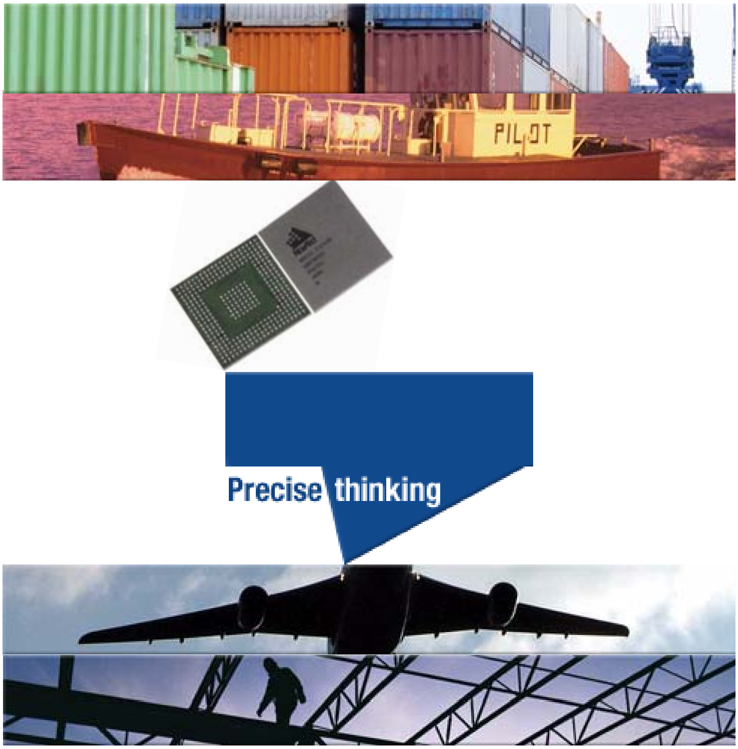

OEMV Family Firmware Reference Manual

OM-20000094 Rev 5

OEMV Family of Receivers - Firmware Reference Manual

Publication Number: OM-20000094
Revision Level: 5
Revision Date: 2007/06/19

This manual reflects firmware version 3.210.

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Narrow Correlator
#5,101,416
#5,390,207
#5,414,729
#5,495,499
#5,809,064
PAC Correlator
#6,243,409 B1
Dual Frequency GPS
#5,736,961
Anti-Jamming Technology
#5,734,674
Position for Velocity Kalman Filter
#6,664,923 B1
#7,193,559 B2

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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 OEMV family command and logging reference.

All OEMV products are equipped with our AdVance RTK engine for RT-2 and RT-20 (GPS-only or GPS + GLONASS). This means a lower ambiguity error rate, faster narrow lane convergence (even at long baseline lengths) and more fixes in a wider range of conditions.

Scope

This manual describes each command and log that the OEMV family of 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.

There is Satellite Based Augmentation System (SBAS) signal functionality on OEMV-1, OEMV-2 and OEMV-3 products. Also, OEMV-2 and OEMV-3 products support GLONASS measurements while OEMV-1 and OEMV-3 cards are L-band capable. Please refer to the *SBAS Overview* and the *Real Time Kinematic (RTK)* sections in the *OEMV Family Installation and Operation User Manual,* the *GLONASS Overview* section in the *GPS+ Reference Manual* and the *Conventions* section below for more information. All three also support NMEA, DGPS and RTK. If you have any of these options and wish to learn more about them, please refer to the *GPS+ Reference Manual,* available on our website at http://www.novatel.com/support/docupdates.htm, 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 *OEMV Family Installation and Operation User Manual* for technical information on 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 OEMV family of receivers. Feature-tagging symbols have been created to help clarify which commands and logs are only available with certain cards and options. The tags are in the title of the command or log and also appear in tables where features are mentioned as footnotes. The numbering at the start of the tag indicates V followed by 1 for OEMV-1, 2 for OEMV-2 and 3 for OEMV-3 while the lettering suffix is described below:

V123	Features available on OEMV-1, OEMV-1G, OEMV-2 or OEMV-3-based products. If a feature isn't available, its card number is omitted, for example, *V23*, *V13* or *V3.*

V123_RT20	Features available only with receivers equipped with the RT-20 option
V23_RT2	Features available only with receivers equipped with the RT-2 option
V123_DGPS	Feature used when operating in differential mode
V123_NMEA	National Marine Electronics Association format
V123_SBAS	SBAS messages available when tracking an SBAS satellite (refer to the *GPS+ Reference Manual*)
V3_HP	OmniSTAR high performance (HP), extra performance (XP) and virtual base station (VBS) available with an OmniSTAR subscription (refer to the *GPS+ Reference Manual*)
V13_VBS	OmniSTAR VBS available with an OmniSTAR subscription
V13_CDGPS	The free Canada-Wide Differential Global Positioning System (CDGPS) available without a subscription (refer to the *GPS+ Reference Manual*)
V1G23_G	GLONASS positioning available (refer to the *GPS+ Reference Manual)*
V3_G	Available only on OEMV-3-based products with the GLONASS option
V23_L2C	Capable of receiving the L2C signal (refer to the *GPS+ Reference Manual*)

Other simple conventions are:

This is a notebox that contains important information before you use a command or log.

This is a usage box that contains additional information or examples.

- Command defaults:
  - The factory defaults for commands are shown in *Section 2.4, Factory Defaults* on *Page 48*. Each factory default is also shown after the syntax but before the example of each command description starting on *Page 51*.
  - The default values used by the OEMV family for optional fields, if you use a command without entering optional parameter values, if applicable, is given in each 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 20*.
- 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 48* for a list of factory default settings.
- Command descriptions' brackets, [ ], represent the optionality of parameters.
- 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 69 on Page 367*.

  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 *Unit Conversion* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

- 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.
- The terms OEMV-1, OEMV-2 and OEMV-3 will not be used in this manual unless a specific detail refers to it alone. The term receiver will infer that the text is applicable to an OEMV-1, OEMV-2 or OEMV-3, either stand-alone or in an enclosure, unless otherwise stated.
- Relevant SBAS commands and logs start with WAAS except for RAWWAASFRAME. Generally, the PRN field of the WAASx logs is common, and 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.

What's New in Rev 5 of this Manual?

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

- RTCM Version 3.0 Types 1007-1012, 1019 and 1020 (see the RTCM V3 standard logs starting on *Page 442*) for antenna, GLONASS and ephemeris information
- RTCM Version 2.3 Types 18 to 21 now support GPS + GLONASS
- PSRTIME log for estimating the difference between GNSS systems' times (see *Page 389*)
- RT-20 (GPS or GPS + GLONASS) joins RT-2 in AdVance RTK (see *Congratulations!* on *Page 13* and refer to the *Positioning Modes of Operation* chapter in the *OEMV Family Installation and Operation User Manual*)
- Two satellite differential code bias commands (see DIFFCODEBIASCONTROL on *Page 104* and SETDIFFCODEBIASES on *Page 179*)
- RTKQUALITYLEVEL command to select an RTK quality level mode: Normal or Extra_Safe in cases where satellite visibility is poor (see *Page 165*)
- RTKTIMEOUT command to set the age of RTK data accepted (see *Page 169*)
- SETIONOTYPE command to set the ionospheric corrections model for your applications (see *Page 180*)
- The default undulation table used by the receiver changed from OSU89B to EGM96 (see *Page 190*)

The most up-to-date version of this manual and addendums can be downloaded from the support/docupdates.htm section of the NovAtel website at www.novatel.com.

Prerequisites

As this reference manual is focused on the OEMV family 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 *OEMV Family Installation and Operation User Manual* before proceeding.

Chapter 1 Messages

1.1 Message Types

The receiver handles all 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 OEMV family 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, RTCMV3, RTCM, CMR, CMRPLUS and NMEA format messaging, see the chapter on *Message Formats* in the *OEMV Family 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 dependant on the bit format in the message's binary header, see *Binary* on *Page 20*.

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 Page 17

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

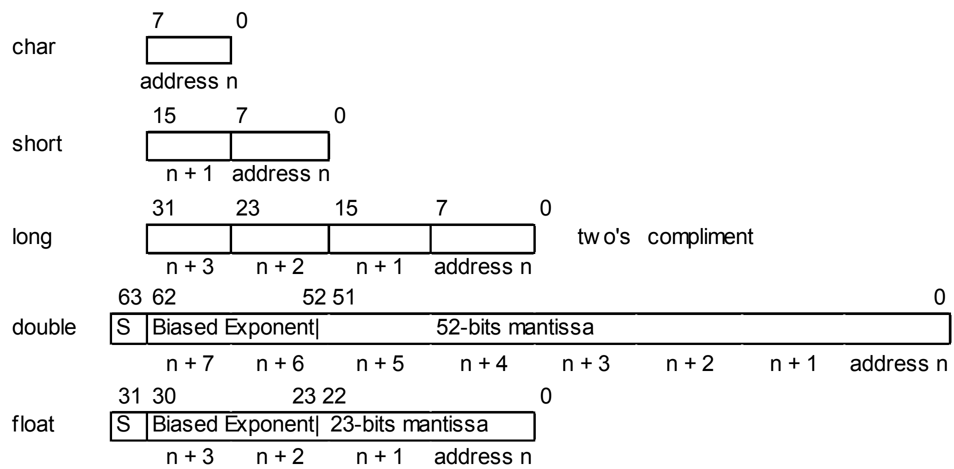

Table 2 shows the arrangement of bytes within each field type when used by IBM PC computers. All data sent to or from the OEMV family receiver, however, is read least significant bit (LSB) first, opposite to what is shown in *Table 2*. Data is then stored in the receiver LSB first. For example, in char type data, the LSB is bit 0 and the most significant bit (MSB) is bit 7. See *Table 69, Channel Tracking Example* on *Page 367* 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 29* 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 580* 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 is formatted as follows:

Table 3: ASCII Message Header Structure

Field #	Field Name	Field Type	Description	Ignored on Input
1	Sync	Char	Sync character. The ASCII message is always preceded by a single '#' symbol.	N
2	Message	Char	This is the ASCII name of the log (see a list of all the logs in *Table 42, Logs By Function* on *Page 206*).	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	GPS Time Status	Enum	This value indicates the quality of the GPS time (see *Table 7, GPS Time Status* on *Page 27*)	Y
7	Week	Ulong	GPS week number.	Y
8	Seconds	GPSec	Seconds from the beginning of the GPS week accurate to the millisecond level.	Y
9	Receiver Status	Ulong	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 92, Receiver Status* on *Page 503*).	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
<          COM3 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 29* 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 21.*

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 44, OEMV Family Logs in Order of their Message IDs* on *Page 220* 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 25*) 0 = Original Message 1 = Response Message	1	6	N
7	Port Address	Uchar	See *Table 5* on *Page 23* (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 Page 22

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 time (see *Table 7, GPS Time Status* on *Page 27*).	1 [c]	13	N [d]
12	Week	Ushort	GPS week number.	2	14	N [d]
13	ms	GPSec	Milliseconds from the beginning of the GPS 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 92, Receiver Status* on *Page 503*)	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)

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

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

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
COM3_ALL	3	3	All virtual ports for COM port 3
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
AUX_ALL	10	16	All virtual ports for the AUX port [b]
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
COM3	60	96	COM port 3, virtual port 0
. . .			
COM3_31	7f	127	COM port 3, 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
. . .			

Continued on Page 24

ASCII Port Name	Hex Port Value	Decimal Port Value [a]	Description
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
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
AUX	8a0	2208	AUX port, virtual port 0 [b]
. . .			
AUX_31	8bf	2239	AUX port, virtual port 31 [b]
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 195*, and cannot be used in the UNLOG command, *Page 193,* or in the binary message header, see *Table 4* on *Page 21.*

b. The AUX port is available on OEMV-2-based and OEMV-3-based products.

✉ COM1_ALL, COM2_ALL, COM3_ALL, THISPORT_ALL, ALL_PORTS, USB1_ALL, USB2_ALL, USB3_ALL and AUX_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 130*). The response will be in the exact format that you entered the message (that is, binary input = binary response).

Abbreviated Response

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

<OK

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:

#BESTPOSR,COM1,0,67.0,FINE,1028,422060.400,00000000,a31b,0;"OK" *b867caad

Binary Response

Similar to an ASCII response except that it follows the binary protocols:

- Binary header with message type set to response value (for example, 0x82), see *Field 6* in *Table 4, Binary Message Header Structure* on *Page 21.*
- ENUM response ID, see *Table 104, Response Messages* on *Page 580.*
- String containing the ASCII response to match the ENUM response ID above (for example, 0x4F4B = OK)

Table 6, 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 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

The OEMV-1G, OEMV-2 and OEMV-3 can track GLONASS satellites. Up to 12 channels can be configured to track GLONASS signals that can be used in the solution. See also *Table 12, OEMV Channel Configurations* on *Page 61*.

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 510*.

Refer also to the *GLONASS* chapter in the *GPS+ Reference Manual* for more information.

1.4 GPS Time Status

All reported receiver times are subject to a qualifying time status. This status gives you an indication of how well a time is known, see *Table 7*:

Table 7: GPS Time Status

GPS Time Status (Decimal)	GPS 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.
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:

- UNKNOWN
- COARSE
- FREEWHEELING
- FINE
- FINESTEERING

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

If time is input to the receiver using the SETAPPROXTIME command, see *Page 177*, or on receipt of an RTCAEPHEM message, see *Page 393*, 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 modelling the position range biases and the receiver clock offset.

