock steering status
COMCONFIG	317	Current COM port configuration
GLOALMANAC	718	GLONASS almanac data
GLOCLOCK	719	GLONASS clock information
GLOEPHEMERIS	723	GLONASS ephemeris data
GLORAWALM	720	Raw GLONASS almanac data
GLORAWEPHEM	792	Raw GLONASS ephemeris data
GLORAWFRAME	721	Raw GLONASS frame data
GLORAWSTRING	722	Raw GLONASS string data
GPSEPHEM	7	GPS ephemeris data
IONUTC	8	Ionospheric and UTC model information
LOGLIST	5	A list of system logs
MARKPOS	181	Position at time of mark input event
MARKTIME	231	Time of mark input event
NAVIGATE	161	Navigation waypoint status
PASSCOM1, PASSCOM2, PASSXCOM1, PASSXCOM2, PASSXCOM3 PASSUSB1, PASSUSB2, PASSUSB3	233, 234, 235, 405, 406, 795 690, 607, 608, 609	Pass-through logs
PDPPOS	469	PDP filter position
PDPVEL	470	PDP filter velocity
PDPXYZ	471	PDP filter Cartesian position and velocity
PORTSTATS	72	COM or USB port statistics

Continued on the following page.

NovAtel Format Logs		
Datatype	**Message ID**	**Description**
PSRDOP	174	DOP of SVs currently tracking
PSRDOP2	1163	Pseudorange Least Squares DOP
PSRPOS	47	Pseudorange position information
PSRTIME	881	Time offsets from the pseudorange filter
PSRVEL	100	Pseudorange velocity information
PSRXYZ	243	Pseudorange Cartesian coordinate position
RAIMSTATUS	1286	RAIM status
RANGE	43	Satellite range information
RANGECMP	140	Compressed version of the RANGE log
RAWALM	74	Raw almanac
RAWEPHEM	41	Raw ephemeris
RAWGPSSUBFRAME	25	Raw subframe data
RAWGPSWORD	407	Raw navigation word
RAWWAASFRAME	287	Raw SBAS frame data
RTCADATA1	392	Type 1 Differential GPS Corrections
RTCADATAEPHEM	393	Type 7 Ephemeris and Time Information
RTCMDATA1	396	Type 1 Differential GPS Corrections
RTCMDATA9	404	Type 9 Partial Differential GPS Corrections
RTCMDATA15	397	Type 15 Ionospheric Corrections
RTCMDATA16	398	Type 16 Special Message
RTCMDATA31	868	Type 31 GLONASS Differential Corrections
RTCMDATA36	879	Type 36 Special Message
RTCMDATA59GLO	905	NovAtel proprietary GLONASS differential
RXCONFIG	128	Receiver configuration status
RXSTATUS	93	Self-test status
RXSTATUSEVENT	94	Status event indicator
SATVIS	48	Satellite visibility
SATXYZ	270	SV position in ECEF Cartesian coordinates
TIME	101	Receiver time information
TRACKSTAT	83	Satellite tracking status
VALIDMODELS	206	Model and expiry date information for receiver
VERSION	37	Receiver hardware and software version numbers
WAAS0	290	Remove PRN from the solution

Continued on the following page.

NovAtel Format Logs		
Datatype	**Message ID**	**Description**
WAAS1	291	PRN mask assignments
WAAS2	296	Fast correction slots 0-12
WAAS3	301	Fast correction slots 13-25
WAAS4	302	Fast correction slots 26-38
WAAS5	303	Fast correction slots 39-50
WAAS6	304	Integrity message
WAAS7	305	Fast correction degradation
WAAS9	306	GEO navigation message
WAAS10	292	Degradation factor
WAAS12	293	SBAS network time and UTC
WAAS17	294	GEO almanac message
WAAS18	295	IGP mask
WAAS24	297	Mixed fast/slow corrections
WAAS25	298	Long term slow satellite corrections
WAAS26	299	Ionospheric delay corrections
WAAS27	300	SBAS service message
WAASCORR	313	SBAS range corrections used
RTCA Format Logs [a]		
RTCA1	10	Type 1 Differential GPS Corrections
RTCAEPHEM	347	Type 7 Ephemeris and Time Information
RTCM Format Logs [a]		
RTCM1	107	Type 1 Differential GPS Corrections
RTCM9	275	Type 9 Partial Differential GPS Corrections
RTCM15	307	Type 15 Ionospheric Corrections
RTCM16	129	Type16 Special Message
RTCM31	864	Type 31 Differential GLONASS Corrections
RTCM Format Logs [a]		
Datatype	**Message ID**	**Description**
RTCM36	875	Type 36 Special Message
RTCM36T	877	Type 36T Special Text Message
RTCM59GLO	903	NovAtel proprietary GLONASS differential

Continued on the following page.

NMEA Format Logs		
GLMLA	859	NMEA GLONASS almanac data
GPALM	217	Almanac Data
GPGGA	218	GPS Fix Data and Undulation
GPGGALONG	521	GPS Fix Data, Extra Precision and Undulation
GPGLL	219	Geographic Position - latitude/longitude
GPGRS	220	GPS Range Residuals for Each Satellite
GPGSA	221	GPS DOP and Active Satellites
GPGST	222	Pseudorange Measurement Noise Statistics
GPGSV	223	GPS Satellites in View
GPRMB	224	Generic Navigation Information
GPRMC	225	GPS Specific Information
GPVTG	226	Track Made Good and Ground Speed
GPZDA	227	UTC Time and Date

a. RTCA and RTCM logs may be logged with an A or B extension to give an ASCII or Binary output with a NovAtel header followed by Hex or Binary data respectively

Table 41: OEMStar Logs in Order of their Message IDs

NovAtel Format Logs		
Message ID	**Datatype**	**Description**
5	LOGLIST	A list of system logs
7	GPSEPHEM	GPS ephemeris data
8	IONUTC	Ionospheric and UTC model information
16	CLOCKMODEL	Current clock model matrices
25	RAWGPSSUBFRAME	Raw subframe data
26	CLOCKSTEERING	Clock steering status
37	VERSION	Receiver hardware and software version numbers
41	RAWEPHEM	Raw ephemeris
42	BESTPOS	Best position data
43	RANGE	Satellite range information
47	PSRPOS	Pseudorange position information
48	SATVIS	Satellite visibility
72	PORTSTATS	COM or USB port statistics
73	ALMANAC	Current almanac information
74	RAWALM	Raw almanac
83	TRACKSTAT	Satellite tracking status
93	RXSTATUS	Self-test status
94	RXSTATUSEVENT	Status event indicator
99	BESTVEL	Velocity data
100	PSRVEL	Pseudorange velocity information
101	TIME	Receiver time information
128	RXCONFIG	Receiver configuration status
140	RANGECMP	Compressed version of the RANGE log
161	NAVIGATE	Navigation waypoint status
172	AVEPOS	Position averaging
174	PSRDOP	DOP of SVs currently tracking
181	MARKPOS	Position at time of mark input event
206	VALIDMODELS	Model and expiry date information for receiver
231	MARKTIME	Time of mark input event
233, 234	PASSCOM1, PASSCOM2	Pass-through logs
241	BESTXYZ	Cartesian coordinate position data

Continued on the following page.

NovAtel Format Logs		
Message ID	**Datatype**	**Description**
243	PSRXYZ	Pseudorange Cartesian coordinate position
270	SATXYZ	SV position in ECEF Cartesian coordinates
287	RAWWAASFRAME	Raw SBAS frame data
290	WAAS0	Remove PRN from the solution
291	WAAS1	PRN mask assignments
292	WAAS10	Degradation factor
293	WAAS12	SBAS network time and UTC
294	WAAS17	GEO almanac message
295	WAAS18	IGP mask
296	WAAS2	Fast correction slots 0-12
297	WAAS24	Mixed fast/slow corrections
298	WAAS25	Long term slow satellite corrections
299	WAAS26	Ionospheric delay corrections
300	WAAS27	SBAS service message
301	WAAS3	Fast correction slots 13-25
302	WAAS4	Fast correction slots 26-38
303	WAAS5	Fast correction slots 39-50
304	WAAS6	Integrity message
305	WAAS7	Fast correction degradation
306	WAAS9	GEO navigation message
313	WAASCORR	SBAS range corrections used
317	COMCONFIG	Current COM port configuration
392	RTCADATA1	Type 1 Differential GPS Corrections
393	RTCADATAEPHEM	Type 7 Ephemeris and Time Information
396	RTCMDATA1	Type 1 Differential GPS Corrections
397	RTCMDATA15	Type 15 Ionospheric Corrections
398	RTCMDATA16	Type 16 Special Message
403	RTCMDATA59	Type 59N-0 NovAtel Proprietary: RT20 Differential
404	RTCMDATA9	Type 9 Partial Differential GPS Corrections
405, 406	PASSXCOM1, PASSXCOM2	Pass-through logs
407	RAWGPSWORD	Raw navigation word

Continued on the following page.

NovAtel Format Logs		
Message ID	**Datatype**	**Description**
469	PDPPOS	PDP filter position
470	PDPVEL	PDP filter velocity
471	PDPXYZ	PDP filter Cartesian position and velocity
607, 608, 609	PASSUSB1, PASSUSB2, PASSUSB3	Pass-through logs (for receivers that support USB)
718	GLOALMANAC	GLONASS almanac data
719	GLOCLOCK	GLONASS clock information
720	GLORAWALM	Raw GLONASS almanac data
721	GLORAWFRAME	Raw GLONASS frame data
722	GLORAWSTRING	Raw GLONASS string data
723	GLOEPHEMERIS	GLONASS ephemeris data
726	BESTUTM	Best available UTM data
795	PASSXCOM3	Pass through log
868	RTCMDATA31	Type 31 GLONASS Differential Corrections
879	RTCMDATA36	Type 36 Special Message
881	PSRTIME	Time offsets from the pseudorange filter
897	RTCMDATA1009	GLONASS L1-Only RTK
898	RTCMDATA1010	Extended GLONASS L1-Only RTK
899	RTCMDATA1011	GLONASS L1/L2 RTK
905	RTCMDATA59GLO	NovAtel proprietary GLONASS differential corrections
1148	CHANCONFIGLIST	All available channel configurations
1163	PSRDOP2	Pseudorange Least Squares DO
1170	CLOCKMODEL2	Clock bias
1286	RAIMSTATUS	RAIM status
RTCA Format Logs[aa]		
10	RTCA1	Type 1 Differential GPS Corrections
347	RTCAEPHEM	Type 7 Ephemeris and Time Information
RTCM Format Logs [a]		
Message ID	**Datatype**	**Description**
107	RTCM1	Type 1 Differential GPS Corrections

Continued on the following page.

RTCM Format Logs [a]		
Message ID	**Datatype**	**Description**
129	RTCM16	Type16 Special Message
275	RTCM9	Type 9 Partial Differential GPS Corrections
307	RTCM15	Type 15 Ionospheric Corrections
864	RTCM31	Type 31 Differential GLONASS Corrections
875	RTCM36	Type 36 Special Message
877	RTCM36T	Type 36T Special Text Message
903	RTCM59GLO	NovAtel proprietary GLONASS differential NovAtel
NMEA Format Data Logs		
217	GPALM	Almanac Data
218	GPGGA	GPS Fix Data and Undulation
219	GPGLL	Geographic Position - latitude/longitude
220	GPGRS	GPS Range Residuals for Each Satellite
221	GPGSA	GPS DOP and Active Satellites
222	GPGST	Pseudorange Measurement Noise Statistics
223	GPGSV	GPS Satellites in View
224	GPRMB	Generic Navigation Information
225	GPRMC	GPS Specific Information
226	GPVTG	Track Made Good and Ground Speed
227	GPZDA	UTC Time and Date
521	GPGGALONG	GPS Fix Data, Extra Precision and Undulation
859	GLMLA	NMEA GLONASS Almanac Data

a. RTCA and RTCM logs may be logged with an A or B extension to give an ASCII or Binary output with a NovAtel header followed by Hex or Binary data respectively.

3.3 Log Reference

3.3.1 ALMANAC Decoded Almanac

This log contains the decoded almanac parameters from Subframe four and five as received from the satellite with the parity information removed and appropriate scaling applied. Multiple messages are transmitted, one for each SV almanac collected. For more information about Almanac data, refer to the GPS SPS Signal Specification (refer also to our please refer to the Knowledge and Learning page in the Support section on our Web site at www.novatel.com.).

OEMStar receivers automatically save almanacs in their non-volatile memory (NVM), therefore creating an almanac boot file is not necessary.

Message ID: **73**

Log Type: **Asynch**

Recommended Input:

log almanaca onchanged

ASCII Example:

```
#ALMANACA,COM1,0,54.0,SATTIME,1364,409278.000,00000000,06de,2310;
29,
1,1364,589824.0,6.289482e-03,-7.55460039e-09,-2.2193421e+00,-1.7064776e+00,
-7.94268362e-01,4.00543213e-05,3.63797881e-12,1.45856541e-04,2.6560037e+07,
4.45154034e-02,1,0,0,FALSE,
2,1364,589824.0,9.173393e-03,-8.16033991e-09,1.9308788e+00,1.9904300e+00,
6.60915023e-01,-1.62124634e-05,0.00000000,1.45860023e-04,2.6559614e+07,
8.38895743e-03,1,0,0,FALSE,
3,1364,589824.0,7.894993e-03,-8.04604944e-09,7.95206128e-01,6.63875501e-01,
-2.00526792e-01,7.91549683e-05,3.63797881e-12,1.45858655e-04,2.6559780e+07,
-1.59210428e-02,1,0,0,TRUE,
...
28,1364,589824.0,1.113367e-02,-7.87461372e-09,-1.44364969e-01,-2.2781989e+00,
1.6546425e+00,3.24249268e-05,0.00000000,1.45859775e-04,2.6559644e+07,
1.80122900e-02,1,0,0,FALSE,
29,1364,589824.0,9.435177e-03,-7.57745849e-09,-2.2673888e+00,-9.56729511e-01,
1.1791713e+00,5.51223755e-04,1.09139364e-11,1.45855297e-04,2.6560188e+07,
4.36225787e-02,1,0,0,FALSE,
30,1364,589824.0,8.776665e-03,-8.09176563e-09,-1.97082451e-01,1.2960786e+00,
2.0072936e+00,2.76565552e-05,0.00000000,1.45849410e-04,2.6560903e+07,
2.14517626e-03,1,0,0,FALSE*de7a4e45
```

✉ The speed at which the receiver locates and locks onto new satellites is improved if the receiver has approximate time and position, as well as an almanac. This allows the receiver to compute the elevation of each satellite so it can tell which satellites are visible and their Doppler offsets, improving time to first fix (TTFF).

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	ALMANAC header	Log header		H	0
2	#messages	The number of satellite PRN almanac messages to follow. Set to zero until almanac data is available.	Long	4	H
3	PRN	Satellite PRN number for current message, dimensionless	Ulong	4	H+4
4	week	Almanac reference week (GPS reference week number)	Ulong	4	H+8
5	seconds	Almanac reference time, seconds into the week	Double	8	H+12
6	ecc	Eccentricity, dimensionless - defined for a conic section where $e = 0$ is a circle, $e = 1$ is a parabola, $0<e<1$ is an ellipse and $e>1$ is a hyperbola.	Double	8	H+20
7	$\mathring{\omega}$	Rate of right ascension, radians/second	Double	8	H+28
8	ω_0	Right ascension, radians	Double	8	H+36
9	ω	Argument of perigee, radians - measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion.	Double	8	H+44
10	M_o	Mean anomaly of reference time, radians	Double	8	H+52
11	a_{fo}	Clock aging parameter, seconds	Double	8	H+60
12	a_{f1}	Clock aging parameter, seconds/second	Double	8	H+68
13	N	Corrected mean motion, radians/second	Double	8	H+76
14	A	Semi-major axis, metres	Double	8	H+84
15	incl-angle	Angle of inclination relative to 0.3 π, radians	Double	8	H+92
16	SV config	Satellite configuration	Ulong	4	H+100
17	health-prn	SV health from Page 25 of subframe 4 or 5 (6 bits)	Ulong	4	H+104
18	health-alm	SV health from almanac (8 bits)	Ulong	4	H+108
19	antispoof	Anti-spoofing on? 0 = FALSE 1 = TRUE	Enum	4	H+112
20...	Next PRN offset = H + 4 + (#messages x 112)				
21	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 4 + (112 x #messages)
22	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.2 AVEPOS Position Averaging

When position averaging is underway, the various fields in the AVEPOS log contain the parameters being used in the position averaging process. *Table 42* below shows the possible position averaging status values seen in field #8 of the AVEPOS log table on the next page.

See the description of the POSAVE command on *page 122*. Refer also to please refer to the Knowledge and Learning page in the Support section on our Web site at www.novatel.com.

All quantities are referenced to the geoid (average height above sea level), regardless of the use of the DATUM or USERDATUM commands, except for the height parameter (field #4 in the AVEPOS log table on the next page). The relation between the geoid and WGS84 ellipsoid is the geoidal undulation, and can be obtained from the PSRPOS log, see *page 293*.

Asynchronous logs should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.

Message ID: **172**

Log Type: **Asynch**

Recommended Input:

log aveposa onchanged

ASCII Example:

```
#AVEPOSA,COM1,0,48.5,FINESTEERING,1364,492100.000,80000000,e3b4,2310;
51.11635589900,-114.03833558937,1062.216134356,1.7561,0.7856,1.7236,
INPROGRESS,2400,2*72a550c1
```

Table 42: Position Averaging Status

Binary	ASCII	Description
0	OFF	Receiver is not averaging
1	INPROGRESS	Averaging is in progress
2	COMPLETE	Averaging is complete

When a GPS position is computed, there are four unknowns being solved: latitude, longitude, height and receiver clock offset (often just called time). The solutions for each of the four unknowns are correlated to satellite positions in a complex way. Since satellites are above the antenna (none are below it) there is a geometric bias. Therefore geometric biases are present in the solutions and affect the computation of height. These biases are called DOPs (Dilution Of Precision). Smaller biases are indicated by low DOP values. VDOP (Vertical DOP) pertains to height. Most of the time, VDOP is higher than HDOP (Horizontal DOP) and

TDOP (Time DOP). Therefore, of the four unknowns, height is the most difficult to solve. Many GPS receivers output the standard deviations (SD) of the latitude, longitude and height. Height often has a larger value than the other two.

Accuracy is based on statistics, reliability is measured in percent. When a receiver says that it can measure height to one metre, this is an accuracy. Usually this is a one sigma value (one SD). A one sigma value for height has a reliability of 68%. In other words, the error is less than one metre 68% of the time. For a more realistic accuracy, double the one sigma value (one metre) and the result is 95% reliability (error is less than two metres 95% of the time). Generally, GPS heights are 1.5 times poorer than horizontal positions. See also *page 251* for CEP and RMS definitions.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	AVEPOS header	Log header		H	0
2	lat	Average WGS84 latitude (degrees)	Double	8	H
3	lon	Average WGS84 longitude (degrees)	Double	8	H+8
4	ht	Average height above sea level (m)	Double	8	H+16
5	lat σ	Estimated average standard deviation of latitude solution element (m)	Float	4	H+24
6	lon σ	Estimated average standard deviation of longitude solution element (m)	Float	4	H+28
7	hgt σ	Estimated average standard deviation of height solution element (m)	Float	4	H+32
8	posave	Position averaging status (see *Table 42*)	Enum	4	H+36
9	ave time	Elapsed time of averaging (s)	Ulong	4	H+40
10	#samples	Number of samples in the average	Ulong	4	H+44
11	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.3 BESTPOS Best Position

This log contains the best available position (in metres) computed by the receiver. In addition, it reports several status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

If the system is operating in DGPS mode, pseudorange differential solutions continue for the time specified in the DGPSTIMEOUT command, see *page 81*.

See also the PSRPOS log on *page 293*.

Message ID: **42**

Log Type: **Synch**

Recommended Input:

log bestposa ontime 1

See *Section 2.1, Command Formats on page 33* for more examples of log requests.

ASCII Example 1:

```
#BESTPOSA,COM1,0,83.5,FINESTEERING,1419,336148.000,00000040,6145,2724;
SOL_COMPUTED,SINGLE,51.11636418888,-114.03832502118,1064.9520,-16.2712,
WGS84,1.6961,1.3636,3.6449,"",0.000,0.000,8,8,0,0,0,06,0,03*6f63a93d
```

ASCII Example 2:

```
#BESTPOSA,COM1,0,78.5,FINESTEERING,1419,336208.000,00000040,6145,2724;
SOL_COMPUTED,PSRDIFF,51.11635910984,-114.03833105168,1063.8416,-16.2712,
WGS84,0.0135,0.0084,0.0172,"AAAA",1.000,0.000,8,8,8,8,0,01,0,03*3d9fbd48
```

Table 43: Position or Velocity Type

Type (binary)	Type (ASCII)	Description
0	NONE	No solution
1	FIXEDPOS[a]	Position has been fixed by the FIX POSITION command
2	FIXEDHEIGHT[a]	Position has been fixed by the FIX HEIGHT/AUTO command
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	WAAS	Solution calculated using corrections from an SBAS
19	PROPAGATED	Propagated by a Kalman filter without new observations

a. With default PDPFILTER ENABLE, the bestpos will no longer show that the position has been fixed, unless PDPFILTER is DISABLED.

Table 44: Solution Status

Solution Status (Binary)	Solution Status (ASCII)	Description
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
2	NO_CONVERGENCE	No convergence
3	SINGULARITY	Singularity at parameters matrix
4	COV_TRACE	Covariance trace exceeds maximum (trace > 1000 m)
5	TEST_DIST	Test distance exceeded (maximum of 3 rejections if distance > 10 km)
6	COLD_START	Not yet converged from cold start
7	V_H_LIMIT	Height or velocity limits exceeded (in accordance with export licensing restrictions)
8	VARIANCE	Variance exceeds limits
9	RESIDUALS	Residuals are too large
10	DELTA_POS	Delta position is too large
11	NEGATIVE_VAR	Negative variance
12	Reserved	
13	INTEGRITY_WARNING	Large residuals make position unreliable
14-17	Reserved	
18	PENDING	When a FIX POSITION command is entered, the receiver computes its own position and determines if the fixed position is valid [a]
19	INVALID_FIX	The fixed position, entered using the FIX POSITION command, is not valid
21	ANTENNA_WARNING	Antenna warnings

a. PENDING implies there are not enough satellites being tracked to verify if the FIX POSITION entered into the receiver is valid. The receiver needs to be tracking two or more GPS satellites to perform this check. Under normal conditions you should only see PENDING for a few seconds on power up before the GPS receiver has locked onto its first few satellites. If your antenna is obstructed (or not plugged in) and you have entered a FIX POSITION command, then you may see PENDING indefinitely.

Table 45: Signal-Used Mask

Bit	Mask	Description
0	0x01	GPS L1 used in Solution
3	0x08	Reserved
4	0x10	GLONASS L1 used in Solution
6-7	0x40-0x80	Reserved

Table 46: Extended Solution Status

Bit	Mask	Description
0	0x01	Reserved
1-3	0x0E	Pseudorange Iono Correction 0 = Unknown[a] 1 = Klobuchar Broadcast 2 = SBAS Broadcast 3 = Reserved 4 = PSRDiff Correction 5 = NovAtel Blended Iono Value
4-7	0xF0	Reserved

a. Unknown can indicate that the Iono Correction type is None or that the default Klobuchar parameters are being used.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BESTPOS header	Log header		H	0
2	sol stat	Solution status, see *Table 44* on *page 197*	Enum	4	H
3	pos type	Position type, see *Table 43* on *page 196*	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the ellipsoid (m) of the chosen datum [a]	Float	4	H+32
8	datum id#	Datum ID number (see *Chapter 2, Table 18, Reference Ellipsoid Constants* on *page 73*)	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#SVs	Number of satellite vehicles tracked	Uchar	1	H+64
16	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+65
17	#ggL1	Number of GPS plus GLONASS L1 used in solution	Uchar	1	H+66
18	Reserved				
19	Reserved				
20	ext sol stat	Extended solution status (see *Table 46, Extended Solution Status* on *page 198*)	Hex	1	H+69
21	Reserved		Hex	1	H+70
22	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 45* on *page 198*)	Hex	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	1	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

3.3.4 BESTUTM Best Available UTM Data

This log contains the best available position computed by the receiver in UTM coordinates.

See also the UTMZONE command on *page 171* and the BESTPOS log on *page 195*.

Message ID: **726**
Log Type: **Synch**

The latitude limits of the UTM System are 80°S to 84°N. If your position is outside this range, the BESTUTM log outputs a northing, easting and height of 0.0, along with a zone letter of ‘*’and a zone number of 0, so that it is obvious that the data in the log is unusable.

Recommended Input:

log bestutma ontime 1

ASCII Example:

```
#BESTUTMA,COM1,0,73.0,FINESTEERING,1419,336209.000,00000040,eb16,2724;
SOL_COMPUTED,PSRDIFF,11,U,5666936.4417,707279.3875,1063.8401,-16.2712,
WGS84,0.0135,0.0084,0.0173,"AAAA",1.000,0.000,8,8,8,8,0,01,0,03*a6d06321
```

Please refer to http://earth-info.nga.mil/GandG/coordsys/grids/referencesys.html for more information and a world map of UTM zone numbers.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BESTUTM header	Log header		H	0
2	sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H
3	pos type	Position type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+4
4	z#	Longitudinal zone number	Ulong	4	H+8
5	zletter	Latitudinal zone letter	Ulong	4	H+12
6	northing	Northing (m) where the origin is defined as the equator in the northern hemisphere and as a point 10000000 metres south of the equator in the southern hemisphere (that is, a 'false northing' of 10000000 m)	Double	8	H+16
7	easting	Easting (m) where the origin is 500000 m west of the central meridian of each longitudinal zone (that is, a 'false easting' of 500000 m)	Double	8	H+24
8	hgt	Height above mean sea level	Double	8	H+32
9	undulation	Undulation - the relationship between the geoid and the ellipsoid (m) of the chosen datum [a]	Float	4	H+40
10	datum id#	Datum ID number (see *Chapter 2, Table 18, Reference Ellipsoid Constants* on *page 73*)	Enum	4	H+44
11	N σ	Northing standard deviation	Float	4	H+48
12	E σ	Easting standard deviation	Float	4	H+52
13	hgt σ	Height standard deviation	Float	4	H+56
14	stn id	Base station ID	Char[4]	4	H+60
15	diff_age	Differential age in seconds	Float	4	H+64
16	sol_age	Solution age in seconds	Float	4	H+68
17	#SVs	Number of satellite vehicles tracked	Uchar	1	H+72
18	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+73
19	#ggL1	Number of GPS plus GLONASS L1 used in solution	Uchar	1	H+74
20	Reserved				
21	Reserved				

Continued on the following page.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
22	ext sol stat	Extended solution status (see *Table 46, Extended Solution Status* on *page 198*)	Hex	1	H+77
23	Reserved		Hex	1	H+78
24	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 45* on *page 198*)	Hex	1	H+79
25	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+80
26	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

3.3.5 BESTVEL Best Available Velocity Data

This log contains the best available velocity information computed by the receiver. In addition, it reports a velocity status indicator, which is useful in indicating whether or not the corresponding data is valid. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value.

The velocity type is from the same source that was chosen for BESTPOS. So if BESTPOS is from the pseudorange filter, the BESTVEL velocity type is the same as for PSRVEL, see *page 296*.

While the receiver is static (or motionless), the velocity may jump several centimetres per second. If the velocity in the BESTVEL log comes from the pseudorange filter, it has been computed from instantaneous doppler measurements. You know that you have an instantaneous doppler velocity solution when you see PSRDIFF, WAAS, or DOPPLER_VELOCITY in field #3 (*vel type*). The instantaneous doppler velocity has low latency and is not delta position dependent. If you change your velocity quickly, you can see this in the DOPPLER_VELOCITY solution. This instantaneous doppler velocity translates into a velocity latency of 0.15 seconds.

Message ID: **99**

Log Type: **Synch**

Recommended Input:

log bestvela ontime 1

ASCII Example:

```
#BESTVELA,COM1,0,61.0,FINESTEERING,1337,334167.000,00000000,827b,1984;
SOL_COMPUTED,PSRDIFF,0.250,4.000,0.0206,227.712486,0.0493,0.0*0e68bf05
```

Velocity vector (speed and direction) calculations involve a difference operation between successive satellite measurement epochs and the error in comparison to the position calculation is reduced. As a result you can expect velocity accuracy approaching plus or minus 0.03 m/s, 0.07 m.p.h., or 0.06 knots assuming phase measurement capability and a relatively high measurement rate (that is, 1 Hz or better) by the GPS receiver.

Direction accuracy is derived as a function of the vehicle speed. A simple approach would be to assume a worst case 0.03 m/s cross-track velocity that would yield a direction error function something like:

$$d\ (\text{speed}) = \tan^{-1}(0.03/\text{speed})$$

For example, if you are flying in an airplane at a speed of 120 knots, or 62 m/s, the approximate directional error will be:

$$\tan^{-1}(0.03/62) = 0.03 \text{ degrees}$$

Consider another example applicable to hiking at an average walking speed of 3 knots or 1.5 m/s. Using the same error function yields a direction error of about 1.15 degrees.

You can see from both examples that a faster vehicle speed allows for a more accurate heading indication. As the vehicle slows down, the velocity information becomes less and less accurate. If the vehicle is stopped, a GPS receiver still outputs some kind of movement at speeds between 0 and 0.5 m/s in random and changing directions. This represents the random variation of the static position.

In a navigation capacity, the velocity information provided by your GPS receiver is as, or more, accurate than that indicated by conventional instruments as long as the vehicle is moving at a reasonable rate of speed. It is important to set the GPS measurement rate fast enough to keep up with all major changes of the vehicle's speed and direction. It is important to keep in mind that although the velocity vector is quite accurate in terms of heading and speed, the actual track of the vehicle might be skewed or offset from the true track by plus or minus 0 to 1.8 metres as per the standard positional errors.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BESTVEL header	Log header		H	0
2	sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H
3	vel type	Velocity type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+4
4	latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8
5	age	Differential age in seconds	Float	4	H+12
6	hor spd	Horizontal speed over ground, in metres per second	Double	8	H+16
7	trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	vert spd	Vertical speed, in metres per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.6 BESTXYZ Best Available Cartesian Position and Velocity

This log contains the receiver's best available position and velocity in ECEF coordinates. The position and velocity status fields indicate whether or not the corresponding data is valid. See *Figure 7, page 209* for a definition of the ECEF coordinates.

See also the BESTPOS log on *page 195*.

These quantities are always referenced to the WGS84 ellipsoid, regardless of the use of the DATUM or USERDATUM commands.