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

The final logical time status flag depends on whether CLOCKADJUST is enabled or not, see *Page 74*. 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.

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

The data in synchronous logs (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 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 time. Logs that contain satellite broadcast data (for example, ALMANAC, GPSEPHEM) have the transmit time of their last subframe in the header. In the header of differential time matched logs (for example, MATCHEDPOS) is the time of the matched reference and local observation that they are based on. Logs triggered by a mark event (for example, MARKEDPOS, MARKTIME) have the estimated GPS time of the mark event in their header. In the header of polled logs (for example, LOGLIST, PORTSTATS, VERSION) is the approximate GPS 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 Week Number

The GPS 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 OEMV family 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, a log 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 OEMV family 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 Commands

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 COM2 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 497*. 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 328*, shows all active logs in the receiver beginning with the LOG command. The COMCONFIG log, see *Page 267*, 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, LOG, and INTERFACEMODE), 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 8 lists the commands by function while *Table 9* on *Page 37* is an alphabetical listing of commands (repeated in *Table 10* on *Page 42* with the commands in the order of their message IDs). Please see *2.5, Command Reference* on *Page 49* for a more detailed description of individual commands which are listed alphabetically.

Table 8: Commands By Function

COMMANDS	DESCRIPTIONS
COMMUNICATIONS, CONTROL AND STATUS	
ANTENNAPOWER	Control power to low-noise amplifier (LNA) of an active antenna
COM	Set COM port configuration
COMCONTROL	Control the hardware control lines of the RS232 ports
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
RESET	Perform a hardware reset
FRESET	Reset receiver to factory default

Continued on Page 34

GENERAL RECEIVER CONTROL	
MODEL	Switch receiver to a previously AUTHed model
NVMRESTORE	Restore NVM data after a failure in NVM
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
DIFFCODEBIASCONTROL	Enable or disable satellite differential code biases
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
HPSEED	Specify the initial position for OmniSTAR HP/XP
HPSTATICINIT	Set static initialization of OmniSTAR HP/XP
NMEATALKER	Set the NMEA talker ID
RTKCOMMAND	Reset the RTK filter or set the filter to default settings
RTKDYNAMICS	Setup the RTK dynamics mode
SBASCONTROL	Set SBAS test mode and PRN
SETDIFFCODEBIASES	Set satellite differential code biases
SETIONOTYPE	Set the ionospheric corrections model
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
ASSIGNALL	Assign all satellite channels

Continued on Page 35

SATELLITE TRACKING AND CHANNEL CONTROL	
CNOUPDATE	C/No update rate and resolution
DYNAMICS	Tune receiver parameters
ECUTOFF	Set satellite tracking elevation cut-off
FORCEGPSL2CODE	Force the receiver to track L2C or P-code
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 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	
BASEANTENNAMODEL	Enter or change a base antenna model
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
MOVINGBASESTATION	Set ability to use a moving base station position
POSAVE	Set up position averaging
FIXPOSDATUM	Fix position in a datum
RTKANTENNA	Specify L1 phase center (PC) or antenna reference point (ARP)

Continued on Page 36

DIFFERENTIAL BASE STATION	
RTKSVENTRIES	Set the number of satellites to include in RTK corrections
SETRTCM16	Enter ASCII message to be sent in RTCM data stream
SETRTCM36	Enter ASCII message including Russian characters

DIFFERENTIAL ROVER STATION	
ANTENNAMODEL	Enter or change a rover antenna model
ASSIGNLBAND	Set L-band satellite communication parameters
DGPSEPHEMDELAY	DGPS ephemeris delay
CDGPSTIMEOUT	Set maximum age of CDGPS data accepted
DGPSTIMEOUT	Set maximum age of differential data accepted
HPSEED	Specify the initial position for OmniSTAR HP/XP
HPSTATICINIT	Set static initialization of OmniSTAR HP/XP
INTERFACEMODE	Set interface type, Receive (Rx), for a COM port
POSTIMEOUT	Set the position time out value for RTK
PSRDIFFSOURCE	Set the pseudorange correction source
RTKDYNAMICS	Set the RTK dynamics mode
RTKCOMMAND	Issue RTK specific commands
RTKQUALITYLEVEL	Choose an RTK quality mode
RTKSOURCE	Set the RTK correction source
RTKTIMEOUT	Set the maximum age of RTK data accepted
SBASCONTROL	Set SBAS test mode and PRN
SETAPPROXPOS	Set an approximate position
SETAPPROXTIME	Set an approximate GPS 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

Continued on Page 37

CLOCK INFORMATION, STATUS, AND TIME	
EXTERNALCLOCK	Set the parameters for an external clock
SETAPPROXTIME	Set an approximate time

Table 9: OEMV Family Commands in Alphabetical Order

Command	Message ID	Description	Syntax
ADJUST1PPS	429	Adjust the receiver clock	adjust1pps mode [period] [offset]
ANTENNAMODEL	841	Enter or change a rover antenna model	antennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]
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]]
ASSIGNLBAND	729	Set L-band satellite communication parameters	assignlband mode freq baud
AUTH	49	Add authorization code for new model	auth [state] part1 part2 part3 part4 part5 model [date]
BASEANTENNA-MODEL	870	Enter or change a base antenna model	baseantennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]
CDGPSTIMEOUT	850	Set maximum age of CDGPS data accepted	cdgpstimeout mode [delay]
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

Continued on Page 38

Command	Message ID	Description	Syntax
CNOUPDATE	849	C/No update rate and resolution	cnoupdate rate
COMCONTROL	431	Control the hardware control lines of the RS232 ports	comcontrol port signal control
COM	4	COM port configuration control	com [port] bps [parity [databits [stopbits [handshake [echo [break]]]]]]
CSMOOTH	269	Set carrier smoothing	csmooth L1time [L2time]
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
DIFFCODEBIAS-CONTROL	913	Enable or disable satellite differential code biases	diffcodebiascontrol switch
DYNAMICS	258	Tune receiver parameters	dynamics dynamics
ECUTOFF	50	Set satellite elevation cut-off	ecutoff angle
EXTERNALCLOCK	230	Set external clock parameters	externalclock clocktype [freq] [h0 [h1 [h2]]]
FIX	44	Constrain to fixed height or position	fix type [param1 [param2 [param3]]]
FIXPOSDATUM	761	Set the position in a specified datum	position datum [lat [lon [height]]]
FORCEGPSL2CODE	796	Force the receiver to track L2C or P-code	forcegpsl2code L2type
FREQUENCYOUT	232	Sets the output pulse train available on VARF.	frequencyout [switch] [pulsewidth] [period]

Continued on Page 39

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]...
GLOECUTOFF	735	Set the GLONASS satellite elevation cut-off angle	gloecutoff angle
GLOCSMOOTH	830	Carrier smoothing for GLONASS channels	glocsmooth L1time [L2time]
HPSEED	782	Specify the initial position for OmniSTAR HP/XP	hpseed mode lat lon hgt lats lons hgts datum undulation
HPSTATICINIT	780	Set static initialization of OmniSTAR HP/XP	hpstaticinit switch
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
MOVINGBASE-STATION	763	Set ability to use a moving base station position	movingbasestation switch
NMEATALKER	861	Set the NMEA talker ID	nmeatalker ID

Continued on Page 40

Command	Message ID	Description	Syntax
NVMRESTORE	197	Restore NVM data after a failure in NVM	nvmrestore
POSAVE	173	Implement position averaging for base station	posave [state] maxtime [maxhstd [maxvstd]]
POSTIMEOUT	612	Sets the position time out value for RTK	postimeout sec
PPSCONTROL	613	Control the PPS output	ppscontrol switch [polarity] [rate]
PSRDIFFSOURCE	493	Set the pseudorange correction source	psrdiffsource type ID
RESET	18	Perform a hardware reset	reset [delay]
RTKANTENNA	858	Specify L1 phase center (PC) or antenna reference point (ARP)	rtkantenna posref [pc]
RTKCOMMAND	97	Reset the RTK filter or set the filter to default settings	rtkcommand action
RTKDYNAMICS	183	Set the RTK dynamics mode	rtkdynamics mode
RTKQUALITYLEVEL	844	Choose an RTK quality level	rtkqualitylevel mode
RTKSOURCE	494	Set the RTK correction source	rtksource type ID
RTKSVENTRIES	92	Set the number of satellites to use in corrections	rtksventries number
RTKTIMEOUT	910	Set the maximum age of RTK data accepted	rtktimeout delay
SAVECONFIG	19	Save current configuration in non-volatile memory	saveconfig
SBASCONTROL	652	Set SBAS test mode and PRN	sbascontrol keyword [system] [prn] [testmode]

Continued on Page 41

Command	Message ID	Description	Syntax
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 time	setapproxtime week sec
SETDIFFCODE-BIASES	687	Set satellite differential code biases	setdiffcodebiases [bias_type] [array of 40 biases (ns)]
SETIONOTYPE	711	Set the ionospheric corrections model	setionotype model
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
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

Continued on Page 42

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

Table 10: OEMV 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

Continued on Page 43

Message ID	Command	Description	Syntax
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
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
92	RTKSVENTRIES	Set the number of satellites to use in corrections	rtksventries number
95	STATUSCONFIG	Configure various status mask fields in RXSTATUSEVENT log	statusconfig type word mask

Continued on Page 44

Message ID	Command	Description	Syntax
97	RTKCOMMAND	Reset the RTK filter or set the filter to default settings	rtkcommand action
98	ANTENNAPOWER	Control power to low-noise amplifier of an active antenna	antennapower flag
102	SETAPPROXTIME	Set an approximate GPS 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
139	UNLOCKOUTALL	Reinstate all previously locked out satellites	unlockoutall
142	DGPSEPHEMDELAY	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

Continued on Page 45

Message ID	Command	Description	Syntax
180	MAGVAR	Set magnetic variation correction	magvar type [correction [stddev]]
183	RTKDYNAMICS	Set the RTK dynamics mode	rtkdynamics mode
197	NVMRESTORE	Restore NVM data after a failure in NVM	nvmrestore
214	UNDULATION	Choose undulation	undulation option [separation]
230	EXTERNALCLOCK	Set external clock parameters	externalclock clocktype [freq] [h0 [h1 [h2]]]
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 [L2time]
377	SETAPPROXPOS	Set an approximate position	setapproxpos lat lon height
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]
431	COMCONTROL	Control the hardware control lines of the RS232 ports	comcontrol port signal control
493	PSRDIFFSOURCE	Set the pseudorange correction source	psrdiffsource type ID
494	RTKSOURCE	Set the RTK correction source	rtksource 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

Continued on Page 46

Message ID	Command	Description	Syntax
613	PPSCONTROL	Control the PPS output	ppscontrol switch [polarity] [rate]
614	MARKCONTROL	Control the processing of the mark inputs	markcontrol signal switch [polarity] [timebias [timeguard]]
652	SBASCONTROL	Set SBAS test mode and PRN	sbascontrol keyword [system] [prn] [testmode]
687	SETDIFFCODE-BIASES	Set satellite differential code biases	setdiffcodebiases [bias_type] [array of 40 biases (ns)]
691	GGAQUALITY	Customize the GPGGA GPS quality indicator	#entries [pos type1][qual1] [pos type2] [qual2]...
711	SETIONOTYPE	Set the ionospheric corrections model	setionotype model
729	ASSIGNLBAND	Set L-band satellite communication parameters	assignlband mode freq baud
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	position datum [lat [lon [height]]]
763	MOVINGBASE-STATION	Set ability to use a moving base station position	movingbasestation switch
780	HPSTATICINIT	Set static initialization of OmniSTAR HP/XP	hpstaticinit switch
782	HPSEED	Specify the initial position for OmniSTAR HP/XP	hpseed mode lat lon hgt lats lons hgts datum undulation
783	USEREXPDATUM	Set custom expanded datum	userexpdatum semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev refdate
796	FORCEGPSL2CODE	Force the receiver to track L2C or P-code	forcegpsl2code L2type
830	GLOCSMOOTH	Carrier smoothing for GLONASS channels	glocsmooth L1time [L2time]

Continued on Page 47

Message ID	Command	Description	Syntax
841	ANTENNAMODEL	Enter or change a rover antenna model	antennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]
844	RTKQUALITYLEVEL	Choose an RTK quality level	rtkqualitylevel mode
849	CNOUPDATE	C/No update rate and resolution	cnoupdate rate
850	CDGPSTIMEOUT	Set maximum age of CDGPS data accepted	cdgpstimeout mode [delay]
851	WAASTIMEOUT	Set maximum age of WAAS data accepted	waastimeout mode [delay]
858	RTKANTENNA	Specify L1 phase center (PC) or antenna reference point (ARP)	rtkantenna posref [pc]
861	NMEATALKER	Set the NMEA talker ID	nmeatalker ID
870	BASEANTENNA-MODEL	Enter or change a base antenna model	baseantennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]
880	SETRTCM36	Enter ASCII message including Russian chars	setrtcm36 extdtext
910	RTKTIMEOUT	Set the maximum age of RTK data accepted	rtktimeout delay
913	DIFFCODEBIAS-CONTROL	Enable or disable satellite differential code biases	diffcodebiascontrol switch

When the receiver is first powered up, or after an 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, Saved Ephemeris, and L-band-related data, excluding subscription information).

2.4 Factory Defaults

When the receiver is first powered up, or after a FRESET command (see *Page 117*), 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 170*) can be used to save these defaults. Use the RXCONFIG log (see *Page 497*) to reference many command and log settings.

The factory defaults are:

```
ADJUST1PPS OFF
ANTENNAPOWER ON
ASSIGNLBAND IDLE
CLOCKADJUST ENABLE
CLOCKOFFSET 0
COM COM1 9600 N 8 1 N OFF ON
COM COM2 9600 N 8 1 N OFF ON
COM COM3 9600 N 8 1 N OFF ON
COM AUX 9600 N 8 1 N OFF ON
COMCONTROL COM1 RTS DEFAULT
COMCONTROL COM2 RTS DEFAULT
COMCONTROL COM3 RTS DEFAULT
CSMOOTH 100 100
DATUM WGS84
DGPSEPHEMDELAY 120
DGPSTIMEOUT 300
DGPSTXID AUTO “ANY”
DYNAMICS AIR
ECUTOFF 5.0
EXTERNALCLOCK DISABLE
FIX NONE
FIXPOSDATUM NONE
FORCEGPSL2CODE DEFAULT
FREQUENCYOUT DISABLE
GLOCSMOOTH 100 100
GLOECUTOFF 5.0
HPSEED RESET
HPSTATICINIT DISABLE
INTERFACEMODE COM1 NOVATEL NOVATEL ON
INTERFACEMODE COM2 NOVATEL NOVATEL ON
INTERFACEMODE COM3 NOVATEL NOVATEL ON
INTERFACEMODE AUX 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 COM3 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG AUX 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
MARKCONTROL MARK2 ENABLE NEGATIVE 0 0
MOVINGBASESTATION DISABLE
NMEATALKER gp
POSAVE OFF
POSTIMEOUT 600
PPSCONTROL ENABLE NEGATIVE 1.0 0
PSRDIFFSOURCE AUTO "ANY"
RTKCOMMAND USE_DEFAULTS
RTKANTENNA l1pc
RTKDYNAMICS DYNAMIC
RTKQUALITYLEVEL NORMAL
RTKSVENTRIES 12
RTKSOURCE AUTO "ANY"
RTKTIMEOUT 60
SBASCONTROL DISABLE AUTO 0 NONE
SETIONOTYPE AUTO
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 48* 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 *V123*

This command is used to adjust the receiver clock or as part of the procedure to transfer time between receivers. The number of pulses per second (PPS) is always set to 1 Hz with this command. It is typically used when the receiver is not adjusting its own clock and is using an external reference frequency.

To disable the automatic adjustment of the clock, refer to the CLOCKADJUST command on *Page 74*. To configure the receiver to use an external reference oscillator, see the EXTERNALCLOCK command on *Page 109*.

The ADJUST1PPS command can be used to:

1. Manually shift the phase of the clock
2. Adjust the phase of the clock so that the output 1PPS signal matches an external signal
3. Set the receiver clock close to that of another GPS receiver
4. Set the receiver clock exactly in phase of another GPS receiver

---

1. The resolution of the clock synchronization is 50 ns.
2. 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 80*.
3. If the 1PPS rate is adjusted, the new rate does not start until the next second begins.

Figure 1 on *Page 51* shows the IPPS alignment between a Fine and a Cold Clock receiver. See also the TIMESYNC log on *Page 517* and the *Transfer Time Between Receivers* section in the *OEMV Family Installation and Operation User Manual*.

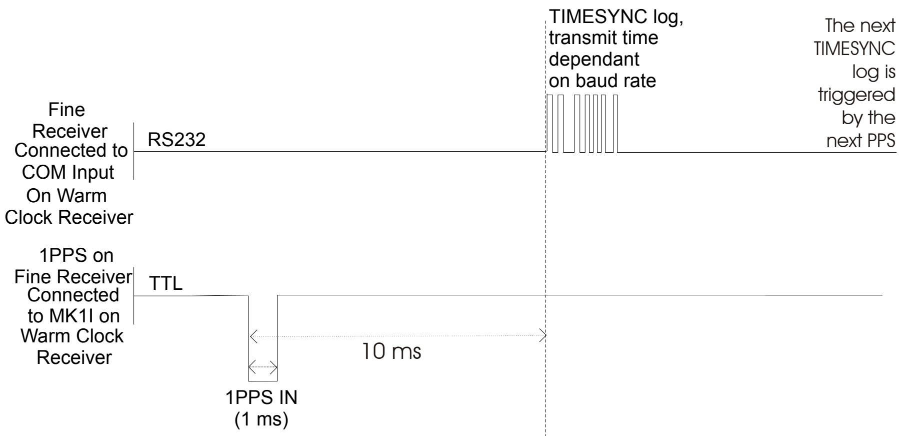

Figure 1: 1PPS Alignment

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

If you are using a:

Bare Card	The 1PPS output strobe is on pin# 7 of the OEMV-2 or pin# 4 of the OEMV-1.
ProPak-V3	A DB9F connector on the back of 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.

Alternatively, the 1PPS signal can be set up to be output on the RTS signal of COM1, COM2, or COM3, or the DTR signal of COM2 using the COMCONTROL command, see *Page 85*. The accuracy of the 1PPS is less using this method, but may be more convenient in some circumstances.

✉ COM3 is not available on the OEMV-1 card.

To find out the time of the last 1PPS output signal use the TIMESYNCA/B output message, see *Page 517*, which can be output serially on any available COM port, for example:

```
LOG COM1 TIMESYNCA ONTIME 1
```

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

ADJUST1PPS mode [period] [offset]

Factory Default:

adjust1pps off

ASCII Example:

adjust1pps mark continuous 240

You can use the ADJUST1PPS command to synchronize two OEMV cards in a primary/secondary relationship to a common external clock.

At the Primary Receiver:

log com2 timesynca ontime 1

clockadjust disable

externalclock ocxo (you can choose rubidium, cesium or user instead)

externalclock frequency 10 (you can choose 5 instead)

At the Secondary Receiver:

interfacemode com2 novatel novatel

clockadjust disable

adjust1pps mark (or markwithtime or time depending on your connection, see *Figure 2* on *Page 53*)

externalclock ocxo (you can choose rubidium, cesium or user instead)

externalclock frequency 10 (you can choose 5 instead)

Connections:

- Null modem cable connected from Primary COM2 to Secondary COM2
- OCXO signal sent through a splitter to feed both the Primary and Secondary external clock inputs
- Primary 1PPS (pin# 2) connected to Secondary MKI (Mark Input, pin# 4)

Make sure that you connect everything before you apply power. If power is applied and the OEMV receivers have acquired satellites before the OCXO and/or 1PPS = MKI is set up, the times reported by the TIMESYNC logs still diverge. We noted that after the clock model was stabilized at state 0, the time difference between the Primary and Secondary reported by the TIMESYNC log was less than 10 ns.

In *Figure 2* on *Page 53*, the examples are for the transfer of time. If you need position, you must be tracking satellites and your receiver must have a valid almanac.

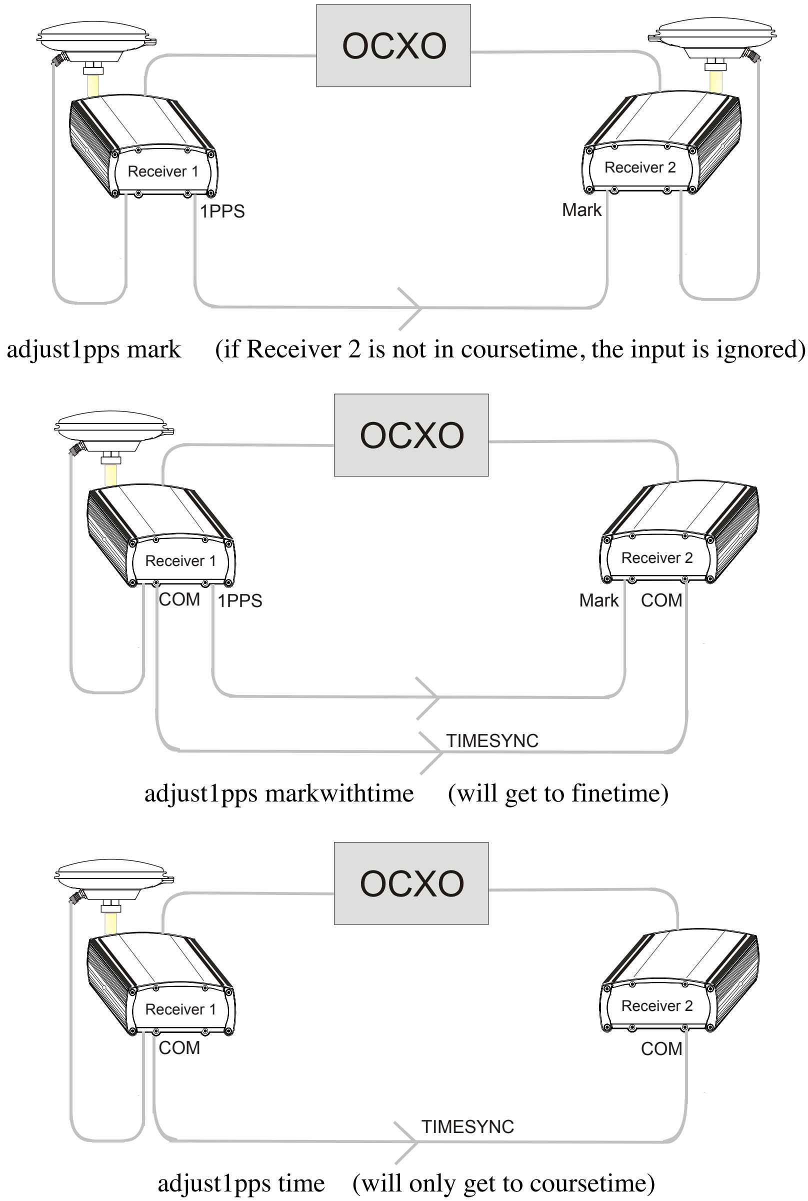

Figure 2: ADJUST1PPS Connections

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

Continued on Page 54

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
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.			
		MARKWITHTIME[b]	3	Shifts the receiver time to align its 1PPS with the signal received in the MK1I port adjusted by the offset field in ns, and sets the receiver TOW and week number, to that embedded in a received TIMESYNC log, see *Page 517*. It also sets the receiver Time Status to that embedded in the TIMESYNC log, which must have arrived between 800 and 1000 ms prior to the MK1I event (presumably the 1PPS from the Primary), or it is rejected as an invalid message.			
		TIME	4	If the receiver clock is not at least COARSE adjusted, this command enables the receiver to COARSE adjust its time upon receiving a valid TIMESYNC log in any of the ports. The clock state embedded in the TIMESYNC log must be at least FINE or FINESTEERING before it is considered. The receiver does not use the MK1I event in this mode.			

Continued on Page 55

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
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.			
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	Long	4	H+8

a. Only the MK1I input can be used to synchronize the 1PPS signal. Synchronization cannot be done using the MK2I input offered on some receivers.

b. It is presumed that the TIMESYNC log, see *Page 517*, was issued by a Primary GPS receiver within 1000 ms, but not less than 800 ms, of the last 1PPS event, see *Figure 1, 1PPS Alignment on Page 51.* Refer also to the *Transfer Time Between Receivers* section in the *OEMV Family Installation and Operation User Manual*.

2.5.2 ANTENNAMODEL Enter/change rover antenna model *V123*

This command allows you to enter or change an antenna model for a rover receiver. You can set the antenna set-up ID to any value from 0-255. See also BASEANTENNAMODEL, *Page 71*, to set these parameters at the base, and RTKANTENNA, *Page 161*.

It is recommended that the ANTENNNAMODEL, BASEANTENNAMODEL and RTKANTENNA commands only be used if complete antenna model information is available. These commands are best used in high-precision static survey situations where antenna models are available for the base and rover receivers.

Abbreviated ASCII Syntax: **Message ID: 841**

ANTENNAMODEL name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]

Factory Default:

antennamodel none none 0 none

ASCII Example:

antennamodel 702gg nae07070025 3 user 0.1 0.0 0.1 0.0

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ANTENNA-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	name			Antenna name	String[32]	Vari-able [a]	H
3	SN			Antenna serial number	String[32]	Vari-able [a]	Vari-able
4	setupID			Setup identification - setting this value changes the appropriate field in RTCM23, RTCM1007 and RTCM1008, see *Pages 429, 461* and *463* respectively	Ulong	4	Vari-able
5	type			Antenna model type 0 = No antenna 1 = User antenna	Enum	4	Vari-able
6	L1 offset			L1 phase center offsets (default = 0.0 0.0 0.0)	Double [3]	24	Vari-able
7	L1 var			L1 phase center variations (default = 0.0 *for all 19*)	Double [19]	152	Vari-able
8	L2 offset			L1 phase center offsets (default = 0.0 0.0 0.0)	Double [3]	24	Vari-able
9	L2 var			L1 phase center variations (default = 0.0 *for all 19*)	Double [19]	152	Vari-able

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

2.5.3 ANTENNAPOWER Control power to the antenna *V23*

This command enables or disables the supply of electrical power from the internal (refer to the *OEMV Family Installation and Operation User Manual* for information on 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 92, Receiver Status* on *Page 503*) 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 OEMV-3 card, it is possible to supply power to the LNA of an active antenna either from the antenna port of the OEM card itself or from an external source. The internal antenna power supply of the cards can produce +4.75 to +5.10 VDC at up to 100 mA. This meets the needs of any of NovAtel's dual-frequency GPS antennas, so, in most cases, an additional LNA power supply is not required.

External LNA power is not possible with an OEMV-2. The internal antenna power supply from the OEMV-2 card can produce +4.75 to +5.10 VDC at up to 100 mA.

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.			

2.5.4 ASSIGN Assign a channel to a PRN *V123*

1. The ASSIGN command should only be used by advanced users.
2. Assigning a SV channel sets the forced assignment bit in the channel tracking status field which is reported in the RANGE and TRACKSTAT logs
3. 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 11: 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
4	OUTPUT	Assign a channel to output the signal

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.

OEMV cards have 2 assigned channels for SBAS. They automatically use the GEO satellites with the highest elevations. You can use the ASSIGN command to enter a GEO PRN manually.

Table 12: OEMV Channel Configurations

Configurations	OEMV Card	Channels
GPS/SBAS	OEMV-1, OEMV-1G, OEMV-2 and OEMV-3	0 to 13 for GPS 14 to 15 for SBAS
GPS/SBAS/L-band	OEMV-1 and OEMV-3	0 to 13 for GPS 14 for SBAS 15 for L-band
GPS/SBAS/GLONASS	OEMV-1G, OEMV-2 and OEMV-3	0 to 13 for GPS 14 to 15 for SBAS 16 to 27 for GLONASS
GPS/SBAS/GLONASS/L-band	OEMV-3	0 to 13 for GPS 14 to 15 for SBAS 16 to 27 for GLONASS 28 for L-band

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 *1.1, Message Types* on *Page 16)*.	-	H	0
2	channel	See *Table 12, OEMV Channel Configurations* on *Page 61*		Desired SV channel number where channel 0 is the first SV channel. The last channel depends on your model configuration. [a]	ULong	4	H
3	state	See *Table 11, Channel State* on *Page 60*		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

a. The last channel is currently forced to the L-band signal (if available). See also *Table 12, OEMV Channel Configurations* on *Page 61*.

2.5.5 ASSIGNALL Assign all channels to a PRN V123

✉ 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 13: Channel System

Binary	ASCII	Description
0	GPSL1	GPS L1 dedicated SV channels only
1	GPSL1L2	GPS L1 and L2 dedicated SV channels only
2	NONE	No dedicated SV channels
3	ALL	All channels (default)
4	WAASL1	SBAS SV channels only
6	GPSL1L2C	GPS L1/L2C channels only
7	GPSL1L2AUTO	Automatically select GPS L1 or L2 channels
8	GLOL1L2	GLONASS L1 and L2 dedicated SV channels only
9	LBAND	L-band channels only
10	GLOL1	GLONASS L1 dedicated SV channels only

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 gpsl1l2,28,-250,0

All L1 and L2 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 works the same way as ASSIGN except that it affects **all** SV channels.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ASSIGNALL 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 13*		System that SV channel is tracking	Enum	4	H
3	state	See *Table 11, Channel State* on *Page 60*		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

2.5.6 ASSIGNLBAND Set L-band satellite communication parameters

V3_HP, V13_VBS or V13_CDGPS

You must use this command to ensure that the receiver searches for a specified L-band satellite at a specified frequency with a specified baud rate. The factory parameter default is ASSIGNLBAND IDLE.

1. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.

2. The frequency assignment, field #3 below, can be made in kHz or Hz. For example:

   ASSIGNLBAND OMNISTAR 1536782 1200

   A value entered in Hz is rounded to the nearest 500 Hz.

3. The NAD83 (CSRS) datum is available to CDGPS users. The receiver automatically transforms the CDGPS computed coordinates into WGS84 (the default datum of the receiver). Alternatively, select any datum, including CSRS, for a specified coordinate system output. See also *Table 21, Datum Transformation Parameters* on *Page 94*.

Abbreviated ASCII Syntax: **Message ID: 729**

ASSIGNLBAND mode freq baud

Factory Default:

assignlband idle

ASCII Example 1:

assignlband cdgps 1547547 4800

ASCII Example 2:

assignlband idle

Table 14: L-band Mode

Binary	ASCII	Description
0	Reserved	
1	OMNISTAR	When you select OmniSTAR, enter a dedicated frequency and baud rate.
2	CDGPS	When you select CDGPS, enter a dedicated frequency and baud rate.
3	IDLE	When you select IDLE, the receiver is configured to stop tracking any L-band satellites. The 'freq' and 'baud' fields are optional so that you may select IDLE without specifying the other fields.
4	OMNISTARAUTO	When you select OMNISTARAUTO, the receiver automatically selects the best OmniSTAR beam to track based on the receiver's position. This requires the receiver to have a downloaded satellite list from an OmniSTAR satellite. Therefore, a manual assignment is necessary the first time an OmniSTAR satellite is assigned on a new receiver. After collection, the satellite list is stored in NVM for subsequent auto assignments. Lists are considered valid for 6 months and are constantly updated while an OmniSTAR signal is tracking. If the receiver has a valid satellite list, it is reported in a status bit in the LBANDSTAT log, see *Page 322*. [a]

a. The receiver will always track an available local beam over a global beam. The receiver constantly monitors the satellite list to ensure it is tracking the best one and automatically switches beams if it is not tracking the best one. You can view the satellite list by logging the OMNIVIS message, see *Page 347*.

Beam Frequencies

You can switch between Omnistar VBS and CDGPS by using the following commands:

Use CDGPS

assignlband cdgps <freq> 4800

psrdiffsource cdgps

Use OmniStar VBS

assignlband omnistar <freq> 1200

psrdiffsource omnistar

Where `<freq>` is determined for CDGPS or OmniStar as follows:

1. CDGPS beam frequency chart:

   - East 1547646 or 1547646000

- East-Central 1557897 or 1557897000
- West-Central 1557571 or 1557571000
- West 1547547 or 1547547000

2. The OmniStar beam frequency chart can be found at http://www.omnistar.com/chart.html.

   For example:

   Eastern US (Coverage is Northern Canada to southern Mexico) 1530359 or 1530359000

OmniSTAR has changed channels (frequencies) on the AMSC Satellite that broadcasts OmniSTAR corrections for North America. NovAtel receivers do not need a firmware change. To change frequencies, connect your receiver and issue an ASSIGNLBAND command. For example, the Western Beam frequency as stated on Omnistar's website is 1536.7820 MHz. Input into the receiver: assignlband omnistar 1536782 1200

A NovAtel receiver with CDGPS has many advantages over other existing wide area correction systems. Most importantly, it delivers superior correction signal penetration, high accuracy and high resolution differential GPS corrections that are critical to many dynamic positioning applications. In addition, there is no subscription cost for users of this service. These features make a NovAtel OEMV with CDGPS an ideal sub-meter positioning system for a wide range of applications including agriculture, GIS, marine, and unmanned systems.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	ASSIGNLBAND header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively (see *1.1, Message Types* on *Page 16*).	-	H	0