Message ID: **241**

Log Type: **Synch**

Recommended Input:

log bestxyza ontime 1

ASCII Example:

```
#BESTXYZA,COM1,0,55.0,FINESTEERING,1419,340033.000,00000040,d821,2724;
SOL_COMPUTED,PSRDIFF,-1634531.5683,-3664618.0326,4942496.3270,
0.0099,0.0219,0.0115,SOL_COMPUTED,PSRDIFF,0.0011,-0.0049,-0.0001,
0.0199,0.0439,0.0230,"AAAA",0.250,1.000,0.000,12,11,11,11,0,01,0,33*e9eafeca
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BESTXYZ header	Log header		H	0
2	P-sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H
3	pos type	Position type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+4
4	P-X	Position X-coordinate (m)	Double	8	H+8
5	P-Y	Position Y-coordinate (m)	Double	8	H+16
6	P-Z	Position Z-coordinate (m)	Double	8	H+24
7	P-X σ	Standard deviation of P-X (m)	Float	4	H+32
8	P-Y σ	Standard deviation of P-Y (m)	Float	4	H+36
9	P-Z σ	Standard deviation of P-Z (m)	Float	4	H+40
10	V-sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H+44
11	vel type	Velocity type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+48
12	V-X	Velocity vector along X-axis (m/s)	Double	8	H+52
13	V-Y	Velocity vector along Y-axis (m/s)	Double	8	H+60
14	V-Z	Velocity vector along Z-axis (m/s)	Double	8	H+68
15	V-X σ	Standard deviation of V-X (m/s)	Float	4	H+76
16	V-Y σ	Standard deviation of V-Y (m/s)	Float	4	H+80
17	V-Z σ	Standard deviation of V-Z (m/s)	Float	4	H+84
18	stn ID	Base station identification	Char[4]	4	H+88
19	V-latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+92
20	diff_age	Differential age in seconds	Float	4	H+96
21	sol_age	Solution age in seconds	Float	4	H+100
22	#SVs	Number of satellite vehicles tracked	Uchar	1	H+104
23	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+105

Continued on the following page.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
24	#ggL1	Number of GPS plus GLONASS L1 used in solution	Uchar	1	H+106
25	Reserved				
26	Reserved				
27	ext sol stat	Extended solution status (see *Table 46, Extended Solution Status* on *page 198*)	Hex	1	H+109
28	Reserved				
29	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 45* on *page 198*)	Hex	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

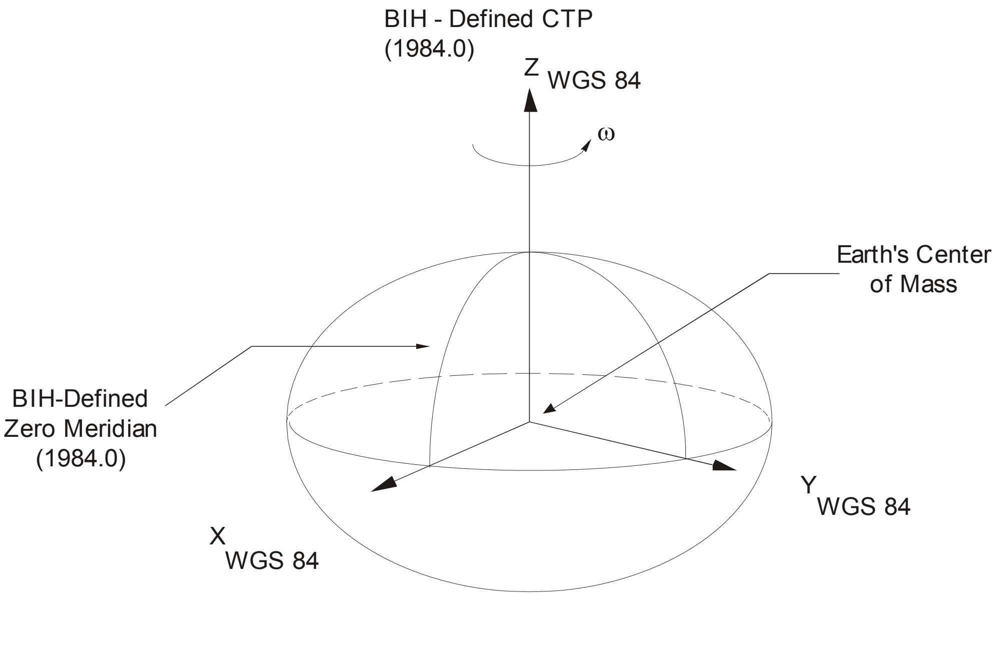
- Definitions - *

Origin = Earth's center of mass

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

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

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



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

Figure 7: The WGS84 ECEF Coordinate System

3.3.7 CHANCONFIGLIST All available channel configurations

This log lists all of the possible channel configurations available on the receiver, given the model options. For configurations with GLONASS channels to be available, a GLONASS-capable model must be loaded on the OEMStar receiver. To use a different channel configuration, use the SELECTCHANCONFIG command (see *page 138*). The CHANCONFIGLIST log is variable length, with a maximum size of 132 bytes, not including the header length.

Message ID: **1148**
Log Type: **Asynch**

Recommended Input:

log chanconfiglista once

ASCII Example:

```
#CHANCONFIGLISTA,COM1,0,87.5,UNKNOWN,0,8.018,004c0020,eea8,4602;6,1,14,GPSL1,
2,12,GPSL1,2,SBASL1,2,10,GPSL1,4,GLOL1,2,8,GPSL1,6,GLOL1,3,8,GPSL1,4,GLOL1,2,
SBASL1,3,10,GPSL1,2,GLOL1,2,SBASL1*baa33607
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CHANCONFIGLIST header	Log header		H	0
2	Set in Use	Channel configuration set currently used by the receiver	ULONG	4	H
3	Num Sets	Total available sets of channel configurations for this model.	ULONG	4	H+4
4	Num Configurations	Total number of signal types in this set.	ULONG	4	H+8
5	Num Channels	Number of channels of this signal type	ULONG	4	H+12
6	Signal Type	Signal type associated with these channels 0 = GPS L1 4 = SBAS L1 10 = GLO L1	Enum	8	H+16
7	Next set offset = H + 8 + (# sets * 8)				
8	Next configuration offset = H + 8 + (# sets * 8) + 4 + (# configs * 8)				

3.3.8 CLOCKMODEL Current Clock Model Status

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

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

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

The following symbols are used throughout this section:

B = range bias (m)

BR = range bias rate (m/s)

SAB = Gauss-Markov process representing range bias error due to satellite clock dither (m)

The standard clock model now used is as follows:

clock parameters array = [B BR SAB]

covariance matrix =

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

Table 47: Clock Model Status

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

Message ID: **16**

Log Type: **Synch**

Recommended Input:

log clockmodela ontime 1

ASCII Example:

```
#CLOCKMODELA,COM1,0,52.0,FINESTEERING,1364,489457.000,80000000,98f9,2310;
VALID,0,489457.000,489457.000,7.11142843e+00,6.110131956e-03,
-4.93391151e+00,3.02626565e+01,2.801659017e-02,-2.99281529e+01,
2.801659017e-02,2.895779736e-02,-1.040643538e-02,-2.99281529e+01,
-1.040643538e-02,3.07428979e+01,2.113,2.710235665e-02,FALSE*3d530b9a
```

The CLOCKMODEL log can be used to monitor the clock drift of the internal oscillator once the CLOCKADJUST mode has been disabled. Watch the CLOCKMODEL log to see the drift rate and adjust the oscillator until the drift stops.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CLOCKMODEL header	Log header		H	0
2	clock status	Clock model status as computed from current measurement data, see *Table 47, Clock Model Status* on *page 211*	Enum	4	H
3	reject	Number of rejected range bias measurements	Ulong	4	H+4
4	noise time	GPS reference time of last noise addition	GPSec	4	H+8
5	update time	GPS reference time of last update	GPSec	4	H+12
6	parameters	Clock correction parameters (a 1x3 array of length 3), listed left-to-right	Double	8	H+16
7				8	H+24
8				8	H+32
9	cov data	Covariance of the straight line fit (a 3x3 array of length 9), listed left-to-right by rows	Double	8	H+40
10				8	H+48
11				8	H+56
12				8	H+64
13				8	H+72
14				8	H+80
15				8	H+88
16				8	H+96
17				8	H+104
18	range bias	Last instantaneous measurement of the range bias (metres)	Double	8	H+112
19	range bias rate	Last instantaneous measurement of the range bias rate (m/s)	Double	8	H+120
20	change	Is there a change in the constellation? 0 = FALSE 1 = TRUE	Enum	4	H+128
21	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+132
22	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.9 CLOCKMODEL2 Clock Bias

The CLOCKMODEL2 log contains the current clock bias for each satellite systems available to the receiver.

Monitoring the CLOCKMODEL2 log allows you to determine the error in your receiver reference oscillator as compared to the satellite system reference.

Message ID: 1170

Log Type: Synch

Recommended Input:

log clockmodel2a ontime 1

ASCII Example:

#CLOCKMODEL2A,COM1,0,90.0,FINESTEERING,1613,165046.000,00000008,9d3d,39031;VALID,-3.094174473e-02,3,GPS,1.7918e-0,2.1739e-09,GLONASS,-2.6204e-07,2.2853e-09,GALILEO,1.2732e-08,3.3356e-04*2fe0835a

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CLOCKMODEL2 header	Log header		H	0
2	clock status	Clock model status as computed from current measurement data, see *Table 47, Clock Model Status* on *page 211*	Enum	4	H
3	rate	Rate of change of time offset	Double	8	H+8
4	NumSystemBiases	number of records to follow	ULong	4	H+12
5	system	See *Table 43* on *page 227*	Enum	4	H+16
6	bias	Time bias	Double	8	H+20
7	biasStdDev	Time bias standard deviation	Double	8	H+28
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+32
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.10 CLOCKSTEERING Clock Steering Status

The CLOCKSTEERING log is used to monitor the current state of the clock steering process. All oscillators have some inherent drift. By default the receiver attempts to steer the receiver's clock to accurately match GPS reference time. If for some reason this is not desired, this behavior can be disabled using the CLOCKADJUST command, see *page 60*.

Message ID: **26**

Log Type: **Asynch**

Recommended Input:

log clocksteeringa onchanged

ASCII Example:

```
#CLOCKSTEERINGA,COM1,0,56.5,FINESTEERING,1337,394857.051,00000000,0f61,1984;
INTERNAL,SECOND_ORDER,4400,1707.554687500,0.029999999,-2.000000000,-0.224,
0.060*0e218bbc
```

Table 48: Clock Source

Binary	ASCII	Description
0	INTERNAL	The receiver is currently steering its internal VCTCXO using an internal VARF signal

Table 49: Steering State

Binary	ASCII	Description
0	FIRST_ORDER	Upon start-up, the clock steering task adjusts the VARF pulse width to reduce the receiver clock drift rate to below 1 ms using a 1st order control loop. This is the normal start-up state of the clock steering loop.
1	SECOND_ORDER	Once the receiver has reduced the clock drift to below 1 m/s, it enters a second order control loop and attempts to reduce the receiver clock offset to zero. This is the normal runtime state of the clock steering process.
2	CALIBRATE_HIGH [a]	This state corresponds to when the calibration process is measuring at the "High" pulse width setting
3	CALIBRATE_LOW [a]	This state corresponds to when the calibration process is measuring at the "Low" pulse width setting
4	CALIBRATE_CENTER [b]	This state corresponds to the "Center" calibration process. Once the center has been found, the modulus pulse width, center pulse width, loop bandwidth, and measured slope values are saved in NVM and are used from now on for the internal oscillator.

a. These states are only seen if you force the receiver to do a clock steering calibration using the CLOCKCALIBRATE command, see *page 62*. With the CLOCKCALIBRATE command, you can force the receiver to calibrate the slope and center pulse width of the internal oscillator, to steer. The receiver measures the drift rate at several "High" and "Low" pulse width settings.

b. After the receiver has measured the "High" and "Low" pulse width setting, the calibration process enters a "Center calibration" process where it attempts to find the pulse width required to zero the clock drift rate.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CLOCKSTEERING header	Log header		H	0
2	source	Clock source, see *Table 48, Clock Source* on *page 215.*	Enum	4	H
3	steeringstate	Steering state, see *Table 49, Steering State* on *page 216*.	Enum	4	H+4
4	period	Period of the FREQUENCYOUT signal used to control the oscillator, refer to the FREQUENCYOUT command. This value is set using the CLOCKCALIBRATE command.	Ulong	4	H+8
5	pulsewidth	Current pulse width of the FREQUENCYOUT signal. The starting point for this value is set using the CLOCKCALIBRATE command. The clock steering loop continuously adjusts this value in an attempt to drive the receiver clock offset and drift terms to zero.	Double	8	H+12
6	bandwidth	The current band width of the clock steering tracking loop in Hz. This value is set using the CLOCKCALIBRATE command.	Double	8	H+20
7	slope	The current clock drift change in m/s/bit for a 1 LSB pulse width. This value is set using the CLOCKCALIBRATE command.	Float	4	H+28
8	offset	The last valid receiver clock offset computed (m). It is the same as Field # 18 of the CLOCKMODEL log, see *page 211*.	Double	8	H+32
9	driftrate	The last valid receiver clock drift rate received (m/s). It is the same as Field # 19 of the CLOCKMODEL log.	Double	8	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.11 CMR Standard Logs

The OEMStar does not currently transmit carrier phase corrections.

The OEMStar can be configured to receive the CMR corrections issued in *Table 50* below and compute a DGPS (pseudorange) position.

The GLONASS option is required for GLONASS corrections to be used in the DGPS position.

Table 50: CMR Carrier-Phase Messages

Message ID	Log Name	Description
310	CMRDESC	Base Station Description Information
882	CMRGLOOBS	CMR Data GLONASS Observations (CMR Type 3 message)
103	CMROBS	Base Station Satellite Observation Information
717	CMRPLUS	CMR+ Output Information
105	CMRREF	Base Station Position Information

3.3.12 COMCONFIG Current COM Port Configuration

This log outputs the current COM port configuration for each port on your receiver.

Message ID: **317**

Log Type: **Polled**

Recommended Input:

log comconfiga once

ASCII example:

```
#COMCONFIGA,COM1,0,57.5,FINESTEERING,1337,394947.236,00000000,85aa,1984;
3,
COM1,57600,N,8,1,N,OFF,ON,NOVATEL,NOVATEL,ON,
COM2,9600,N,8,1,N,OFF,ON,RTCA,NONE,ON,
```

COM1 on the OEMStar is user-configurable for RS-422. Refer to the *Technical Specifications* appendix and the *User-Selectable Port Configuration* section of the *OEMStar Installation and Operation User Manual*.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	COMCONFIG header	Log header		H	0
2	#port	Number of ports with information to follow	Long	4	H
3	port	Serial port identifier, see *Table 15, COM Serial Port Identifiers* on *page 68*	Enum	4	H+4
4	baud	Communication baud rate	Ulong	4	H+8
5	parity	See *Table 16, Parity* on *page 68*	Enum	4	H+12
6	databits	Number of data bits	Ulong	4	H+16
7	stopbits	Number of stop bits	Ulong	4	H+20
8	handshake	See *Table 17, Handshaking* on *page 68*	Enum	4	H+24
9	echo	When echo is on, the port is transmitting any input characters as they are received. 0 = OFF 1 = ON	Enum	4	H+28
10	breaks	Breaks are turned on or off 0 = OFF 1 = ON	Enum	4	H+32
11	rx type	The status of the receive interface mode, see *Table , You must understand your post-processing and real-time software requirements. Good software supports a generic standard while poor software locks you into one brand of GPS equipment. For the most flexibility, insist on generic data format support for all hardware and software solutions.* on *page 101*	Enum	4	H+36
12	tx type	The status of the transmit interface mode, *Table , You must understand your post-processing and real-time software requirements. Good software supports a generic standard while poor software locks you into one brand of GPS equipment. For the most flexibility, insist on generic data format support for all hardware and software solutions.* on *page 101*	Enum	4	H+40
13	response	Responses are turned on or off 0 = OFF 1 = ON	Enum	4	H+44
14	next port offset = H + 4 + (#port x 44)				

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
15	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+(#port x44)
16	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.13 GLMLA NMEA GLONASS Almanac Data GLO

This log outputs almanac data for GLONASS satellites. Multiple sentences are transmitted, one for each satellite.

GLONASS satellites:

GLO PRN# $_{NovAtel}$ = GLO PRN# $_{NMEA}$ - 24

Slot# $_{\text{To match NovAtel format logs or GLONASS status Web site}}$ = GLO PRN# $_{NMEA}$ -24 -37

Message ID: **859**

Log Type: **Asynch**

Recommended Input:

log glmlaa onchanged

ASCII Example:

```
$GLMLA,16,01,65,1176,07,0496,4c,5ff2,8000,34c05e,0e93e8,04b029,001fa2,099,213*68
$GLMLA,16,02,66,1176,01,12e3,4c,42cc,8000,34c08e,10fae9,02f48c,00224e,099,003*64
$GLMLA,16,03,67,1176,8c,08f6,4a,ef4d,8000,34c051,13897b,00d063,001b09,099,000*63
$GLMLA,16,04,68,1176,06,116b,48,3a00,8000,34c09d,02151f,0e49e8,00226e,099,222*63
$GLMLA,16,05,70,1176,01,140f,49,45c4,8000,34c0bc,076637,0a3e40,002214,099,036*37
$GLMLA,16,06,71,1176,05,0306,4c,5133,8000,34c025,09bda7,085d84,001f83,099,21d*6E
$GLMLA,16,07,72,1176,06,01b1,4c,4c19,8000,34c021,0c35a0,067db8,001fca,099,047*3D
$GLMLA,16,08,74,1176,84,076b,45,7995,8000,34c07b,104b6d,0e1557,002a38,099,040*35
$GLMLA,16,09,78,1176,84,066c,46,78cf,8000,34c07b,0663f0,1a6239,0029df,099,030*38
$GLMLA,16,10,79,1176,80,0afc,45,8506,8000,34c057,08de48,1c44ca,0029d7,099,000*6B
$GLMLA,16,11,82,1176,8a,12d3,0f,e75d,8000,34be85,10aea6,1781b7,00235a,099,207*6E
$GLMLA,16,12,83,1176,03,0866,0f,6c08,8000,34c009,11f32e,18839d,002b22,099,214*36
$GLMLA,16,13,85,1176,88,01a6,0d,9dc9,8000,34bff8,031887,02da1e,002838,099,242*6D
$GLMLA,16,14,86,1176,8a,00e1,0e,4b15,8000,34c016,058181,010433,0027f0,099,227*6F
$GLMLA,16,15,87,1176,03,0383,0f,824c,8000,34bfda,081864,1104ea,002b04,099,00c*60
$GLMLA,16,16,88,1176,02,0821,0f,8ac8,8000,34c05b,0a8510,12dcb6,002b6f,099,020*3F
```

For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field	Structure	Field Description	Symbol	Example
1	$GLMLA	Log header		$GLMLA
2	#alm	Number of NMEA almanac messages in the set	x.x	16
3	alm#	Current message number	x.x	13
4	slot	Slot number for satellite (65-96) [a]	xx	85
5	N	Calendar day count within the four year period from the last leap year	x.x	1176
6	hlth & freq	Health and frequency for satellite [b]	hh	88
7	ecc	Eccentricity [c]	hhhh	01a6
8	ΔTdot	Rate of change of orbital period (s/orbital period^2) [c]	hh	0d
9	ω	Argument of perigee (PZ-90.02), in radians [c]	hhhh	9dc9
10	τ_{16MSB}	Clock offset, in seconds [c]	hhhh	8000
11	ΔT	Correction to the mean value of the Draconian period (s/orbital period) [c]	hhhhhh	34bff8
12	tλ	GLONASS Time of ascending node equator crossing, in seconds [c]	hhhhhhh	031887
13	λ	Longitude of ascending node equator crossing (PZ-90.02), in radians [c]	hhhhhhh	02da1e
14	Δi	Correction to nominal inclination, in radians [c]	hhhhhhh	002838
15	τ_{12LSB}	Clock offset, in seconds [c]	hhh	099
16	t	Coarse value of the time scale shift [c]	hhh	242
17	xxxx	32-bit CRC (ASCII and Binary only)	Hex	*6D
18	[CR][LF]	Sentence terminator (ASCII only)	-	[CR][LF]

a. The NMEA GLONASS PRN numbers are 64 plus the GLONASS slot number. Current slot numbers are 1 to 24 which give the range 65 to 88. PRN numbers 89 to 96 are available if slot numbers above 24 are allocated to on-orbit spares.

b. Health and carrier frequency number are represented in this 2-character Hex field as:

```
hh = [8][7][6][5][4][3][2][1] (LSB)
      |   | |  |  |  |  |_____ carrier frequency number of satellite
      |   |_|__________ spare bits
      |_________ health of satellite
```

c. The LSB of the Hex data field corresponds to the LSB of the word indicated in the Table 4.3 of the GLONASS Interface Control Document, 1995. If the number of available bits in the Hex field is greater than the word, the MSB (upper bits) are unused and filled with zeroes.

3.3.14 GLOALMANAC Decoded Almanac GLO

The GLONASS almanac reference time and week are in GPS reference time coordinates. GLONASS ephemeris information is available through the GLMLA log.

Nominal orbit parameters of the GLONASS satellites are as follows:

- Draconian period - 11 hours 15 minutes 44 seconds (see fields 14 and 15 on *page 225*)
- Orbit altitude - 19100 km
- Inclination - 64.8 (see field 11)
- Eccentricity - 0 (see field 12)

Message ID: 718

Log Type: Asynch

Recommended Input:

log gloalmanaca onchanged

ASCII Example:

```
#GLOALMANACA,COM1,0,52.5,SATTIME,1364,410744.000,00000000,ba83,2310;
24,
1364,336832.625,1,2,0,0,2018.625000000,-2.775537500,0.028834045,0.001000404,
2.355427500,-2656.076171875,0.000000000,0.000091553,
1364,341828.437,2,1,0,0,7014.437500000,-3.122226146,0.030814438,0.004598618,
1.650371580,-2656.160156250,0.000061035,0.000095367,
1364,347002.500,3,12,0,0,12188.500000000,2.747629236,0.025376596,0.002099991,
-2.659059822,-2656.076171875,-0.000061035,-0.000198364,
1364,351887.125,4,6,0,0,17073.125000000,2.427596502,0.030895332,0.004215240,
1.438586358,-2656.167968750,-0.000061035,0.000007629,
.
.
.
1364,364031.187,23,11,0,1,29217.187500000,0.564055522,0.030242192,
0.001178741,2.505278248,-2655.957031250,0.000366211,0.000019073,
1364,334814.000,24,3,0,1,0.000000000,0.000000000,0.000000000,0.000000000,
0.000000000,0.000000000,0.000000000,0.000000000*4dc981c7
```

For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLOALMANAC header	Log header		H	0
2	#recs	The number of GLONASS almanac records to follow. Set to zero until almanac data is available.	Long	4	H
3	week	GPS reference week, in weeks	Ulong	4	H+4
4	time	GPS reference time, in milliseconds (binary data) or seconds (ASCII data)	Ulong	4	H+8
5	slot	Slot number for satellite, ordinal	Uchar	1	H+12
6	frequency	Frequency for satellite, ordinal (frequency channels are in the range -7 to +13)	Char	1	H+13
7	sat type	Satellite type where 0 = GLO_SAT 1 = GLO_SAT_M (new M type)	Uchar	1	H+14
8	health	Almanac health where 0 = GOOD 1 = BAD	Uchar	1	H+15
9	TlambdaN	GLONASS Time of ascending node equator crossing, in seconds	Double	8	H+16
10	lambdaN	Longitude of ascending node equator crossing (PZ-90.02), in radians	Double	8	H+24
11	deltaI	Correction to nominal inclination, in radians	Double	8	H+32
12	ecc	Eccentricity	Double	8	H+40
13	ArgPerig	Argument of perigee (PZ-90.02), in radians	Double	8	H+48
14	deltaT	Correction to the mean value of the Draconian period (s/orbital period)	Double	8	H+56
15	deltaTD	Rate of change of orbital period (s/orbital period^2)	Double	8	H+64
16	tau	Clock offset, in seconds	Double	8	H+72
17...	Next message offset = H + 4 + (#recs x 76)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 4 + (76 x #recs)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.15 GLOCLOCK GLONASS Clock Information GLO

This log contains the time difference information between GPS and GLONASS time as well as status flags. The status flags are used to indicate the type of time processing used in the least squares adjustment. GPS and GLONASS time are both based on the Universal Time Coordinated (UTC) time scale with some adjustments. GPS reference time is continuous and does not include any of the leap second adjustments to UTC applied since 1980. The result is that GPS reference time currently leads UTC time by 14 seconds.

GLONASS time applies leap seconds but is also three hours ahead to represent Moscow time. The nominal offset between GPS and GLONASS time is therefore due to the three hour offset minus the leap second offset. Currently this value is at 10787 seconds with GLONASS leading. As well as the nominal offset, there is a residual offset on the order of nanoseconds which must be estimated in the least squares adjustment. The GLONASS-M satellites broadcasts this difference in the navigation message.

This log also contains information from the GLONASS navigation data relating GLONASS time to UTC.

Message ID: **719**

Log Type: **Asynch**

Recommended Input:

log gloclocka onchanged

ASCII Example:

```
#GLOCLOCKA,COM1,0,54.5,SATTIME,1364,411884.000,00000000,1d44,2310;
0,0.000000000,0.000000000,0,0,-0.000000275,792,-0.000001207,
0.000000000,0.000000000,0*437e9afaf
```

✉ For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLOCLOCK header	Log header		H	0
2	Reserved		Ulong	4	H
3			Double	8	H+4
4			Double	8	H+12
5	sat type	Satellite type where 0 = GLO_SAT 1 = GLO_SAT_M (new M type)	Uchar	1	H+20
6	N^4	Four-year interval number starting from 1996	Uchar	1 [a]	H+21 [a]
7	τ_{GPS}	GPS reference time scale correction to UTC(SU) given at beginning of day N^4, in seconds	Double	8	H+24
8	N^A	GLONASS calendar day number within a four year period beginning since the leap year, in days	Ushort	2 [a]	H+32 [a]
9	τ_C	GLONASS time scale correction to UTC time, in seconds	Double	8	H+36
10	b1	Beta parameter 1st order term	Double	8	H+44
11	b2	Beta parameter 2nd order term	Double	8	H+52
12	Kp	Kp provides notification of the next expected leap second. For more information, see *Table 51*.	Uchar	1	H+60
13	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+61
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

Table 51: Kp UTC Leap Second Descriptions

Kp	Information on UTC Leap Second[a]
00	No UTC correction at the end of current quarter.
01	UTC correction by plus (+1 s) in the end of current quarter.
10	No final decision yet on UTC correction at end of current quarter.
11	UTC correction by minus (-1 s) in the end of current quarter.

a. Based on GLONASS ICD version 5.0, 2002.

3.3.16 GLOEPHEMERIS GLONASS Ephemeris Data GLO

GLONASS ephemeris information is available through the GLOEPHEMERIS log. GLONASS ephemerides are referenced to the PZ90.02 geodetic datum. No adjustment between the GPS and GLONASS reference frames are made for positioning.

Message ID: **723**

Log Type: **Asynch**

Recommended Input:

log gloephemerisa onchanged

Example:

```
#GLOEPHEMERISA,COM1,3,49.0,SATTIME,1364,413624.000,00000000,6b64,2310;
43,8,1,0,1364,413114000,10786,792,0,0,87,0,9.0260864257812500e+06,
-6.1145468750000000e+06,2.2926090820312500e+07,1.4208841323852539e+03,
2.8421249389648438e+03,1.9398689270019531e+02,0.00000000000000000,
-2.79396772384643555e-06,-2.79396772384643555e-06,2.12404876947402954e-04,
-1.396983862e-08,-3.63797880709171295e-12,78810,3,15,0,12*a02ce18b
#GLOEPHEMERISA,COM1,2,49.0,SATTIME,1364,413626.000,00000000,6b64,2310;
44,11,1,0,1364,413116000,10784,792,0,0,87,13,-1.2882617187500000e+06,
-1.9318657714843750e+07,1.6598909179687500e+07,9.5813846588134766e+02,
2.0675134658813477e+03,2.4769935607910156e+03,2.79396772384643555e-06,
-3.72529029846191406e-06,-1.86264514923095703e-06,6.48368149995803833e-05,
-4.656612873e-09,3.63797880709171295e-12,78810,3,15,3,28*e2d5ef15
#GLOEPHEMERISA,COM1,1,49.0,SATTIME,1364,413624.000,00000000,6b64,2310;
45,13,0,0,1364,413114000,10786,0,0,0,87,0,-1.1672664062500000e+07,
-2.2678505371093750e+07,4.8702343750000000e+05,-1.1733341217041016e+02,
1.3844585418701172e+02,3.5714883804321289e+03,2.79396772384643555e-06,
-2.79396772384643555e-06,0.00000000000000000,-4.53162938356399536e-05,
5.587935448e-09,-2.36468622460961342e-11,78810,0,0,0,8*c15abfeb
#GLOEPHEMERISA,COM1,0,49.0,SATTIME,1364,413624.000,00000000,6b64,2310;
59,17,0,0,1364,413114000,10786,0,0,0,87,0,-2.3824853515625000e+05,
-1.6590188964843750e+07,1.9363733398437500e+07,1.3517074584960938e+03,
-2.2859592437744141e+03,-1.9414072036743164e+03,1.86264514923095703e-06,
-3.72529029846191406e-06,-1.86264514923095703e-06,7.92574137449264526e-05,
4.656612873e-09,2.72848410531878471e-12,78810,0,0,0,12*ed7675f5
```

For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Table 52: GLONASS Ephemeris Flags Coding

N0	<- <- Nibble Number		
4 3 2 1 0 Bit	Description	Range Values	Hex Value
lsb = 0	P1 FLAG - TIME INTERVAL BETWEEN ADJACENT iISSUE (t_b) VALUES	See the following table	00000001
1			00000002
2	P2 FLAG - ODDNESS OR EVENNESS OF iISSUE (t_b) VALUE	0 = even, 1 = odd	00000004
3	P3 FLAG - NUMBER OF SATELLITES WITH ALMANAC INFORMATION WITHIN CURRENT SUBFRAME	0 = five, 1 = four	00000008
4 : 31	RESERVED (N-1 through N-7)		

Table 53: ***Bits 0 - 1: P1 Flag Range Values***

State	Description
00	0 minutes
01	30 minutes
10	45 minutes
11	60 minutes

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLO-EPHEMERIS header	Log header		H	0
2	sloto	Slot information offset - PRN identification (Slot + 37). This is also called SLOTO in CDU	Ushort	2	H
3	freqo	Frequency channel offset for satellite in the range 0 to 20	Ushort	2	H+2
4	sat type	Satellite type where 0 = GLO_SAT 1 = GLO_SAT_M (new M type)	Uchar	1	H+4
5	Reserved			1	H+5
6	e week	Reference week of ephemeris (GPS reference time)	Ushort	2	H+6
7	e time	Reference time of ephemeris (GPS reference time) in ms	Ulong	4	H+8
8	t offset	Integer seconds between GPS and GLONASS time. A positive value implies GLONASS is ahead of GPS reference time.	Ulong	4	H+12
9	Nt	Current data number. This field is only output for the new M type satellites. See example output from both satellite types (field 4) on *page 228*.	Ushort	2	H+16
10	Reserved			1	H+18
11	Reserved			1	H+19
12	issue	15-minute interval number corresponding to ephemeris reference time	Ulong	4	H+20
13	health	Ephemeris health where 0 = GOOD 1 = BAD	Ulong	4	H+24
14	pos x	X coordinate for satellite at reference time (PZ-90.02), in metres	Double	8	H+28
15	pos y	Y coordinate for satellite at reference time (PZ-90.02), in metres	Double	8	H+36
16	pos z	Z coordinate for satellite at reference time (PZ-90.02), in metres	Double	8	H+44
17	vel x	X coordinate for satellite velocity at reference time (PZ-90.02), in metres/s	Double	8	H+52

Continued on the following page

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
18	vel y	Y coordinate for satellite velocity at reference time (PZ-90.02), in metres/s	Double	8	H+60
19	vel z	Z coordinate for satellite velocity at reference time (PZ-90.02), in metres/s	Double	8	H+68
20	LS acc x	X coordinate for lunisolar acceleration at reference time (PZ-90.02), in metres/s/s	Double	8	H+76
21	LS acc y	Y coordinate for lunisolar acceleration at reference time (PZ-90.02), in metres/s/s	Double	8	H+84
22	LS acc z	Z coordinate for lunisolar acceleration at reference time (PZ-90.02), in metres/s/s	Double	8	H+92
23	tau_n	Correction to the nth satellite time t_n relative to GLONASS time t_c, in seconds	Double	8	H+100
24	delta_tau_n	Time difference between navigation RF signal transmitted in L2 sub-band and navigation RF signal transmitted in L1 sub-band by nth satellite, in seconds	Double	8	H+108
25	gamma	Frequency correction, in seconds/second	Double	8	H+116
26	Tk	Time of frame start (since start of GLONASS day), in seconds	Ulong	4	H+124
27	P	Technological parameter	Ulong	4	H+128
28	Ft	User range	Ulong	4	H+132
29	age	Age of data, in days	Ulong	4	H+136
30	Flags	Information flags, see *Table 52, GLONASS Ephemeris Flags Coding* on *page 229*	Ulong	4	H+140
31	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+144
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.17 GLORAWALM Raw GLONASS Almanac Data GLO

This log contains the raw almanac subframes as received from the GLONASS satellite.

Message ID: **720**
Log Type: **Asynch**

Recommended Input:

log glorawalma onchanged

Example:

```
#GLORAWALMA,COM1,0,44.5,SATTIME,1364,419924.000,00000000,77bb,2310;
1364,419954.069,54,
0563100000a4000000006f,0,
0681063c457a12cc0419be,0,
075ff807e2a69804e0040b,0,
0882067fcd80141692d6f2,0,
09433e1b6676980a40429b,0,
0a838d1bfcb4108b089a8c,0,
0bec572f9c869804f05882,0,
.
.
.
06950201e02e13d3819564,0,
07939a4a16fe97fe814ad0,0,
08960561cecc13b0014613,0,
09469a5d70c69802819466,0,
0a170165bed413b704d416,0,
0b661372213697fd41965a,0,
0c180000000000000006,0,
0d000000000000000652,0,
0e00000000000000000d0,0*b516623b
```

For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLORAWALM header	Log header		H	0
2	week	GPS reference week, in weeks	Ulong	4	H
3	time	GPS reference time, in milliseconds (binary data) or seconds (ASCII data)	Ulong	4	H+4
4	#recs	Number of records to follow.	Ulong	4	H+8
5	string	GLONASS data string	Uchar [string size] [a]	variable	H+12
6	Reserved		Uchar	1	variable
7...	Next record offset = H + 16 + (#recs x [string size + 1])				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 12 + (#recs x [string size+1])
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.18 GLORAWEPHEM Raw GLONASS Ephemeris Data GLO

This log contains the raw ephemeris frame data as received from the GLONASS satellite.

Message ID: **792**
Log Type: **Asynch**

Recommended Input:

log glorawephema onchanged

Example:

```
#GLORAWEPHEMA,COM1,3,47.0,SATTIME,1340,398653.000,00000000,332d,2020;
38,9,0,1340,398653.080,4,
0148d88460fc115dbdaf78,0,0218e0033667aec83af2a5,0,
038000b9031e14439c75ee,0,0404f22660000000000065,0*17f3dd17
…
#GLORAWEPHEMA,COM1,0,47.0,SATTIME,1340,398653.000,00000000,332d,2020;
41,13,0,1340,398653.078,4,
0108d812532805bfa1cd2c,0,0208e0a36e8e0952b111da,0,
03c02023b68c9a32410958,0,0401fda44000000000002a,0*0b237405
```

For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLORAWEPHEM header	Log header		H	0
2	sloto	Slot information offset - PRN identification (Slot + 37). Ephemeris relates to this slot and is also called SLOTO in CDU.	Ushort	2	H
3	freqo	Frequency channel offset in the range 0 to 20	Ushort	2	H+2
4	sigchan	Signal channel number	Ulong	4	H+4
5	week	GPS reference week, in weeks	Ulong	4	8
6	time	GPS reference time, in milliseconds (binary data) or seconds (ASCII data)	Ulong	4	12
7	#recs	Number of records to follow	Ulong	4	H+16
8	string	GLONASS data string	Uchar [string size] [a]	variable	H+20
9	Reserved		Uchar	1	variable
10...	Next record offset = H + 20 + (#recs x [string size + 1])				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 20 + (#recs x [string size+1])
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.19 GLORAWFRAME Raw GLONASS Frame Data *GLO*

This log contains the raw GLONASS frame data as received from the GLONASS satellite.

Message ID: **721**

Log Type: **Asynch**

Recommended Input:

log glorawframea onchanged

Example:

```
#GLORAWFRAMEA,COM1,19,53.0,SATTIME,1340,398773.000,00000000,8792,2020;
3,39,8,1340,398773.067,44,44,15,
0148dc0b67e9184664cb35,0,
0218e09dc8a3ae8c6ba18d,0,
…
0f000000000000000000000,0*11169f9e
…
#GLORAWFRAMEA,COM1,0,53.0,SATTIME,1340,398713.000,00000000,8792,2020;
1,41,13,1340,398713.077,36,36,15,
0108da12532805bfa1cded,0,
0208e0a36e8e0952b111da,0,
03c02023b68c9a32410958,0,
…
0f6efb59474697fd72c4e2,0*0a6267c8
```

✉ For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLORAWFRAME header	Log header		H	0
2	frame#	Frame number	Ulong	2	H
3	sloto	Slot information offset - PRN identification (Slot + 37). Ephemeris relates to this slot and is also called SLOTO in CDU.	Ushort	2	H+2
4	freqo	Frequency channel offset in the range 0 to 20	Ushort	2	H+4
5	week	GPS reference week, in weeks	Ulong	4	H+6
6	time	GPS reference time, in milliseconds (binary data) or seconds (ASCII data)	Ulong	4	H+10
7	frame decode	Frame decoder number	Ulong	4	H+14
8	sigchan	Signal channel number	Ulong	4	H+18
9	#recs	Number of records to follow	Ulong	4	H+22
10	string	GLONASS data string	Uchar [string size] [a]	variable	H+26
11	Reserved		Uchar	1	variable
12...	Next record offset = H + 26 + (#recs x [string size + 1])				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 26 + (#recs x [string size+1])
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.20 GLORAWSTRING Raw GLONASS String GLO

This log contains the raw string data as received from the GLONASS satellite.