2	mode	See *Table 14*		Set the mode and enter specific frequency and baud rate values	Enum	4	H
3	freq	1525000 to 1560000 or 1525000000 to 1560000000		L-band service beam frequency of satellite (Hz or kHz). See also *Beam Frequencies* on *Page 66*. (default = 1536782 if the mode is OMNISTAR)	Ulong	4	H+4
4	baud	300, 600, 1200, 2400 or 4800		Data rate for communication with L-band satellite (default = 1200)	Ulong	4	H+8

2.5.7 AUTH Add authorization code for new model *V123*

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 5 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 Service.

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 oemvl1l2 990131

auth 1234 5678 9abc def0 1234 oemvl1l2

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 Service/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

2.5.8 BASEANTENNAMODEL Enter/change base antenna model *V123*

This command allows you to enter or change an antenna model for a base receiver. Use the ANTENNAMODEL command to set these parameters for the rover. See also ANTENNAMODEL on *Page 56* and RTKANTENNA on *Page 161*.

Abbreviated ASCII Syntax: **Message ID: 870**

BASEANTENNAMODEL name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]

Factory Default:

baseantennamodel none none 0 none

ASCII Example:

baseantennamodel 702 nvh05410007 1 user

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	BASE-ANTENNA-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	name			Antenna name	String[32]	Variable [a]	H
3	SN			Antenna serial number	String[32]	Variable [a]	Variable
4	setupID			Setup identification - setting this value changes the appropriate field in RTCM23, RTCM1007 and RTCM1008, see *429, 461* and *463* respectively	Ulong	4	Variable
5	type			Antenna model type 0 = No antenna 1 = User antenna	Enum	4	Variable
6	L1 offset			L1 phase center offsets (default = 0.0 0.0 0.0)	Double [3]	24	Variable
7	L1 var			L1 phase center variations (default = 0.0 *for all 19*)	Double [19]	152	Variable
8	L2 offset			L1 phase center offsets (default = 0.0 0.0 0.0)	Double [3]	24	Variable
9	L2 var			L1 phase center variations (default = 0.0 *for all 19*)	Double [19]	152	Variable

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

2.5.9 CDGPSTIMEOUT Set CDGPS position time out *V13_CDGPS*

This command is used to set the amount of time the receiver remains in a CDGPS position if it stops receiving CDGPS corrections. See the DGPSEPHEMDELAY command on *Page 99* to set the ephemeris change-over delay for base stations.

Abbreviated ASCII Syntax: **Message ID: 850**

CDGPSTIMEOUT mode [delay]

Factory Default:

cdgpstimeout auto

ASCII Example (rover):

cdgpstimeout set 60

When the time out mode is set to AUTO, the time out delay is 120 seconds.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	CDGPS-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		Time out mode (default = auto)	Enum	4	H
3	delay	2 to 1000 s		Maximum CDGPS age (default = 120)	Double	8	H+4
4	Reserved				Double	8	H+12

Table 15: Time Out Mode

Binary	ASCII	Description
0	Reserved	
1	AUTO	Set the default value (120 s)
2	SET	Set the delay in seconds

2.5.10 CLOCKADJUST Enable clock adjustments *V123*

All oscillators have some inherent drift. By default the receiver attempts to steer the receiver's clock to accurately match GPS 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.

1. The CLOCKADJUST command should only be used by advanced users.
2. If the CLOCKADJUST command is ENABLED, and the receiver is configured to use an external reference frequency (set in the EXTERNALCLOCK command, see *Page 109*, for an external clock - TCXO, OCXO, RUBIDIUM, CESIUM, or USER), then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command, see *Page 117*.
3. When disabled, the range measurement bias errors continue to accumulate with clock drift.
4. Pseudorange, carrier phase and Doppler measurements may jump if the CLOCKADJUST mode is altered while the receiver is tracking.
5. When disabled, the time reported on all logs may be offset from GPS time. The 1PPS output may also be offset. The amount of this offset may be determined from the TIME log, see *Page 512*.
6. A discussion on GPS time may be found in *Section 1.4, GPS 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 an 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			

2.5.11 CLOCKCALIBRATE Adjust clock steering parameters *V123*

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 74*, 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 252*.

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 2.5.29 on Page 120* for more details.

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

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

ASCII Example:

clockcalibrate auto

The receiver by default steers its INTERNAL VCTCXO but can be commanded to control an EXTERNAL reference oscillator. Use the EXTERNALCLOCK command, see *Page 109*, to configure the receiver to use an external reference oscillator. If the receiver is configured for an external reference oscillator and configured to adjust its clock, then the clock steering loop attempts to steer the external reference oscillator through the use of the VARF signal. Note that the clock steering control process conflicts with the manual FREQUENCYOUT command, see *Page 117*. It is expected that the VARF signal is used to provide a stable reference voltage by the use of a filtered charge pump type circuit (not supplied).

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 currently selected steered oscillator (INTERNAL or EXTERNAL)	Enum	4	H
		AUTO	1	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 selected oscillator.			
		OFF	2	Terminates a calibration process currently underway			
3	period	0 to 262144		Signal period in 25 ns steps. Frequency Output = 40,000,000 / Period. (default = 4400)	Ulong	4	H+4

Continued on Page 78

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
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 2200. If this value is not known, (in the case of a new external oscillator) then it should be set to ½ the period and the mode should be set to AUTO to force a calibration.	Ulong	4	H+8
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 and EXTERNAL clocks is -2.0 and -0.01 respectively. 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 252*). This process should be repeated until the measured slope value remains constant (less than a 5% change).	Float	4	H+12

Continued on Page 79

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
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 values are 0.03 and 0.001 Hz respectively for the INTERNAL and EXTERNAL clocks.	Float	4	H+16

2.5.12 CLOCKOFFSET Adjust for delay in 1PPS output *V123*

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 *1.1, Message Types* on *Page 16*).	-	H	0
2	offset	-200 to +200		Specifies the offset in nanoseconds	Long	4	H

2.5.13 CNOUPDATE Set the C/No update rate and resolution *V123*

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	0	DEFAULT	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
		1	20HZ				

2.5.14 COM COM port configuration control *V123*

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 195)*
- Clear the transmit and receive buffers on the current port
- Return the current port to its default settings (see *Page 48* for details)
- Set the interface mode to NovAtel for both input and output (see the INTERFACEMODE command on *Page 130*)

See also *Section 2.4, Factory Defaults* on *Page 48* for a description of the factory defaults, and the COMCONFIG log on *Page 267*.

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1. The COMCONTROL command, see *Page 85*, may conflict with handshaking of the selected COM port. If handshaking is enabled, then unexpected results may occur.
2. 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, 460800 bps and 921600 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
com com3 9600 n 8 1 n off on
com aux 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 16: COM Serial Port Identifiers

Binary	ASCII	Description
1	COM1	COM port 1
2	COM2	COM port 2
3	COM3	COM port 3
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
16	AUX [c]	AUX port
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 130* and LOG on *Page 135*.

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.

c. The AUX port is available on OEMV-2-based and OEMV-3-based products.

✉ The OEMV-3 AUX port does not support hardware handshaking. Only transmit and receive lines exist for the AUX port on the OEMV-3.

Table 17: Parity

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

Table 18: 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 16, COM Serial Port Identifiers* on *Page 83*		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). Bauds of 460800 and 921600 are also available on COM1 of OEMV-2-based products.	ULong	4	H+4
4	parity	See *Table 17* on *Page 83*		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 18* on *Page 84*		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)			

2.5.15 COMCONTROL Control the RS232 hardware control lines *V123*

This command is used to control the hardware control lines of the RS232 ports. The TOGGLEPPS mode of this command is typically used to supply a timing signal to a host PC computer by using the RTS or DTR lines. The accuracy of controlling the COM control signals is better than 900 µs. The other modes are typically used to control custom peripheral devices. Also, it is possible to communicate with all three serial ports simultaneously using this command.

---

1. If handshaking is disabled, any of these modes can be used without affecting regular RS232 communications through the selected COM port. However, if handshaking is enabled, it may conflict with handshaking of the selected COM port, causing unexpected results.
2. The PULSEPPSLOW control type cannot be issued for a TX signal.

   Only PULSEPPSHIGH, FORCEHIGH and FORCELOW control types can be used for a TX signal.

Abbreviated ASCII Syntax: **Message ID: 431**

COMCONTROL port signal control

Factory Default:

comcontrol com1 rts default

comcontrol com2 rts default

comcontrol com3 rts default

ASCII Example 1:

com com1 9600 n 8 1 n (to disable handshaking)

comcontrol com1 rts forcelow

comcontrol com2 dtr togglepps

ASCII Example 2:

comcontrol com1 rts togglepps

comcontrol com2 rts togglepps

comcontrol com3 rts togglepps

ASCII Example 3:

OEMV-3:

To set a break condition on AUX:

comcontrol aux tx forcelow

A break condition remains in effect until it is cleared.

To clear a break condition on AUX:

comcontrol com1 tx default

or

comcontrol com1 tx forcehigh

Table 19: Tx, DTR and RTS Availability

	Tx Available On:	DTR Available On:	RTS Available On:
OEMV-1	COM1 and COM2	N/A	N/A
OEMV-2	COM1 and COM2	N/A	COM1 and COM2
OEMV-3	COM1, COM3 and AUX	COM2	COM1, COM2 and COM3

COM1 on the OEMV-3 is user-configurable for RS-422. Refer to the *Technical Specifications* appendix and also the *User-Selectable Port Configuration* section of the *OEMV Family Installation and Operation User Manual*.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	COMCONTROL 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	COM1	1	RS232 port to control. Valid ports are COM1, COM2, COM3 and AUX. The AUX port is only available on OEMV-3-based products.	Enum	4	H
		COM2	2				
		COM3	3				
		AUX	16				
3	signal	RTS	0	COM signal to control. The controllable COM signals are RTS, DTR and TX. See also *Table 19, Tx, DTR and RTS Availability* on *Page 86*	Enum	4	H+4
		DTR	1				
		TX	2				

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Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
4	control	DEFAULT	0	Disables this command and returns the COM signal to its default state	Enum	4	H+8
		FORCEHIGH	1	Immediately forces the signal high			
		FORCELOW	2	Immediately forces the signal low			
		TOGGLE	3	Immediately toggles the current sate of the signal			
		TOGGLEPPS	4	Toggles the state of the selected signal within 900 μs after each 1PPS event. The state change of the signal lags the 1PPS by an average value of 450 μs. The delay of each pulse varies by a uniformly random amount less than 900 μs.			
		PULSEPPSLOW	5	Pulses the line low at a 1PPS event and to high 1 ms after it. Not for TX.			
		PULSEPPSHIGH	6	Pulses the line high for 1 ms at the time of a 1PPS event			

2.5.16 CSMOOTH Set carrier smoothing *V123*

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.

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

CSMOOTH L1time [L2time]

Factory Default:

csmooth 100 100

Abbreviated ASCII Example:

csmooth 500

1. 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 Service Department, see the *Customer Service* section at the start of the *OEMV Family Installation and Operation User Manual.*
2. 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, if both the base and rover stations are using the same type of receiver (both OEM4 or both OEMV family). However if the base and rover stations use different types of receivers (OEM4 and OEMV family), it is recommended that the CSMOOTH command default value is used at each receiver (CSMOOTH 100 100 and GLOCSMOOTH 100 100).

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.

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	[L2time]	5-2000		L2 carrier smoothing time constant, in seconds (default = 100)	Ulong	4	H+4

2.5.17 DATUM Choose a datum name type *V123*

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 NAD83 (CSRS) datum is available to CDGPS users. The receiver automatically transforms the CDGPS computed coordinates into WGS84 (the default datum of the receiver). Alternatively, select any datum, including CSRS, for a specified coordinate system output.

The transformation for the WGS84 to Local used in the OEMV family 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 21* on *Page 94* for a complete listing of all available predefined datums.

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 20 on *Page 93* 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 Defence World Geodetic System 1984 and Relationships with Local Geodetic Systems - Revised March 1, 1988.
2. TR 8350.2B Supplement to Department of Defence 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 (ITRF) which is compatible with WGS84
CDGPS	Corrects to NAD83 and then transforms to WGS84 If you select the CSRS datum, the WGS84 transformation is undone and position is returned to CSRS
OmniSTAR XP/HP	Corrects to ITRF which is compatible with WGS84
OmniSTAR VBS	Corrects to ITRF which is compatible with WGS84
PSRDIFF and RTK	Unknown, as the rover does not know how the user fixed the base position, but must be close to WGS84

Table 20: Reference Ellipsoid Constants

ELLIPSOID	ID CODE	a (meters)	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	PZ90	6378136	298.257839303	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 21: Datum Transformation Parameters

Datum ID# [a]	NAME	DX	DY	DZ	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 [b]	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. [c]	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. [c]	Clarke 1866

Continued on Page 95

Datum ID#	NAME	DX	DY	DZ	DATUM DESCRIPTION	ELLIPSOID
20	KAUAI	45	-290	-172	**Do not use.** Use ID# 78 or ID# 82 instead. [c]	Clarke 1866
21	MAUI	65	-290	-190	**Do not use.** Use ID# 79 or ID# 83 instead. [c]	Clarke 1866
22	OAHU	56	-284	-181	**Do not use.** Use ID# 80 or ID# 84 instead. [c]	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 [b]	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. [c]	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. [c]	Clarke 1866
33	MINDA	-133	-70	-72	This datum has been updated, see ID# 73 [b]	Clarke 1866
34	MERCH	31	146	47	Merchich (Morocco)	Clarke 1880
35	NAHR	-231	-196	482	This datum has been updated, see ID# 74 [b]	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

Continued on Page 96

Datum ID#	NAME	DX	DY	DZ	DATUM DESCRIPTION	ELLIPSOID
39	NAD27	-8	160	176	N. American Conus 1927	Clarke 1866
40	CARIBB	-7	152	178	This datum has been updated, see ID# 75 [b]	Clarke 1866
41	MEXICO	-12	130	190	N. American Mexico	Clarke 1866
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 [b]	Everest (EB)
56	TOKYO	-128	481	664	This datum has been updated, see ID# 86 [b]	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

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Datum ID#	NAME	DX	DY	DZ	DATUM DESCRIPTION	ELLIPSOID
59	WAK60	101	52	-39	This datum has been updated, see ID# 67 [b]	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
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) [b]	Clarke 1880
66	ARSM	-160	-6	-302	ARC 1960 (Kenya, Tanzania) [b]	Clarke 1880
67	ENW	102	52	-38	Wake-Eniwetok (Marshall Islands) [b]	Hough 1960
68	HTN	-637	-549	-203	Hu-Tzu-Shan (Taiwan) [b]	International 1924
69	INDB	282	726	254	Indian (Bangladesh) [c]	Everest (EA)
70	INDI	295	736	257	Indian (India, Nepal) [c]	Everest (EA)
71	IRL	506	-122	611	Ireland 1965 [c]	Modified Airy
72	LUZA	-133	-77	-51	Luzon (Philippines excluding Mindanoa Is.) [cd]	Clarke 1866
73	LUZB	-133	-79	-72	Mindanoa Island [b]	Clarke 1866
74	NAHC	-243	-192	477	Nahrwan (Saudi Arabia) [b]	Clarke 1880
75	NASP	-3	142	183	N. American Caribbean [b]	Clarke 1866
76	OGBM	375	-111	431	Great Britain 1936 (Ordinance Survey) [c]	Airy 1830
77	OHAA	89	-279	-183	Hawaiian Hawaii [c]	Clarke 1866
78	OHAB	45	-290	-172	Hawaiian Kauai [c]	Clarke 1866
79	OHAC	65	-290	-190	Hawaiian Maui [c]	Clarke 1866

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Datum ID#	NAME	DX	DY	DZ	DATUM DESCRIPTION	ELLIPSOID
80	OHAD	58	-283	-182	Hawaiian Oahu [c]	Clarke 1866
81	OHIA	229	-222	-348	Hawaiian Hawaii [c]	International 1924
82	OHIB	185	-233	-337	Hawaiian Kauai [c]	International 1924
83	OHIC	205	-233	-355	Hawaiian Maui [c]	International 1924
84	OHID	198	-226	-347	Hawaiian Oahu [c]	International 1924
85	TIL	-679	669	-48	Timbalai (Brunei and East Malaysia) 1948 [b]	Everest (EB)
86	TOYM	-148	507	685	Tokyo (Japan, Korea and Okinawa) [b]	Bessel 1841

a. The default user datum is WGS84. See also the USERDATUM and USEREXPDATUM commands starting on *Page 196*. The following logs report the datum used according to the OEM card Datum ID column: BESTPOS, BESTUTM, MATCHEDPOS and PSRPOS.

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.

2.5.18 DGPSEPHEMDELAY DGPS ephemeris delay *V123_DGPS*

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 (default = 120 s)	ULong	4	H

2.5.19 DGPSTIMEOUT Set maximum age of differential data *V123_DGPS*

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. RTK differential data is set at 60 seconds but can be changed using the RTKTIMEOUT command, see *Page 169*. See DGPSEPHEMDELAY on *Page 99* 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 only applies to local pseudorange differential (RTCA, RTCM and OmniSTAR VBS) corrections as if they were from a local base station.

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 (default = 300 s)	ULong	4	H

2.5.20 DGPSTXID DGPS transmit ID *V123_DGPS*

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.

For example, if you want to compare RTCM and RTCMV3 corrections, you would be easily able to identify their base stations by first setting their respective DGPSTXID values.

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 cmr 30	- using a cmr type and id
dgpstxid cmr "any"	- using the default cmr id
dgpstxid rtca d36	- using an rtca type and id
dgpstxid rtcmv3 2050	- using an rtcmv3 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. There are three major categories we can look at:

- 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 would be in the 1 meter range.
- for a DGPS system using L1 C/A-code and carrier data, you require approximately 5 minutes of data including the initialization procedure under optimal conditions. This type of system provides you with accuracies in the 10 cm range. If cm-level accuracy is required, you need approximately 30 to 40 minutes of data, again under optimal conditions.
- for a DGPS system using L1 C/A-code and carrier data along with L2 P-code and carrier data, you require approximately 10 to 20 minutes of data under optimal conditions. This type of system provides you with accuracies in the cm 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 32, DGPS Type* on *Page 158*		ID Type	Enum	4	H
3	ID	String [max. 5] or “ANY”		ID string ANY type defaults: RTCM - 0 RTCMV3 - 0 RTCA - AAAA CMR - 0 The following range values are in affect: $0 \leq$ CMR ID ≤ 31 $0 \leq$ RTCM ID ≤ 1023 $0 \leq$ RTCMV3 ID ≤ 4095 RTCA: any four character string containing only alpha (a-z) or numerical characters (0-9)	String [max. 5]	Vari-able[a]	Variabl e

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

2.5.21 DIFFCODEBIASCONTROL Enable or disable satellite differential code biases *V123*

The purpose of the differential code biases is to correct pseudorange errors that affect the L1/L2 ionospheric corrections. This command enables/disables the biases. A set of biases is included in the firmware, and use of the biases is enabled by default. See also the SETDIFFCODEBIASES command on *Page 179*.

Abbreviated ASCII Syntax: **Message ID: 913**

DIFFCODEBIASCONTROL switch

Factory Default:

diffcodebiascontrol enable

Example:

diffcodebiascontrol disable

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	DIFFCODE-BIAS-CONTROL 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 the differential code bias	Enum	4	H
		ENABLE	1	Enable the differential code bias (default)			

2.5.22 DYNAMICS Tune receiver parameters *V123*

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 67, Tracking State* on *Page 367*. When the receiver loses the position solution, see *Table 47, Solution Status* on *Page 233*, 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, effectively increasing the steering time. The three states 0, 1, and 2 set the time-out to 5, 10, or 20 s respectively.

1. The DYNAMICS command should only be used by advanced users. The default of AIR should **not** be changed except under very specific conditions.
2. 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 RTK 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 22: 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 22*		Receiver dynamics based on your environment	Enum	4	H

2.5.23 ECUTOFF Set satellite elevation cut-off *V123*

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

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

2.5.24 EXTERNALCLOCK Set external clock parameters *V23*

Overview

The EXTERNALCLOCK command allows the OEMV card to operate with an optional external oscillator. You are able to optimally adjust the clock model parameters of these receivers for various types of external clocks.

1. This command affects the interpretation of the CLOCKMODEL log.
2. If the EXTERNALCLOCK command is enabled and set for an external clock (TCXO, OCXO, RUBIDIUM, CESIUM, or USER) and the CLOCKADJUST command, see *Page 74*, is ENABLED, then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command, see *Page 117*. If clocksteering is not used with the external oscillator, the clocksteering process must be disabled by using the CLOCKADJUST DISABLE command.

There are three steps involved in using an external oscillator:

1. Follow the procedure outlined in the *OEMV Family Installation and Operation User Manual* to connect an external oscillator to your OEMV.
2. Using the EXTERNALCLOCK command, select a standard oscillator and its operating frequency.
3. Using the CLOCKADJUST command, disable the clocksteering process if external clocksteering is not used.

Theory

An unsteered oscillator can be approximated by a three-state clock model, with two states representing the range bias and range bias rate, and a third state assumed to be a Gauss-Markov (GM) process representing the range bias error generated from satellite clock dither. The third state is included because the Kalman filter assumes an (unmodeled) white input error. The significant correlated errors produced by satellite clock dither are obviously not white and the Markov process is an attempt to handle this kind of short-term variation.

The internal units of the new clock model's three states (offset, drift and GM state) are meters, meters per second, and meters. When scaled to time units for the output log, these become seconds, seconds per second, and seconds, respectively. Note that the old units of the third clock state (drift rate) were meters per second per second.

The user has control over 3 process noise elements of the linear portion of the clock model. These are the h_0, $h\_{}_{-1}$, and $h\_{}_{-2}$ elements of the power law spectral density model used to describe the frequency noise characteristics of oscillators:

$$S_y(f) = \frac{h_{-2}}{f^2} + \frac{h_{-1}}{f} + h_0 + h_1 f + h_2 f^2$$

where f is the sampling frequency and $S_y(f)$ is the clock's power spectrum. Typically only h_0, h_{-1}, and h_{-2} affect the clock's Allan variance and the clock model's process noise elements.

Usage

Before you use an optional external oscillator, several clock model parameters must be set. There are default settings for a voltage-controlled temperature-compensated crystal oscillator (VCTCXO), ovenized crystal oscillator (OCXO), Rubidium and Cesium standard, which are given in *Table 24* on *Page 111*. You may alternatively choose to supply customized settings.

The EXTERNALCLOCK command determines whether the OEMV receiver (OEMV-2, OEMV-3, DL-V3 or ProPak-V3 only) uses its own internal temperature-compensated crystal oscillator, or that of an external oscillator, as a frequency reference. It also sets which clock model is used for an external oscillator:

To force the OEMV to use the internal oscillator, use the EXTERNALCLOCK DISABLE command and physically disconnect the external oscillator input. Do not use the EXTERNALCLOCK OCXO, CESIUM, RUBIDIUM or USER parameters if there is no external oscillator connected to the OEMV.

The EXTERNALCLOCK FREQUENCY command sets the OEMV to accept either a 5 MHz or 10 MHz external oscillator frequency. For example:

```
EXTERNALCLOCK FREQUENCY 5
```

Abbreviated ASCII Syntax: **Message ID: 230**

EXTERNALCLOCK clocktype [freq] [h0[h $_{-1}$[h $_{-2}$]]]

Factory Default:

```
externalclock disable
```

ASCII Examples:

```
externalclock user 10mhz 1.0167e-23 6.87621e-25 8.1762e-26

externalclock tcxo 5mhz
```

Table 23: Clock Type

ASCII	Binary	Description
DISABLE	0	Turns the external clock input off, reverts back to the on-board VCTCXO
TCXO	1	Sets the pre-defined values for a VCTCXO
OCXO	2	Sets the pre-defined values for an OCXO
RUBIDIUM	3	Sets the pre-defined values for a rubidium oscillator
CESIUM	4	Sets the pre-defined values for a cesium oscillator
USER	5	Defines custom process noise elements

Table 24: Pre-Defined Values for Oscillators

Clock Type	h_0	h_{-1}	h_{-2}
VCTCXO	1.0 e-21	1.0 e-20	1.0 e-20
OCXO	2.51 e-26	2.51 e-23	2.51 e-22
Rubidium	1.0 e-23	1.0 e-22	1.3 e-26
Cesium	2.0 e-20	7.0 e-23	4.0 e-29

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	EXTERNALCLOCK 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	clocktype	See *Table 23* on *Page 111*		Clock type	Enum	4	H
3	freq	0MHz	0	Optional frequency. If a value is not specified, the default is 5 MHz.	Enum	4	H+4
		5MHz	1				
		10MHz	2				
		20MHz	3				
4	h0	1.0 e-31 to 1.0 e-18		Optional timing standards. These fields are only valid when the USER clocktype is selected.	Double	8	H+8
5	h_{-1}	1.0 e-31 to 1.0 e-18			Double	8	H+16
6	h_{-2}	1.0 e-31 to 1.0 e-18			Double	8	H+24

2.5.25 FIX Constrain to fixed height or position *V123*

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 115*, 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.

1. NovAtel strongly recommends that the FIX POSITION entered be good to within a few meters. This level of accuracy can be obtained from a receiver using single point positioning once 5 or 6 satellites are being tracked.
2. FIX POSITION should only be used for base station receivers. Applying FIX POSITION to a rover, switches it from RT20, or RT2, mode to a fixed position mode. Applying FIX POSITION to the rover does not speed up ambiguity resolution.
3. Any setting other than FIX POSITION disables output of differential corrections unless the MOVINGBASESTATION command is set to ENABLE, see also *Page 147*.
4. 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 also *Page 190.*

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 an RTK 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 25: FIX Parameters

ASCII Type Name	Parameter 1	Parameter 2	Parameter 3
AUTO	Not used	Not used	Not used
HEIGHT	Default MSL height [a] [b] (-1000 to 20000000 m)	Not used	Not used
NONE	Not used	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)

a. For a discussion on height, refer to the *GPS Overview* chapter of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

b. See also *Note #4* on *Page 112*

Table 26: 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 231*, and is in meters. 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. This command only affects pseudorange corrections and solutions, and so has no meaning within the context of RTK.

Continued on Page 114

ASCII Name	Binary Value	Description
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, RTCMV3, RTCA, or CMR. See the *OEMV Family Installation and Operation User Manual* for information on 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 centre. 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.
PENDING	18	There is not enough measurements available to verify the FIX POSITION entry
INVALID_FIX	19	The errors in the FIX POSITION entry are too large

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 26* on *Page 113*		Fix type	Enum	4	H
3	param1	See *Table 25*		Parameter 1	Double	8	H + 4
4	param2			Parameter 2	Double	8	H + 12
5	param3			Parameter 3	Double	8	H + 20

2.5.26 FIXPOSDATUM Set position in a specified datum *V123*

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 112*, 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 21* on *Page 94*		Datum ID	Enum	4	H
3	lat	-90 to +90		Latitude (degrees)	Double	8	H + 4
4	lon	-360 to +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 a discussion on height, refer to the *GPS Overview* chapter of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

2.5.27 FORCEGPSL2CODE Force receiver to track L2 P or L2C code *V23_L2C*

This command allows you to force the receiver to track L2 P-code or L2C code. AUTO tells the receiver to use the best L2 code type available.

Abbreviated ASCII Syntax: **Message ID: 796**

FORCEGPSL2CODE L2type

Factory Default:

forcegpsl2code default

ASCII Example:

forcegpsl2code p

Table 27: L2 Code Type

Binary	ASCII	Description
0	AUTO	Receiver uses the best L2 code type available
1	P	L2 P-code or L2 Precise code
2	C	L2C code or L2 Civilian code
3	DEFAULT	Set to channel default

In surveying, a benefit of choosing to track the L2C code is the ability to track extremely weak L2 signals. L2C is just 2.3 dB weaker than L1 C/A code. Compared to codeless and semicodeless techniques, L2 tracking with L2C is slightly improved.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	FORCEGPSL2-CODE 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	L2type	See *Table 27* above		GPS L2 code type	Enum	4	H

2.5.28 FREQUENCYOUT Set output pulse train available on VARF *V123*

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 3* below.

If the CLOCKADJUST command is ENABLED, see *Page 74*, and the receiver is configured to use an external reference frequency (set in the EXTERNALCLOCK command, see *Page 109*, for an external clock - TCXO, OCXO, RUBIDIUM, CESIUM, or USER), then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command.

Figure 3, 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 2 4

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

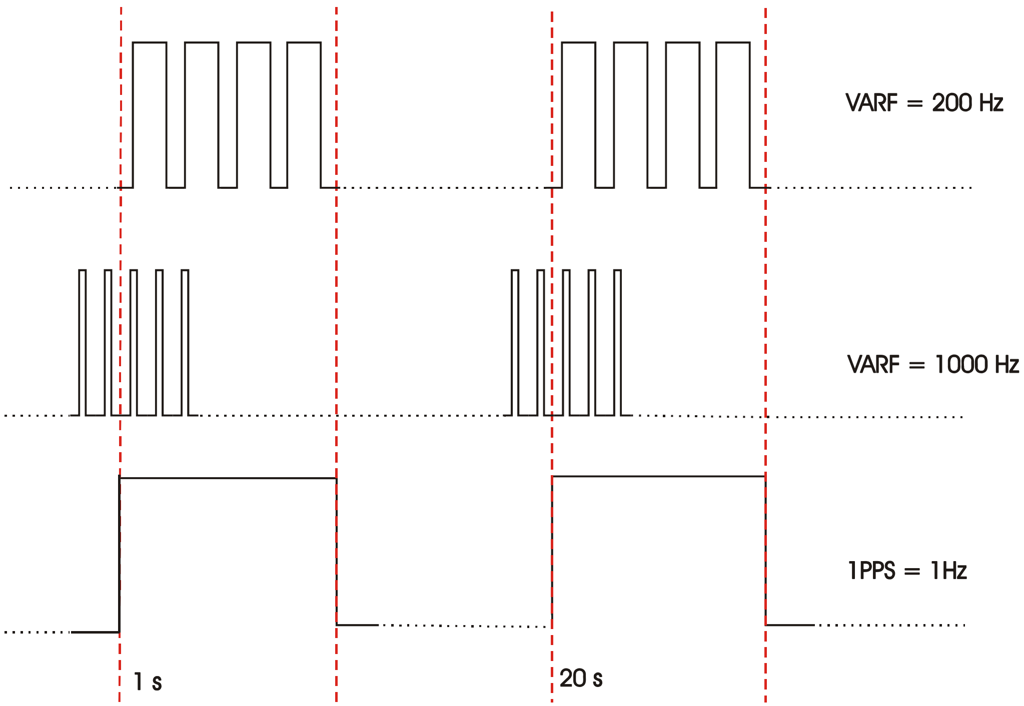

Figure 3: Pulse Width and 1PPS Coherency

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 262144)		Number of 25 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.	Ulong	4	H+4
4	period	(0 to 262144)		Signal period in 25 ns steps. Frequency Output = 40,000,000 / Period (default = 0)	Ulong	4	H+8

2.5.29 FRESET Clear selected data from NVM and reset *V123*

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, almanac, and L-band 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 CLKCALIBRATION 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 28*) 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 28: FRESET Target

Binary	ASCII	Description
0	STANDARD	Resets commands, ephemeris, and almanac (default). Also resets all L-band related data except for the subscription information.
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 28*		What data is to be reset by the receiver	Enum	4	H

2.5.30 GGAQUALITY Customize the GPGGA GPS quality indicator *V123_NMEA*

This command allows you to customize the NMEA GPGGA GPS quality indicator. See also the GPGGA log on *Page 290*.

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 2 waas 2 narrow_float 3

Makes the WAAS solution type show 2, and the NARROW_FLOAT solution type show 3, as their quality indicators.

Input Example 3:

ggaquality 0

Sets all the quality indicators back to the default.

Some solution types, see *Table 46, Position or Velocity Type* on *Page 232*, store a quality indicator. For example, OmniSTAR_HP, OmniSTAR_XP and NARROW_FLOAT all share an indicator of 2. 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 46, Position or Velocity Type* on *Page 232*		The 1st position type that is being re-mapped	Enum	4	H+8
4	qual1	See *Page 290*		The number that appears in the GPGGA log for the 1st position type	Ulong	4	H+12
5	pos type2	See *Table 46* on *Page 232*		The 2nd position type that is being re-mapped, if applicable	Enum	4	H+16
6	qual2	See *Page 290*		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		

2.5.31 GLOCSMOOTH GLONASS channel carrier smoothing *V1G23_G*

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 [L2time]

Factory Default:

glocsmooth 100 100

Abbreviated ASCII Example:

glocsmooth 200

1. 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 Service Department, see the *Customer Service* section at the start of the *OEMV Family Installation and Operation User Manual.*
2. 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, if both the base and rover stations are using the same type of receiver (both OEMV family). However if the base and rover stations use different types of receivers (OEM4 and OEMV family), it is recommended that the CSMOOTH and GLOCSMOOTH command default value is used at each receiver.

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

2.5.32 GLOECUTOFF Set GLONASS satellite elevation cut-off *V1G23_G*

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 for more information on elevation cut-off commands.

GLONASS measurements can be used for post-processed positioning solutions or in user-designed programs. NovAtel plans to offer GLONASS positioning in the future. In the meantime, OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also www.novatel.com for details.

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

GLOECUTOFF angle

Factory Default:

gloecutoff 5.0

ASCII Example:

gloecutoff 0

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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

2.5.33 HPSEED Specify the initial OmniSTAR HP/XP position *V3_HP*

This OmniSTAR HP/XP command allows you to specify the initial position for OmniSTAR HP/XP. It allows you to specify the datum and undulation for the position entered. Position is then transformed into the datum currently set in the receiver. You can use STORE or RESTORE as a variable.

The HPSEED command does not get saved when you use the SAVECONFIG command. Rather, if STORE is issued with the HPSEED command, it stores in it NVM. The RESTORE variable re-sends the stored HPSEED command.

Abbreviated ASCII Syntax: **Message ID: 782**

HPSEED mode [lat lon hgt latσ lonσ hgtσ [datum undulation]]

Factory Default:

hpseed reset

There is more information on HP/XP seeding in the usage box starting on *Page 128*.

Here are some ASCII Examples:

- To store the current HP/XP position so that it can be used as the seed in the future:

  HPSEED STORE

- To use the stored HP/XP position as the seed:

  HPSEED RESTORE

- To use a known position in the native datum of OmniSTAR HP/XP as the seed:

  HPSEED SET 51.11633810554 -114.03839550586 1048.2343 0.0086,0.0090,0.0191

- To use a known position from a datum other than the native OmniSTAR HP/XP datum as the seed:

  HPSEED SET 51.11633810554 -114.03839550586 1048.2343 0.0086,0.0090,0.0191 CANADA EGM96

Table 29: Seeding Mode

Binary Value	ASCII Mode Name	Description
0	RESET	Clear current seed and restart HP/XP [a]
1	SET	Specify a position and inject it into HP/XP as seed
2	STORE	Store current HP/XP position in NVM for use as a future seed [a]
3	RESTORE	Inject NVM-stored position into HP/XP as seed [a]

a. No further parameters are needed in the syntax

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	HPSEED 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 29* on *Page 127*		Seeding mode	Enum	4	H
3	lat	-90 to +90		Latitude (degrees)	Double	8	H+4
4	lon	-360 to +360		Longitude (degrees)	Double	8	H+12
5	hgt	-1000 to 20000000		Height above mean sea level (m)	Double	8	H+20
6	latσ			Latitude standard deviation (m)	Float	4	H+28
7	lonσ			Longitude standard deviation (m)	Float	4	H+32
8	hgtσ			Height standard deviation (m)	Float	4	H+36
9	datum	See *Table 21, Datum Transformation Parameters* on *Page 94*		Datum ID (default = WGS84)	Enum	4	H+40
10	undulation	see the UNDULATION command's *option* field values on *Page 190*		Undulation type (default = TABLE)	Enum	4	H+44

2.5.34 HPSTATICINIT Set OmniSTAR HP/XP static initialization *V3_HP*

This command enables or disables static initialization of OmniSTAR HP/XP. If the OmniSTAR HP/XP process knows that the receiver is stationary, it can converge more quickly.

If the HP/XP filter perceives receiver motion, it may abort static initialization. See the Static Initialization Mode bit in the HP/XP Status field of the LBANDSTAT log, details *starting on Page 322*, to confirm that static initialization is in progress.

Abbreviated ASCII Syntax: **Message ID: 780**

HPSTATICINIT switch

Factory Default:

hpstaticinit disable

ASCII Example:

hpstaticinit enable

HP/XP seeding is restarting the HP/XP filter from known coordinates with a known accuracy as a starting point such that it is already converged. This is implemented by using the HPSEED command, see *Page 126*.

There are two ways of using our implementation of HP/XP seeding:

1. Seed HP/XP from a stored HP/XP position:

You can use this method to save the converged HP/XP position and feed it back in when your vehicle, for example, your tractor, hasn't moved since shutting down.

When HP/XP is converged and the vehicle is stopped, enter HPSEED STORE to save the current HP/XP position to NVM.

When the vehicle is restarted, enter HPSEED RESTORE to feed the previously known position into the HP/XP process so it can start from the previous accuracy.

2. Seed HP/XP from an externally generated known position and accuracy:

Consider the case of survey customers who enter the known antenna location with

HPSEED SET <latitude> <longitude> <msl height> <lat stdev> <long stdev> <height stdev>

If the source of the position is in a different datum than the native datum of HP/XP, or if a different undulation has been used, the transformation can be specified after <height stdev> with <datum id> <undulation type>.

Note: Initial position estimate for HP/XP and fallback when HP/XP is lost:

When HP/XP starts up, it requests the current position to get itself started. In the start-up timeline that we have implemented, this is the first valid position available when the task running HP/XP receives its first L-band data. This may or may not be a VBS position when VBS is also enabled. It depends on how things start up - whatever pseudorange filter position is available is used. If you want to hold off on HP/XP using the position estimate until you've confirmed that the VBS corrections have started and plenty of satellites are in the solution, you can start up with PSRDIFFSOURCE OMNISTAR and RTKSOURCE NONE, wait for the condition of the VBS position to be satisfactory and then set RTKSOURCE OMNISTAR as well. The HP/XP start-up will be waiting until you set the RTKSOURCE. This may give some minor improvement to the convergence time of HP/XP.

This is somewhat related to the position falling back to VBS when HP/XP is lost. If both PSRDIFFSOURCE OMNISTAR and RTKSOURCE OMNISTAR is set, the BESTPOS log contains the best available of the two. There is normally an offset between the HP/XP solution and VBS.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	HPSTATICINIT 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	The receiver is not stationary	Enum	4	H
		ENABLE	1	The receiver is stationary			

2.5.35 INTERFACEMODE Set receive or transmit modes for ports *V123*

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, RTCM, RTCMV3 or CMR. 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 PASSCOM, PASSXCOM, PASSAUX and PASSUSB. See *Page 349* for details on these logs and the *Operation* chapter, in the *OEMV Family Installation and Operation User Manual*, for information on pass-through logging. See also the COMCONFIG log on *Page 267*.

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 82*, 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 com3 novatel novatel on

interfacemode aux novatel novatel on

interfacemode usb1 novatel novatel on

interfacemode usb2 novatel novatel on

interfacemode usb3 novatel novatel on

ASCII Example:

interfacemode com1 rtca novatel on

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 30: 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/generates CMR corrections
5	Reserved	
6		
7	IMU	This port supports communication with a NovAtel supported IMU, contact Customer Service, or refer to your *SPAN for OEMV User Manual* for more information
8	RTCMNOCR	RTCM with no CR/LF appended [a]

Continued on Page 132

Binary Value	ASCII Mode Name	Description
9	CDGPS	The port accepts GPS*C data [b]
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 82*. Only serial ports may be in a tunnel configuration: COM1, COM2, COM3 or AUX may be used. For example, configure a tunnel at 115200 bps between COM1 and AUX: COM AUX 115200 COM COM1 115200 INTERFACEMODE AUX TCOM1 NONE OFF INTERFACEMODE COM1 TAUX NONE OFF The tunnel is fully configured to receive/transmit at a baud rate of 115200 bps.
11	TCOM2	
12	TCOM3	
13	TAUX [c]	
14	RTCMV3	The port accepts/generates 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 349.*

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.

b. CDGPS has three options for output of differential corrections - NMEA, RTCM, and GPS*C. If you have a ProPak-V3 receiver, you do not need to use the INTERFACEMODE command with CDGPS as the argument. The CDGPS argument is for use with obsolete external non-NovAtel CDGPS receivers. These receivers use GPS*C (NavCanada's proprietary format differential corrections from the CDGPS service).

c. The AUX port, and therefore TAUX mode, is only available on OEMV-2-based and OEMV-3-based products.

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 16, COM Serial Port Identifiers* on *Page 83*		Serial port identifier (default = THISPORT)	Enum	4	H