Message ID: 722

Log Type: Asynch

Recommended Input:

log glorawstringa onchanged

Example:

```
#GLORAWSTRINGA,COM1,0,51.0,SATTIME,1340,399113.000,00000000,50ac,2020;
4,6,061000000000000000004f,0*5b215fb2
```

For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLORAWSTRING header	Log header		H	0
2	slot	Slot identification	Uchar	2	H
3	freq	Frequency channel (frequency channels are in the range -7 to +13)	Char	2	H+2
4	string	GLONASS data string	Uchar [string size] [a]	variable	H+4
5	Reserved		Uchar	1	variable
6	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	(H +4 + string size +1)
7	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.21 GPALM Almanac Data

This log outputs raw almanac data for each satellite PRN contained in the broadcast message. A separate record is logged for each PRN, up to a maximum of 32 records. GPALM outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then UTC time is then set to VALID. It takes a minimum of 12.5 minutes to collect a complete almanac following receiver boot-up. If an almanac was stored in NVM, the stored values are reported in the GPALM log once time is set on the receiver.

✉ To obtain copies of ICD-GPS-200, seen in the GPALM table footnotes. Please refer to the ARINC Web site at www.arinc.com.For NMEA information, please refer to the NMEA Web site at www.nmea.org.

Message ID: **217**

Log Type: **Asynch**

Recommended Input:

log gpalm onchanged

Example:

```
$GPALM,28,01,01,1337,00,305a,90,1b9d,fd5b,a10ce9,ba0a5e,2f48f1,cccb76,006,001
*27
$GPALM,28,02,02,1337,00,4aa6,90,0720,fd50,a10c5a,4dc146,d89bab,0790b6,fe4,000
*70
.
.
.
$GPALM,28,24,26,1337,00,878c,90,1d32,fd5c,a10c90,1db6b6,2eb7f5,ce95c8,00d,000
*23
$GPALM,28,25,27,1337,00,9cde,90,07f2,fd54,a10da5,adc097,562da3,6488dd,00e,000
*2F
$GPALM,28,26,28,1337,00,5509,90,0b7c,fd59,a10cc4,a1d262,83e2c0,3003bd,02d,000
*78
$GPALM,28,27,29,1337,00,47f7,90,1b20,fd58,a10ce0,d40a0b,2d570e,221641,122,006
*7D
$GPALM,28,28,30,1337,00,4490,90,0112,fd4a,a10cc1,33d10a,81dfc5,3bdb0f,178,004
*28
```

✉ Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPALM	Log header		$GPALM
2	# msg	Total number of messages logged. Set to zero until almanac data is available.	x.x	17
3	msg #	Current message number	x.x	17
4	PRN	Satellite PRN number: GPS = 1 to 32	xx	28
5	GPS wk	GPS reference week number [a].	x.x	653
6	SV hlth	SV health, bits 17-24 of each almanac page [b]	hh	00
7	ecc	e, eccentricity [c d]	hhhh	3EAF
8	alm ref time	toa, almanac reference time [c]	hh	87
9	incl angle	$(sigma)_i$, inclination angle [c]	hhhh	OD68
10	omegadot	OMEGADOT, rate of right ascension [c]	hhhh	FD30
11	rt axis	$(A)^{1/2}$, root of semi-major axis [c]	hhhhhh	A10CAB
12	omega	omega, argument of perigee [c e]	hhhhhh	6EE732
13	long asc node	$(OMEGA)_o$,longitude of ascension node [c]	hhhhhh	525880
14	M_o	Mo, mean anomaly [c]	hhhhhh	6DC5A8
15	a_{f0}	af0, clock parameter [c]	hhh	009
16	a_{f1}	af1, clock parameter [c]	hhh	005
17	*xx	Checksum	*hh	*37
18	[CR][LF]	Sentence terminator		[CR][LF]

a Variable length integer, 4-digits maximum from (2) most significant binary bits of Subframe 1, Word 3 reference Table 20-I, ICD-GPS-200, Rev. B, and (8) least significant bits from subframe 5, page 25, word 3 reference Table 20-I, ICD-GPS-200

b Reference paragraph 20.3.3.5.1.3, Table 20-VII and Table 20-VIII, ICD-GPS-200, Rev. B

c Reference Table 20-VI, ICD-GPS-200, Rev. B for scaling factors and units.

d A quantity defined for a conic section where e= 0 is a circle, e = 1 is an ellipse, 0<e<1 is a parabola and e>1 is a hyperbola.

e A measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion

3.3.22 GPGGA GPS Fix Data and Undulation

Time, position and fix-related data of the GPS receiver. For greater precision, use the GPGGALONG log (see *page 243*). See also *Table 54, Position Precision of NMEA Logs* on *page 245*.

The GPGGA log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

Message ID: **218**

Log Type **Synch**

Recommended Input:

log gpgga ontime 1

Example:

```
$GPGGA,134658.00,5106.9792,N,11402.3003,W,2,09,1.0,1048.47,M,-16.27,M,
08,AAAA*60
```

✉ The NMEA (National Marine Electronics Association) has defined standards that specify how electronic equipment for marine users communicate. GPS receivers are part of this standard and the NMEA has defined the format for several GPS data logs otherwise known as 'sentences'.

Each NMEA sentence begins with a '$' followed by the prefix 'GP' followed by a sequence of letters that define the type of information contained in the sentence. Data contained within the sentence is separated by commas and the sentence is terminated with a two digit checksum followed by a carriage return/line feed. Here is an example of an NMEA sentence that describes time, position, and fix related data:

$GPGGA,134658.00,5106.9792,N,11402.3003,W,2,09,1.0,1048.47,M,

-16.27,M,08,AAAA*60

The GPGGA sentence shown above, and other NMEA logs, are output the same no matter what GPS receiver is used, providing a standard way to communicate and process GPS information.

Field	Structure	Field Description	Symbol	Example
1	$GPGGA	Log header		$GPGGA
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	202134.00
3	lat	Latitude (DDmm.mm)	llll.ll	5106.9847
4	lat dir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.2986
6	lon dir	Longitude direction (E = East, W = West)	a	W
7	GPS qual	GPS Quality indicator 0 = fix not available or invalid 1 = GPS fix 2 = C/A differential GPS 6 = Dead reckoning mode 7 = Manual input mode (fixed position) 8 = Simulator mode 9 = WAAS [a]	x	1
8	# sats	Number of satellites in use. May be different to the number in view	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna altitude above/below mean sea level	x.x	1062.22
11	a-units	Units of antenna altitude (M = metres)	M	M
12	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid	x.x	-16.271
13	u-units	Units of undulation (M = metres)	M	M
14	age	Age of Differential GPS data (in seconds) [b]	xx	*(empty when no differential data is present)*
15	stn ID	Differential base station ID, 0000-1023	xxxx	*(empty when no differential data is present)*
16	*xx	Checksum	*hh	*48
17	[CR][LF]	Sentence terminator		[CR][LF]

a. An indicator of 9 has been temporarily set for WAAS (NMEA standard for WAAS not decided yet). This indicator can be customized using the GGAQUALITY command.

b. The maximum age reported here is limited to 99 seconds.

3.3.23 GPGGALONG Fix Data, Extra Precision and Undulation

Time, position, undulation and fix-related data of the GPS receiver. This is output as a GPGGA log but the GPGGALONG log differs from the normal GPGGA log by its extra precision. See also *Table 54, Position Precision of NMEA Logs* on *page 245*.

The GPGGALONG log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

Message ID: 521

Log Type: Synch

Recommended Input:

log gpggalong ontime 1

Example 1:

```
$GPGGA,181126.00,5106.9802863,N,11402.3037304,W,7,11,0.9,1048.234,M,
-16.27,M,,*51
```

Example 2:

```
$GPGGA,134658.00,5106.9802863,N,11402.3037304,W,2,09,1.0,1048.234,M,
-16.27,M,08,AAAA
```

Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPGGA-LoNG	Log header		$GPGGA
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	202126.00
3	lat	Latitude (DDmm.mm)	llll.ll	5106.9847029
4	lat dir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.2986286
6	lon dir	Longitude direction (E = East, W = West)	a	W
7	GPS qual	GPS Quality indicator 0 = fix not available or invalid 1 = GPS fix 2 = C/A differential GPS 6 = Dead reckoning mode 7 = Manual input mode (fixed position) 8 = Simulator mode 9 = WAAS [a]	x	1
8	# sats	Number of satellites in use (00-12). May be different to the number in view	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna altitude above/below msl	x.x	1062.376
11	units	Units of antenna altitude (M = metres)	M	M
12	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid	x.x	-16.271
13	u-units	Units of undulation (M = metres)	M	M
14	age	Age of Differential GPS data (in seconds) [b]	xx	10 *(empty when no differential data is present)*
15	stn ID	Differential base station ID, 0000-1023	xxxx	AAAA *(empty when no differential data is present)*
16	*xx	Checksum	*hh	*48
17	[CR][LF]	Sentence terminator		[CR][LF]

a. An indicator of 9 has been temporarily set for WAAS (NMEA standard for WAAS is not decided yet).

b. The maximum age reported here is limited to 99 seconds.

3.3.24 GPGLL Geographic Position

Latitude and longitude of present vessel position, time of position fix, and status.

Table 54 compares the position precision of selected NMEA logs.

The GPGLL log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

✉ If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems).

Message ID: **219**
Log Type: **Synch**

Recommended Input:

log gpgll ontime 1

Example1 (GPS only):

```
$GPGLL,5107.0013414,N,11402.3279144,W,205412.00,A,A*73
```

Example 2 (Combined GPS and GLONASS):

```
$GNGLL,5107.0014143,N,11402.3278489,W,205122.00,A,A*6E
```

Table 54: Position Precision of NMEA Logs

NMEA Log	Latitude (# of decimal places)	Longitude (# of decimal places)	Altitude (# of decimal places)
GPGGA	4	4	2
GPGGALONG	7	7	3
GPGLL	7	7	N/A
GPRMC	7	7	N/A

✉ Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPGLL	Log header		$GPGLL
2	lat	Latitude (DDmm.mm)	llll.ll	5106.7198674
3	lat dir	Latitude direction (N = North, S = South)	a	N
4	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.3587526
5	lon dir	Longitude direction (E = East, W = West)	a	W
6	utc	UTC time of position (hours/minutes/seconds/decimal seconds)	hhmmss.ss	220152.50
7	data status	Data status: A = Data valid, V = Data invalid	A	A
8	mode ind	Positioning system mode indicator, see *Table 55* on *page 255*	a	A
9	*xx	Checksum	*hh	*1B
10	[CR][LF]	Sentence terminator		[CR][LF]

3.3.25 GPGRS GPS Range Residuals for Each Satellite

Range residuals can be computed in two ways, and this log reports those residuals. Under mode 0, residuals output in this log are used to update the position solution output in the GPGGA message. Under mode 1, the residuals are re-computed after the position solution in the GPGGA message is computed. The receiver computes range residuals in mode 1. An integrity process using GPGRS would also require GPGGA (for position fix data), GPGSA (for DOP figures), and GPGSV (for PRN numbers) for comparative purposes.

The GPGRS log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

✉ If the range residual exceeds ± 99.9, then the decimal part is dropped. Maximum value for this field is ± 999. The sign of the range residual is determined by the order of parameters used in the calculation as follows:

range residual = calculated range - measured range

If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.

Message ID: **220**

Log Type: **Synch**

Recommended Input:

log gpgrs ontime 1

Example 1 (GPS only):

```
$GPGRS,142406.00,1,-1.1,-0.1,1.7,1.2,-2.0,-0.5,1.2,-1.2,-0.1,,,*67
```

Example 2 (Combined GPS and GLONASS):

```
$GNGRS,143209.00,1,-0.2,-0.5,2.2,1.3,-2.0,-1.3,1.3,-0.4,-1.2,-0.2,,*72
$GNGRS,143209.00,1,1.3,-6.7,,,,,,,,,,*73
```

✉ Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPGRS	Log header		$GPGRS
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	192911.0
3	mode	Mode 0 =residuals were used to calculate the position given in the matching GGA line (a priori) (not used by OEMStar receivers) Mode 1 =residuals were recomputed after the GGA position was computed (preferred mode)	x	1
4 - 15	res	Range residuals for satellites used in the navigation solution. Order matches order of PRN numbers in GPGSA.	x.x,x.x,.....	-13.8,-1.9,11.4,-33.6,0.9, 6.9,-12.6,0.3,0.6, -22.3
16	*xx	Checksum	*hh	*65
17	[CR][LF]	Sentence terminator		[CR][LF]

3.3.26 GPGSA GPS DOP and Active Satellites

GPS receiver operating mode, satellites used for navigation and DOP values.

The GPGSA log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

> If the DOP values exceed 9999.0, or there is an insufficient number of satellites to calculate a DOP value, 9999.0 is reported for PDOP and HDOP. VDOP is reported as 0.0 in this case.
>
> If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.

Message ID: **221**

Log Type: **Synch**

Recommended Input:

log gpgsa ontime 1

Example 1 (GPS only):

```
$GPGSA,M,3,17,02,30,04,05,10,09,06,31,12,,,1.2,0.8,0.9*35
```

Example 2 (Combined GPS and GLONASS):

```
$GNGSA,M,3,17,02,30,04,05,10,09,06,31,12,,,1.2,0.8,0.9*2B
$GNGSA,M,3,87,70,,,,,,,,,,,1.2,0.8,0.9*2A
```

> The DOPs provide a simple characterization of the user-satellite geometry. DOP is related to the volume formed by the intersection points of the user-satellite vectors, with the unit sphere centered on the user. Larger volumes give smaller DOPs. Lower DOP values generally represent better position accuracy. The role of DOP in GPS positioning, however, is often misunderstood. A lower DOP value does not automatically mean a low position error. The quality of a GPS-derived position estimate depends upon both the measurement geometry as represented by DOP values, and range errors caused by signal strength, ionospheric effects, multipath and so on.
>
> Please see also the GPGGA usage box that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPGSA	Log header		$GPGSA
2	mode MA	A = Automatic 2D/3D M = Manual, forced to operate in 2D or 3D	M	M
3	mode 123	Mode: 1 = Fix not available; 2 = 2D; 3 = 3D	x	3
4 - 15	prn	PRN numbers of satellites used in solution (null for unused fields), total of 12 fields GPS = 1 to 32 SBAS = 33 to 64 (add 87 for PRN number) GLO = 65 to 96 [a]	xx,xx,.....	18,03,13, 25,16, 24,12, 20,,,,
16	pdop	Position dilution of precision	x.x	1.5
17	hdop	Horizontal dilution of precision	x.x	0.9
18	vdop	Vertical dilution of precision	x.x	1.2
19	*xx	Checksum	*hh	*3F
20	[CR][LF]	Sentence terminator		[CR][LF]

a. The NMEA GLONASS PRN numbers are 64 plus the GLONASS slot number. Current slot numbers are 1 to 24 which give the range 65 to 88. PRN numbers 89 to 96 are available if slot numbers above 24 are allocated to on-orbit spares.

3.3.27 GPGST Pseudorange Measurement Noise Statistics

Pseudorange measurement noise statistics are translated in the position domain in order to give statistical measures of the quality of the position solution.

This log reflects the accuracy of the solution type used in the BESTPOS, see *page 195*, and GPGGA, see *page 241*, logs except for the RMS field. The RMS field, since it specifically relates to pseudorange inputs, does not represent carrier-phase based positions. Instead it reflects the accuracy of the pseudorange position which is given in the PSRPOS log, see *page 293*.

The GPGST log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

✉ If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.

Message ID: **222**

Log Type: **Synch**

Recommended Input:

log gpgst ontime 1

Example 1 (GPS only):

```
$GPGST,141451.00,1.18,0.00,0.00,0.0000,0.00,0.00,0.00*6B
```

Example 2 (Combined GPS and GLONASS):

```
$GNGST,143333.00,7.38,1.49,1.30,68.1409,1.47,1.33,2.07*4A
```

✉ Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Accuracy is based on statistics, reliability is measured in percent. When a receiver can measure height to one metre, this is an accuracy. Usually this is a one sigma value (one SD). A one sigma value for height has a reliability of 68%, that is, the error is less than one metre 68% of the time. For a more realistic accuracy, double the one sigma value (1 m) and the result is 95% reliability (error is less than 2 m 95% of the time). Generally, GPS heights are 1.5 times poorer than horizontal positions.

As examples of statistics, the GPGST message and NovAtel performance specifications use root mean square RMS. Specifications may be quoted in CEP:

RMS:root mean square (a probability level of 68%)

CEP:circular error probable (the radius of a circle such that 50% of a set of events occur inside the boundary)

Field	Structure	Field Description	Symbol	Example
1	$GPGST	Log header		$GPGST
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	173653.00
3	rms	RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudoranges and DGPS corrections.	x.x	2.73
4	smjr std	Standard deviation of semi-major axis of error ellipse (m)	x.x	2.55
5	smnr std	Standard deviation of semi-minor axis of error ellipse (m)	x.x	1.88
6	orient	Orientation of semi-major axis of error ellipse (degrees from true north)	x.x	15.2525
7	lat std	Standard deviation of latitude error (m)	x.x	2.51
8	lon std	Standard deviation of longitude error (m)	x.x	1.94
9	alt std	Standard deviation of altitude error (m)	x.x	4.30
10	*xx	Checksum	*hh	*6E
11	[CR][LF]	Sentence terminator		[CR][LF]

3.3.28 GPGSV GPS Satellites in View

Number of SVs in view, PRN numbers, elevation, azimuth and SNR value. Four satellites maximum per message. When required, additional satellite data sent in 2 or more messages (a maximum of 9). The total number of messages being transmitted and the current message being transmitted are indicated in the first two fields.

The GPGSV log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

Satellite information may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value 1. The second field identifies the order of this message (message number), minimum value 1.

If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only) or GL (GLONASS satellites only), or GN (satellites from both systems).

A variable number of 'PRN-Elevation-Azimuth-SNR' sets are allowed up to a maximum of four sets per message. Null fields are not required for unused sets when less than four sets are transmitted.

Message ID: **223**

Log Type: **Synch**

Recommended Input:

log gpgsv ontime 1

Example (Including GPS and GLONASS sentences):

```
$GPGSV,3,1,11,18,87,050,48,22,56,250,49,21,55,122,49,03,40,284,47*78
$GPGSV,3,2,11,19,25,314,42,26,24,044,42,24,16,118,43,29,15,039,42*7E
$GPGSV,3,3,11,09,15,107,44,14,11,196,41,07,03,173,*4D
$GLGSV,2,1,06,65,64,037,41,66,53,269,43,88,39,200,44,74,25,051,*64
$GLGSV,2,2,06,72,16,063,35,67,01,253,*66
```

The GPGSV log can be used to determine which satellites are currently available to the receiver. Comparing the information from this log to that in the GPGSA log shows you if the receiver is tracking all available satellites. Please see also the GPGGA note that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPGSV	Log header		$GPGSV
2	# msgs	Total number of messages (1-9)	x	3
3	msg #	Message number (1-9)	x	1
4	# sats	Total number of satellites in view. May be different than the number of satellites in use (see also the GPGGA log on *page 241*).	xx	09
5	prn	Satellite PRN number GPS = 1 to 32 SBAS = 33 to 64 (add 87 for PRN#s) GLO = 65 to 96 [a]	xx	03
6	elev	Elevation, degrees, 90 maximum	xx	51
7	azimuth	Azimuth, degrees True, 000 to 359	xxx	140
8	SNR	SNR (C/No) 00-99 dB, null when not tracking	xx	42
... ...	... ...	Next satellite PRN number, elev, azimuth, SNR, ... Last satellite PRN number, elev, azimuth, SNR,		
variable	*xx	Checksum	*hh	*72
variable	[CR][LF]	Sentence terminator		[CR][LF]

a. The NMEA GLONASS PRN numbers are 64 plus the GLONASS slot number. Current slot numbers are 1 to 24 which give the range 65 to 88. PRN numbers 89 to 96 are available if slot numbers above 24 are allocated to on-orbit spares.

3.3.29 GPRMB Navigation Information

Navigation data from present position to a destination waypoint. The destination is set active by the receiver SETNAV command.

The GPRMB log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

Message ID: **224**

Log Type: **Synch**

Recommended Input:

log gprmb ontime 1

Example 1 (GPS only):

```
$GPRMB,A,5.14,L,FROM,TO,5109.7578000,N,11409.0960000,W,5.1,303.0,-0.0,V,A*6F
```

Example 2 (Combined GPS and GLONASS):

```
$GNRMB,A,5.14,L,FROM,TO,5109.7578000,N,11409.0960000,W,5.1,303.0,-0.0,V,A*71
```

✉ If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.

Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Table 55: NMEA Positioning System Mode Indicator

Mode	Indicator
A	Autonomous
D	Differential
E	Estimated (dead reckoning) mode
M	Manual input
N	Data not valid

Field	Structure	Field Description	Symbol	Example
1	$GPRMB	Log header		$GPRMB
2	data status	Data status: A = data valid; V = navigation receiver warning	A	A
3	xtrack	Cross track error [a]	x.x	5.14
4	dir	Direction to steer to get back on track (L/R) [b]	a	L
5	origin ID	Origin waypoint ID [c]	c--c	FROM
6	dest ID	Destination waypoint ID [C]	c--c	TO
7	dest lat	Destination waypoint latitude (DDmm.mm [c]	llll.ll	5109.7578000
8	lat dir	Latitude direction (N = North, S = South) [c]	a	N
9	dest lon	Destination waypoint longitude (DDDmm.mm) [c]	yyyyy.yy	11409.0960000
10	lon dir	Longitude direction (E = East, W = West) [c]	a	W
11	range	Range to destination, nautical miles [d]	x.x	5.1
12	bearing	Bearing to destination, degrees True	x.x	303.0
13	vel	Destination closing velocity, knots	x.x	-0.0
14	arr status	Arrival status: A = perpendicular passed V = destination not reached or passed	A	V
15	mode ind	Positioning system mode indicator, see *Table 55* on *page 255*	a	A
16	*xx	Checksum	*hh	*6F
17	[CR][LF]	Sentence terminator		[CR][LF]

a. - If cross track error exceeds 9.99 NM, display 9.99
- Represents track error from intended course
- One nautical mile = 1,852 metres

b. Direction to steer is based on the sign of the crosstrack error, that is, L = xtrack error (+);
R = xtrack error (-)

c. Fields 5, 6, 7, 8, 9, and 10 are tagged from the SETNAV command, see *page 143*.

d. If range to destination exceeds 999.9 NM, display 999.9

3.3.30 GPRMC GPS Specific Information

Time, date, position, track made good and speed data provided by the GPS navigation receiver. RMC and RMB are the recommended minimum navigation data to be provided by a GPS receiver.

A comparison of the position precision between this log and other selected NMEA logs can be seen in *Table 54, Position Precision of NMEA Logs* on *page 245*.

The GPRMC log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.

Message ID: **225**

Log Type: **Synch**

Recommended Input:

log gprmc ontime 1

Example 1 (GPS):

```
$GPRMC,144326.00,A,5107.0017737,N,11402.3291611,W,0.080,323.3,210307,0.0,E,A*
20
```

Example 2 (Combined GPS and GLONASS):

```
$GNRMC,143909.00,A,5107.0020216,N,11402.3294835,W,0.036,348.3,210307,0.0,E,A*
31
```

Please see the GPGGA note applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPRMC	Log header		$GPRMC
2	utc	UTC of position	hhmmss.ss	144326.00
3	pos status	Position status: A = data valid, V = data invalid	A	A
4	lat	Latitude (DDmm.mm)	llll.ll	5107.0017737
5	lat dir	Latitude direction N = North, S = South	a	N
6	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.3291611
7	lon dir	Longitude direction E = East, W = West	a	W
8	speed Kn	Speed over ground, knots	x.x	0.080
9	track true	Track made good, degrees True	x.x	323.3
10	date	Date: dd/mm/yy	xxxxxx	210307
11	mag var	Magnetic variation, degrees [a]	x.x	0.0
12	var dir	Magnetic variation direction E/W [b]	a	E
13	mode ind	Positioning system mode indicator, see *Table 55* on *page 255*	a	A
14	*xx	Checksum	*hh	*20
15	[CR][LF]	Sentence terminator		[CR][LF]

a. Note that this field is the actual magnetic variation and will always be positive. The direction of the magnetic variation is always positive. The direction of the magnetic variation will be opposite to the magnetic variation correction value entered in the MAGVAR command, see *page 110* for more information.

b. Easterly variation (E) subtracts from True course and Westerly variation (W) adds to True course.

3.3.31 GPSEPHEM Decoded GPS Ephemerides

A single set of GPS ephemeris parameters.

Message ID: **7**
Log Type: **Asynch**

Recommended Input:

log gpsephema onchanged

ASCII Example:

```
#GPSEPHEMA,COM1,12,59.0,SATTIME,1337,397560.000,00000000,9145,1984;
3,397560.0,0,99,99,1337,1337,403184.0,2.656004220e+07,4.971635660e-09,
-2.752651501e+00,7.1111434372e-03,6.0071892571e-01,2.428889275e-06,
1.024827361e-05,1.64250000e+02,4.81562500e+01,1.117587090e-08,
-7.078051567e-08,9.2668266314e-01,-1.385772009e-10,-2.098534041e+00,
-8.08319384e-09,99,403184.0,-4.190951586e-09,2.88095e-05,3.06954e-12,
0.00000,TRUE,1.458614684e-04,4.00000000e+00*0f875b12
#GPSEPHEMA,COM1,11,59.0,SATTIME,1337,397560.000,00000000,9145,1984;
25,397560.0,0,184,184,1337,1337,403200.0,2.656128681e+07,4.897346851e-09,
1.905797220e+00,1.1981436634e-02,-1.440195331e+00,-1.084059477e-06,
6.748363376e-06,2.37812500e+02,-1.74687500e+01,1.825392246e-07,
-1.210719347e-07,9.5008501632e-01,2.171519024e-10,2.086083072e+00,
-8.06140722e-09,184,403200.0,-7.450580597e-09,1.01652e-04,9.09495e-13,
0.00000,TRUE,1.458511425e-04,4.00000000e+00*18080b24
.
.
.
#GPSEPHEMA,COM1,0,59.0,SATTIME,1337,397560.000,00000000,9145,1984;
1,397560.0,0,224,224,1337,1337,403200.0,2.656022490e+07,3.881233098e-09,
2.938005195e+00,5.8911956148e-03,-1.716723741e+00,-2.723187208e-06,
9.417533875e-06,2.08687500e+02,-5.25625000e+01,9.126961231e-08,
-7.636845112e-08,9.8482911735e-01,1.325055194e-10,1.162012787e+00,
-7.64138972e-09,480,403200.0,-3.259629011e-09,5.06872e-06,2.04636e-12,
0.00000,TRUE,1.458588731e-04,4.00000000e+00*97058299
```

The GPSEPHEM log can be used to monitor changes in the orbits of GPS satellites.

Table 56: URA Variance

Index Value	A: Standard Deviations	Variance: A^2 (m^2)
0	2.0	4
1	2.8	7.84
2	4.0	16
3	5.7	32.49
4	8	64
5	11.3	127.69
6	16.0	256
7	32.0	1024
8	64.0	4096
9	128.0	16384
10	256.0	65536
11	512.0	262144
12	1024.0	1048576
13	2048.0	4194304
14	4096.0	16777216
15	8192.0	67108864

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GPSEPHEM header	Log header		H	0
2	PRN	Satellite PRN number	Ulong	4	H
3	tow	Time stamp of subframe 0 (seconds)	Double	8	H+4
4	health	Health status - a 6-bit health code as defined in ICD-GPS-200 [a]	Ulong	4	H+12
5	IODE1	Issue of ephemeris data 1	Ulong	4	H+16
6	IODE2	Issue of ephemeris data 2	Ulong	4	H+20
7	week	GPS reference week number	Ulong	4	H+24
8	z week	Z count week number. This is the week number from subframe 1 of the ephemeris. The 'toe week' (field #7) is derived from this to account for rollover.	Ulong	4	H+28
9	toe	Reference time for ephemeris, seconds	Double	8	H+32
10	A	Semi-major axis, metres	Double	8	H+40
11	ΔN	Mean motion difference, radians/second	Double	8	H+48
12	M_0	Mean anomaly of reference time, radians	Double	8	H+56
13	ecc	Eccentricity, dimensionless - quantity defined for a conic section where e= 0 is a circle, e = 1 is a parabola, 0<e<1 is an ellipse and e>1 is a hyperbola.	Double	8	H+64
14	ω	Argument of perigee, radians - measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion.	Double	8	H+72
15	cuc	Argument of latitude (amplitude of cosine, radians)	Double	8	H+80
16	cus	Argument of latitude (amplitude of sine, radians)	Double	8	H+88
17	crc	Orbit radius (amplitude of cosine, metres)	Double	8	H+96
18	crs	Orbit radius (amplitude of sine, metres)	Double	8	H+104
19	cic	Inclination (amplitude of cosine, radians)	Double	8	H+112
20	cis	Inclination (amplitude of sine, radians)	Double	8	H+120
21	I_0	Inclination angle at reference time, radians	Double	8	H+128

Continued on the following page

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
22	$\overset{\circ}{I}$	Rate of inclination angle, radians/second	Double	8	H+136
23	ω_0	Right ascension, radians	Double	8	H+144
24	$\overset{\circ}{\omega}$	Rate of right ascension, radians/second	Double	8	H+152
25	iodc	Issue of data clock	Ulong	4	H+160
26	toc	SV clock correction term, seconds	Double	8	H+164
27	tgd	Estimated group delay difference, seconds	Double	8	H+172
28	a_{f0}	Clock aging parameter, seconds (s)	Double	8	H+180
29	a_{f1}	Clock aging parameter, (s/s)	Double	8	H+188
30	a_{f2}	Clock aging parameter, (s/s/s)	Double	8	H+196
31	AS	Anti-spoofing on:0 = FALSE 1 = TRUE	Enum	4	H+204
32	N	Corrected mean motion, radians/second	Double	8	H+208
33	URA	User Range Accuracy variance, m^2. The ICD [a] specifies that the URA index transmitted in the ephemerides can be converted to a nominal standard deviation value using an algorithm listed there. We publish the square of the nominal value (variance). The correspondence between the original URA index and the value output is shown in *Table 56*.	Double	8	H+216
34	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+224
35	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. To obtain copies of ICD-GPS-200, refer to www.arinc.com.

3.3.32 GPVTG Track Made Good And Ground Speed

The track made good and speed relative to the ground.

The GPVTG log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

Message ID: **226**
Log Type: **Synch**

Recommended Input:

log gpvtg ontime 1

Example 1 (GPS only):

```
$GPVTG,172.516,T,155.295,M,0.049,N,0.090,K,D*2B
```

Example 2 (Combined GPS and GLONASS):

```
$GNVTG,134.395,T,134.395,M,0.019,N,0.035,K,A*33
```

If the NMEATALKER command, see *page 116*, is set to AUTO, the talker (the first 2 characters after the $ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.

Please see the GPGGA note that applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPVTG	Log header		$GPVTG
2	track true	Track made good, degrees True	x.x	24.168
3	T	True track indicator	T	T
4	track mag	Track made good, degrees Magnetic; Track mag = Track true + (MAGVAR correction) See the *MAGVAR* command, *page 110*.	x.x	24.168
5	M	Magnetic track indicator	M	M
6	speed Kn	Speed over ground, knots	x.x	0.4220347
7	N	Nautical speed indicator (N = Knots)	N	N
8	speed Km	Speed, kilometres/hour	x.x	0.781608
9	K	Speed indicator (K = km/hr)	K	K
10	mode ind	Positioning system mode indicator, see *Table 55* on *page 255*	a	A
11	*xx	Checksum	*hh	*7A
12	[CR][LF]	Sentence terminator		[CR][LF]

3.3.33 GPZDA UTC Time and Date

The GPZDA log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

Message ID: **227**

Log Type: **Synch**

Recommended Input:

log gpzda ontime 1

Example:

```
$GPZDA,143042.00,25,08,2005,,*6E
```

Please see the GPGGA usage note applies to all NMEA logs on *page 241*.

Field	Structure	Field Description	Symbol	Example
1	$GPZDA	Log header		$GPZDA
2	utc	UTC time	hhmmss.ss	220238.00
3	day	Day, 01 to 31	xx	15
4	month	Month, 01 to 12	xx	07
5	year	Year	xxxx	1992
6	null	Local zone description - not available	xx	*(empty when no data is present)*
7	null	Local zone minutes description - not available [a]	xx	*(empty when no data is present)*
8	*xx	Checksum	*hh	*6F
9	[CR][LF]	Sentence terminator		[CR][LF]

a. Local time zones are not supported by OEMStar receivers. Fields 6 and 7 are always null.

3.3.34 IONUTC Ionospheric and UTC Data

The Ionospheric Model parameters (ION) and the Universal Time Coordinated parameters (UTC) are provided.

Message ID: 8

Log Type: Asynch

Recommended Input:

log ionutca onchanged

ASCII Example:

```
#IONUTCA,COM1,0,58.5,FINESTEERING,1337,397740.107,00000000,ec21,1984;
1.210719347000122e-08,2.235174179077148e-08,-5.960464477539062e-08,
-1.192092895507812e-07,1.003520000000000e+05,1.146880000000000e+05,
-6.553600000000000e+04,-3.276800000000000e+05,1337,589824,
-1.2107193470001221e-08,-3.907985047e-14,1355,7,13,14,0*c1dfd456
```

The Receiver-Independent Exchange (RINEX1[1]) format is a broadly-accepted, receiver-independent format for storing GPS data. It features a non-proprietary ASCII file format that can be used to combine or process data generated by receivers made by different manufacturers.

The Convert4 utility can be used to produce RINEX files from NovAtel receiver data files. For best results, the NovAtel receiver input data file should contain the logs as specified in the *PC Software and Firmware* chapter of the *OEMStar Installation and Operation User Manual* including IONUTC.

---

1. Refer to the U.S. National Geodetic Survey Web site at

   http://www.ngs.noaa.gov/CORS/Rinex2.html

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	IONUTC header	Log header		H	0
2	a0	Alpha parameter constant term	Double	8	H
3	a1	Alpha parameter 1st order term	Double	8	H+8
4	a2	Alpha parameter 2nd order term	Double	8	H+16
5	a3	Alpha parameter 3rd order term	Double	8	H+24
6	b0	Beta parameter constant term	Double	8	H+32
7	b1	Beta parameter 1st order term	Double	8	H+40
8	b2	Beta parameter 2nd order term	Double	8	H+48
9	b3	Beta parameter 3rd order term	Double	8	H+56
10	utc wn	UTC reference week number	Ulong	4	H+64
11	tot	Reference time of UTC parameters	Ulong	4	H+68
12	A0	UTC constant term of polynomial	Double	8	H+72
13	A1	UTC 1st order term of polynomial	Double	8	H+80
14	wn lsf	Future week number	Ulong	4	H+88
15	dn	Day number (the range is 1 to 7 where Sunday = 1 and Saturday = 7)	Ulong	4	H+92
16	deltat ls	Delta time due to leap seconds	Long	4	H+96
17	deltat lsf	Future delta time due to leap seconds	Long	4	H+100
18	deltat utc	Time difference	Ulong	4	H+104
19	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+108
20	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.35 LOGLIST List of System Logs

Outputs a list of log entries in the system. The following tables show the binary ASCII output. See also the RXCONFIG log on *page 345* for a list of current command settings.

Message ID: 5

Log Type: Polled

Recommended Input:

log loglista once

ASCII Example:

```
#LOGLISTA,COM1,0,60.5,FINESTEERING,1337,398279.996,00000000,c00c,1984; 8,
COM1,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
COM2,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
USB1,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
USB2,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
USB3,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
COM1,BESTPOSA,ONTIME,10.000000,0.000000,NOHOLD,
COM1,LOGLISTA,ONCE,0.000000,0.000000,NOHOLD*5b29eed3
```

WARNING!:**Do not use undocumented logs or commands! Doing so may produce errors and void your warranty.**

Before contacting NovAtel Customer Support regarding software concerns, please do the following:

1. Issue a FRESET command
2. Log the following data to a file on your PC/laptop for 30 minutes:

   RXSTATUSB once

   RAWEPHEMB onchanged

   RANGEB ontime 1

   BESTPOSB ontime 1

   RXCONFIGA once

   VERSIONA once
3. Send the file containing the logs to NovAtel Customer Support, using the support@novatel.com e-mail address.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	LOGLIST (binary) header	Log header		H	0
2	#logs	Number of messages to follow, maximum = 30	Long	4	H
3	port	Output port, see *Table 4, The header is in the format shown in Table 4, Binary Message Header Structure on page 20.* on *page 19*	Enum	4	H+4
4	message	Message ID of log	Ushort	2	H+8
5	message type	Bits 0-4 = Reserved Bits 5-6 = Format 00 = Binary 01 = ASCII 10 = Abbreviated ASCII, NMEA 11 = Reserved Bit 7 = Response Bit (see *Section 1.2, Responses on page 24*) 0 = Original Message 1 = Response Message	Char	1	H+10
6	reserved		Char	3[a]	H+11
7	trigger	0 = ONNEW 1 = ONCHANGED 2 = ONTIME 3 = ONNEXT 4 = ONCE 5 = ONMARK	Enum	4	H+14
8	period	Log period for ONTIME	Double	8	H+18
9	offset	Offset for period (ONTIME trigger)	Double	8	H+26
10	hold	0 = NOHOLD 1 = HOLD	Enum	4	H+32
11...	Next log offset = H + 4 + (#logs x 32)				
variable	xxxx	32-bit CRC	Hex	4	H+4+(#logs x 32)

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

Field #	Field type	Data Description	Format
1	LOGLIST (ASCII) header	Log header	
2	#port	Number of messages to follow, maximum = 30	Long
3	port	Output port, see *Table 4, The header is in the format shown in Table 4, Binary Message Header Structure on page 20.* on *page 19*	Enum
4	message	Message name of log with no suffix for abbreviated ascii, an A suffix for ascii and a B suffix for binary.	Char [ ]
5	trigger	ONNEW ONCHANGED ONTIME ONNEXT ONCE ONMARK	Enum
6	period	Log period for ONTIME	Double
7	offset	Offset for period (ONTIME trigger)	Double
8	hold	NOHOLD HOLD	Enum
9...	Next port		
variable	xxxx	32-bit CRC	Hex
variable	[CR][LF]	Sentence terminator	-

3.3.36 MARKPOS Position at Time of Mark Input Event

This log contains the estimated position of the antenna when a pulse is detected at a mark input. MARKPOS is a result of a pulse on the MK1I input. Refer to the *Technical Specifications* appendix in the *OEMStar Installation and Operation User Manual* for mark input pulse specifications and the location of the mark input pins.

The position at the mark input pulse is extrapolated using the last valid position and velocities. The latched time of mark impulse is in GPS reference weeks and seconds into the week. The resolution of the latched time is 49 ns. See also the notes on MARKPOS in the MARKTIME log on *page 272*.

Message ID: **181 (MARKPOS)**

Log Type: **Asynch**

Recommended Input:

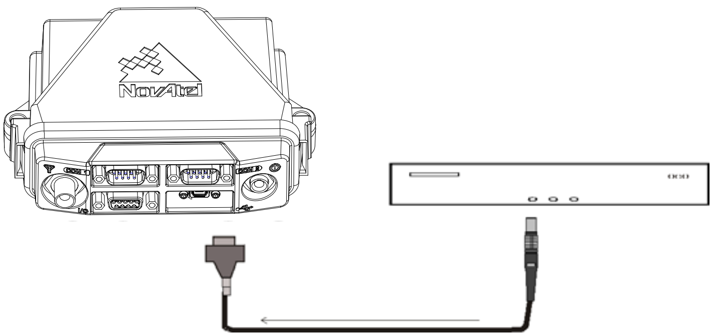
log markposa onnew

Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

Abbreviated ASCII Example:

```
SOL_COMPUTED,PSRDIFF,51.11637234389,-114.03824932277,1063.8475,-16.2713,
WGS84,0.0095,0.0078,0.0257,"AAAA",1.000,0.000,17,10,10,9,0,1,0,03
```

Consider the case where you have a user point device such as video equipment. Connect the device to the receiver's I/O port using a cable that is compatible to both the receiver and the device. Refer to your device's documentation for information about its connectors and cables. The arrow along the cable in the figure below indicates a MARKIN pulse, from the user device on the right to the receiver I/O port:



Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	MARKPOS header	Log header		H	0
2	sol status	Solution status (see *Table 44* on *page 197*)	Enum	4	H
3	pos type	Position type (see *Table 43* on *page 196*)	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) [a]	Float	4	H+32
8	datum id#	Datum ID number (see *Chapter 2, Table 18, Reference Ellipsoid Constants* on *page 73*)	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#SVs	Number of satellite vehicles tracked	Uchar	1	H+64
16	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+65
17	#ggL1	Number of GPS plus GLONASS L1 used in solution	Uchar	1	H+66
18	Reserved		Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status (see *Table 46, Extended Solution Status* on *page 198*)	Hex	1	H+69
21	Reserved		Hex	1	H+70
22	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 45* on *page 198*)	Hex	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

3.3.37 MARKTIME Time of Mark Input Event

This log contains the time of the leading edge of the detected mark input pulse. MARKTIME gives the time when a pulse occurs on the MK1I input. Refer to the *Technical Specifications* appendix in the *OEMStar Installation and Operation User Manual* for mark input pulse specifications and the location of the mark input pins. The resolution of this measurement is 49 ns.

Use the ONNEW trigger with this or the MARKPOS logs.

Only the MARKPOS logs, the MARKTIME logs, and ‘polled’ log types are generated ‘on the fly’ at the exact time of the mark. Synchronous and asynchronous logs output the most recently available data.

Message ID: 231 (MARKTIME)
Log Type: Asynch

Recommended Input:

log marktimea onnew

Example:

```
#MARKTIMEA,COM1,0,77.5,FINESTEERING,1358,422621.000,00000000,292e,2214;
1358,422621.000000500,-1.398163614e-08,7.812745577e-08,-14.000000002,
VALID*d8502226
```

These logs allow you to measure the time when events are occurring in other devices (such as a video recorder). See also the MARKCONTROL command on *page 113*.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	MARKTIME header	Log header		H	0
2	week	GPS reference week number	Long	4	H
3	seconds	Seconds into the week as measured from the receiver clock, coincident with the time of electrical closure on the Mark Input port.	Double	8	H+4
4	offset	Receiver clock offset, in seconds. A positive offset implies that the receiver clock is ahead of GPS reference time. To derive GPS reference time, use the following formula: GPS reference time = receiver time - (offset)	Double	8	H+12
5	offset std	Standard deviation of receiver clock offset (s)	Double	8	H+20
6	utc offset	This field represents the offset of GPS reference time from UTC time, computed using almanac parameters. UTC time is GPS reference time plus the current UTC offset plus the receiver clock offset. UTC time = GPS reference time + offset + UTC offset[a]	Double	8	H+28
7	status	Clock model status, see *Table 47, Clock Model Status* on *page 211*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. 0 indicates that UTC time is unknown because there is no almanac available in order to acquire the UTC offset.

3.3.38 NAVIGATE User Navigation Data

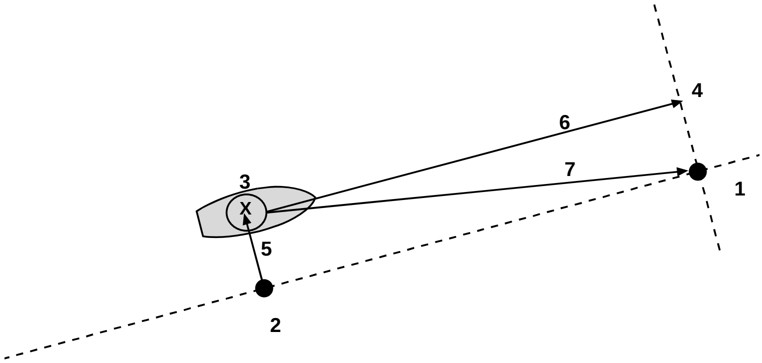
This log reports the status of the waypoint navigation progress. It is used in conjunction with the SETNAV command, see *page 143*.

See *Figure 8, below*, for an illustration of navigation parameters.

✉ The SETNAV command must be enabled before valid data will be reported from this log.

Message ID: 161

Log Type: Synch



Reference	Description
1	TO lat-lon
2	X-Track perpendicular reference point
3	Current GPS position
4	A-Track perpendicular reference point
5	X-Track (cross track)
6	A-Track (along track)
7	Distance and bearing from 3 to 1

Figure 8: Navigation Parameters

Table 57: Navigation Data Type

Navigation Data Type Binary	Navigation Data Type ASCII	Description
0	GOOD	Navigation is good
1	NOVELOCITY	Navigation has no velocity
2	BADNAV	Navigation calculation failed for an unknown reason
3	FROM_TO_SAME	“From” is too close to “To” for computation
4	TOO_CLOSE_TO_TO	Position is too close to “To” for computation
5	ANTIPODAL_WAYPTS	Waypoints are antipodal on surface

Recommended Input:

log navigatea ontime 1

ASCII Example:

```
#NAVIGATEA,COM1,0,56.0,FINESTEERING,1337,399190.000,00000000,aece,1984;
SOL_COMPUTED,PSRDIFF,SOL_COMPUTED,GOOD,9453.6278,303.066741,133.7313,
9577.9118,1338,349427.562*643cd4e2
```

✉ Use the NAVIGATE log in conjunction with the SETNAV command to tell you where you currently are with relation to known To and From points. You can find a specific latitude, longitude or height knowing where you started from. A backpacker for example, could use these two commands to program a user-supplied graphical display on a digital GPS compass to show their progress as they follow a specific route.

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	NAVIGATE header	Log header		H	0
2	sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H
3	pos type	Position type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+4
4	vel type	Velocity type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+8
5	nav type	Navigation data type (see *Table 57, Navigation Data Type* on *page 274*).	Enum	4	H+12
6	distance	Straight line horizontal distance from current position to the destination waypoint, in metres (see *Figure 8, Navigation Parameters on page 274).* This value is positive when approaching the waypoint and becomes negative on passing the waypoint.	Double	8	H+16
7	bearing	Direction from the current position to the destination waypoint in degrees with respect to True North (or Magnetic if corrected for magnetic variation by MAGVAR command)	Double	8	H+24
8	along track	Horizontal track distance from the current position to the closest point on the waypoint arrival perpendicular; expressed in metres. This value is positive when approaching the waypoint and becomes negative on passing the waypoint.	Double	8	H+32
9	xtrack	The horizontal distance (perpendicular track-error) from the vessel's present position to the closest point on the great circle line that joins the FROM and TO waypoints. If a "track offset" has been entered in the SETNAV command, xtrack is the perpendicular error from the "offset track". Xtrack is expressed in metres. Positive values indicate the current position is right of the Track, while negative offset values indicate left.	Double	8	H+40
10	eta week	Estimated GPS reference week number at time of arrival at the "TO" waypoint along track arrival perpendicular based on current position and speed, in units of GPS reference weeks. If the receiving antenna is moving at a speed of less than 0.1 m/s in the direction of the destination, the value in this field is "9999".	Ulong	4	H+48

Continued on the following page

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
11	eta secs	Estimated GPS seconds into week at time of arrival at destination waypoint along track arrival perpendicular, based on current position and speed, in units of GPS seconds into the week. If the receiving antenna is moving at a speed of less than 0.1 m/s in the direction of the destination, the value in this field is "0.000".	Double	8	H+52
12	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+60
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.39 NMEA Standard Logs

GLMLA	**GLONASS ALMANAC DATA**
GPALM	**ALMANAC DATA**
GPGGA	**GLOBAL POSITION SYSTEM FIX DATA AND UNDULATION**
GPGGALONG	**GPS FIX DATA, EXTRA PRECISION AND UNDULATION**
GPGLL	**GEOGRAPHIC POSITION**
GPGRS	**GPS RANGE RESIDUALS FOR EACH SATELLITE**
GPGSA	**GPS DOP AN ACTIVE SATELLITES**
GPGST	**PSEUDORANGE MEASUREMENT NOISE STATISTICS**
GPGSV	**GPS SATELLITES IN VIEW**
GPRMB	**NAVIGATION INFORMATION**
GPRMC	**GPS SPECIFIC INFORMATION**
GPVTG	**TRACK MADE GOOD AND GROUND SPEED**
GPZDA	**UTC TIME AND DATE**

The NMEA log structures follow format standards as adopted by the National Marine Electronics Association. The reference document used is "Standard For Interfacing Marine Electronic Devices NMEA 0183 Version 3.01". For further information, refer to the NMEA Web site at www.nmea.org. The following table contains excerpts from Table 6 of the NMEA Standard which defines the variables for the NMEA logs. The actual format for each parameter is indicated after its description.

✉ Please see the GPGGA note box that applies to all NMEA logs on *page 241*.

Field Type	Symbol	Definition
Special Format Fields		
Status	A	Single character field: A = Yes, Data Valid, Warning Flag Clear V = No, Data Invalid, Warning Flag Set
Latitude	llll.ll	Fixed/Variable length field: degrees|minutes.decimal - 2 fixed digits of degrees, 2 fixed digits of mins and a variable number of digits for decimal-fraction of mins. Leading zeros always included for degrees and mins to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Longitude	yyyyy.yy	Fixed/Variable length field: degrees|minutes.decimal - 3 fixed digits of degrees, 2 fixed digits of mins and a variable number of digits for decimal-fraction of mins. Leading zeros always included for degrees and mins to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required
Time	hhmmss.ss	Fixed/Variable length field: hours|minutes|seconds.decimal - 2 fixed digits of hours, 2 fixed digits of mins, 2 fixed digits of seconds and variable number of digits for decimal-fraction of seconds. Leading zeros always included for hours, mins and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Defined field		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following which are used to indicate field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy"
Numeric Value Fields		
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required (example: 73.10 = 73.1 = 073.1 = 73)
Fixed HEX	hh___	Fixed length HEX numbers only, MSB on the left
Information Fields		
Variable text	c--c	Variable length valid character field.
Fixed alpha	aa___	Fixed length field of uppercase or lowercase alpha characters
Fixed	xx___	Fixed length field of numeric characters
Fixed text	cc___	Fixed length field of valid characters

NOTES:

1. Spaces may only be used in variable text fields.
2. A negative sign "-" (HEX 2D) is the first character in a Field if the value is negative. The sign is omitted if the value is positive.
3. All data fields are delimited by a comma (,).
4. Null fields are indicated by no data between two commas (,,). Null fields indicate invalid data or no data available.
5. The NMEA Standard requires that message lengths be limited to 82 characters.

3.3.40 PASSCOM, PASSXCOM, PASSUSB Redirect Data

The pass-through logging feature enables the receiver to redirect any ASCII or binary data that is input at a specified port to any specified receiver port. It allows the receiver to perform bidirectional communications with other devices such as a modem, terminal or another receiver. See also the *INTERFACEMODE* command on *page 100*.

There are several pass-through logs. PASSCOM1, PASSCOM2, PASSXCOM1, PASSXCOM2 and PASSXCOM3 allow for redirection of data that is arriving at COM1, COM2, virtual COM1, virtual COM2, or virtual COM3 respectively. PASSUSB1, PASSUSB2, PASSUSB3 are only available on receivers that support USB and can be used to redirect data from USB1, USB2, or USB3.

A pass-through log is initiated the same as any other log, that is, LOG [to-port] [data-type] [trigger]. However, pass-through can be more clearly specified as: LOG [to-port] [from-port-AB] [onchanged]. Now, the [from-port-AB] field designates the port which accepts data (that is, COM1, COM2, USB1, USB2, or USB3) as well as the format in which the data is logged by the [to-port] (A for ASCII or B for Binary).

When the [from-port-AB] field is suffixed with an [A], all data received by that port is redirected to the [to-port] in ASCII format and logs according to standard NovAtel ASCII format. Therefore, all incoming ASCII data is redirected and output as ASCII data. However, any binary data received is converted to a form of ASCII hexadecimal before it is logged.

When the [from-port-AB] field is suffixed with a [B], all data received by that port is redirected to the [to-port] exactly as it is received. The log header and time-tag adhere to standard NovAtel Binary format followed by the pass-through data as it was received (ASCII or binary).

Pass-through logs are best utilized by setting the [trigger] field as onchanged or onnew.

If the data being injected is ASCII, then the data is grouped together with the following rules:

- blocks of 80 characters
- any block of characters ending in a <CR>
- any block of characters ending in a <LF>
- any block remaining in the receiver code when a time-out occurs (100 ms)

If the data being injected is binary, or the port INTERFACEMODE mode is set to GENERIC, then the data is grouped as follows:

- blocks of 80 bytes
- any block remaining in the receiver code when a time-out occurs (100 ms)

If a binary value is encountered in an ASCII output, then the byte is output as a hexadecimal byte preceded by a backslash and an x. For example 0A is output as \x0A. An actual ‘\’ in the data is output as \\. The output counts as one pass-through byte although it is four characters.

The first character of each pass-through record is time tagged in GPS reference weeks and seconds.

PASSCOM1 Message ID:233

PASSCOM2 Message ID:234

PASSXCOM1 Message ID: 405

PASSXCOM2 Message ID: 406

PASSXCOM3 Message ID: 795

PASSUSB1 Message ID: 607

PASSUSB2 Message ID: 608

PASSUSB3 Message ID: 609

Log Type: Asynch

Recommended Input:

log passcom1a onchanged

✉ Asynchronous logs should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.

ASCII Example 1:

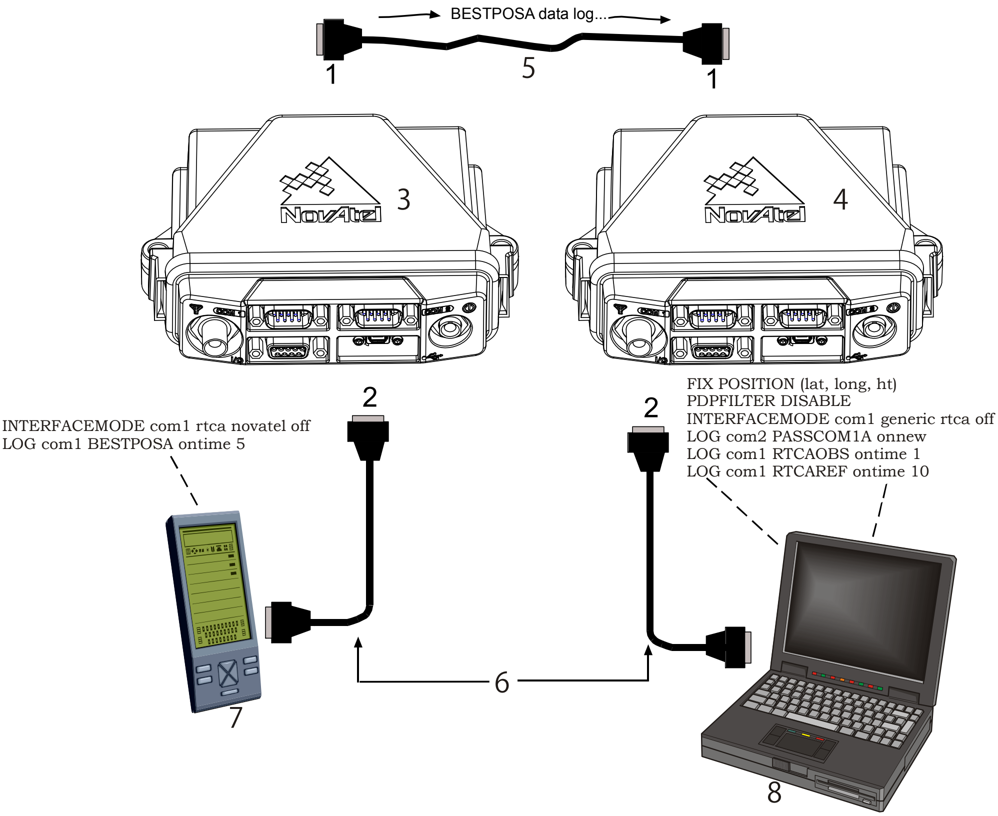
```
#PASSCOM2A,COM1,0,59.5,FINESTEERING,1337,400920.135,00000000,2b46,1984;
80,#BESTPOSA,COM1,0,80.0,FINESTEERING,1337,400920.000,00000000,4ca6,1899;
SOL_COMPUT*f9dfab46
#PASSCOM2A,COM1,0,64.0,FINESTEERING,1337,400920.201,00000000,2b46,1984;
80,ED,SINGLE,51.11636326036,-114.03824210485,1062.6015,-16.2713,WGS84,
1.8963,1.0674*807fd3ca
#PASSCOM2A,COM1,0,53.5,FINESTEERING,1337,400920.856,00000000,2b46,1984;
49,,2.2862,"",0.000,0.000,9,9,0,0,0,0,0,0*20b24878\x0d\x0a*3eef4220
#PASSCOM1A,COM1,0,53.5,FINESTEERING,1337,400922.463,00000000,13ff,1984;
17,unlog passcom2a\x0d\x0a*ef8d2508
```

ASCII Example 2:

```
#PASSCOM2A,COM1,0,53.0,FINESTEERING,1337,400040.151,00000000,2b46,1984;
80,\x99A\x10\x04\x07yN &\xc6\xea\xf10\x00\x01\xde\x00\x00\x10\xfe\xbf\xfe1\
xfe\x9c\xf4\x03\xe2\xef\x9f\x1f\xf3\xff\xd6\xff\xc3_A~z \xaa\xfe\xbf\xf9\
xd3\xf8\xd4\xf4-\xe8kHo\xe2\x00>\xe0QOC>\xc3\x9c\x11\xff\x7f\xf4\xa1\xf3t\
xf4'\xf4xvo\xe6\x00\x9d*dcd2e989
```

In the example, note that '~' is a printable character.

✉ For example, you could connect two OEMStar receivers together via their COM1 ports such as in the figure below (a rover station to base station scenario). If the rover station is logging BESTPOSA data to the base station, it is possible to use the pass-through logs to pass through the received BESTPOSA data to a disk file (let's call it diskfile.log) at the base station host PC hard disk.



Reference	Description	Reference	Description
1	To COM1	5	Data link
2	To COM2	6	Serial cables
3	Rover receiver	7	Pocket PC - rover
4	Base receiver	8	Laptop PC - base

Figure 9: Pass-Through Log Data

Under default conditions the two receivers "*chatter"* back and forth with the *Invalid Command Option* message (due to the command interpreter in each receiver not recognizing the command prompts of the other receiver). This *chattering* in turn causes the accepting receiver to transmit new pass-through logs with the response data from the other receiver. To avoid this chattering problem, use the INTERFACEMODE command on the accepting port to disable error reporting from the receiving port command interpreter.

If the accepting port's error reporting is disabled by INTERFACEMODE, the BESTPOSA data record passes through and creates two records.

The reason that two records are logged from the accepting receiver is because the first record was initiated by receipt of the BESTPOSA first terminator <CR>. Then the second record followed in response to the BESTPOSA second terminator <LF>.

The time interval between the first character received and the terminating <LF> can be calculated by differencing the two GPS reference time tags. This pass-through feature is useful for time tagging the arrival of external messages. These messages can be any user-related data. If you are using this feature for tagging external events, it is recommended that the rover receiver be disabled from interpreting commands, so that the receiver does not respond to the messages, using the INTERFACEMODE command, see *page 100*.

If the BESTPOSB binary log data is input to the accepting port (log com2 passcom1a onchanged), the BESTPOSB binary data at the accepting port is converted to a variation of ASCII hexadecimal before it is passed through to COM2 port for logging.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PASSCOM header	Log header		H	0
2	#bytes	Number of bytes to follow	Ulong	4	H
3	data	Message data	Char [80]	80	H+4
4	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+8+(#bytes)
5	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.41 PDPPOS PDP filter position

The PDPPOS log contains the pseudorange position computed by the receiver with the PDP filter enabled. See also the PDPFILTER command on *page 119*.

Message ID: 469

Log Type: Synch

Recommended Input:

```
log pdpposa ontime 1
```

ASCII Example:

```
#PDPPOSA,COM1,0,75.5,FINESTEERING,1431,494991.000,00040000,a210,35548;
SOL_COMPUTED,SINGLE,51.11635010310,-114.03832575772,1065.5019,-16.9000,
WGS84,4.7976,2.0897,5.3062,"",0.000,0.000,8,8,0,0,0,0,0,0*3cbfa646
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PDPPOS header	Log header		H	0
2	sol status	Solution status	Enum	4	H
3	pos type	Position type	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) [a]	Float	4	H+32
8	datum id#	Datum ID number	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#sats	Number of satellite vehicles tracked	Uchar	1	H+64
16	#sats soln	Number of satellites in the solution	Uchar	1	H+65
17	Reserved		Uchar	1	H+66
18			Uchar	1	H+67
19			Uchar	1	H+68
20			Uchar	1	H+69
21			Uchar	1	H+70
22			Uchar	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

3.3.42 PDPVEL PDP filter velocity

The PDPVEL log contains the pseudorange velocity computed by the receiver with the PDP filter enabled. See also the PDPFILTER command on *page 119*.

Message ID: **470**

Log Type: **Synch**

Recommended Input:

log pdpvela ontime 1

ASCII Example:

```
#PDPVELA,COM1,0,75.0,FINESTEERING,1430,505990.000,00000000,b886,2859;
SOL_COMPUTED,SINGLE,0.150,0.000,27.4126,179.424617,-0.5521,0.0*7746b0fe
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PDPVEL header	Log header		H	0
2	sol status	Solution status	Enum	4	H
3	vel type	Velocity type	Enum	4	H+4
4	latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8
5	age	Differential age in seconds	Float	4	H+12
6	hor spd	Horizontal speed over ground, in metres per second	Double	8	H+16
7	trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	height	Height in metres where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.43 PDPXYZ PDP filter Cartesian position and velocity

The PDPXYZ log contains the Cartesian position in X, Y and Z coordinates as computed by the receiver with the PDP filter enabled. See also the PDPFILTER command on *page 119*.

Message ID: **471**

Log Type: **Synch**

Recommended Input:

```
log pdpxyza ontime 1
```

ASCII Example:

```
#PDPXYZA,COM1,0,75.5,FINESTEERING,1431,494991.000,00040000,33ce,35548;
SOL_COMPUTED,SINGLE,-1634531.8128,-3664619.4862,4942496.5025,2.9036,
6.1657,3.0153,SOL_COMPUTED,SINGLE,-2.5588e-308,-3.1719e-308,3.9151e-308,
0.0100,0.0100,0.0100,"",0.150,0.000,0.000,8,8,0,0,0,0,0,0*a20dbd4f
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PDPXYZ header	Log header		H	0
2	P-sol status	Solution status	Enum	4	H
3	pos type	Position type	Enum	4	H+4
4	P-X	Position X-coordinate (m)	Double	8	H+8
5	P-Y	Position Y-coordinate (m)	Double	8	H+16
6	P-Z	Position Z-coordinate (m)	Double	8	H+24
7	P-X σ	Standard deviation of P-X (m)	Float	4	H+32
8	P- Y σ	Standard deviation of P-Y (m)	Float	4	H+36
9	P-Z σ	Standard deviation of P-Z (m)	Float	4	H+40
10	V-sol status	Solution status	Enum	4	H+44
11	vel type	Velocity type	Enum	4	H+48
12	V-X	Velocity vector along X-axis (m)	Double	8	H+52
13	V-Y	Velocity vector along Y-axis (m)	Double	8	H+60
14	V-Z	Velocity vector along Z-axis (m)	Double	8	H+68
15	V-X σ	Standard deviation of V-X (m)	Float	4	H+76
16	V-Y σ	Standard deviation of V-Y (m)	Float	4	H+80
17	V-Z σ	Standard deviation of V-Z (m)	Float	4	H+84
18	stn ID	Base station ID	Char[4]	4	H+88
19	V-latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+92
20	diff_age	Differential age in seconds	Float	4	H+96
21	sol_age	Solution age in seconds	Float	4	H+100
22	#sats	Number of satellite vehicles tracked	Uchar	1	H+104
23	#sats soln	Number of satellite vehicles used in solution	Uchar	1	H+105
24	Reserved		Uchar	1	H+106
25			Uchar	1	H+107
26			Uchar	1	H+108
27			Uchar	1	H+109
28			Uchar	1	H+110
29			Uchar	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.44 PORTSTATS Port Statistics

This log conveys various status parameters of the receiver's COM ports and, if supported, USB ports. The receiver maintains a running count of a variety of status indicators of the data link. This log outputs a report of those indicators.

Message ID: **72**

Log Type: **Polled**

Recommended Input:

log portstatsa once

ASCII example:

```
#PORTSTATSA,COM1,0,59.0,FINESTEERING,1337,403086.241,00000000,a872,1984;
6,COM1,4450,58494,4450,0,1869,0,0,0,0,
COM2,5385946,0,5385941,0,192414,0,0,5,0,
USB1,0,0,0,0,0,0,0,0,0,
USB2,0,0,0,0,0,0,0,0,0,
USB3,0,0,0,0,0,0,0,0,0*f7f6ea50
```

Parity and framing errors occur for COM ports 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. Characters may be dropped when the CPU is overloaded.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PORTSTATS header	Log header		H	0
2	#port	Number of ports with information to follow	Long	4	H
3	port	Serial port identifier, see *Table 15, COM Serial Port Identifiers* on *page 68*	Enum	4	H+4
4	rx chars	Total number of characters received through this port	Ulong	4	H+8
5	tx chars	Total number of characters transmitted through this port	Ulong	4	H+12
6	acc rx chars	Total number of accepted characters received through this port	Ulong	4	H+16
7	dropped chars	Number of software overruns	Ulong	4	H+20
8	interrupts	Number of interrupts on this port	Ulong	4	H+24
9	breaks	Number of breaks (This field does not apply for a USB port and is always set to 0 for USB.)	Ulong	4	H+28
10	par err	Number of parity errors (This field does not apply for a USB port and is always set to 0 for USB.)	Ulong	4	H+32
11	fram err	Number of framing errors (This field does not apply for a USB port and is always set to 0 for USB.)	Ulong	4	H+36
12	overruns	Number of hardware overruns	Ulong	4	H+40
13	Next port offset = H + 4 + (#port x 40)				
14	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#port x 40)
15	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.45 PSRDOP Pseudorange DOP

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 receiver. This log is updated once every 60 seconds or whenever a change in the satellite constellation occurs. Therefore, the total number of data fields output by the log is variable and depends on the number of SVs that are being tracked.

✉ If a satellite is locked out using the LOCKOUT command, it will still be shown in the PRN list, but it will be significantly de-weighted in the DOP calculation

The vertical dilution of precision can be calculated by: $vdop = \sqrt{pdop^2 - hdop^2}$

Message ID: **174**

Log Type: **Asynch**

Recommended Input:

log psrdopa onchanged

ASCII Example:

```
#PSRDOPA,COM1,0,56.5,FINESTEERING,1337,403100.000,00000000,768f,1984;
1.9695,1.7613,1.0630,1.3808,0.8812,5.0,10,14,22,25,1,24,11,5,20,30,7*106de10a
```

✉ When operating in differential mode, you require at least four common satellites at the base and rover. The number of common satellites being tracked at large distances is less than at short distances. This is important because the accuracy of GPS and DGPS positions depend a great deal on how many satellites are being used in the solution (redundancy) and the geometry of the satellites being used (DOP). DOP stands for dilution of precision and refers to the geometry of the satellites. A good DOP occurs when the satellites being tracked and used are evenly distributed throughout the sky. A bad DOP occurs when the satellites being tracked and used are not evenly distributed throughout the sky or grouped together in one part of the sky.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PSRDOP header	Log header		H	0
2	gdop	Geometric dilution of precision - assumes 3-D position and receiver clock offset (all 4 parameters) are unknown.	Float	4	H
3	pdop	Position dilution of precision - assumes 3-D position is unknown and receiver clock offset is known.	Float	4	H+4
4	hdop	Horizontal dilution of precision.	Float	4	H+8
5	htdop	Horizontal position and time dilution of precision.	Float	4	H+12
6	tdop	Time dilution of precision - assumes 3-D position is known and only the receiver clock offset is unknown.	Float	4	H+16
7	cutoff	Elevation cut-off angle.	Float	4	H+20
8	#PRN	Number of satellites PRNs to follow.	Long	4	H+24
9	PRN	PRN of SV PRN tracking, null field until position solution available.	Ulong	4	H+28
10...	Next PRN offset = H + 28 + (#prn x 4)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+28+ (#prn x 4)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.46 PSRDOP2 Pseudorange DOP

This log is similar to the PSRDOP log, but contains the per-system TDOPs.

Message ID: **1163**
Log Type: **Asynch**

Recommended Input:

log psrdop2a onchanged

ASCII Example:

```
#PSRDOP2A,COM1,0,89.5,FINESTEERING,1613,164820.000,00000008,0802,39031;1.6740
,1.3010,0.6900,1.1030,2,GPS,0.6890,GLONASS,0.7980*5dd123d0.
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PSRDOP2 header	Log header		H	0
2	GDOP	Geometric dilution of precision - assumes 3-D position and receiver clock offset (all 4 parameters) are unknown.	Float	4	H
3	PDOP	Position dilution of precision - assumes 3-D position is unknown and receiver clock offset is known.	Float	4	H+4
4	HDOP	Horizontal dilution of precision	Float	4	H+8
5	VDOP	Vertical dilution of precision	Float	4	H+12
6	#systems	Number of systems	ULong	4	H+16
6	system	See *Table 29* on *page 156*	Enum	4	H+20
8	TDOP	Time dilution of precision	Long	4	H+24
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+28+
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.47 PSRPOS Pseudorange Position

This log contains the pseudorange position (in metres) computed by the receiver, along with three status flags. In addition, it reports other status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections.

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

Recommended Input:

log psrposa ontime 1

ASCII Example:

```
#PSRPOSA,COM1,0,58.5,FINESTEERING,1419,340037.000,00000040,6326,2724;
SOL_COMPUTED,SINGLE,51.11636177893,-114.03832396506,1062.5470,-16.2712,
WGS84,1.8532,1.4199,3.3168,"",0.000,0.000,12,12,0,0,0,06,0,33*d200a78c
```

✉ There are variations of DGPS which can easily be perceived as using only one receiver. For example, the US Coast Guard operates a differential correction service which broadcasts GPS differential corrections over marine radio beacons. As a user, all you need is a marine beacon receiver and a GPS receiver to achieve positioning accuracy of less than 1 m. In this case, the Coast Guard owns and operates the base receiver at known coordinates. Other examples of users appearing to use only one GPS receiver include FM radio station correction services, privately owned radio transmitters, and corrections carried by communication satellites. Some of the radio receivers have built-in GPS receivers and combined antennas, so they even appear to look as one self-contained unit.

The major factors degrading GPS signals which can be removed or reduced with differential methods are the atmosphere, ionosphere, satellite orbit errors, and satellite clock errors. Some errors which are not removed include receiver noise and multipath.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PSRPOS header	Log header		H	0
2	sol status	Solution status (see *Table 44, Solution Status* on *page 197*)	Enum	4	H
3	pos type	Position type (see *Table 43, Position or Velocity Type* on *page 196*)	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) [a]	Float	4	H+32
8	datum id#	Datum ID number (see *Table 18, Reference Ellipsoid Constants* on *page 73*)	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#SVs	Number of satellite vehicles tracked	Uchar	1	H+64
16	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+65
17	Reserved		Uchar	1	H+66
18			Uchar	1	H+67
19			Uchar	1	H+68
20	ext sol stat	Extended solution status (see *Table 46, Extended Solution Status* on *page 198*)	Hex	1	H+69
21	Reserved		Hex	1	H+70
22	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 45* on *page 198*)	Hex	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

3.3.48 PSRTIME Time Offsets from the Pseudorange Filter

This log contains the instantaneous receiver clock offsets calculated in the pseudorange filter for each GNSS used in the solution.

Message ID: **881**

Log Type: **Synch**

Recommended Input:

log psrtimea ontime 1

ASCII Example:

```
#PSRTIMEA,COM1,0,62.5,FINESTEERING,1423,231836.000,00000000,462f,35520;
2,
GPS,-1.2631e-09,7.1562e-09,
GLONASS,-7.0099e-07,2.4243e-08*40aa2af1
```

✉ Uses for this log include i) estimating the difference between GPS and GLONASS satellite system times and ii) estimating the difference between UTC and GLONASS system time.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PSRTIME header	Log header		H	0
2	#recs	Number of records to follow	Ulong	4	H
3	system	Navigation System 0 = GPS 1 = GLONASS	Enum	4	H+4
4	offset	GNSS time offset from the pseudorange filter	Double	8	H+8
5	offset stdv	Time offset standard deviation	Double	8	H+12
vari-able	Next binary offset = H+4+(#recs x 20)				
vari-able	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	vari-able
vari-able	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.49 PSRVEL Pseudorange Velocity

In the PSRVEL log the actual speed and direction of the receiver antenna over ground is provided. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value.

The velocity in the PSRVEL log is determined by the pseudorange filter. Velocities from the pseudorange filter are calculated from the Doppler.

The velocity status indicates varying degrees of velocity quality. To ensure healthy velocity, the velocity sol-status must also be checked. If the sol-status is non-zero, the velocity is likely invalid. It should be noted that the receiver does not determine the direction a vessel, craft, or vehicle is pointed (heading), but rather the direction of the motion of the GPS antenna relative to the ground.

The latency of the instantaneous Doppler velocity is always 0.15 seconds. The latency represents an estimate of the delay caused by the tracking loops under acceleration of approximately 1 G. For most users, the latency can be assumed to be zero (instantaneous velocity).

Message ID: 100

Log Type: Synch

Recommended Input:

log psrvela ontime 1

ASCII Example:

```
#PSRVELA,COM1,0,52.5,FINESTEERING,1337,403362.000,00000000,658b,1984;
SOL_COMPUTED,PSRDIFF,0.250,9.000,0.0698,26.582692,0.0172,0.0*a94e5d48
```

Consider the case where vehicles are leaving a control center. The control center’s coordinates are known but the vehicles are on the move. Using the control center’s position as a reference, the vehicles are able to report where they are with PSRPOS and their speed and direction with PSRVEL at any time.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PSRVEL header	Log header		H	0
2	sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H
3	vel type	Velocity type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+4
4	latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8
5	age	Differential age in seconds	Float	4	H+12
6	hor spd	Horizontal speed over ground, in metres per second	Double	8	H+16
7	trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	vert spd	Vertical speed, in metres per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.50 PSRXYZ Pseudorange Cartesian Position and Velocity

This log contains the receiver’s pseudorange position and velocity in ECEF coordinates. The position and velocity status field’s indicate whether or not the corresponding data is valid. See *Figure 7, page 209* for a definition of the ECEF coordinates.

The velocity status indicates varying degrees of velocity quality. To ensure healthy velocity, the velocity sol-status must also be checked. If the sol-status is non-zero, the velocity is likely invalid. It should be noted that the receiver does not determine the direction a vessel, craft, or vehicle is pointed (heading), but rather the direction of the motion of the GPS antenna relative to the ground.

The latency of the instantaneous Doppler velocity is always 0.15 seconds. The latency represents an estimate of the delay caused by the tracking loops under acceleration of approximately 1 G. For must users, the latency can be assumed to be zero (instantaneous velocity).

Message ID: **243**

Log Type: **Synch**

Recommended Input:

log psrxyza ontime 1

ASCII Example:

```
#PSRXYZA,COM1,0,58.5,FINESTEERING,1419,340038.000,00000040,4a28,2724;
SOL_COMPUTED,SINGLE,-1634530.7002,-3664617.2823,4942495.5175,1.7971,
2.3694,2.7582,SOL_COMPUTED,DOPPLER_VELOCITY,0.0028,0.0231,-0.0120,
0.2148,0.2832,0.3297,"",0.150,0.000,0.000,12,12,0,0,0,06,0,33*4fdbcdb1
```

The instantaneous Doppler is the measured Doppler frequency which consists of the satellite's motion relative to the receiver (Satellite Doppler + User Doppler) and the clock (local oscillator) drift.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	PSRXYZ header	Log header		H	0
2	P-sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H
3	pos type	Position type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+4
4	P-X	Position X-coordinate (m)	Double	8	H+8
5	P-Y	Position Y-coordinate (m)	Double	8	H+16
6	P-Z	Position Z-coordinate (m)	Double	8	H+24
7	P-X σ	Standard deviation of P-X (m)	Float	4	H+32
8	P- Y σ	Standard deviation of P-Y (m)	Float	4	H+36
9	P-Z σ	Standard deviation of P-Z (m)	Float	4	H+40
10	V-sol status	Solution status, see *Table 44, Solution Status* on *page 197*	Enum	4	H+44
11	vel type	Velocity type, see *Table 43, Position or Velocity Type* on *page 196*	Enum	4	H+48
12	V-X	Velocity vector along X-axis (m)	Double	8	H+52
13	V-Y	Velocity vector along Y-axis (m)	Double	8	H+60
14	V-Z	Velocity vector along Z-axis (m)	Double	8	H+68
15	V-X σ	Standard deviation of V-X (m)	Float	4	H+76
16	V-Y σ	Standard deviation of V-Y (m)	Float	4	H+80
17	V-Z σ	Standard deviation of V-Z (m)	Float	4	H+84
18	stn ID	Base station ID	Char[4]	4	H+88
19	V-latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+92
20	diff_age	Differential age in seconds	Float	4	H+96
21	sol_age	Solution age in seconds	Float	4	H+100
22	#SVs	Number of satellite vehicles tracked	Uchar	1	H+104
23	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+105

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
24	Reserved		Char	1	H+106
25			Char	1	H+107
26			Char	1	H+108
27	ext sol stat	Extended solution status (see *Table 46, Extended Solution Status* on *page 198*)	Hex	1	H+109
28	Reserved		Hex	1	H+110
29	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 45* on *page 198*)	Hex	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.51 RAIMSTATUS RAIM status RAIM

This log provides information on RAIM status. See *Section 2.5.40* starting on *page 130*.

Message ID: 1286

Log Type: Synch

Recommended Input:

log raimstatusa ontime 1

ASCII Examples:

```
#RAIMSTATUSA,COM1,0,93.5,FINESTEERING,1595,387671.500,00000008,bf2d,5968;DEFA
ULT,PASS,NOT_AVAILABLE,0.000,NOT_AVAILABLE,0.000,0*96a129ee

#RAIMSTATUSA,COM1,0,95.5,FINESTEERING,1595,387672.000,00000008,bf2d,5968;APPR
OACH,PASS,PASS,17.037,PASS,25.543,0*2a53f2b9
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	RAIMSTATUS Header	Log header	-	H	0
2	RAIM Mode	RAIM mode, see *Table 27* on *page 131*	enum	4	H
3	Integrity status	Integrity Status, see *Table 58* on *page 302*	enum	4	H+4
4	HPL status	Horizontal protection level status, see *Table 59* on *page 302*	enum	4	H+8
5	HPL	Horizontal protection level	double	8	H+12
6	VPL status	Vertical protection level status, see *Table 59* on *page 302*	enum	4	H+20
7	VPL	Vertical protection level	double	8	H+24
8	Num of SVs	Number of excluded satellites	ulong	4	H+32
9	System	Satellite system	enum	4	H+36
10	Satellite ID	In binary logs, the satellite ID field is 4 bytes. The 2 lowest-order bytes, interpreted as a USHORT, are the system identifier: for instance, the PRN for GPS, or the slot for GLONASS. The 2 highest-order bytes are the frequency channel for GLONASS, interpreted as a SHORT, and zero for all other systems. In ASCII and abbreviated ASCII logs, the satellite ID field is the system identifier. If the system is GLONASS and the frequency channel is not zero, then the signed channel is appended to the system identifier. For example, slot 13, frequency channel -2 is output as 13-2.	ulong	4	H+40
...	....	Next excluded satellite system	....	....	
...	....	Next excluded satellite ID	....	....	
	xxxx	32-bit CRC (ASCII and Binary only)	hex	4	
	[CR][LF]	Sentence terminator (ASCII only)			

Table 58: Integrity Status

Binary	ASCII	Description
0	NOT_AVAILABLE	RAIM is unavailable because either there is no solution, or because the solution is unique, that is, there is no redundancy.
1	PASS	RAIM succeeded. Either there were no bad observations, or the bad observations were successfully removed from the solution.
2	FAIL	RAIM detected a failure, but was unable to isolate the bad observations.

Table 59: PL Status

Binary	ASCII	Description
0	NOT_AVAILABLE	When RAIM is not available for example, after issuing a FRESET command, or when there are not enough satellites tracked to produce the required redundant observations.
1	PASS	Current protection levels are below alert limits, meaning that positioning accuracy requirements are fulfilled. $HPL < HAL$ $VPL < VAL$
2	ALERT	Current protection levels are above alert limits, meaning that required positioning accuracy cannot be guaranteed by RAIM algorithm. $HPL \geq HAL$ $VPL \geq VAL$

3.3.52 RANGE Satellite Range Information

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

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

Message ID: **43**

Log Type: **Synch**

Recommended Input:

log rangea ontime 30

ASCII Example:

```
#RANGEA,COM1,0,63.5,FINESTEERING,1429,226979.000,00000000,5103,2748;
26,
6,0,23359924.081,0.078,-122757217.106875,0.015,-3538.602,43.3,19967.080,
08109c04,
21,0,20200269.147,0.038,-106153137.954409,0.008,-86.289,49.5,13397.470,
08109c44,
.
.
.
44,12,19388129.378,0.335,-103786179.553598,0.012,975.676,36.6,3726.656,
18119e24,
43,8,20375687.399,0.253,-108919708.904476,0.012,-2781.090,39.1,10629.934,
18119e84
```

✉ Consider the case where you have a computer to record data at a fixed location, and another laptop in the field also recording data as you travel. Can you take the difference between the recorded location and the known location of the fixed point and use that as an error correction for the recorded data in the field?

The simple answer is yes. You can take the difference between recorded position and known location and apply this as a position correction to your field data. Then, what is the difference between pseudorange and position differencing?

The correct and more standard way of computing this correction is to compute the range error to each GPS satellite being tracked at your fixed location and to apply these range corrections to the observations at your mobile station.

The position corrections method is seldom used in industry. The drawback of this method is that computed corrections vary depending on the location of the fixed station. The geometry is not accounted for between the fixed station and the tracked satellites. Also, position corrections at the fixed site are computed with a certain group of satellites while the field station is tracking a different group of satellites. In general, when the position correction method is used, the farther the fixed and field stations are apart, the less accurate the solution.

The range corrections method is more commonly used in industry. The advantage of using this method is that it provides consistent range corrections and hence field positions regardless of the location of your fixed station. You are only able to obtain a "good" differential position if both the fixed and field stations are tracking the same four satellites at a minimum.

DGPS refers to using 1 base receiver at a known location and 1 or more rover receivers at unknown locations. As the position of the base is accurately known, we can determine the error that is present in GPS at any given instant by either of the two methods previously described. We counter the bias effects present in GPS including: ionospheric, tropospheric, ephemeris, receiver and satellite clock errors. You could choose either method depending on your application and the accuracy required.

Table 60: Tracking State

State	Description	State	Description
0	L1 Idle	7	L1 Frequency-lock loop
1	L1 Sky search		
2	L1 Wide frequency band pull-in		
3	L1 Narrow frequency band pull-in		
4	L1 Phase lock loop		
5	L1 Reacquisition		
6	L1 Steering		

Table 61: Correlator Type

State	Description
0	N/A
1	Standard correlator: spacing = 1 chip
2	Narrow Correlator®: spacing < 1 chip
3	Reserved
4	Pulse Aperture Correlator (PAC)
5-6	Reserved

Table 62: Channel Tracking Example

	N7				N6				N5				N4				N3				N2				N1				N0			
0x	0				8				1				0				9				C				0				4			
Bit #	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary[a]	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0
Data	Chan. Assignment	Reserved (R)			Primary L1	R	Signal Type					Grouping	R	Satellite System			Correlator Spacing			Code locked flag	Parity flag	Phase lock flag	Channel Number					Tracking State				
Value	Automatic				Primary		L1 C/A					Grouped		GPS			PAC			Locked	Known	Locked	Channel 0					L1 Phase Lock Loop				

a. For a complete list of hexadecimal and binary equivalents please refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Table 63: Channel Tracking Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Tracking state	0-11, see *Table 60, Tracking State* on *page 304*
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010		
	5	0x00000020	SV channel number	0-n (0 = first, n = last)
	6	0x00000040		
	7	0x00000080		
N2	8	0x00000100		
	9	0x00000200		
	10	0x00000400	Phase lock flag	0 = Not locked, 1 = Locked
	11	0x00000800	Parity known flag	0 = Not known, 1 = Known
N3	12	0x00001000	Code locked flag	0 = Not locked, 1 = Locked
	13	0x00002000	Correlator type	0-7, see *Table 61, Correlator Type* on *page 304*
	14	0x00004000		
	15	0x00008000		

Continued on the following page

Nibble #	Bit #	Mask	Description	Range Value
N4	16	0x00010000	Satellite system	0 = GPS 1= GLONASS 2 = WAAS 3-6 = Reserved 7 = Other
	17	0x00020000		
	18	0x00040000		
	19	0x00080000	Reserved	
N5	20	0x00100000	Reserved	
	21	0x00200000	Signal type	Dependent on satellite system above: GPS: 0 = L1 C/A GLONASS: 0 = L1 C/A SBAS 0 = L1 C/A
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000	Forward Error Correction	0 = Not FEC, 1 = FEC
	27	0x08000000	Primary L1 channel	0 = Not primary, 1 = Primary
N7	28	0x10000000	Carrier phase measurement [a]	0 = Half Cycle Not Added, 1 = Half Cycle Added
	29	Reserved		
	30	0x40000000	PRN lock flag [b]	0 = PRN Not Locked Out,
	31	0x80000000	Channel assignment	0 = Automatic, 1 = Forced

a. This bit is zero until the parity is known and the parity known flag (bit 11) is set to 1.

b. A PRN can be locked out using the LOCKOUT command, see also *page 104*.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RANGE header	Log header		H	0
2	# obs	Number of observations with information to follow	Long	4	H
3	PRN/slot	Satellite PRN number of range measurement (GPS: 1 to 32, SBAS: 120 to 138, and GLONASS: 38 to 61, see *Section 1.3* on *page 26*)	UShort	2	H+4
4	glofreq	(GLONASS Frequency + 7), see *Section 1.3* on *page 26*.	UShort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	psr std	Pseudorange measurement standard deviation (m)	Float	4	H+16
7	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+20
8	adr std	Estimated carrier phase standard deviation (cycles)	Float	4	H+28
9	dopp	Instantaneous carrier Doppler frequency (Hz)	Float	4	H+32
10	C/No	Carrier to noise density ratio $C/No = 10[\log_{10}(S/N_0)]$ (dB-Hz)	Float	4	H+36
11	locktime	# of seconds of continuous tracking (no cycle slipping)	Float	4	H+40
12	ch-tr-status	Tracking status (see *63, Channel Tracking Status* on *page 305* and the example in *Table 62*)	ULong	4	H+44
13...	Next PRN offset = H + 4 + (#obs x 44)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#obs x 44)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.53 RANGECMP Compressed Version of the RANGE Log

Message ID: **140**

Log Type: **Synch**

Recommended Input:

log rangecmpa ontime 10

Example:

```
#RANGECMPA,COM1,0,63.5,FINESTEERING,1429,226780.000,00000000,9691,2748;
26,
049c10081857f2df1f4a130ba2888eb9600603a709030000,
449c1008340400e0aaa9a109a7535bac2015cf71c6030000,
...
0b9d301113c8ffefc284000c6ea051dbf3089da1a0010000,
249d1018c6b7f67fa228820af2e5e39830180ae1a8030000,
449d1018be18f41f2aacad0a1a934efc40074ecf88030000,
849d101817a1f95f16d7af0a69fbe1fa401d3fd064030000,
249e1118af4e0470f66d4309a0a631cd642cf5b821320000,
849e1118b878f54f4ed2aa098c35558a532bde1765220000*0eeead18
```

✉ Consider the case where commercial vehicles are leaving a control center. The control center's coordinates are known but the vehicles are on the move. Using the control center's position as a reference, the vehicles are able to report where they are at any time. Post-processed information gives more accurate comparisons.

Post-processing can provide post-mission position and velocity using raw GPS collected from the vehicles. The logs necessary for post-processing include:

RANGECMPB ONTIME 1

RAWEPHEMB ONNEW

Above, we describe and give an example of data collection for post-processing. OEMStar-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. Refer also to our Web site at www.novatel.com for details.

Table 64: Range Record Format (RANGECMP only)

Data	Bit(s) first to last	Length (bits)	Scale Factor	Units
Channel Tracking Status	0-31	32	see *Table 63*	-
Doppler Frequency	32-59	28	1/256	Hz
Pseudorange (PSR)	60-95	36	1/128	m
ADR [a]	96-127	32	1/256	cycles
StdDev-PSR	128-131	4	see note b	m
StdDev-ADR	132-135	4	(n + 1)/512	cycles
PRN/Slot [c]	136-143	8	1	-
Lock Time [d]	144-164	21	1/32	s
C/No [e]	165-169	5	(20 + n)	dB-Hz
Reserved	170-191	22		

a. ADR (Accumulated Doppler Range) is calculated as follows:

ADR_ROLLS = (RANGECMP_PSR / WAVELENGTH + RANGECMP_ADR) / MAX_VALUE
Round to the closest integer
IF (ADR_ROLLS ≤ 0)
    ADR_ROLLS = ADR_ROLLS - 0.5
ELSE
    ADR_ROLLS = ADR_ROLLS + 0.5
At this point integerise ADR_ROLLS
CORRECTED_ADR = RANGECMP_ADR - (MAX_VALUE*ADR_ROLLS)
where
ADR has units of cycles
WAVELENGTH = 0.1902936727984 for GPS L1
WAVELENGTH = 0.2442102134246 for GPS L2
MAX_VALUE = 8388608

Note: *GLONASS satellites emit L1 carrier waves at a satellite-specific frequency, refer to the GNSS Reference Book for more on GLONASS frequencies.*

b.

Code	StdDev-PSR (m)
0	0.050
1	0.075
2	0.113
3	0.169
4	0.253
5	0.380
6	0.570
7	0.854
8	1.281
9	2.375
10	4.750
11	9.500
12	19.000
13	38.000
14	76.000
15	152.000

c. GPS: 1 to 32, SBAS: 120 to 138, and GLONASS: 38 to 61, see *Section 1.3* on *page 26*.

d. The *Lock Time* field of the RANGECMP log is constrained to a maximum value of 2,097,151 which represents a lock time of 65535.96875 s (2097151 ÷ 32).

e. C/No is constrained to a value between 20-51 dB-Hz. Thus, if it is reported that C/No = 20 dB-Hz, the actual value could be less. Likewise, if it is reported that C/No = 51, the true value could be greater.

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	RANGECMP header	Log header		H	0
2	#obs	Number of satellite observations with information to follow.	Long	4	H
3	1st range record	Compressed range log in format of *Table 64* on *page 309*	Hex	24	H+4
4	Next rangecmp offset = H + 4 + (#obs x 24)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 4 + (#obs x 24)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.54 RAWALM Raw Almanac Data

This log contains the undecoded almanac subframes as received from the satellite. For more information about Almanac data, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Message ID: **74**

Log Type: **Asynch**

Recommended Input:

log rawalma onchanged

ASCII Example:

```
#RAWALMA,COM1,0,56.0,SATTIME,1337,405078.000,00000000,cc1b,1984;
1337,589824.000,43,
3,8b04e4839f35433a5590f5aefd3900a10c9aaa6f40187925e50b9f03003f,
27,8b04e483a1325b9cde9007f2fd5300a10da5562da3adc0966488dd01001a,
4,8b04e483a1b44439979006e2fd4f00a10d15d96b3b021e6c6c5f23feff3c,
28,8b04e483a3b05c5509900b7cfd5800a10cc483e2bfa1d2613003bd050017,
5,8b04e483a43745351c90fcb0fd4500a10d8a800f0328067e5df8b6100031,
57,8b04e483a6337964e036d74017509f38e13112df8dd92d040605eeaaaaaa,
6,8b04e483a6b54633e390fa8bfd3f00a10d4facbc80b322528f62146800ba,
29,8b04e483a8b05d47f7901b20fd5700a10ce02d570ed40a0a2216412400cb,
7,8b04e483a935476dee90fb94fd4300a10d93aba327b7794ae853c02700ba,
.
.
.
1,8b04e483d8b641305a901b9dfd5a00a10ce92f48f1ba0a5dcccb7500003b,
25,8b04e483dab25962259004fcfd4c00a10dc154eee5c555d7a2a5010d000d,
2,8b04e483db37424aa6900720fd4f00a10c5ad89baa4dc1460790b6fc000f,
26,8b04e483dd305a878c901d32fd5b00a10c902eb7f51db6b6ce95c701fff4*83cae97a
```

OEMStar receivers automatically save almanacs in their non-volatile memory (NVM), therefore creating an almanac boot file is not necessary.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWALM header	Log header		H	0
2	ref week	Almanac reference week number	Ulong	4	H
3	ref secs	Almanac reference time (s)	Ulong	4	H+4
4	subframes	Number of subframes to follow	Ulong	4	H+8
5	svid	SV ID (satellite vehicle ID) [a]	UShort	2	H+12
6	data	Subframe page data	Hex	30	H+14
7...	Next subframe offset = H + 12 + (subframe x 32)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 12 + (32 x subframes)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. A value between 1 and 32 for the SV ID indicates the PRN of the satellite. Any other values indicate the page ID. See section 20.3.3.5.1.1, *Data ID and SV ID*, of ICD-GPS-200C for more details. To obtain copies of ICD-GPS-200, refer to the ARINC Web site at www.arinc.com.

3.3.55 RAWEPHEM Raw Ephemeris

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

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

Message ID: 41

Log Type: Asynch

Recommended Input:

log rawephema onnew

ASCII Example:

```
#RAWEPHEMA,COM1,15,60.5,FINESTEERING,1337,405297.175,00000000,97b7,1984;
3,1337,403184,8b04e4818da44e50007b0d9c05ee664ffbfe695df763626f00001b03c6b3,
8b04e4818e2b63060536608fd8cdaa051803a41261157ea10d2610626f3d,
8b04e4818ead0006aa7f7ef8ffda25c1a69a14881879b9c6ffa79863f9f2*0bb16ac3
.
.
.
#RAWEPHEMA,COM1,0,60.5,SATTIME,1337,405390.000,00000000,97b7,1984;
1,1337,410400,8b04e483f7244e50011d7a6105ee664ffbfe695df9e1643200001200aa92,
8b04e483f7a9e1faab2b16a27c7d41fb5c0304794811f7a10d40b564327e,
8b04e483f82c00252f57a782001b282027a31c0fba0fc525ffac84e10a06*c5834a5b
```

A way to use only one receiver and achieve accuracy of less than 1 metre is to use precise orbit and clock files. Three types of GPS ephemeris, clock and earth orientation solutions are compiled by an elaborate network of GPS receivers around the world all monitoring the satellite characteristics. IGS rapid orbit data is processed to produce files that correct the satellite clock and orbit parameters. Since there is extensive processing involved, these files are available on a delayed schedule from the US National Geodetic Survey at: http://www.ngs.noaa.gov/orbits/l

Precise ephemeris files are available today to correct GPS data which was collected a few days ago. All you need is one GPS receiver and a computer to process on. Replace the ephemeris data with the precise ephemeris data and post-process to correct range values.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWEPHEM header	Log header		H	0
2	prn	Satellite PRN number	Ulong	4	H
3	ref week	Ephemeris reference week number	Ulong	4	H+4
4	ref secs	Ephemeris reference time (s)	Ulong	4	H+8
5	subframe1	Subframe 1 data	Hex	30	H+12
6	subframe2	Subframe 2 data	Hex	30	H+42
7	subframe3	Subframe 3 data	Hex	30	H+72
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+102
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.56 RAWGPSSUBFRAME Raw Subframe Data

This log contains the raw GPS subframe data. A raw GPS subframe is 300 bits in total. This includes the parity bits which are interspersed with the raw data ten times in six bit chunks, for a total of 60 parity bits. Note that in Field #5, the 'data' field below, we have stripped out these 60 parity bits, and only the raw subframe data remains, for a total of 240 bits. There are two bytes added onto the end of this 30 byte packed binary array to pad out the entire data structure to 32 bytes in order to maintain 4 byte alignment.

Message ID: **25**

Log Type: **Asynch**

Recommended Input:

log rawgpssubframea onnew

ASCII Example:

```
#RAWGPSSUBFRAMEA,COM1,59,62.5,SATTIME,1337,405348.000,00000000,f690,1984;2,22
,4,8b04e483f3b17ee037a3732fe0fc8ccf074303ebdf2f6505f5aaaaaaaaa9,2*41e768e4
...
#RAWGPSSUBFRAMEA,COM1,35,62.5,SATTIME,1337,405576.000,00000000,f690,1984;4,25
,2,8b04e48406a8b9fe8b364d786ee827ff2f062258840ea4a10e20b964327e,4*52d460a7
...
#RAWGPSSUBFRAMEA,COM1,0,62.5,SATTIME,1337,400632.000,00000000,f690,1984;20,9,
3,8b04e4826aadff3557257871000a26fc34a31d7a300bede5ffa3de7e06af,20*55d16a4a
```

✉ The RAWGPSSUBFRAME log can be used to receive the data bits with the parity bits stripped out. Alternately, you can use the RAWGPSWORD log to receive the parity bits in addition to the data bits.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWGPSSUBFRAME header	Log header		H	0
2	decode #	Frame decoder number	Ulong	4	H
3	PRN	Satellite PRN number	Ulong	4	H+4
4	subfr id	Subframe ID	Ulong	4	H+8
5	data	Raw subframe data	Hex[30]	32[a]	H+12
6	chan	Signal channel number that the frame was decoded on.	Ulong	4	H+44
7	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.57 RAWGPSWORD Raw Navigation Word

This message contains the framed raw navigation words. Each log contains a new 30 bit navigation word (in the least significant 30 bits), plus the last 2 bits of the previous word (in the most significant 2 bits). The 30 bit navigation word contains 24 bits of data plus 6 bits of parity. The GPS reference time stamp in the log header is the time that the first bit of the 30 bit navigation word was received. Only navigation data that has passed parity checking appears in this log. One log appears for each PRN being tracked every 0.6 seconds if logged ONNEW or ONCHANGED.

Message ID: 407

Log Type: Asynch

Recommended Input:

log rawgpsworda onnew

ASCII Example:

```
#RAWGPSWORDA,COM1,0,58.5,FINESTEERING,1337,405704.473,00000000,9b16,1984;
14,7ff9f5dc*8e7b8721
...
#RAWGPSWORDA,COM1,0,57.0,FINESTEERING,1337,405783.068,00000000,9b16,1984;
1,93feff8a*6dd62c81
...
#RAWGPSWORDA,COM1,0,55.5,FINESTEERING,1337,405784.882,00000000,9b16,1984;
5,fffff8ce*a948b4de
```

The RAWGPSWORD log can be used to receive the parity bits in addition to the data bits. Alternately, you can use the RAWGPSSUBFRAME log which already has the parity bits stripped out.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWGPSWORD header	Log header		H	0
2	PRN	Satellite PRN number	Ulong	4	H
3	nav word	Raw navigation word	Ulong	4	H+4
4	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+8
5	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.58 RAWWAASFRAME Raw SBAS Frame Data SBAS

This log contains the raw SBAS frame data of 226 bits (8-bit preamble, 6-bit message type and 212 bits of data but without a 24-bit CRC). Only frame data with a valid preamble and CRC are reported.

Message ID: 287
Log Type: Asynch

Recommended Input:

log rawwaasframea onnew

ASCII Example:

```
#RAWWAASFRAMEA,COM1,0,39.0,SATTIME,1337,405963.000,00000000,58e4,1984;29,122,
10,5328360984c80130644dc53800c004b1244000000000000000000000,29*7b398c7a

#RAWWAASFRAMEA,COM1,0,43.0,SATTIME,1337,405964.000,00000000,58e4,1984;29,122,
3,9a0e9ffc035fffff5ffc00dffc008044004005ffdfffabbb9b96217b80,29*f2139bad

#RAWWAASFRAMEA,COM1,0,43.0,SATTIME,1337,405965.000,00000000,58e4,1984;29,122,
2,c608bff9ffdffffec00bfa4019ffdffdfffffc04c0097bb9f27bb97940,29*364848b7

...

#RAWWAASFRAMEA,COM1,0,44.5,SATTIME,1337,405983.000,00000000,58e4,1984;29,122,
2,c608bff5ffdffffec00ffa8015ffdffdfffff804c0017bb9f27bb97940,29*a5dc4590
```

The RAWWAASFRAME log output contains all the raw data required for an application to compute its own SBAS correction parameters.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWWAASFRAME header	Log header		H	0
2	decode #	Frame decoder number	Ulong	4	H
3	PRN	SBAS satellite PRN number	Ulong	4	H+4
4	WAASmsg id	SBAS frame ID	Ulong	4	H+8
5	data	Raw SBAS frame data. There are 226 bits of data and 6 bits of padding.	Uchar[29]	32[a]	H+12
6	chan	Signal channel number that the frame was decoded on	Ulong	4	H+44
7	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

3.3.59 RTCA Standard Logs

RTCA1 DIFFERENTIAL GPS CORRECTIONS *DGPS_Tx*
Message ID: 10

RTCAEPHEM EPHEMERIS AND TIME INFORMATION *DGPS_Tx*
Message ID: 347

The above messages can be logged with an A or B suffix for an ASCII or Binary output with a NovAtel header followed by Hex or Binary raw data respectively.

RTCADATA logs output the details of the above logs if they have been sent.

The OEMStar does not currently transmit carrier-phase (RTK) corrections.

The OEMStar can be configured to receive the carrier-phase RTCA corrections listed in *Table 65* below and compute a DGPS (pseudorange) position.

The GLONASS option is required for GLONASS corrections to be used in the DGPS position.

Table 65: RTCA Carrier-Phase Messages

Type of Log	Message ID	Log Name	Description
GPS-only	6	RTCAOBS	Base Station Observations
GPS+GLONASS	805	RTCAOBS2	Base Station Observations 2
	11	RTCAREF	Base Station Parameters

The RTCA (Radio Technical Commission for Aviation Services) Standard is being designed to support Differential Global Navigation Satellite System (DGNSS) Special Category I (SCAT-I) precision instrument approaches. The RTCA Standard is in a preliminary state. Described below is NovAtel's current support for this standard. It is based on "Minimum Aviation System Performance Standards DGNSS Instrument Approach System: Special Category I (SCAT-I)".[1]

OEMStar has one proprietary RTCA Standard Type 7 binary-format message, RTCAEPHEM, for base station transmission. This message can be used with single-frequency NovAtel receivers. The RTCA message format outperforms the RTCM format in the following ways, among others:

- a more efficient data structure (lower overhead)
- better error detection
- allowance for a longer message, if necessary

Refer to the *Receiving and Transmitting Corrections* section in the *OEMStar Installation and Operation Manual* for more information about using these message formats for differential operation.

Input Example

```
interfacemode com2 none RTCA
pdpfiler disable
fix position 51.1136 -114.0435 1059.4
log com2 rtca1 ontime 5
log com2 rtcaephem ontime 10 1.
```

1.For further information about RTCA Standard messages, you refer to: *Minimum Aviation System Performance Standards - DGNSS Instrument Approach System: Special Category I (SCAT-I)*, Document No. RTCA/DO-217 (April 19,1995); Appx A, Pg 21

3.3.60 RTCADATA1 Differential GPS Corrections *DGPS_Tx*

See *Section 3.3.59* starting on *page 319* for information about RTCA standard logs.

Message ID: **392**
Log Type: **Synch**

Recommended Input:

log rtcadata1a ontime 10 3

ASCII Example:

```
#RTCADATA1A,COM1,0,60.0,FINESTEERING,1364,493614.000,00100000,606b,2310;
414.000000000,0,9,
30,-6.295701472,111,-0.019231669,1.000000000,
2,-4.720861644,60,-0.021460577,1.000000000,
6,-11.464165041,182,-0.015610195,1.000000000,
4,-6.436236222,7,-0.021744921,1.000000000,
5,-5.556760025,39,0.003675566,1.000000000,
10,-14.024430156,181,-0.013904139,1.000000000,
7,-5.871886130,48,-0.016165427,1.000000000,
25,-22.473942049,59,-0.003024942,1.000000000,
9,-28.422760762,130,-0.048257797,1.000000000*56d5182f
```

RTCA1

This log enables transmission of RTCA Standard format Type 1 messages from the receiver when operating as a base station. Before this message can be transmitted, the receiver FIX POSITION command must be set, see *page 88*. The RTCA log is accepted by a receiver operating as a rover station over a COM port after the INTERFACEMODE *port* RTCA and PDPFILTER DISABLE commands are issued, see *page 100*.

The RTCA Standard for SCAT-I stipulates that the maximum age of differential correction (Type 1) messages accepted by the rover station cannot be greater than 22 seconds. See the DGPSTIMEOUT command on *page 81* for information regarding DGPS delay settings.

The RTCA Standard also stipulates that a base station shall wait five minutes after receiving a new ephemeris before transmitting differential corrections. Refer to the DGPSEPHEMDELAY command on *page 79* for information regarding ephemeris delay settings.

The basic SCAT-I Type 1 differential correction message is as follows:

Format: Message length = 11 + (6*obs): (83 bytes maximum)

Field Type	Data		Scaling	Bits	Bytes
SCAT-I header	–	Message block identifier	-	8	6
	–	Base station ID	-	24	
	–	Message type	-	8	
	–	Message length	-	8	
Type 1 header	–	Modified z-count	0.2 s	13	2
	–	Acceleration error bound	-	3	
Type 1 data	–	Satellite ID	-	6	6 * obs
	–	Pseudorange correction[a]	0.02 m	16	
	–	Issue of data	-	8	
	–	Range rate correction[a]	0.002 m/s	12	
	–	UDRE	0.2 m	6	
CRC	Cyclic redundancy check		-		3

a. The pseudorange correction and range rate correction fields have a range of ±655.34 metres and ±4.049 m/s respectively. Any satellite which exceeds these limits are not included.

At the base station it is possible to log out the contents of the standard corrections in a form that is easier to read or process. These larger variants have the correction fields broken out into standard types within the log, rather than compressed into bit fields. This can be useful if you wish to modify the format of the corrections for a non-standard application, or if you wish to look at the corrections for system debugging purposes. These variants have "DATA" as part of their names (for example, RTCADATA1).

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCADATA1 header	Log header	-	H	0
2	z-count	Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.	Double	8	H
3	AEB	Acceleration Error Bound	Uchar	4 [a]	H+8
4	#prn	Number of satellite corrections with information to follow	Ulong	4	H+12
5	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138.)	Ulong	4	H+16
6	range	Pseudorange correction (m)	Double	8	H+20
7	IODE	Issue of ephemeris data	Uchar	4 [a]	H+28
8	range rate	Pseudorange rate correction (m/s)	Double	8	H+32
9	UDRE	User differential range error	Float	4	H+40
10...	Next prn offset = H+16 + (#prns x 28)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

3.3.61 RTCADATAEPHEM Ephemeris and Time Information DGPS_Tx

See *Section 3.3.59* starting on *page 319* for information about RTCA standard logs.

RTCAEPHEM Type 7

An RTCAEPHEM (RTCA Satellite Ephemeris Information) message contains raw satellite ephemeris information. It can be used to provide a rover receiver with a set of GPS ephemerides. Each message contains a complete ephemeris for one satellite and the GPS reference time of transmission from the base. The message is 102 bytes (816 bits) long. This message should be sent once every 5-10 seconds (The faster this message is sent, the quicker the rover station receives a complete set of ephemerides). Also, the rover receiver automatically sets an approximate system time from this message if time is still unknown. Therefore, this message can be used in conjunction with an approximate position to improve time to first fix (TTFF). For more information about TTFF and satellite acquisition, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Message ID: **393**

Log Type: **Synch**

Recommended Input:

log rtcadataephema ontime 10 7

ASCII Example:

```
#RTCADATAEPHEMA,COM1,0,49.0,FINESTEERING,1364,494422.391,00100000,d869,2310;
78,2,340,494422,4,0,
8b0550a0f0a455100175e6a09382232523a9dc04f307794a00006415c8a98b0550a0f12a070b1
2394e4f991f8d09e903cd1e4b0825a10e669c794a7e8b0550a0f1acffe54f81e9c0004826b947
d725ae063beb05ffa17c07067d*c9dc4f88
```

A hot position is when the receiver has a saved almanac, saved recent ephemeris data and an approximate position.

A hot position aids the time to first fix (TTFF). The TTFF is the actual time required by a GPS receiver to achieve a position solution. or more information about TTFF and satellite acquisition, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCADATAEPHEM header	Log header	-	H	0
2	des	NovAtel designator	Uchar	1	H
3	subtype	RTCA message subtype	Uchar	3[a]	H+1
4	week	GPS reference week number (weeks)	Ulong	4	H+4
5	sec	Seconds into the week (seconds)	Ulong	4	H+8
6	prn	PRN number	Ulong	4	H+12
7	Reserved		Uchar	4[b]	H+16
8	raw data	Raw ephemeris data	Hex[90]	92[a]	H+20
9	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
10	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

b. In the binary log case an additional 3 bytes of padding are added to maintain 4 byte alignment

3.3.62 RTCM Standard Logs

RTCM1 DIFFERENTIAL GPS CORRECTIONS *DGPS_Tx*
Message ID: 107

RTCM9 PARTIAL DIFFERENTIAL GPS CORRECTIONS *DGPS_Tx*
MESSAGE ID: 275

RTCM15 IONOSPHERIC CORRECTIONS *DGPS_Tx*
Message ID: 307

RTCM16 SPECIAL MESSAGE *DGPS_Tx*
Message ID: 129

RTCM31 DIFFERENTIAL GLONASS *DGPS_Tx & GLO*
Message ID: 864

RTCM36 SPECIAL EXTENDED MESSAGE *DGPS_Tx & GLO*
Message ID: 875

RTCM36T SPECIAL EXTENDED MESSAGE *DGPS_Tx & GLO*, see also *page 152*
Message ID: 877

RTCM59GLO PROPRIETARY GLONASS DIFFERENTIAL *DGPS_Tx & GLO*
Message ID: 903

The RTCM messages can be logged with an A or B suffix for an ASCII or Binary output with a NovAtel header followed by Hex or Binary raw data respectively.

Combinations of integer offsets and fractional offsets are not supported for RTCM logs. See also the LOG command starting on *page 105* for more details on offsets.

RTCMDATA logs output the details of the above logs if they have been sent.

✉ The OEMStar does not currently transmit carrier phase corrections.

The OEMStar can be configured to receive the carrier-phase RTCM corrections listed in *Table 66* below and compute a DGPS (pseudorange) position.

The GLONASS option is required for GLONASS RTCM corrections to be used in the DGPS position.

Table 66: RTCM Carrier-Phase Messages

Type of Log	Message ID	Log Name	Description
GPS+GLONASS	260	RTCM1819	Type 18 and 19 raw measurements
GPS+GLONASS	370	RTCM2021	Type 20 and 21 raw measurements
	118	RTCM22	Type 22 extended base parameters

The Radio Technical Commission for Maritime Services (RTCM) was established to facilitate the establishment of various radio navigation standards, which includes recommended GPS differential standard formats. Refer to the *Receiving and Transmitting Corrections* section in the *OEMStar Installation and Operation Manual* for more information about using these message formats for differential operation.

The standards recommended by the Radio Technical Commission for Maritime Services Special Committee 104, Differential GPS Service (RTCM SC-104,Washington, D.C.), have been adopted by NovAtel for implementation into the receiver. Because the receiver is capable of utilizing RTCM formats, it can easily be integrated into positioning systems around the globe.

As it is beyond the scope of this manual to provide in-depth descriptions of the RTCM data formats, it is recommended that anyone requiring explicit descriptions of such, should obtain a copy of the published RTCM specifications. Refer to the *Radio Technical Commission for Maritime Services* Web site at http://www.rtcm.org for information.

RTCM SC-104[1] Type 3 & 59 messages can be used for base station transmissions in differential systems.

✉ The error-detection capability of an RTCM-format message is less than that of an RTCA-format message. The communications equipment that you use may have an error-detection capability of its own to supplement that of the RTCM message, although at a penalty of a higher overhead. Consult the radio vendor’s documentation for further information.

1. For further information about RTCM SC-104 messages, refer to:

   RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.3 at http://www.rtcm.org/overview.php.

If RTCM-format messaging is being used, the optional *station id* field that is entered using the FIX POSITION command can be any number within the range of 0 - 1023 (for example, 119). The representation in the log message is identical to what was entered.

The NovAtel logs which implement the RTCM Standard Format for Type 1, 9, 16, 31and 36 messages are known as the RTCM1, RTCM9, RTCM16, RTCM31and RTCM36 logs, respectively.

All receiver RTCM standard format logs adhere to the structure recommended by RTCM SC-104. Thus, all RTCM message are composed of 30 bit words. Each word contains 24 data bits and 6 parity bits. All RTCM messages contain a 2-word header followed by 0 to 31 data words for a maximum of 33 words (990 bits) per message.

Message Frame Header	Data		Bits
Word 1	–	Message frame preamble for synchronization	8
	–	Frame/message type ID	6
	–	Base station ID	10
	–	Parity	6
Word 2	–	Modified z-count (time tag)	13
	–	Sequence number	3
	–	Length of message frame	5
	–	Base health	3
	–	Parity	6

Version 3.0, also developed by the RTCM SC-104, consists primarily of messages designed to support real-time kinematic (RTK) operations. It provides messages that support GPS and GLONASS RTK operations, including code and carrier phase observables, antenna parameters, and ancillary system parameters. 3.1 adds RTCM messages containing transformation data and information about Coordinate Reference Systems.[1]

The remainder of this section provides further information concerning receiver commands and logs that utilize the RTCM data formats.

Example Input:

interfacemode com2 none RTCM

pdpfilter disable

fix position 51.1136 -114.0435 1059.4

log com2 rtcm31 ontime 2

log com2 rtcm1 ontime 5

---

1. For further information about RTCM SC-104 messages, refer to:

   RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 3.0 at http://www.rtcm.org/overview.php.

3.3.63 RTCMDATA1 Differential GPS Corrections DGPS_Tx

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs.

Message ID: **396**

Log Type: **Synch**

Recommended Input:

log rtcmdata1a ontime 10 3

ASCII Example:

```
#RTCMDATA1A,COM1,0,68.5,FINESTEERING,1420,506618.000,00180020,d18a,1899;
1,0,4363,0,0,6,
9,
0,0,26,22569,-2,231,
0,0,19,-3885,-36,134,
0,0,3,-14036,-23,124,
0,0,24,1853,-36,11,
0,0,18,5632,15,6,
0,0,21,538,-26,179,
0,0,9,12466,3,4,
0,0,14,-21046,17,27,
0,0,22,-7312,16,238*35296338
```

RTCM1

This is the primary RTCM log used for pseudorange differential corrections. This log follows the RTCM Standard Format for a Type 1 message. It contains the pseudorange differential correction data computed by the base station generating this Type 1 log. The log is of variable length depending on the number of satellites visible and pseudoranges corrected by the base station. Satellite specific data begins at word 3 of the message.

Structure:

Type 1 messages contain the following information for each satellite in view at the base station:

- Satellite ID
- Pseudorange correction
- Range-rate correction
- Issue of Data (IOD)

When operating as a base station, the receiver must be in FIX POSITION mode and have the INTERFACEMODE command set before the data can be correctly logged. When operating as a rover station, the receiver COM port receiving the RTCM data must have the PDPFILTER mode disabled and have its INTERFACEMODE command set. Refer to the *Receiving and Transmitting Corrections* section in the *OEMStar Installation and Operation Manual* for more information about using these commands and RTCM message formats.

✉ **REMEMBER**: Upon a change in ephemeris, base stations transmit Type 1 messages based on the old ephemeris for a period of time defined by the DGPSEPHEMDELAY command, see *page 79*. After the time out, the base station begins to transmit the Type 1 messages based on the new ephemeris.

RTCMDATA logs provide you with the ability to monitor the RTCM messages, being used by the NovAtel receiver, in an easier to read format than the RTCM standard format. You can also use the RTCMDATA logs as a diagnostic tool to identify when the receivers are operating in the required modes.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health.	Ulong	4	H+20
8	#prn	Number of PRNs with information to follow	Ulong	4	H+24
9	scale	Scale where 0 = 0.02 m and 0.002 m/s 1 = 0.32 m and 0.032 m/s	Ulong	4	H+28
10	UDRE	User differential range error	Ulong	4	H+32
11	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138.)	Ulong	4	H+36
12	psr corr	Scaled pseudorange correction (metres)	Long	4	H+40
13	rate corr	Scaled range rate correction	Long	4	H+44
14	IOD	Issue of data	Long	4	H+48
15...	Next PRN offset = H+28 + (#prns x 24)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.64 RTCMDATA9 Partial Differential GPS Corrections *DGPS_Tx*

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs. This log is the same as the RTCMDATA1 log but there are only corrections for a maximum of 3 satellites.

Message ID: **404**

Log Type: **Synch**

Recommended Input:

log rtcmdata9a ontime 10

ASCII Example:

```
#RTCMDATA9A,COM1,0,68.5,FINESTEERING,1420,506833.000,00180020,37f9,1899;
9,0,4721,0,0,6,
3,
0,0,26,22639,11,231,
0,0,19,-4387,-22,134,
0,0,3,-14572,-27,124*6016236c
```

RTCM9 Partial Satellite Set Differential Corrections

RTCM Type 9 messages follow the same format as Type 1 messages. However, unlike a Type 1 message, Type 9 does not require a complete satellite set. This allows for much faster differential correction data updates to the rover stations, thus improving performance and reducing latency.

Type 9 messages should give better performance with slow or noisy data links.

The base station transmitting RTCM Type 9 corrections with an OEMStar must be operating with a high-stability clock to prevent degradation of navigation accuracy due to the unmodeled clock drift that can occur between Type 9 messages. The OEMStar does not support external clocks at this time.

Structure:

Type 9 messages contain the following information for a group of three satellites in view at the base station:

- Scale factor
- User Differential Range Error
- Satellite ID
- Pseudorange correction
- Range-rate correction
- Issue of Data (IOD)

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA9 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health	Ulong	4	H+20
8	#prn	Number of PRNs with information to follow (maximum of 3)	Ulong	4	H+24
9	scale	Scale where 0 = 0.02 m and 0.002 m/s 1 = 0.32 m and 0.032 m/s	Ulong	4	H+28
10	UDRE	User differential range error	Ulong	4	H+32
11	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see *Section 1.3* on *page 26*.)	Ulong	4	H+36
12	psr corr	Scaled pseudorange correction (m)	Long	4	H+40
13	rate corr	Scaled range rate correction	Long	4	H+44
14	IOD	Issue of data	Long	4	H+48
15...	Next PRN offset = H+28 + (#prns x 24)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.65 RTCMDATA15 Ionospheric Corrections *DGPS_Tx*

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs.

Message ID: **397**

Log Type: **Synch**

Recommended Input:

log rtcmdata15a ontime 10

ASCII Example:

```
#RTCMDATA15A,COM1,0,74.5,FINESTEERING,1117,160783.000,00100020,9601,399;
15,0,3971,7799968,5163500,6,
10,
0,0,3,1631,445,
0,0,15,1423,-222,
0,0,18,1275,-334,
0,0,21,1763,-334,
0,0,17,1454,-556,
0,0,6,2063,0,
0,0,26,1579,222,
0,0,23,1423,-111,
0,0,28,1874,445,
0,0,22,2146,-445*19ed193f
```

This data message provides data to continually enable you to remove ionospheric components from received pseudorange corrections. The *ion rate* and *ion delay* fields can be added just like Type 1 corrections to provide “iono-free” data collection.

RTCM15 Ionospheric Corrections

RTCM Type 15 messages support the broadcast of ionospheric delay and rate of change measurements for each satellite as determined by the base station receiver. They are used to improve the ionospheric de-correlation that would otherwise be experienced by a rover at a long distance from the base. This log works in conjunction with Type 1 messages using dual frequency receivers. Type 15 messages are broadcast every 5-10 minutes and follow the RTCM standard for Type 15 messages.

Type 15 messages enable the rover to continuously remove the ionospheric component from received pseudorange corrections. The delay and rate terms are added like Type 1 corrections to provide the total ionospheric delay at a given time, which is then subtracted from the pseudorange corrections. The resulting corrections are then "iono-free". The rover subtracts its measurements (or estimates) of ionospheric delay from its own pseudorange measurements and applies the iono-free corrections.

Structure:

Type 15 messages contain the following information for each satellite in view at the base station:

- Satellite ID
- Ionospheric delay
- Iono rate of change

When operating as a base station, the receiver must be in FIX POSITION mode, have the PDPFILTER mode disabled, and have the INTERFACEMODE command set before the data can be correctly logged. You must also log the RTCM Type 1 corrections. See *pages 88* and *100* respectively.

When operating as a rover station, the receiver COM port receiving the RTCM data must have its INTERFACEMODE command set.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA15 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health	Ulong	4	H+20
8	#prn	Number of PRNs with information to follow	Ulong	4	H+24
9	Reserved		Ulong	4	H+28
10	sat type	Satellite type where 0 = GPS 1 = GLONASS	Ulong	4	H+32
11	PRN/slot	Satellite PRN number of range measurement (GPS: 1 to 32,SBAS: 120 to 138 and for GLONASS, see *page 26*.)	Ulong	4	H+36
12	ion delay	Ionospheric delay (cm)	Ulong	4	H+40
13	ion rate	Ionospheric rate (0.05 cm / min.)	Long	4	H+44
14...	Next PRN offset = H+28 + (#prns x 20)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.66 RTCMDATA16 Special Message *DGPS_Tx*

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs.

Message ID: **398**

Log Type: **Synch**

Recommended Input:

log rtcmdata16a once

ASCII Example:

```
#RTCMDATA16A,COM1,0,65.0,FINESTEERING,1420,507147.000,00180020,2922,1899;
16,0,5245,0,0,6,37,"base station will shut down in 1 hour"*ac5ee822
```

RTCM16 Special Message

This log contains a special ASCII message that can be displayed on a printer or monitor. Once set, the message can then be issued at the required intervals with the “LOG *port* RTCM16 *interval*” command. The Special Message setting can be verified in the RXCONFIGA log, see *page 345*.

The RTCM16 data log follows the RTCM Standard Format. Words 1 and 2 contain RTCM header information followed by words 3 to *n* (where *n* is variable from 3 to 32) which contain the special message ASCII text. Up to 90 ASCII characters can be sent with each RTCM Type 16 message frame.

✉ Message Type 16 is a special ASCII message capable of being displayed on a printer or monitor. The message can be up to 90 characters long.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA16 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health	Ulong	4	H+20
8	#chars	Number of characters to follow	Ulong	4	H+24
9	character	Character	Char	4[a]	H+28
10...	Next char offset = H+28 + (#chars x 4)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

3.3.67 RTCMDATA31 GLONASS Differential Corrections DGPS_Tx & GLO

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs.

Message ID: **868**

Log Type: **Synch**

Recommended Input:

log rtcmdata31a ontime 2

ASCII Example:

```
#RTCMDATA31A,COM1,0,59.5,FINESTEERING,1417,171572.000,00140000,77c0,2698;
31,1000,3953,0,0,6,4,0,0,4,-506,-6,1,77,0,0,2,-280,-9,1,77,0,0,18,-645,
-4,1,77,0,0,19,-660,-6,1,77*29664bf3
```

RTCM31 Differential GLONASS Corrections (DGPS)

Message Type 31 provides differential GLONASS corrections.

The Type 31 format complies with the tentative RTCM 2.3 standard but is subject to change as the RTCM specifications change. It currently matches the Type 59GLO format, but unlike Type 31 which may change, Type 59GLO will stay in the same format.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA31 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health	Ulong	4	H+20
8	#recs	Number of records to follow	Ulong	4	H+24
9	scale	Scale factor	Long	4	H+28
10	udre	User differential range error	Ulong	4	H+32
11	prn	Satellite ID	Ulong	4	H+36
12	cor	Correction	Int	4	H+40
13	cor rate	Correction rate	Int	4	H+44
14	change	Change bit	Ulong	4	H+48
15	τ_K	Time of day	Ulong	4	H+52
16	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
17	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.68 RTCMDATA36 Special Message DGPS_Tx & GLO

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs.

Message ID: **879**

Log Type: **Synch**

Recommended Input:

log rtcmdata36a once

ASCII Example:

```
#RTCMDATA36A,COM1,0,64.5,FINESTEERING,1399,237113.869,00500000,
f9f5,35359;36,0,5189,0,0,6,11,"QUICK\d166\d146\d174\d144\d140"
*8bdeae71
```

RTCM36 Special Message Including Russian Characters

This log contains a special ASCII message that can be displayed on a printer or terminal. The base station wishing to log this message out to rover stations that are logged onto a computer, must use the SETRTCM36T command to set the required ASCII text message. Once set, the message can then be issued at the required intervals with the "LOG *port* RTCM36 *interval*" command. The Special Message setting can be verified in the RXCONFIGA log, see *page 345*. The received ASCII text can be displayed at the rover by logging RTCM36T ONNEW.

The RTCM36 data log follows the RTCM Standard Format. Words 1 and 2 contain RTCM header information followed by words 3 to *n* (where *n* is variable from 3 to 32) which contain the special message ASCII text. Up to 90 ASCII characters, including an extended ASCII set as shown in *Table 33* on *page 153*, can be sent with each RTCM Type 36 message frame.

✉ The ASCII extended character set includes Cyrillic characters to provide, for example, Russian language messages.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA36 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health	Ulong	4	H+20
8	#chars	Number of characters to follow	Ulong	4	H+24
9	character	Character	Char	4[a]	H+28
10...	Next char offset = H+28 + (#chars x 4)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

3.3.69 RTCMDATA59GLO NovAtel Proprietary GLONASS Differential Corrections *DGPS_Tx & GLO*

See *Section 3.3.62* starting on *page 326* for information about RTCM standard logs.

Message ID: **905**

Log Type: **Synch**

Recommended Input:

log rtcmdata59gloa ontime 2

ASCII Example:

```
#RTCMDATA59GLOA,COM1,0,71.5,FINESTEERING,1420,509339.000,00100008,e896,2733;
59,10,2898,0,0,6,110,2,0,0,19,-459,-9,0,56,0,0,4,570,-7,1,56*00dee641
```

The Type 31 format, see *page 338*, currently matches the Type 59GLO format, but unlike Type 31 which may change, Type 59GLO will stay in the same format. The Type 31 format complies with the tentative RTCM 2.3 standard but is subject to change as the RTCM specifications change.

RTCM59GLO Differential GLONASS Corrections (DGPS)

Message Type 59GLO provides differential GLONASS corrections.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA-59GLO header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris	Ulong	4	H+8
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health	Ulong	4	H+20
8	subtype	Message subtype	Uchar	4 [a]	H+24
9	#recs	Number of records to follow	Ulong	4	H+28
10	scale	Scale factor	Long	4	H+32
11	udre	User differential range error	Ulong	4	H+36
12	prn	Satellite ID	Ulong	4	H+40
13	cor	Correction	Int	4	H+44
14	cor rate	Correction rate	Int	4	H+48
15	change	Change bit	Ulong	4	H+52
16	τ_K	Time of day	Ulong	4	H+56
17	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
18	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment.

3.3.70 RTCMV3 Standard Logs

The OEMStar does not currently transmit carrier phase corrections.

The OEMStar can be configured to receive RTCMV3 corrections and compute a DGPS (pseudorange) position.

The GLONASS option is required for GLONASS RTCMV3 corrections to be used in the DGPS position.

Table 67: RTCMV3 Corrections

Type of Log	Log Name	Description
GPS-only	RTCM1001	L1-only RTK observables
GPS-only	RTCM1002	Extended L1-only RTK observables
GPS-only	RTCM1003	L1 and L2 RTK observables
GPS-only	RTCM1004	Extended L1 and L2 RTK observables
	RTCM1005	Stationary RTK base station antenna reference point (ARP)
	RTCM1006	Stationary RTK base station ARP with antenna height
	RTCM1007	Extended antenna description and setup information
	RTCM1008	Extended antenna reference station description and serial number
GLONASS-only	RTCM1009	L1-only RTK
GLONASS-only	RTCM1010	Extended L1-only RTK
GLONASS-only	RTCM1011	L1/L2 RTK
GLONASS-only	RTCM1012	Extended L1/L2 RTK
GPS-only	RTCM1019	Ephemerides
GLONASS-only	RTCM1020	Ephemerides

3.3.71 RXCONFIG Receiver Configuration

This log is used to output a list of all current command settings. When requested, an RXCONFIG log is output for each setting. See also the LOGLIST log on *page 267* for a list of currently active logs.

Message ID: 128

Log Type: Polled

Recommended Input:

log rxconfiga once

ASCII Example[1]:

```
#RXCONFIGA,COM1,71,47.5,APPROXIMATE,1337,333963.260,00000000,f702,1984;
#ADJUST1PPSA,COM1,71,47.5,APPROXIMATE,1337,333963.260,00000000,f702,1984;
OFF,ONCE,0*ba85a20b*91f89b07
#RXCONFIGA,COM1,70,47.5,APPROXIMATE,1337,333963.398,00000000,f702,1984;
#ANTENNAPOWERA,COM1,70,47.5,APPROXIMATE,1337,333963.398,00000000,f702,1984;
ON*d12f6135*8f8741be
#RXCONFIGA,COM1,69,47.5,APPROXIMATE,1337,333963.455,00000000,f702,1984;
#CLOCKADJUSTA,COM1,69,47.5,APPROXIMATE,1337,333963.455,00000000,f702,1984;
ENABLE*0af36d92*b13280f2
...
#RXCONFIGA,COM1,7,47.5,APPROXIMATE,1337,333966.781,00000000,f702,1984;
#STATUSCONFIGA,COM1,7,47.5,APPROXIMATE,1337,333966.781,00000000,f702,1984;
CLEAR,COM2,0*a6141e28*d0bba9f2
#RXCONFIGA,COM1,2,47.5,APPROXIMATE,1337,333967.002,00000000,f702,1984;
#WAASECUTOFFA,COM1,2,47.5,APPROXIMATE,1337,333967.002,00000000,f702,1984;
-5.000000000*b9b11096*2e8b77cf
#RXCONFIGA,COM1,1,47.5,FINESTEERING,1337,398382.787,00000000,f702,1984;
#LOGA,COM1,1,47.5,FINESTEERING,1337,398382.787,00000000,f702,1984;
COM1,BESTPOSA,ONNEW,0.000000,0.000000,NOHOLD*a739272d*6692c084
#RXCONFIGA,COM1,0,47.5,FINESTEERING,1337,400416.370,00000000,f702,1984;
#LOGA,COM1,0,47.5,FINESTEERING,1337,400416.370,00000000,f702,1984;
COM2,PASSCOM2A,ONCHANGED,0.000000,0.000000,NOHOLD*55fc0c62*17086d18
```

***WARNING!:* Do not use undocumented commands or logs! Doing so may produce errors and void your warranty.**

1. The embedded CRCs are flipped to make the embedded messages recognizable to the receiver. For example, consider the first embedded message above.

   91f89b07: 10010001111110001001101100000111

   11100000110110010001111110001001:e0d91f89

   Its CRC is really e0d91f89.

✉ The RXCONFIG log can be used to ensure that your receiver is set up correctly for your application.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RXCONFIG header	Log header	-	H	0
2	e header	Embedded header	-	h	H
3	e msg	Embedded message	Varied	a	H + h
4	e xxxx	Embedded (inverted) 32-bit CRC (ASCII and Binary only). The embedded CRC is inverted so that the receiver does not recognize the embedded messages as messages to be output but continues with the RXCONFIG message. If you wish to use the messages output from the RXCONFIG log, simply flip the embedded CRC around for individual messages.	Long	4	H+ h + a
5	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+ h + a + 4
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.72 RXSTATUS Receiver Status

This log conveys various status parameters of the GPS receiver system. These include the Receiver Status and Error words which contain several flags specifying status and error conditions. If an error occurs (shown in the Receiver Error word) the receiver idles all channels, turns off the antenna, and disables the RF hardware as these conditions are considered to be fatal errors. The log contains a variable number of status words to allow for maximum flexibility and future expansion.

The receiver gives the user the ability to determine the importance of the status bits. In the case of the Receiver Status, setting a bit in the priority mask causes the condition to trigger an error. This causes the receiver to idle all channels, turn off the antenna, and disable the RF hardware, the same as if a bit in the Receiver Error word is set. Setting a bit in an Auxiliary Status priority mask causes that condition to set the bit in the Receiver Status word corresponding to that Auxiliary Status. See also the STATUSCONFIG command on *page 156*.

✉ Field #4, the receiver status word as represented in *Table* , is also in Field #8 of the header. See the *ASCII Example* below and *Table* on *page 347* for clarification.

Refer also to the chapter on *Built-In Status Tests* in the *OEMStar Installation and Operation User Manual*.

Message ID: **93**

Log Type: **Asynch**

Recommended Input:

log rxstatusa onchanged

ASCII Example:

```
#RXSTATUSA,COM1,0,43.5,FINESTEERING,1337,407250.846,00000000,643c,1984;
00000000,4,00000000,00000000,00000000,00000000,00000083,00000008,00000000,
00000000,00000000,00000000,00000000,00000000,00000000,00000000,00000000,
00000000*ba27dfae
```

✉ Receiver errors automatically generate event messages. These event messages are output in RXSTATUSEVENT logs. It is also possible to have status conditions trigger event messages to be generated by the receiver. This is done by setting/clearing the appropriate bits in the event set/clear masks. The set mask tells the receiver to generate an event message when the bit becomes set. Likewise, the clear mask causes messages to be generated when a bit is cleared. See the STATUSCONFIG command on *page 156* for details.

If you wish to disable all these messages without changing the bits, simply UNLOG the RXSTATUSEVENT logs on the appropriate ports. See also the UNLOG command on *page 165*.

Table 68: Receiver Error

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Dynamic Random Access Memory (DRAM) status [a]	OK	Error
	1	0x00000002	Invalid firmware	OK	Error
	2	0x00000004	ROM status	OK	Error
	3	Reserved			
N1	4	0x00000010	Electronic Serial Number (ESN) access status	OK	Error
	5	0x00000020	Authorization code status	OK	Error
	6	0x00000040	Slow ADC status	OK	Error
	7	0x00000080	Supply voltage status	OK	Error
N2	8	0x00000100	Reserved		
	9	0x00000200			
	10	0x00000400	Processor status	OK	Error
	11	0x00000800	PLL RF1 hardware status - L1	OK	Error
N3	12	0x00001000	Reserved		
	13	0x00002000	RF1 hardware status - L1	OK	Error
	14	0x00004000	Reserved		
	15	0x00008000	NVM status	OK	Error
N4	16	0x00010000	Software resource limit	OK	Error
	17	0x00020000	Model not valid for this receiver	OK	Error
	18	0x00040000	Reserved		
	19	0x00080000			

Continued on the following page

Table 68: Receiver Error (continued)

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N5	20	0x00100000	Remote loading has begun	No	Yes
	21	0x00200000	Export restriction	OK	Error
	22	0x00400000	Reserved		
	23	0x00800000			
N6	24	0x01000000			
	25	0x02000000			
	26	0x04000000			
	27	0x08000000			
N7	28	0x10000000			
	29	0x20000000			
	30	0x40000000			
	31	0x80000000	Component hardware failure	OK	Error

a. RAM failure on an OEMStar card may also be indicated by a flashing red LED.

Table 69: Receiver Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Error flag, see *Table* , on *page 347*	No error	Error
	1	0x00000002	Temperature status	Within specifications	Warning
	2	0x00000004	Voltage supply status	OK	Warning
	3	0x00000008	Antenna power status See *ANTENNAPOWER* on *Page 52*	Powered	Not powered
N1	4	0x00000010	Reserved		
	5	0x00000020	Reserved		
	6	0x00000040	Antenna shorted flag	OK	Shorted
	7	0x00000080	CPU overload flag	No overload	Overload
N2	8	0x00000100	COM1 buffer overrun flag	No overrun	Overrun
	9	0x00000200	COM2 buffer overrun flag	No overrun	Overrun
	10	0x00000400	Reserved		
	11	0x00000800	USB buffer overrun flag [a]	No overrun	Overrun
N3	12	0x00001000	Reserved		
	13	0x00002000			
	14	0x00004000			
	15	0x00008000	RF1 AGC status	OK	Bad
N4	16	0x00010000	Reserved		
	17	0x00020000	RF2 AGC status	OK	Bad
	18	0x00040000	Almanac flag/UTC known	Valid	Invalid
	19	0x00080000	Position solution flag	Valid	Invalid
N5	20	0x00100000	Position fixed flag, see *FIX* on *page 88*	Not fixed	Fixed
	21	0x00200000	Clock steering status	Enabled	Disabled
	22	0x00400000	Clock model flag	Valid	Invalid
	23	0x00800000	Reserved		

Continued on the following page

Table 69: Receiver Status (continued)

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N6	24	0x01000000	Software resource	OK	Warning
	25	0x02000000	Reserved		
	26	0x04000000			
	27	0x08000000			
N7	28	0x10000000			
	29	0x20000000	Auxiliary 3 status event flag	No event	Event
	30	0x40000000	Auxiliary 2 status event flag	No event	Event
	31	0x80000000	Auxiliary 1 status event flag	No event	Event

a. This flag indicates if any of the three USB ports (USB1, USB2, or USB3) are overrun. See the auxiliary status word for the specific port for which the buffer is overrun.

Table 70: Auxiliary 1 Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Reserved		
	1	0x00000002			
	2	0x00000004			
	3	0x00000008	Position averaging	Off	On
N1	4	0x00000010	Reserved		
	5	0x00000020			
	6	0x00000040			
	7	0x00000080	USB connection status	Connected	Not connected
N2	8	0x00000100	USB1 buffer overrun flag	No overrun	Overrun
	9	0x00000200	USB2 buffer overrun flag	No overrun	Overrun
	10	0x00000400	USB3 buffer overrun flag	No overrun	Overrun
	11	0x00000800	Reserved		

Table 71: Auxiliary 2 Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x0000001	Reserved		

Table 72: Auxiliary 3 Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x0000001	Reserved		

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RXSTATUS header	Log header		H	0
2	error	Receiver error (see *Table 68, Receiver Error* on *page 348*). A value of zero indicates no errors.	ULong	4	H
3	# stats	Number of status codes (including Receiver Status)	ULong	4	H+4
4	rxstat	Receiver status word (see *Table 69, Receiver Status* on *page 350*)	ULong	4	H+8
5	rxstat pri	Receiver status priority mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+12
6	rxstat set	Receiver status event set mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+16
7	rxstat clear	Receiver status event clear mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+20
8	aux1stat	Auxiliary 1 status word (see *Table 70, Auxiliary 1 Status* on *page 352*)	ULong	4	H+24
9	aux1stat pri	Auxiliary 1 status priority mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+28
10	aux1stat set	Auxiliary 1 status event set mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+32
11	aux1stat clear	Auxiliary 1 status event clear mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+36
12	aux2stat	Auxiliary 2 status word (see *Table 71, Auxiliary 2 Status* on *page 352*)	ULong	4	H+40
13	aux2stat pri	Auxiliary 2 status priority mask, which can be set using the STATUSCONFIG command (*page 157)*	ULong	4	H+44
14	aux2stat set	Auxiliary 2 status event set mask, which can be set using the STATUSCONFIG command	ULong	4	H+48

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
15	aux2stat clear	Auxiliary 2 status event clear mask, which can be set using the STATUSCONFIG command	ULong	4	H+52
16	aux3stat	Auxiliary 3 status word (see *Table 72, Auxiliary 3 Status* on *page 352*)	ULong	4	H+56
17	aux3stat pri	Auxiliary 3 status priority mask, which can be set using the STATUSCONFIG command (see *page 156)*	ULong	4	H+60
18	aux3stat set	Auxiliary 3 status event set mask, which can be set using the STATUSCONFIG command	ULong	4	H+64
19	aux3stat clear	Auxiliary 3 status event clear mask, which can be set using the STATUSCONFIG command	ULong	4	H+68
20...	Next status code offset = H + 8 + (# stats x 16)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+8+(#stats x 64)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.73 RXSTATUSEVENT Status Event Indicator

This log is used to output event messages as indicated in the RXSTATUS log. An event message is automatically generated for all receiver errors, which are indicated in the receiver error word. In addition, event messages can be generated when other conditions, which are indicated in the receiver status and auxiliary status words, are met. Whether or not an event message is generated under these conditions is specified using the STATUSCONFIG command, which is detailed starting on *page 156*.

On start-up, the receiver is set to log the RXSTATUSEVENTA log ONNEW on all ports. You can remove this message by using the UNLOG command, see *page 165*.

✉ See also the chapter on *Built-In Status Tests* in the *OEMStar Installation and Operation User Manual*.

Message ID: **94**
Log Type: **Asynch**

Recommended Input:

log rxstatuseventa onchanged

ASCII Example 1:

```
#RXSTATUSEVENTA,COM1,0,17.0,FREEWHEELING,1337,408334.510,00480000,b967,1984;
STATUS,19,SET,"No Valid Position Calculated"*6de945ad
```

ASCII Example 2:

```
#RXSTATUSEVENTA,COM1,0,41.0,FINESTEERING,1337,408832.031,01000400,b967,1984;
STATUS,10,SET,"COM2 Transmit Buffer Overrun"*5b5682a9
```

✉ When a fatal event occurs (for example, in the event of a receiver hardware failure), a bit is set in the receiver error word, part of the RXSTATUS log on *page 347*, to indicate the cause of the problem. Bit 0 is set in the receiver status word to show that an error occurred, the error strobe is driven high, and the LED flashes red and orange showing an error code. An RXSTATUSEVENT log is generated on all ports to show the cause of the error. Receiver tracking is disabled at this point but command and log processing continues to allow you to diagnose the error. Even if the source of the error is corrected at this point, the receiver must be reset to resume normal operation.

Table 73: Status Word

Word (binary)	Word (ASCII)	Description
0	ERROR	Receiver Error word, see *Table 68* on *page 348*
1	STATUS	Receiver Status word, see *Table 69* on *page 350*
2	AUX1	Auxiliary 1 Status word, see *Table 70* on *page 352*
3	AUX2	Auxiliary 2 Status word see *Table 71* on *page 352*
4	AUX3	Auxiliary 3 Status word see *Table 72* on *page 352*

Table 74: Event Type

Event (binary)	Event (ASCII)	Description
0	CLEAR	Bit was cleared
1	SET	Bit was set

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RXSTATUSEVENT header	Log header		H	0
2	word	The status word that generated the event message (see *Table 73* above)	Enum	4	H
3	bit position	Location of the bit in the status word (see *Table 69* starting on *Page 350* for the receiver status table or the auxiliary status tables on *page 352*)	Ulong	4	H+4
4	event	Event type (see *Table 74* above)	Enum	4	H+8
3	description	This is a text description of the event or error	Char[32]	32	H+12
5	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.74 SATVIS Satellite Visibility

Satellite visibility log with additional satellite information.

The SATVIS log is meant to provide a brief overview. The satellite positions and velocities used in the computation of this log are based on Almanac orbital parameters, not the higher precision Ephemeris parameters.

In the SATVIS log output there may be double satellite number entries. These are GLONASS antipodal satellites that are in the same orbit plane separated by 180 degrees latitude. For more information about GLONASS, refer to the Knowledge and Learning page in the Support section of our Web site at www.novatel.com.

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

Recommended Input:

log satvisa ontime 60

ASCII Example:

```
#SATVISA,COM1,0,46.5,FINESTEERING,1363,238448.000,00000000,0947,2277;
TRUE,TRUE,61,
7,0,0,86.1,77.4,-69.495,-69.230,
2,0,0,66.3,70.7,-1215.777,-1215.512,
58,7,1,64.7,324.5,1282.673,1282.939,
58,12,0,64.7,324.5,1283.808,1284.074,
30,0,0,60.8,267.7,299.433,299.699,
5,0,0,58.1,205.5,-1783.823,-1783.557,
42,7,1,53.0,79.0,17.034,17.300,
42,9,1,53.0,79.0,20.108,20.373,
...
19,0,0,-86.8,219.3,88.108,88.373*a0b7cc0bConsider sky visibility at each of
the base and rover receivers in a differential setup.
```

The accuracy and reliability of differential messages is proportional to the number of common satellites that are visible at the base and rover. Therefore, if the sky visibility at either station is poor, you might consider increasing the occupation times. This condition is best measured by monitoring the number of visible satellites during data collection along with the PDOP value (a value less than 3 is ideal). Also, the location and number of satellites in the sky is constantly changing. As a result, some periods in the day are slightly better for data collection than others. Use the SATVIS log to monitor satellite visibility. The PSRDOP log, see *page 290*, can be used to monitor the PDOP values.

Site conditions surrounding the station that may affect satellite visibility and can generate noise in the data are water bodies, buildings, trees and nearby vehicles.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	SATVIS header	Log header		H	0
2	sat vis	Is satellite visibility valid? 0 = FALSE 1 = TRUE	Enum	4	H
3	comp alm	Was complete GPS almanac used? 0 = FALSE 1 = TRUE	Enum	4	H+4
4	#sat	Number of satellites with data to follow	Ulong	4	H+8
5	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see *Section 1.3* on *page 26*)	Short	2	H+12
6	glofreq	(GLONASS Frequency + 7), see *Section 1.3* on *page 26*	Short	2	H+14
7	health	Satellite health [a]	Ulong	4	H+16
8	elev	Elevation (degrees)	Double	8	H+20
9	az	Azimuth (degrees)	Double	8	H+28
10	true dop	Theoretical Doppler of satellite - the expected Doppler frequency based on a satellite's motion relative to the receiver. It is computed using the satellite's coordinates and velocity, and the receiver's coordinates and velocity. (Hz)	Double	8	H+36
11	app dop	Apparent Doppler for this receiver - the same as Theoretical Doppler above but with clock drift correction added. (Hz)	Double	8	H+44
12	Next satellite offset = H + 12 + (#sat x 40)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+12+ (#sat x 40)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. Satellite health values may be found in ICD-GPS-200. To obtain copies of ICD-GPS-200, refer to the ARINC Web site at www.arinc.com.

3.3.75 SATXYZ SV Position in ECEF Cartesian Coordinates

When combined with a RANGE log, this data set contains the decoded satellite information necessary to compute the solution: satellite coordinates (ECEF WGS84), satellite clock correction, ionospheric corrections and tropospheric corrections. See the calculation examples in the usage box below. Only those satellites that are healthy are reported here. See also *Figure 7* on *page 209*.

Message ID: **270**

Log Type: **Synch**

Recommended Input:

log satxyz ontime 1

ASCII Example:

```
#SATXYZA,COM1,0,45.5,FINESTEERING,1337,409729.000,00000000,6f3c,1984;0.0,11,
1,8291339.5258,-17434409.5059,18408253.4923,1527.199,2.608578998,
3.200779818,0.000000000,0.000000000,
...
14,18951320.4329,-16297117.6697,8978403.7764,-8190.088,4.139015349,
10.937283220,0.000000000,0.000000000*8a943244
```

The OEMStar uses positive numbers for ionospheric and tropospheric corrections. A positive clock offset indicates that the clock is running ahead of the reference time. Positive ionospheric and tropospheric corrections are added to the geometric ranges or subtracted from the measured pseudoranges. For example:

P = p + pd + c(dT - dt) + d(ion) + d(trop) + Ep

is equivalent to

P - c(dT - dt) - d(ion) - d(trop) = p + pd + Ep

where

P = measured pseudorange

p = geometric range

pd = orbit error

dt = satellite clock offset

dT = receiver clock offset

d(ion) = ionospheric delay

d(trop) = tropospheric delay

c = speed of light

Ep = noise and multipath.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	SATXYZ header	Log header		H	0
2	Reserved		Double	8	H
3	#sat	Number of satellites with Cartesian information to follow	Ulong	4	H+8
4	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see *Section 1.3* on *page 26*.)	Ulong	4	H+12
5	x	Satellite X coordinates (ECEF, m)	Double	8	H+16
6	y	Satellite Y coordinates (ECEF, m)	Double	8	H+24
7	z	Satellite Z coordinates (ECEF, m)	Double	8	H+32
8	clk corr	Satellite clock correction (m)	Double	8	H+40
9	ion corr	Ionospheric correction (m)	Double	8	H+48
10	trop corr	Tropospheric correction (m)	Double	8	H+56
11	Reserved		Double	8	H+64
12			Double	8	H+72
13	Next satellite offset = H + 12 + (#sat x 68)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+12+ (#sat x 68)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.76 TIME Time Data

This log provides several time related pieces of information including receiver clock offset and UTC time and offset. It can also be used to determine any offset in the PPS signal relative to GPS reference time.

To find any offset in the PPS signal, log the TIME log 'ontime' at the same rate as the PPS output. For example, if the PPS output is configured to output at a rate of 0.5 seconds, see the PPSCONTROL command on *page 125*, log the TIME log 'ontime 0.5' as follows:

```
log time ontime 0.5
```

The TIME log offset field can then be used to determine any offset in PPS output relative to GPS reference time.

Message ID: **101**

Log Type: **Synch**

Recommended Input:

log timea ontime 1

ASCII Example:

```
#TIMEA,COM1,0,50.5,FINESTEERING,1337,410010.000,00000000,9924,1984;
VALID,1.953377165e-09,7.481712815e-08,-12.99999999492,2005,8,25,17,
53,17000,VALID*e2fc088c
```

✉ The header of the TIME log gives you the GPS reference time (the week number since January 5th, 1980) and the seconds into that week. The TIME log outputs the UTC offset (offset of GPS reference time from UTC time) and the receiver clock offset from GPS reference time.

If you want the UTC time in weeks and seconds, take the week number from the header. Then take the seconds into that week, also from the header, and add the correction to the seconds using the 2 offsets. Ensure you take care of going negative or rollover (going over the total number of seconds, 604800, in a week. In the case of rollover, add a week and the left over seconds become the seconds into this new week. If negative, subtract a week and the remainder from the seconds of that week. For example:

TIME COM1 0 73.5 FINESTEERING 1432 235661.000 00000000 9924 2616

VALID -0.000000351 0.000000214 -14.00000000106 2007 6 19 17 27 27000 VALID

From the time information above:

GPS reference time = 1432 (GPS reference week), 235661.000 (GPS seconds) from the header.

From the UTC offset row in the TIME log description on *page 362*:

UTC time = GPS reference time + offset + UTC offset

UTC time

= week 1432, 235661.000 s - 0.000000132 (offset) - 14.00000000105 (UTC offset)

= week 1432, seconds 235646.99999986695

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	TIME header	Log header		H	0
2	clock status	Clock model status (not including current measurement data), see *Table 47* on *page 211*	Enum	4	H
3	offset	Receiver clock offset, in seconds from GPS reference time. A positive offset implies that the receiver clock is ahead of GPS reference time. To derive GPS reference time, use the following formula: GPS reference time = receiver time - offset	Double	8	H+4
4	offset std	Receiver clock offset standard deviation.	Double	8	H+12
5	utc offset	The offset of GPS reference time from UTC time, computed using almanac parameters. UTC time is GPS reference time plus the current UTC offset plus the receiver clock offset: UTC time = GPS reference time + offset + UTC offset	Double	8	H+20
6	utc year	UTC year	Ulong	4	H+28
7	utc month	UTC month (0-12) [a]	Uchar	1	H+32
8	utc day	UTC day (0-31) [a]	Uchar	1	H+33
9	utc hour	UTC hour (0-23)	Uchar	1	H+34
10	utc min	UTC minute (0-59)	Uchar	1	H+35
11	utc ms	UTC millisecond (0-60999) [b]	Ulong	4	H+36
12	utc status	UTC status 0 = Invalid 1 = Valid 2 = Warning[c]	Enum	4	H+40
13	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. If UTC time is unknown, the values for month and day are 0.

b. Maximum of 60999 when leap second is applied.

c. Indicates that the leap seconds value is used as a default due to the lack of an almanac.

3.3.77 TRACKSTAT Tracking Status

This log provides channel tracking status information for each of the receiver parallel channels.

Message ID: **83**

Log Type: **Synch**

Recommended Input:

log trackstata ontime 1

ASCII Example:

```
#TRACKSTATA,COM1,0,49.5,FINESTEERING,1337,410139.000,00000000,457c,1984;
SOL_COMPUTED,PSRDIFF,5.0,30,
1,0,18109c04,21836080.582,-2241.711,50.087,1158.652,0.722,GOOD,0.973,
30,0,18109c24,24248449.644,-2588.133,45.237,939.380,-0.493,GOOD,0.519,
...
14,0,18109da4,24747286.206,-3236.906,46.650,1121.760,-0.609,GOOD,0.514,
0,0,0c0221c0,0.000,0.000,0.047,0.000,0.000,NA,0.000*255a732e
```

Table 75: Range Reject Code

Reject Code (binary)	Reject Code (ASCII)	Description
0	GOOD	Observation is good
1	BADHEALTH	Bad satellite health is indicated by ephemeris data
2	OLDEPHEMERIS	Old ephemeris due not being updated during the last 3 hours
3	ECCENTRICANOMALY	Eccentric anomaly error during computation of the satellite's position
4	TRUEANOMALY	True anomaly error during computation of the satellite's position
5	SATCOORDINATE-ERROR	Satellite coordinate error during computation of the satellite's position
6	ELEVATIONERROR	Elevation error due to the satellite being below the cut-off angle
7	MISCLOSURE	Misclosure too large due to excessive gap between estimated and actual positions
8	NODIFFCORR	No compatible differential correction is available for this particular satellite
9	NOEPHEMERIS	Ephemeris data for this satellite has not yet been received
10	INVALIDIODE	Invalid IODE (Issue Of Data Ephemeris) due to mismatch between differential stations
11	LOCKEDOUT	Locked out: satellite is excluded by the user (LOCKOUT command)
12	LOWPOWER	Low power: satellite is rejected due to low carrier/noise ratio
16	NOIONOCORR	No compatible ionospheric correction is available for this particular satellite
17	NOTUSED	Observation is ignored and not used in the solution
99	NA	No observation (a reject code is not applicable)
100	BAD_INTEGRITY	The integrity of the pseudorange is bad

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	TRACKSTAT header	Log header		H	0
2	sol status	Solution status (see *Table 44, Solution Status* on *page 197*)	Enum	4	H
3	pos type	Position type (see *Table 43, Position or Velocity Type* on *page 196*)	Enum	4	H+4
4	cutoff	Tracking elevation cut-off angle	Float	4	H+8
5	# chans	Number of hardware channels with information to follow	Long	4	H+12
6	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see *Section 1.3* on *page 26*)	Short	2	H+16
7	glofreq	(GLONASS Frequency + 7), see *Section 1.3* on *page 26*	Short	2	H+18
8	ch-tr-status	Channel tracking status (see *Table 63, Channel Tracking Status* on *page 305*)	ULong	4	H+20
9	psr	Pseudorange (m) - if this field is zero but the channel tracking status in the previous field indicates that the card is phase locked and code locked, the pseudorange has not been calculated yet.	Double	8	H+24
10	Doppler	Doppler frequency (Hz)	Float	4	H+32
11	C/No	Carrier to noise density ratio (dB-Hz)	Float	4	H+36
12	locktime	Number of seconds of continuous tracking (no cycle slips)	Float	4	H+40
13	psr res	Pseudorange residual from pseudorange filter (m)	Float	4	H+44
14	reject	Range reject code from pseudorange filter (see *Table 75, Range Reject Code* on *page 364*)	Enum	4	H+48
15	psr weight	Pseudorange filter weighting	Float	4	H+52
16...	Next PRN offset = H + 16 + (#chans x 40)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+16+ (#chans x 40)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.78 VALIDMODELS Valid Model Information

This log gives a list of valid authorized models available and expiry date information.

If a model has no expiry date it reports the year, month and day fields as 0, 0 and 0 respectively.

Message ID: **206**

Log Type: **Polled**

Recommended Input:

log validmodelsa once

ASCII Example:

```
#VALIDMODELSA,COM1,0,54.0,FINESTEERING,1337,414753.310,00000000,342f,1984;
1,"LXGDMTS",0,0,0*16c0b1a3
```

Use the VALIDMODELS log to output a list of available models for the receiver. You can use the AUTH command, see *page 58*, to add a model and the MODEL command, see *page 115*, to change the currently active model. See the VERSION log on *page 367* for the currently active model.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	VALIDMODELS header	Log header		H	0
2	#mod	Number of models with information to follow	Ulong	4	H
3	model	Model name	String [max. 16]	Variable[a]	Variable
4	expyear	Expiry year	Ulong	4	Variable Max:H+20
5	expmonth	Expiry month	Ulong	4	Variable Max: H+24
6	expday	Expiry day	Ulong	4	Variable: Max: H+28
7...	Next model offset = H + 4 + (#mods x variable [max:28])				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	Variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.79 VERSION Version Information

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

A component may be hardware (for example, a receiver or data collector) or firmware in the form of applications or data (for example, data blocks for height models or user applications). See *Table 78, VERSION Log: Field Formats* on *page 369* for details on the format of key fields.

See also the VALIDMODELS log on *page 366*.

Message ID: **37**

Log Type: **Polled**

Recommended Input:

log versiona once

ASCII Example:

```
#VERSIONA,COM1,0,48.0,FINESTEERING,1598,252219.008,00000000,3681,5929;1,GPSCA
RD,"LXGDMTS","BHD09320026","M6XV1G-0.00F
TT","L6X010011RN0000","L6X010003RB0000","2010/Jul/22","14:27:12"*19a2d489
```

The VERSION log is a useful log as a first communication with your receiver. Once connected, using CDU or HyperTerminal, log VERSION and check that the output makes sense. Also, ensure that you have the receiver components you expected.

Figure 10: Logging Example in CDU

Table 76: Model Designators

Designator	Description
G	L1 GLONASS channels, frequencies to match GPS configuration
D	Transmit DGPS corrections
M	Measurements
T	10 Hz logging
S	GL1DE
A	API
I	RAIM

Table 77: Component Types

Binary	ASCII	Description
0	UNKNOWN	Unknown component
1	GPSCARD	OEMStar component
2	CONTROLLER	Data collector
3	ENCLOSURE	OEMStar card enclosure
4-6	Reserved	
981073921 (0x3A7A0001)	DB_USERAPP	User application firmware
981073925 (0x3A7A0005)	DB_USERAPPAUTO	Auto-starting user application firmware

a. Please refer to the Acronyms section of our *Introduction to GNSS Book*, available from our Web site at http://www.novatel.com/support/knowledge-and-learning/.

Table 78: VERSION Log: Field Formats

Field Type	Field Format (ASCII)	Description
hw version	P-RS-CCC	P = hardware platform (for example, M6XV1G) R = hardware revision (for example, 1.01) S = processor revision (for example, A) [a] CCC = COM port configuration (for example, 22T) [b]
sw version, boot version	PPPFFFFMMTRVVVV	PPP = product code (L6X for OEMStar) FFFF = feature release number MM = maintenance release number T = version type: Release (R), Special (S, C or E), Beta (B), Internal Development (A, D, M or N) R = distribution type: No Restrictions (N), Restricted (H), Boot Code (B) VVVV = version number
comp date	YYYY/MM/DD	YYYY = year MM = month DD = day (1 - 31)
comp time	HH:MM:SS	HH = hour MM = minutes SS = seconds

a. This field may be empty if the revision is not stamped onto the processor

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

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	VERSION header	Log header		H	0
2	# comp	Number of components (cards, and so on)	Long	4	H
3	type	Component type (see *Table 77, Component Types* on *page 368*)	Enum	4	H+4
4	model	The model designators are shown in *Table 76* on *Page 368*	Char[16]	16	H+8
5	psn	Product serial number	Char[16]	16	H+24
6	hw version	Hardware version, see *Table 78, VERSION Log: Field Formats* on *page 369*	Char[16]	16	H+40
7	sw version	Firmware software version, see *Table 78*	Char[16]	16	H+56
8	boot version	Boot code version, see *Table 78*	Char[16]	16	H+72
9	comp date	Firmware compile date, see *Table 78*	Char[12]	12	H+88
10	comp time	Firmware compile time, see *Table 78*	Char[12]	12	H+100
11...	Next component offset = H + 4 + (#comp x 108)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#comp x 108)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.80 WAAS0 Remove PRN from Solution SBAS

This message tells you, when you are using SBAS messages, not to use a specific PRN message for a period of time outlined in the SBAS signal specification.

See how the WAAS0 message relates to the SBAS testing modes in the SBASCONTROL command on *page 135*.

Message ID: 290
Log Type: Asynch

Recommended Input:

log WAAS0a onchanged

ASCII Example:

```
#WAAS0A,COM1,0,68.5,SATTIME,1093,161299.000,00040020,7d6a,209;122*e9a5ab08
```

Although the WAAS was designed for aviation users, it supports a wide variety of non-aviation uses including agriculture, surveying, recreation, and surface transportation, just to name a few. The WAAS signal has been available for non safety-of-life applications since August 24, 2000. Today, there are many non-aviation WAAS-enabled GPS receivers in use.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	WAAS0 header	Log header		H	0
2	prn	Source PRN message - also PRN not to use	Ulong	4	H
3	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4
4	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.81 WAAS1 PRN Mask Assignments SBAS

The PRN mask is given in WAAS1. The transition of the PRN mask to a new one (which will be infrequent) is controlled with the 2-bit IODP, which sequences to a number between 0 and 3. The same IODP appears in the applicable WAAS2, WAAS3, WAAS4, WAAS5, WAAS7, WAAS24 and WAAS25 messages. This transition would probably only occur when a new satellite is launched or when a satellite fails and is taken out of service permanently. A degraded satellite may be flagged as a don't use satellite temporarily.

Message ID: 291

Log Type: Asynch

Recommended Input:

log WAAS1a onchanged

ASCII Example:

```
#WAAS1A,COM1,0,24.5,SATTIME,1337,415802.000,00000000,5955,1984;
134,ffeffffe0000000000000000000040040000000000000000000,2*3633cf7b
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS1 message can be logged to view the data breakdown of WAAS frame 1 which contains information about the PRN mask assignment.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header		H	0
2	prn	Source PRN of message	Ulong	4	H
3	mask	PRN bit mask	Uchar[27]	28 [a]	H+4
4	iodp	Issue of PRN mask data	Ulong	4	H+32
5	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+36
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. In the binary log case, an additional 1 byte of padding is added to maintain 4-byte alignment

3.3.82 WAAS2 Fast Correction Slots 0-12 SBAS

WAAS2 are fast corrections for slots 0-12 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL command on *page 135* for details).

Message ID: 296

Log Type: Asynch

Recommended Input:

log WAAS2a onchanged

ASCII Example:

```
#WAAS2A,COM1,0,29.0,SATTIME,1337,415925.000,00000000,e194,1984;
134,2,2,3,-3,5,1,2047,-2,2047,2047,2047,2047,2047,-3,2,5,11,7,
8,14,8,14,14,14,14,14,6,12*8d8d2e1c
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS2 message can be logged to view the data breakdown of WAAS frame 2 which contains information about fast correction slots 0-12.

Table 79: Evaluation of UDREI

UDREI [a]	UDRE metres	$\sigma^2_{i.udre}$ metres^2
0	0.75	0.0520
1	1.0	0.0924
2	1.25	0.1444
3	1.75	0.2830
4	2.25	0.4678
5	3.0	0.8315
6	3.75	1.2992
7	4.5	1.8709
8	5.25	2.5465
9	6.0	3.3260
10	7.5	5.1968
11	15.0	20.7870
12	50.0	230.9661
13	150.0	2078.695
14	Not Monitored	Not Monitored
15	Do Not Use	Do Not Use

a. The σ^2UDRE broadcast in WAAS2, WAAS3, WAAS4, WAAS5, WAAS6 and WAAS24 applies at a time prior to or at the time of applicability of the associated corrections.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS2 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodf	Issue of fast corrections data	Ulong	4	H+4	-
4	iodp	Issue of PRN mask data	Ulong	4	H+8	-
5	prc0	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 0-12)	Long	4	H+12	-
6	prc1		Long	4	H+16	-
7	prc2		Long	4	H+20	-
8	prc3		Long	4	H+24	-
9	prc4		Long	4	H+28	-
10	prc5		Long	4	H+32	-
11	prc6		Long	4	H+36	-
12	prc7		Long	4	H+40	-
13	prc8		Long	4	H+44	-
14	prc9		Long	4	H+48	-
15	prc10		Long	4	H+52	-
16	prc11		Long	4	H+56	-
17	prc12		Long	4	H+60	-

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
18	udre0	udre(i): User differential range error indicator for the prn in slot i (i = 0-12)	Ulong	4	H+64	See *Table 79, Evaluation of UDREI* on *page 374*
19	udre1		Ulong	4	H+68	
20	udre2		Ulong	4	H+72	
21	udre3		Ulong	4	H+76	
22	udre4		Ulong	4	H+80	
23	udre5		Ulong	4	H+84	
24	udre6		Ulong	4	H+88	
25	udre7		Ulong	4	H+92	
26	udre8		Ulong	4	H+96	
27	udre9		Ulong	4	H+100	
28	udre10		Ulong	4	H+104	
29	udre11		Ulong	4	H+108	
30	udre12		Ulong	4	H+112	
31	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+116	-
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.83 WAAS3 Fast Corrections Slots 13-25 SBAS

WAAS3 are fast corrections for slots 13-25 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL command on *page 135* for details).

Message ID: 301

Log Type: Asynch

Recommended Input:

log WAAS3a onchanged

ASCII Example:

```
#WAAS3A,COM1,0,17.0,SATTIME,1337,415990.000,00000000,bff5,1984;
134,1,2,2047,0,2047,2047,-21,-4,2047,2047,-1,0,2,2047,6,14,5,
14,14,11,5,14,14,5,7,5,14,8*a25aebc5
```

✉ Each raw WAAS frame gives data for a specific frame decoder number. The WAAS3 message can be logged to view the data breakdown of WAAS frame 3 which contains information about fast correction slots 13-25.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS3 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodf	Issue of fast corrections data	Ulong	4	H+4	-
4	iodp	Issue of PRN mask data	Ulong	4	H+8	-
5	prc13	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 13-25)	Long	4	H+12	-
6	prc14		Long	4	H+16	-
7	prc15		Long	4	H+20	-
8	prc16		Long	4	H+24	-
9	prc17		Long	4	H+28	-
10	prc18		Long	4	H+32	-
11	prc19		Long	4	H+36	-
12	prc20		Long	4	H+40	-
13	prc21		Long	4	H+44	-
14	prc22		Long	4	H+48	-
15	prc23		Long	4	H+52	-
16	prc24		Long	4	H+56	-
17	prc25		Long	4	H+60	-

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
18	udre13	udre(i): User differential range error indicator for the prn in slot i (i = 13-25)	Ulong	4	H+64	See *Table 79, Evaluation of UDREI* on *page 374*
19	udre14		Ulong	4	H+68	
20	udre15		Ulong	4	H+72	
21	udre16		Ulong	4	H+76	
22	udre17		Ulong	4	H+80	
23	udre18		Ulong	4	H+84	
24	udre19		Ulong	4	H+88	
25	udre20		Ulong	4	H+92	
26	udre21		Ulong	4	H+96	
27	udre22		Ulong	4	H+100	
28	udre23		Ulong	4	H+104	
29	udre24		Ulong	4	H+108	
30	udre25		Ulong	4	H+112	
31	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+116	-
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.84 WAAS4 Fast Correction Slots 26-38 SBAS

WAAS4 are fast corrections for slots 26-38 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL on *page 135* command for details).

Message ID: **302**

Log Type: **Asynch**

Recommended Input:

log WAAS4a onchanged

ASCII Example:

```
#WAAS4A,COM1,0,58.0,SATTIME,1093,163399.000,00000020,b4b0,209;
122,0,3,2047,3,-1,2047,2047,2047,-3,-1,5,3,3,
2047,2,14,3,3,14,14,14,6,3,4,5,4,14,3*2e0894b1
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS4 message can be logged to view the data breakdown of WAAS frame 4 which contains information about fast correction slots 26-38.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS4 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodf	Issue of fast corrections data	Ulong	4	H+4	-
4	iodp	Issue of PRN mask data	Ulong	4	H+8	-
5	prc26	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 26-38)	Long	4	H+12	-
6	prc27		Long	4	H+16	-
7	prc28		Long	4	H+20	-
8	prc29		Long	4	H+24	-
9	prc30		Long	4	H+28	-
10	prc31		Long	4	H+32	-
11	prc32		Long	4	H+36	-
12	prc33		Long	4	H+40	-
13	prc34		Long	4	H+44	-
14	prc35		Long	4	H+48	-
15	prc36		Long	4	H+52	-
16	prc37		Long	4	H+56	-
17	prc38		Long	4	H+60	-

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
18	udre26	udre(i): User differential range error indicator for the prn in slot i (i = 26-38)	Ulong	4	H+64	See *Table 79, Evaluation of UDREI* on *page 374*
19	udre27		Ulong	4	H+68	
20	udre28		Ulong	4	H+72	
21	udre29		Ulong	4	H+76	
22	udre30		Ulong	4	H+80	
23	udre31		Ulong	4	H+84	
24	udre32		Ulong	4	H+88	
25	udre33		Ulong	4	H+92	
26	udre34		Ulong	4	H+96	
27	udre35		Ulong	4	H+100	
28	udre36		Ulong	4	H+104	
29	udre37		Ulong	4	H+108	
30	udre38		Ulong	4	H+112	
31	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+116	-
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.85 WAAS5 Fast Correction Slots 39-50 SBAS

WAAS5 are fast corrections for slots 39-50 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL command on *page 135* for details).

Message ID: 303

Log Type: Asynch

Recommended Input:

log WAAS5a onchanged

ASCII Example:

```
#WAAS5A,COM1,0,72.5,SATTIME,1093,161480.000,00040020,31d4,209;122,1,3,
-7,2047,2047,2047,-4,2047,2047,2047,9,2047,2047,-3,-2,11,14,14,14,4,14,14,14,
5,14,14,4,2*2bf0109b
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS5 message can be logged to view the data breakdown of WAAS frame 5 which contains information about fast correction slots 39-50.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS5 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodf	Issue of fast corrections data	Ulong	4	H+4	-
4	iodp	Issue of PRN mask data	Ulong	4	H+8	-
5	prc39	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 39-50)	Long	4	H+12	-
6	prc40		Long	4	H+16	-
7	prc41		Long	4	H+20	-
8	prc42		Long	4	H+24	-
9	prc43		Long	4	H+28	-
10	prc44		Long	4	H+32	-
11	prc45		Long	4	H+36	-
12	prc46		Long	4	H+40	-
13	prc47		Long	4	H+44	-
14	prc48		Long	4	H+48	-
15	prc49		Long	4	H+52	-
16	prc50		Long	4	H+56	-
17	prc51 (Invalid, do not use)		Long	4	H+60	-

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
18	udre39	udre(i): User differential range error indicator for the prn in slot i (i = 39-50)	Ulong	4	H+64	See *Table 79, Evaluation of UDREI* on *page 374*
19	udre40		Ulong	4	H+68	
20	udre41		Ulong	4	H+72	
21	udre42		Ulong	4	H+76	
22	udre43		Ulong	4	H+80	
23	udre44		Ulong	4	H+84	
24	udre45		Ulong	4	H+88	
25	udre46		Ulong	4	H+92	
26	udre47		Ulong	4	H+96	
27	udre48		Ulong	4	H+100	
28	udre49		Ulong	4	H+104	
29	udre50		Ulong	4	H+108	
30	udre51 (Invalid, do not use)		Ulong	4	H+112	
31	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+116	-
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.86 WAAS6 Integrity Message SBAS

WAAS6 is the integrity information message. Each message includes an IODF for each fast corrections message. The σ^2_{UDRE} information for each block of satellites applies to the fast corrections with the corresponding IODF.

Message ID: **304**

Log Type: **Asynch**

Recommended Input:

log WAAS6a onchanged

ASCII Example:

```
#WAAS6A,COM1,0,57.5,SATTIME,1093,273317.000,00000020,526a,209;
122,3,3,3,3,9,14,14,2,3,10,2,14,14,3,14,14,5,14,14,7,14,14,14,14,14,14,3,3,
14,14,14,14,3,15,11,11,15,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*925a2a9b
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS6 message can be logged to view the data breakdown of WAAS frame 6 which contains information about the integrity message.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS6 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	iodf2	Issue of fast corrections data	Ulong	4	H+4	-
4	iodf3	Issue of fast corrections data	Ulong	4	H+8	-
5	iodf4	Issue of fast corrections data	Ulong	4	H+12	-
6	iodf5	Issue of fast corrections data	Ulong	4	H+16	-
7	udre0	udre(i): User differential range error indicator for the prn in slot i (i = 0-50)	Ulong	4	H+20	See *Table 79, Evaluation of UDREI* on *page 374*
8	udre1		Ulong	4	H+24	
9	udre2		Ulong	4	H+28	
10	udre3		Ulong	4	H+32	
11	udre4		Ulong	4	H+36	
12	udre5		Ulong	4	H+40	
13	udre6		Ulong	4	H+44	
14	udre7		Ulong	4	H+48	
15	udre8		Ulong	4	H+52	
16	udre9		Ulong	4	H+56	
17	udre10		Ulong	4	H+60	
18	udre11		Ulong	4	H+64	
19	udre12		Ulong	4	H+68	
20	udre13		Ulong	4	H+72	
21	udre14		Ulong	4	H+76	
22	udre15		Ulong	4	H+80	
23	udre16		Ulong	4	H+84	
24	udre17		Ulong	4	H+88	

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
25	udre18	udre(i): User differential range error indicator for the prn in slot i (i = 0-50)	Ulong	4	H+92	See *Table 79, Evaluation of UDREI* on *page 374*
26	udre19		Ulong	4	H+96	
27	udre20		Ulong	4	H+100	
28	udre21		Ulong	4	H+104	
29	udre22		Ulong	4	H+108	
30	udre23		Ulong	4	H+112	
31	udre24		Ulong	4	H+116	
32	udre25		Ulong	4	H+120	
33	udre26		Ulong	4	H+124	
34	udre27		Ulong	4	H+128	
35	udre28		Ulong	4	H+132	
36	udre29		Ulong	4	H+136	
37	udre30		Ulong	4	H+140	
38	udre31		Ulong	4	H+144	
39	udre32		Ulong	4	H+148	
40	udre33		Ulong	4	H+152	
41	udre34		Ulong	4	H+156	
42	udre35		Ulong	4	H+160	
43	udre36		Ulong	4	H+164	
44	udre37		Ulong	4	H+168	
45	udre38		Ulong	4	H+172	
46	udre39		Ulong	4	H+176	
47	udre40		Ulong	4	H+180	
48	udre41		Ulong	4	H+184	
49	udre42		Ulong	4	H+188	
50	udre43		Ulong	4	H+192	
51	udre44		Ulong	4	H+196	
52	udre45		Ulong	4	H+200	

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
53	udre46	udre(i): User differential range error indicator for the prn in slot i (i = 0-50)	Ulong	4	H+204	See *Table 79, Evaluation of UDREI* on *page 374*
54	udre47		Ulong	4	H+208	
55	udre48		Ulong	4	H+212	
56	udre49		Ulong	4	H+216	
58	udre50		Ulong	4	H+220	
58	udre51 (Invalid, do not use)		Ulong	4	H+224	
59	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+228	-
60	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.87 WAAS7 Fast Correction Degradation *SBAS*

The WAAS7 message specifies the applicable IODP, system latency time and fast degradation factor indicator for computing the degradation of fast and long-term corrections.

Message ID: **305**

Log Type: **Asynch**

Recommended Input:

log WAAS7a onchanged

ASCII Example:

```
#WAAS7A,COM1,0,36.5,SATTIME,1337,416367.000,00000000,12e3,1984;
122,1,2,0,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,
15,15,15,15,15,15,15,15,15,15,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*827a7364
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS7 message can be logged to view the data breakdown of WAAS frame 7 which contains information about fast correction degradation.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	WAAS7 header	Log header		H	0
2	prn	Source PRN of message	Ulong	4	H
3	latency	System latency	Ulong	4	H+4
4	iodp	Issue of PRN mask data	Ulong	4	H+8
5	spare bits	Unused spare bits	Ulong	4	H+12
6	al(0)	al(i): Degradation factor indicator for the prn in slot i (i = 0-50)	Ulong	4	H+16
7	al(1)		Ulong	4	H+20
8	al(2)		Ulong	4	H+24
9	al(3)		Ulong	4	H+28
10	al(4)		Ulong	4	H+32
11	al(5)		Ulong	4	H+36
12	al(6)		Ulong	4	H+40
13	al(7)		Ulong	4	H+44
14	al(8)		Ulong	4	H+48
15	al(9)		Ulong	4	H+52
16	al(10)		Ulong	4	H+56
17	al(11)		Ulong	4	H+60
18	al(12)		Ulong	4	H+64
19	al(13)		Ulong	4	H+68
20	al(14)		Ulong	4	H+72
21	al(15)		Ulong	4	H+76
22	al(16)		Ulong	4	H+80
23	al(17)		Ulong	4	H+84
24	al(18)		Ulong	4	H+88
25	al(19)		Ulong	4	H+92
26	al(20)		Ulong	4	H+96

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
27	al(21)	al(i): Degradation factor indicator for the prn in slot i (i = 0-50)	Ulong	4	H+100
28	al(22)		Ulong	4	H+104
29	al(23)		Ulong	4	H+108
30	al(24)		Ulong	4	H+112
31	al(25)		Ulong	4	H+116
32	al(26)		Ulong	4	H+120
33	al(27)		Ulong	4	H+124
34	al(28)		Ulong	4	H+128
35	al(29)		Ulong	4	H+132
36	al(30)		Ulong	4	H+136
37	al(31)		Ulong	4	H+140
38	al(32)		Ulong	4	H+144
39	al(33)		Ulong	4	H+148
40	al(34)		Ulong	4	H+152
41	al(35)		Ulong	4	H+156
42	al(36)		Ulong	4	H+160
43	al(37)		Ulong	4	H+164
44	al(38)		Ulong	4	H+168
45	al(39)		Ulong	4	H+172
46	al(40)		Ulong	4	H+176
47	al(41)		Ulong	4	H+180
48	al(42)		Ulong	4	H+184
49	al(43)		Ulong	4	H+188
50	al(44)		Ulong	4	H+192
51	al(45)		Ulong	4	H+196
52	al(46)		Ulong	4	H+200
53	al(47)		Ulong	4	H+204
54	al(48)		Ulong	4	H+208

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
55	al(49)	al(i): Degradation factor indicator for the prn in slot i (i = 0-50)	Ulong	4	H+212
56	al(50)		Ulong	4	H+216
57	al(51) (Invalid, do not use)		Ulong	4	H+220
58	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+224
59	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.88 WAAS9 GEO Navigation Message SBAS

WAAS9 provides the GEO navigation message representing the position, velocity and acceleration of the geostationary satellite, in ECEF coordinates and its apparent clock time and frequency offsets.

Also included is the time of applicability, an issue of data (IOD) and an accuracy exponent (URA) representing the estimated accuracy of the message. The time offset and time drift are with respect to SBAS Network Time. Their combined effect is added to the estimate of the satellite's transmit time.

Message ID: **306**

Log Type: **Asynch**

Recommended Input:

log WAAS9a onchanged

ASCII Example:

```
#WAAS9A,COM1,0,38.0,SATTIME,1337,416426.000,00000000,b580,1984;
122,175,70848,2,24802064.1600,-34087313.9200,-33823.2000,
1.591250000,0.107500000,0.6080000,-0.0000750,-0.0001125,
0.000187500,-2.235174179e-08,9.094947018e-12*636051d2
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS9 message can be logged to view the data breakdown of WAAS frame 9 which contains the GEO navigation message.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	WAAS9 header	Log header		H	0
2	prn	Source PRN of message	Ulong	4	H
3	iodn	Issue of GEO navigation data	Ulong	4	H+4
4	t_0	Time of applicability	Ulong	4	H+8
5	ura	URA value	Ulong	4	H+12
6	x	ECEF x coordinate	Double	8	H+16
7	y	ECEF y coordinate	Double	8	H+24
8	z	ECEF z coordinate	Double	8	H+32
9	xvel	X rate of change	Double	8	H+40
10	yvel	Y rate of change	Double	8	H+48
11	zvel	Z rate of change	Double	8	H+56
12	xaccel	X rate of rate change	Double	8	H+64
13	yaccel	Y rate of rate change	Double	8	H+72
14	zaccel	Z rate of rate change	Double	8	H+80
15	a_{f0}	Time offset	Double	8	H+88
16	a_{f1}	Time drift	Double	8	H+96
17	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+104
18	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.89 WAAS10 Degradation Factor *SBAS*

The fast corrections, long-term corrections and ionospheric corrections are all provided in the WAAS10 message.

Message ID: **292**

Log Type: **Asynch**

Recommended Input:

log WAAS10a onchanged

ASCII Example:

```
#WAAS10A,COM1,0,35.5,SATTIME,1337,416469.000,00000000,c305,1984;
122,54,38,76,256,152,100,311,83,256,6,0,300,292,0,1,
0000000000000000000000*8884d248
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS10 message can be logged to view the data breakdown of WAAS frame 10 which contains information about degradation factors.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS10 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	b_{rcc}	Estimated noise and round off error parameter	Ulong	4	H+4	0.002
4	c_{ltc_lsb}	Maximum round off due to the least significant bit (lsb) of the orbital clock	Ulong	4	H+8	0.002
5	c_{ltc_vl}	Velocity error bound	Ulong	4	H+12	0.00005
6	i_{ltc_vl}	Update interval for v=1 long term	Ulong	4	H+16	-
7	c_{ltc_v0}	Bound on update delta	Ulong	4	H+20	0.002
8	i_{ltc_v1}	Minimum update interval v = 0	Ulong	4	H+24	-
9	c_{geo_lsb}	Maximum round off due to the lsb of the orbital clock	Ulong	4	H+28	0.0005
10	c_{geo_v}	Velocity error bound	Ulong	4	H+32	0.00005
11	i_{geo}	Update interval for GEO navigation message	Ulong	4	H+36	-
12	c_{er}	Degradation parameter	Ulong	4	H+40	0.5
13	c_{iono_step}	Bound on ionospheric grid delay difference	Ulong	4	H+44	0.001
14	i_{iono}	Minimum ionospheric update interval	Ulong	4	H+48	-
15	c_{iono_ramp}	Rate of ionospheric corrections change	Ulong	4	H+52	0.000005
16	rss_{udre}	User differential range error flag	Ulong	4	H+56	-
17	rss_{iono}	Root sum square flag	Ulong	4	H+60	-
18	spare bits	Spare 88 bits, possibly GLONASS	Ulong	4	H+64	-
19	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+68	-
20	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.90 WAAS12 SBAS Network Time and UTC *SBAS*

WAAS12 contains information bits for the UTC parameters and UTC time standard from which an offset is determined. The UTC parameters correlate UTC time with the SBAS network time rather than with GPS reference time.

Message ID: 293

Log Type: Asynch

Recommended Input:

log WAAS12a onchanged

✉ Each raw WAAS frame gives data for a specific frame decoder number. The WAAS12 message can be logged to view the data breakdown of WAAS frame 12 which contains information about time parameters.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	WAAS12 header	Log header		H	0
2	prn	Source PRN of message	Ulong	4	H
3	A_1	Time drift (s/s)	Double	8	H+4
4	A_0	Time offset (s)	Double	8	H+12
5	seconds	Seconds into the week (s)	Ulong	4	H+20
6	week	Week number	Ushort	4	H+24
7	dt_{ls}	Delta time due to leap seconds	Short	2	H+28
8	wn_{lsf}	Week number, leap second future	Ushort	2	H+30
9	dn	Day of the week (the range is 1 to 7 where Sunday = 1 and Saturday = 7)	Ushort	2	H+32
10	dt_{lsf}	Delta time, leap second future	Short	2	H+34
11	utc id	UTC type identifier	Ushort	2	H+36
12	gpstow	GPS reference time of the week	Ulong	2	H+38
13	gpswn	GPS de-modulo week number	Ulong	2	H+40
14	glo indicator	Is GLONASS information present? 0 = FALSE 1 = TRUE	Enum	4	H+42
15	Reserved array of hexabytes for GLONASS		Char[10]	12[a]	H+46
16	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+58
17	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.91 WAAS17 GEO Almanac Message *SBAS*

Almanacs for all GEOs are broadcast periodically to alert you of their existence, location, the general service provided, status, and health.

> Unused almanacs have a PRN number of 0 and should be ignored, see *ASCII Example* below.

Message ID: **294**

Log Type: **Asynch**

Recommended Input:

log WAAS17a onchanged

ASCII Example:

```
#WAAS17A,COM1,0,33.5,SATTIME,1337,416653.000,00000000,896c,1984;
122,3,
0,134,0,-42138200,1448200,26000,0,0,0,
0,122,0,24801400,-34088600,-26000,0,0,0,
0,0,0,0,0,0,0,0,0,70848*22d9a0eb
```

> Each raw WAAS frame gives data for a specific frame decoder number. The WAAS17 message can be logged to view the data breakdown of WAAS frame 17 which contains GEO almanacs.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS17 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	#ents	Number of almanac entries with information to follow	Ulong	4	H+4	-
4	data id	Data ID type	Ushort	2	H+8	-
5	entry prn	PRN for this entry	Ushort	2	H+10	-
6	health	Health bits	Ushort	4[a]	H+12	-
7	x	ECEF x coordinate	Long	4	H+16	-
8	y	ECEF y coordinate	Long	4	H+20	-
9	z	ECEF z coordinate	Long	4	H+24	-
10	x vel	X rate of change	Long	4	H+28	-
11	y vel	Y rate of change	Long	4	H+32	-
12	z vel	Z rate of change	Long	4	H+36	-
13...	Next entry = H+8 + (#ents x 32)					-
variable	t0	Time of day in seconds (0 to 86336)	Ulong	4	H+8+ (#ents x 32)	64
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+12+ (#ents x 32)	-
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

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

3.3.92 WAAS18 IGP Mask SBAS

The ionospheric delay corrections are broadcast as vertical delay estimates at specified ionospheric grid points (IGPs), applicable to a signal on L1. The predefined IGPs are contained in 11 bands (numbered 0 to 10). Bands 0-8 are vertical bands on a Mercator projection map, and bands 9-10 are horizontal bands on a Mercator projection map. Since it is impossible to broadcast IGP delays for all possible locations, a mask is broadcast to define the IGP locations providing the most efficient model of the ionosphere at the time.

Message ID: **295**

Log Type: **Asynch**

Recommended Input:

log WAAS18a onchanged

ASCII Example:

```
#WAAS18A,COM1,0,33.0,SATTIME,1337,417074.000,00000000,f2c0,1984;
122,4,2,2,0000ffc0007fc0003ff0000ff80007fe0007fe0003ff0000ff80,0*b1ed353e
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS18 message can be logged to view the data breakdown of WAAS frame 18 which contains information about ionospheric grid points.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	WAAS18 header	Log header		H	0
2	prn	Source PRN of message	Ulong	4	H
3	#bands	Number of bands broadcast	Ulong	4	H+4
4	band num	Specific band number that identifies which of the 11 IGP bands the data belongs to	Ulong	4	H+8
5	iodi	Issue of ionospheric data	Ulong	4	H+12
6	igp mask	IGP mask	Uchar[26]	28[a]	H+16
7	spare bit	One spare bit	Ulong	4	H+44
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.93 WAAS24 Mixed Fast/Slow Corrections SBAS

If there are 6 or fewer satellites in a block, they may be placed in this mixed correction message. There is a fast data set for each satellite and a UDRE indicator. Each message also contains an IODP indicating the associated PRN mask.

The fast correction (PRC) has a valid range of -2048 to +2047. If the range is exceeded a don't use indication is inserted into the user differential range error indicator (UDREI) field, see *Table 79* on *page 374*. You should ignore extra data sets not represented in the PRN mask.

The time of applicability (T0) of the PRC is the start of the epoch of the WNT second that is coincident with the transmission at the GEO satellite of the first bit of the message block.

Message ID: 297

Log Type: Asynch

Recommended Input:

log WAAS24a onchanged

ASCII Example:

```
#WAAS24A,COM1,0,34.0,SATTIME,1337,417108.000,00000000,0a33,1984;
134,2047,2047,2047,2047,-1,-2,14,14,14,14,11,14,2,2,0,0,1,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0*76ff954b
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS24 message can be logged to view the data breakdown of WAAS frame 24 which contains mixed fast/slow corrections.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS24 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	prc0	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 0-5)	Long	4	H+4	-
4	prc1		Long	4	H+8	-
5	prc2		Long	4	H+12	-
6	prc3		Long	4	H+16	-
7	prc4		Long	4	H+20	-
8	prc5		Long	4	H+24	-
9	udre0	udre(i): User differential range error indicator for the prn in slot i (i = 0-5)	Ulong	4	H+28	See *Table 79* on *page 374*
10	udre1		Ulong	4	H+.32	
11	udre2		Ulong	4	H+36	
12	udre3		Ulong	4	H+40	
13	udre4		Ulong	4	H+44	
14	udre5		Ulong	4	H+48	
15	iodp	Issue of PRN mask data	Ulong	4	H+52	-
16	block id	Associated message type	Ulong	4	H+56	
17	iodf	Issue of fast corrections data	Ulong	4	H+60	-
18	spare	Spare value	Ulong	4	H+64	-
19	vel	Velocity code flag	Ulong	4	H+68	-
20	mask1	Index into PRN mask (Type 1)	Ulong	4	H+72	-
21	iode1	Issue of ephemeris data	Ulong	4	H+76	-
22	dx1	Delta x (ECEF)	Long	4	H+80	0.125
23	dy1	Delta y (ECEF)	Long	4	H+84	0.125
24	dz1	Delta z (ECEF)	Long	4	H+88	0.125
25	da^{f0}	Delta a^{f0} clock offset	Long	4	H+92	2^{-31}
26	mask2	Second index into PRN mask (Type 1)	Ulong	4	H+96	-

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
27	iode2	Second issue of ephemeris data	Ulong	4	H+100	-
28	ddx	Delta delta x (ECEF)	Long	4	H+104	2^{-11}
29	ddy	Delta delta y (ECEF)	Long	4	H+108	2^{-11}
30	ddz	Delta delta z (ECEF)	Long	4	H+112	2^{-11}
31	da^{f1}	Delta a^{f1} clock offset	Long	4	H+116	2^{-39}
32	t_0	Applicable time of day	Ulong	4	H+120	16
33	iodp	Issue of PRN mask data	Ulong	4	H+124	-
34	corr spare	Spare value when velocity code is equal to 0	Ulong	4	H+128	-
35	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+132	-
36	[CR][LF]	Sentence terminator (ASCII only)	-	-	H+136	-

3.3.94 WAAS25 Long-Term Slow Satellite Corrections *SBAS*

WAAS25 provides error estimates for slow varying satellite ephemeris and clock errors with respect to WGS-84 ECEF coordinates.

Message ID: 298

Log Type: Asynch

Recommended Input:

log WAAS25a onchanged

ASCII Example:

```
#WAAS25A,COM1,0,37.5,SATTIME,1337,417193.000,00000000,b8ff,1984;
134,1,19,25,-1,-3,0,-15,0,0,0,1,-1,-2,4465,2,0,1,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0*81685317
```

✉ Each raw WAAS frame gives data for a specific frame decoder number. The WAAS25 message can be logged to view the data breakdown of WAAS frame 25 which contains long-term slow satellite corrections.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS25 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	1st half vel	Velocity code flag (0 or 1)	Ulong	4	H+4	-
4	1st half mask1	Index into PRN mask (Type 1)	Ulong	4	H+8	-
5	1st half iode1	Issue of ephemeris data	Ulong	4	H+12	-
6	1st half dx1	Delta x (ECEF)	Long	4	H+16	0.125
7	1st half dy1	Delta y (ECEF)	Long	4	H+20	0.125
8	1st half dz1	Delta z (ECEF)	Long	4	H+24	0.125
9	1st half a^{f0}	Delta a^{f0} clock offset	Long	4	H+28	2^{-31}
10	1st half mask2	Second index into PRN mask (Type 1) Dummy value when velocity code = 1	Ulong	4	H+32	-
11	1st half iode2	Second issue of ephemeris data Dummy value when velocity code = 1	Ulong	4	H+36	-
12	1st half ddx	Delta delta x (ECEF) when velocity code = 1 Delta x (dx) when velocity code = 0	Long	4	H+40	2^{-11}
13	1st half ddy	Delta delta y (ECEF) when velocity code = 1 Delta y (dy) when velocity code = 0	Long	4	H+44	2^{-11}
14	1st half ddz	Delta delta z (ECEF) when velocity code = 1 Delta z (dz) when velocity code = 0	Long	4	H+48	2^{-11}
15	1st half a^{f1}	Delta a^{f1} clock offset when velocity code = 1 Delta a^{f0} clock offset when velocity code = 0	Long	4	H+52	2^{-39}
16	1st half t_0	Applicable time of day Dummy value when velocity code = 0	Ulong	4	H+56	16
17	1st half iodp	Issue of PRN mask data	Ulong	4	H+60	-
18	1st half corr spare	Spare value when velocity code = 0 Dummy value when velocity code = 1	Ulong	4	H+64	-

Continued on the following page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
19	2nd half vel	Velocity code flag (0 or 1)	Ulong	4	H+68	-
20	2nd half mask1	Index into PRN mask (Type 1)	Ulong	4	H+72	-
21	2nd half iode1	Issue of ephemeris data	Ulong	4	H+76	-
22	2nd half dx1	Delta x (ECEF)	Long	4	H+80	0.125
23	2nd half dy1	Delta y (ECEF)	Long	4	H+84	0.125
24	2nd half dz1	Delta z (ECEF)	Long	4	H+88	0.125
25	2nd half a^{f0}	Delta a^{f0} clock offset	Long	4	H+92	2^{-31}
26	2nd half mask2	Second index into PRN mask (Type 1) Dummy value when velocity code = 1	Ulong	4	H+96	-
27	2nd half iode2	Second issue of ephemeris data Dummy value when velocity code = 1	Ulong	4	H+100	-
28	2nd half ddx	Delta delta x (ECEF) when velocity code = 1 Delta x (dx) when velocity code = 0	Long	4	H+104	2^{-11}
29	2nd half ddy	Delta delta y (ECEF) when velocity code = 1 Delta y (dy) when velocity code = 0	Long	4	H+108	2^{-11}
30	2nd half ddz	Delta delta z (ECEF) when velocity code = 1 Delta z (dz) when velocity code = 0	Long	4	H+112	2^{-11}
31	2nd half a^{f1}	Delta a^{f1} clock offset when velocity code = 1 Delta a^{f0} clock offset when velocity code = 0	Long	4	H+116	2^{-39}
32	2nd half t_0	Applicable time of day Dummy value when velocity code = 0	Ulong	4	H+120	16
33	2nd half iodp	Issue of PRN mask data	Ulong	4	H+124	-
34	2nd half corr spare	Spare value when velocity code = 0 Dummy value when velocity code = 1	Ulong	4	H+128	-
35	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+132	-
36	[CR][LF]	Sentence terminator (ASCII only)	-	-	H+136	-

3.3.95 WAAS26 Ionospheric Delay Corrections *SBAS*

WAAS26 provides vertical delays (relative to an L1 signal) and their accuracy at geographically defined IGPs identified by the BAND NUMBER and IGP number. Each message contains a band number and a block ID, which indicates the location of the IGPs in the respective band mask.

Message ID: **299**

Log Type: **Asynch**

Recommended Input:

log WAAS26a onchanged

ASCII Example:

```
#WAAS26A,COM1,0,38.0,SATTIME,1337,417243.000,00000000,ec70,1984;
134,1,2,15,27,11,25,11,23,11,19,11,16,11,16,12,15,13,16,13,29,14,
30,13,27,11,27,11,24,11,19,11,16,12,2,0*3b6d6806
```

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS26 message can be logged to view the data breakdown of WAAS frame 26 which contains ionospheric delay corrections.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS26 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	band num	Band number	Ulong	4	H+4	-
4	block id	Block ID	Ulong	4	H+8	-
5	#pts	Number of grid points with information to follow	Ulong	4	H+12	-
6	igp_{vde}	IGP vertical delay estimates	Ulong	4	H+16	0.125
7	givei	Grid ionospheric vertical error indicator	Ulong	4	H+20	-
8...	Next #pts entry = H + 16 + (#pts x 8)					
variable	iodi	Issue of data - ionosphere	Ulong	4	H+16+ (#pts x 8)	
variable	spare	7 spare bits	Ulong	4	H+20+ (#pts x 8)	-
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+24+ (#pts x 8)	-
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.96 WAAS27 SBAS Service Message *SBAS*

WAAS27 messages apply only to the service provider transmitting the message. The number of service messages indicates the total number of unique WAAS27 messages for the current IODS. Each unique message for that IODS includes a sequential message number. The IODS is incremented in all messages, each time that any parameter in any WAAS27 message is changed.

Message ID: **300**

Log Type: **Asynch**

Recommended Input:

log WAAS27a onchanged

Each raw WAAS frame gives data for a specific frame decoder number. The WAAS27 message can be logged to view the data breakdown of WAAS frame 27 which contains information about SBAS service messages.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS27 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	iods	Issue of slow corrections data	Ulong	4	H+4	-
4	#messages	Low-by-one count of messages	Ulong	4	H+8	-
5	message num	Low-by-one message number	Ulong	4	H+12	-
6	priority code	Priority code	Ulong	4	H+16	-
7	dudre inside	Delta user differential range error - inside	Ulong	4	H+20	-
8	dudre outside	Delta user differential range error -outside	Ulong	4	H+24	-
9...	#reg	Number of regions with information to follow	Ulong	4	H+28	-
variable	lat1	Coordinate 1 latitude	Long	4	H+32	-
variable	lon1	Coordinate 1 longitude	Long	4	H+36	-
variable	lat2	Coordinate 2 latitude	Long	4	H+40	-
variable	lon2	Coordinate 2 longitude	Long	4	H+44	-
variable	shape	Shape where: 0 = triangle 1 = square	Ulong	4	H+48	-
variable	Next #reg entry = H + 32 + (#reg x 20)					
variable	t_0	Time of applicability	Ulong	4	H+32+ (#reg x 20)	16
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+36+ (#reg x 20)	-
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.97 WAASCORR SBAS Range Corrections Used SBAS

The information is updated with each pseudorange position calculation. It has an entry for each tracked satellite. Satellites that are not included in an SBAS corrected solution have 0.0 in both the ‘psr corr’ and ‘corr stdv’ fields.

The ‘psr corr’ is the combined fast and slow corrections and is to be added to the pseudorange. Ionospheric and tropospheric corrections are not included and should be applied separately.

Message ID: **313**

Log Type: **Synch**

Recommended Input:

log waascorra ontime 1

ASCII Example:

```
#WAASCORRA,COM1,0,40.5,FINESTEERING,1337,417485.000,01000000,3b3b,1984;
20,
3,101,0.0000,0.0000,3,0,0.0000,0.0000,
2,133,0.0000,0.0000,2,0,0.0000,0.0000,
23,48,0.0000,0.0000,23,0,0.0000,0.0000,
4,55,0.0000,0.0000,4,0,0.0000,0.0000,
16,197,0.0000,0.0000,16,0,0.0000,0.0000,
20,25,0.0000,0.0000,20,0,0.0000,0.0000,
27,26,0.0000,0.0000,27,0,0.0000,0.0000,
25,186,0.0000,0.0000,25,0,0.0000,0.0000,
13,85,0.0000,0.0000,13,0,0.0000,0.0000,
122,0,0.0000,0.0000,134,0,0.0000,0.0000*0af4c14d
```

The SBAS pseudorange corrections can be added to the raw pseudorange for a more accurate solution in applications that compute their own solutions.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	WAASCORR header	Log header		H	0
2	#sat	Number of satellites with information to follow	Ulong	4	H
3	prn	Satellite PRN	Ulong	4	H+4
4	iode	Issue of ephemeris data for which the corrections apply	Ulong	4	H+8
5	psr corr	SBAS pseudorange correction (m)	Float	4	H+12
6	corr stdv	Standard deviation of pseudorange correction (m)	Float	4	H+16
7...	Next sat entry = H+4 + (#sat x 16)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#sat x 16)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Chapter 4 Responses

The receiver is capable of outputting several responses for various conditions. Most of these responses are error messages to indicate when something is not correct.

The output format of the messages is dependent on the format of the input command. If the command is input as abbreviated ASCII, the output will be abbreviated ASCII. Likewise for ASCII and binary formats. *Table 80* outlines the various responses.

Table 80: Response Messages

ASCII Message	Binary Message ID	Meaning
OK	1	Command was received correctly.
REQUESTED LOG DOES NOT EXIST	2	The log requested does not exist.
NOT ENOUGH RESOURCES IN SYSTEM	3	The request has exceeded a limit (for example, the maximum number of logs are being generated).
DATA PACKET DOESN'T VERIFY	4	Data packet is not verified
COMMAND FAILED ON RECEIVER	5	Command did not succeed in accomplishing requested task.
INVALID MESSAGE ID	6	The input message ID is not valid.
INVALID MESSAGE. FIELD = *X*	7	Field *x* of the input message is not correct.
INVALID CHECKSUM	8	The checksum of the input message is not correct. This only applies to ASCII and binary format messages.
MESSAGE MISSING FIELD	9	A field is missing from the input message.
ARRAY SIZE FOR FIELD *X* EXCEEDS MAX	10	Field *x* contains more array elements than allowed.
PARAMETER *X* IS OUT OF RANGE	11	Field *x* of the input message is outside the acceptable limits.
TRIGGER *X* NOT VALID FOR THIS LOG	14	Trigger type *x* is not valid for this type of log.
AUTHCODE TABLE FULL - RELOAD SOFTWARE	15	Too many authcodes are stored in the receiver. The receiver firmware must be reloaded.
INVALID DATE FORMAT	16	This error is related to the inputting of authcodes. It indicates that the date attached to the code is not valid.

Continued on the following page

ASCII Message	Binary Message ID	Meaning
INVALID AUTHCODE ENTERED	17	The authcode entered is not valid.
NO MATCHING MODEL TO REMOVE	18	The model requested for removal does not exist.
NOT VALID AUTH CODE FOR THAT MODEL	19	The model attached to the authcode is not valid.
CHANNEL IS INVALID	20	The selected channel is invalid.
REQUESTED RATE IS INVALID	21	The requested rate is invalid.
WORD HAS NO MASK FOR THIS TYPE	22	The word has no mask for this type of log.
CHANNELS LOCKED DUE TO ERROR	23	Channels are locked due to error.
INJECTED TIME INVALID	24	Injected time is invalid
COM PORT NOT SUPPORTED	25	The COM or USB port is not supported.
MESSAGE IS INCORRECT	26	The message is invalid.
INVALID PRN	27	The PRN is invalid.
PRN NOT LOCKED OUT	28	The PRN is not locked out.
PRN LOCKOUT LIST IS FULL	29	PRN lockout list is full.
PRN ALREADY LOCKED OUT	30	The PRN is already locked out.
MESSAGE TIMED OUT	31	Message timed out.
UNKNOWN COM PORT REQUESTED	33	Unknown COM or USB port requested.
HEX STRING NOT FORMATTED CORRECTLY	34	Hex string not formatted correctly.
INVALID BAUD RATE	35	The baud rate is invalid.
MESSAGE IS INVALID FOR THIS MODEL	36	This message is invalid for this model of receiver.
COMMAND ONLY VALID IF IN NVM FAIL MODE	40	Command is only valid if NVM is in fail mode
INVALID OFFSET	41	The offset is invalid.
MAXIMUM NUMBER OF USER MESSAGES REACHED	78	Maximum number of user messages has been reached.
GPS PRECISE TIME IS ALREADY KNOWN	84	GPS precise time is already known.

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