3	rxtype	See *Table 30, Serial Port Interface Modes* on *Page 131*		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)			

2.5.36 LOCKOUT Prevent the receiver from using a satellite *V123*

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

2.5.37 LOG Request logs from the receiver *V123*

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 three COM ports and three USB ports. The ONTIME trigger option requires the addition of the *period* parameter. See *Chapter 3, Data Logs on Page 204* 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 193*. To remove all logs that have the [hold] parameter, use the UNLOGALL command with the *held* field set to 1, see *Page 195*.

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

1. The OEMV family of 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.
2. 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.
3. Polled log types do not allow fractional offsets or ONTIME rates faster than 1Hz.
4. Use the ONNEW trigger with the MARKTIME, MARK2TIME, MARKPOS or MARK2POS logs.
5. Only the MARKPOS, MARK2POS, MARKTIME or MARK2TIME 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.
6. 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 com3 rxstatuseventa onnew 0 0 hold

log aux 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 32* 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 21*)	This field contains the message header.	-	H	0
2	port	See *Table 5, Detailed Serial Port Identifiers* on *Page 23*	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 = Abbreviated ASCII, NMEA 11 = Reserved Bit 7 = Response Bit (see *Page 25*) 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]			
7	period	Valid values for the high rate logging are 0.05, 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 [b]	Double	8	H+12

Continued on Page 138

Field	Field Name	Binary Value	Description	Field Type	Binary Bytes	Binary Offset
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 *OEMV Family Installation and Operation User Manual* for more details on the MK1I pin. ONMARK only applies to MK1I. Events on MK2I (if available) do not trigger logs when ONMARK is used. Use the ONNEW trigger with the MARKTIME, MARK2TIME, MARKPOS or MARK2POS logs.

b. See *Appendix A* in the *OEMV Family 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 16, COM Serial Port Identifiers* on *Page 83*	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 *Footnote a* on *Page 138*)	
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 b* on *Page 138*)	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	

2.5.38 MAGVAR Set a magnetic variation correction *V123*

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 4, Illustration of Magnetic Variation & Correction on Page 141.*

The receiver calculates values of magnetic variation for given values of latitude, longitude and time using the International Geomagnetic Reference Field (IGRF) 95 spherical harmonic coefficients and IGRF time corrections to the harmonic coefficients.

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

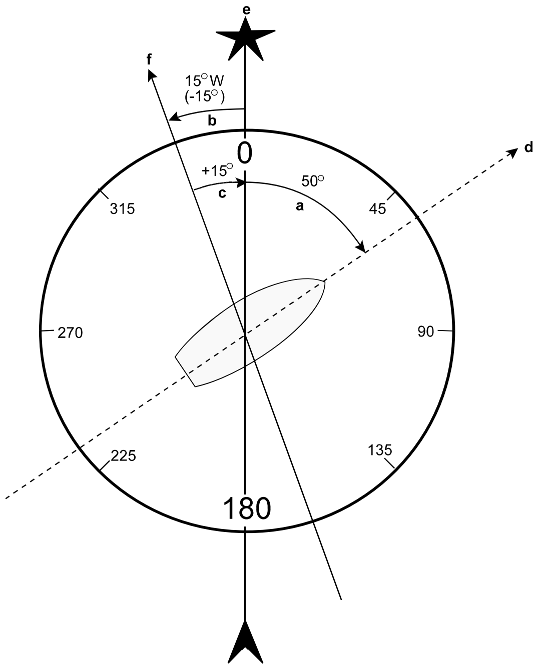

Figure 4: Illustration of Magnetic Variation & Correction

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

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, OEMV 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. Refer to the *GPS+ Reference Manual* for USGS contact information.

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

2.5.39 MARKCONTROL Control processing of mark inputs *V123*

This command provides a means of controlling the processing of the mark 1 (MK1I) and mark 2 (MK2I) inputs for the OEMV. 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 331*, 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

markcontrol mark2 enable negative 0 0

ASCII Example:

markcontrol mark1 enable negative 50 100

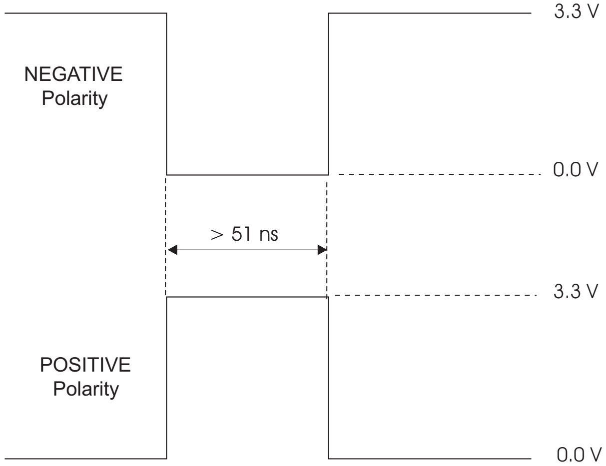

Figure 5: TTL Pulse Polarity

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 331*.

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 and MARK2 for MK2I. Both mark inputs have 10K pull-up resistors to 3.3 V and are leading edge triggered.	Enum	4	H
		MARK2	1				
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 5* 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 *OEMV Family 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.

2.5.40 MODEL Switch to a previously authorized model V123

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 521*. Use the VERSION log to output the active model, see *Page 522*.

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 rt2w

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 an L1 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 69*). Reloading the firmware or returning the receiver for service to upgrade the model is not required. Upgrades are available from NovAtel Customer Service 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]	Variable[a]	Variable

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

2.5.41 MOVINGBASESTATION Set ability to use a moving base station *V23_RT2 or V123_RT20*

This command enables or disables a receiver from transmitting corrections without a fixed position.

The moving base function allows you to obtain a cm level xyz baseline estimate when the base station and possibly the rover are moving. It is very similar to normal RTK, that is, one base station and potentially more than one rover depending on the data link. Communication with each receiver is done in the usual way (refer to the *Transmitting and Receiving Corrections* section of the *Operation* chapter in the *OEMV Family Installation and Operation User Manual*). The BSLNXYZ log is an asynchronous 'matched' log that can be logged with the onchanged trigger to provide an accurate baseline between the base and rover.

At the rover, it is recommended that you only use the PSRPOS log for position when in moving base station mode. PSRPOS has normal accuracy with good standard deviations. Other position logs, for example BESTPOS, can have error levels of 10's to 100's of meters and should be considered invalid. Also, the standard deviation in these logs does not correctly reflect the error level. Other rover position logs, where accuracy and standard deviations are affected by the moving base station mode, are BESTXYZ, GPGST, MARKPOS, MARK2POS, MATCHEDPOS, MATCHEDXYZ, RTKPOS and RTKXYZ.

The MOVINGBASESTATION command must be used to allow the base to transmit messages without a fixed position.

1. Use the PSRPOS position log at the rover. It provides the best accuracy and standard deviations when the MOVINGBASESTATION mode is enabled.
2. Do not use this command with RTCM messaging.
3. The MOVINGBASESTATION mode is functional if any of the following RTK message formats are in use: RTCAOBS, RTCAOBS2, CMROBS, RTCAREF or CMRREF.

Abbreviated ASCII Syntax: **Message ID: 763**

MOVINGBASESTATION switch

Factory Default:

movingbasestation disable

ASCII Example:

movingbasestation enable

1. Consider the case where there is a fixed base and an airplane flying with a moving base station near its front and a rover station at its tail end. See *Figure 6* on *Page 148*.

   Corrections can be sent between the receivers in a 'daisy chain' effect where the fixed base station sends corrections to the moving base station which in turn can send corrections to the rover.

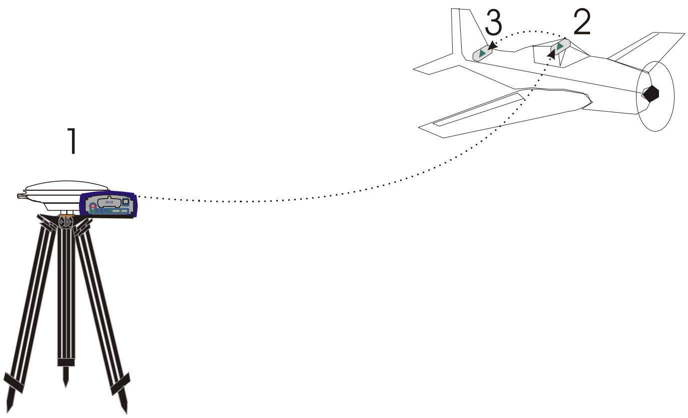

Figure 6: Moving Base Station 'Daisy Chain' Effect

Be cautious however when using this method as a check on the position type is only done at the fixed base station. Moving base stations will continue to operate under any conditions.

2. This command is useful for moving base stations doing RTK positioning at sea. A rover station is used to map out local areas (for marking shipping lanes, hydrographic surveying, and so on), while the base station resides on the control ship. The control ship may not move much (parked at sea), but there is a certain amount of movement due to the fact that it is floating in the ocean. By using the MOVINGBASESTATION command, the control ship is able to use RT2-level RTK positioning and move to new survey sites.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	MOVING-BASESTATION 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	Do not transmit corrections without a fixed position (default)	Enum	4	H
		ENABLE	1	Transmit corrections without a fixed position			

2.5.42 NMEATALKER Set the NMEA talker ID *V123*

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 on only the GPS satellites and have a 'GP' talker solution even when GLONASS satellites are present. The `nmeatalker auto` command changes this behaviour 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 on 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 31* on *Page 150* shows the NMEA logs and whether they use GPS (GP), GLONASS (GL) or combined (GN) talkers with `nmeatalker auto`.

Table 31: 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, GLONASS, combined and/ or Inertial [a]			

a. Inertial only applies when using an inertial navigation system such as NovAtel's SPAN products. Please visit our website, refer to your *SPAN for OEMV User Manual*, or contact NovAtel for more information.

2.5.43 NVMRESTORE Restore NVM data after an NVM failure V123

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 501* and *RXSTATUSEVENT, Page 508*). 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 *OEMV Family 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.

2.5.44 POSAVE Implement base station position averaging *V123_DGPS*

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:

POSAVE ON 24 1 2

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 RTK 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

2.5.45 POSTIMEOUT Sets the position time out *V123*

This commands allows you to set the RTK 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

In performing RTK data collection in a highly dynamic environment (for example, urban canyons or in high-speed operations), you can use POSTIMEOUT to prevent the receiver from using calculated positions that are too old. Use POSTIMEOUT to force the receiver position type to NONE. This ensures that the position information being used in BESTPOS or PSRPOS logs is based on a recent calculation. All position calculations are then re-calculated using the most recent satellite information.

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

2.5.46 PPSCONTROL Control the PPS output *V123*

This command provides a method for controlling the polarity and rate of the PPS output on the OEMV. The PPS output can also be disabled using this command.

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

PPSCONTROL switch [polarity] [rate]

Factory Default:

ppscontrol enable negative 1.0 0

ASCII Example:

ppscontrol enable positive 0.5

This command is used to setup the PPS signal coming from the receiver. Suppose you wanted to take measurements such as temperature or pressure in synch with your GPS data. The PPS signal can be used to trigger measurements in other devices.

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	Disables or enables output of the PPS pulse. The factory default value is ENABLE.	Enum	4	H+4
		ENABLE	1				
4	polarity	NEGATIVE	0	Optional field to specify the polarity of the pulse to be generated on the PPS output. See *Figure 5* for more information. If no value is supplied, the default NEGATIVE is used.	Enum	4	H+8
		POSITIVE	1				
3	rate	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
4	Reserved, set to 0.				ULong	4	H+20

2.5.47 PSRDIFFSOURCE Set the pseudorange correction source *V123_DGPS*

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 166*.

1. When a valid PSRDIFFSOURCE command is received, the current correction is removed immediately rather than in the time specified in DGPSTIMEOUT, see *Page 101*.
2. To use L-band differential corrections, an L-band receiver and a subscription to the OmniSTAR, or use of the free CDGPS, service are required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.

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 OmniSTAR VBS, and HP or XP:
   rtksource omnistar
   psrdiffsource omnistar
3. Enable RTK and PSRDIFF from RTCM, with a fall-back to SBAS:
   rtksource rtcm any
   psrdiffsource rtcm any
   sbascontrol enable auto

Since several errors affecting the signal transmission are nearly the same for two receivers near each other on the ground, a receiver at a point with known coordinates (a base) can monitor the errors and generate corrections for the remote receiver to use. This method is called Differential GPS, and is used by surveyors to obtain millimeter 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 that are not removed include receiver noise and multipath.

Table 32: DGPS Type

Binary	ASCII	Description
0	RTCM [a d]	RTCM ID: 0 ≤ RTCM ID ≤ 1023 **or** ANY
1	RTCA [a d]	RTCA ID: A four character string containing only alpha (a-z) or numeric characters (0-9) **or** ANY
2	CMR [a b d]	CMR ID: 0 ≤ CMR ID ≤ 31 **or** ANY
3	OMNISTAR [c d]	In the PSRDIFFSOURCE command, OMNISTAR enables OmniSTAR VBS and disables other DGPS types. OmniSTAR VBS produces RTCM-type corrections. In the RTKSOURCE command, OMNISTAR enables OmniSTAR HP/XP (if allowed) and disables other RTK types. OmniSTAR HP/XP has its own filter, which computes corrections in RTK float mode or within about 10 cm accuracy.
4	CDGPS [c d]	In the PSRDIFFSOURCE command, CDGPS enables CDGPS and disables other DGPS types. CDGPS produces SBAS-type corrections. **Do not set CDGPS in the RTKSOURCE command as it can not provide carrier phase positioning and disallows all other sources of RTK information**.
5	SBAS [c d]	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. Do not set SBAS in the RTKSOURCE command as it can not provide carrier phase positioning and disallows all other sources of RTK information.
10	AUTO [c d]	In the PSRDIFFSOURCE command, AUTO means the first received RTCM or RTCA message has preference over an L-band message. In the RTKSOURCE command, AUTO means that both the NovAtel RTK filter and the OmniSTAR HP/XP filter (if authorized) are enabled. The NovAtel RTK filter selects the first received RTCM, RTCA, RTCMV3 or CMR message. The BESTPOS log selects the best solution between NovAtel RTK and OmniSTAR HP/XP.
11	NONE [c d]	Disables all the DGPS and OMNISTAR types
12	Reserved	
13	RTCMV3 [b]	RTCM Version 3.0 ID: 0 ≤ RTCMV3 ID ≤ 4095 **or** ANY

a. Disables L-band Virtual Base Stations (VBS)
b. Available only with the RTKSOURCE command, see *Page 166*
c. ID parameter is ignored
d. All PSRDIFFSOURCE entries fall back to SBAS (even 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 32*		ID Type. All types may revert to SBAS (if enabled) or SINGLE position types. See also *Table 46, Position or Velocity Type* on *Page 232.*	Enum	4	H
3	ID	Char [5] or ANY		ID string	Char[5]	8[a]	H+4

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

2.5.48 RESET Perform a hardware reset *V123*

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 120* and *170* 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.

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

2.5.49 RTKANTENNA Specify L1 phase center (PC) or ARP and enable/disable PC modelling *V123_RT20 or V23_RT2*

Use this command to specify whether to use L1 phase center or Antenna Reference Point (ARP) positioning.

You can also decide whether or not to apply phase center variation modeling. If there are any conditions that make a selected mode impossible, the solution status in the position logs indicate an error or warning. Status information is in the *rtk info* field of the RTKDATA log, see *Page 485*.

L1 ARP offsets, L2 ARP offsets and phase center variation parameters can be entered using the ANTENNAMODEL and BASEANTENNAMODEL commands on *Page 56* and *Page 71* respectively.

Error states occur if either the rover does not have the necessary antenna information entered or the base is not sending sufficient information to work in the requested mode. Some examples of these error conditions are:

- RTCM Types 23 and 24 messages are received from the base and no model is available for the specified base antenna
- Phase center modeling is requested but the base is only sending RTCM Types 3 and 22
- Position reference to the ARP is requested but no rover antenna model is available

Abbreviated ASCII Syntax: **Message ID: 858**

RTKANTENNA posref [pcv]

Factory Default:

rtkantenna l1pc

ASCII Example:

rtkantenna arp enable

This command is used for high-precision RTK positioning allowing application of antenna offset and phase centre variation parameters.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKANTENNA 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	posref	L1PC	0	L1 phase centre position reference	Enum	4	H
		ARP	1	ARP position reference			
		UNKNOWN	2	Unknown position reference			
3	pcv	DISABLE	0	Disable PCV modelling (default)	Enum	4	H+4
		ENABLE	1	Enable PCV modelling			
4	Reserved				Bool	4	H+8
5	Reserved				Bool	4	H+12

2.5.50 RTKCOMMAND Reset or set the RTK filter to its defaults
V123_RT20 or V23_RT2

This command provides the ability to reset the RTK filter and clear any set RTK parameters. The RESET parameter causes the AdVance RTK algorithm to undergo a complete reset, forcing the system to restart the ambiguity resolution calculations. The USE_DEFAULTS command executes the following commands:

RTKDYNAMICS DYNAMIC
RTKSVENTRIES 12

Abbreviated ASCII Syntax: **Message ID: 97**

RTKCOMMAND action

Factory Default:

rtkcommand use_defaults

ASCII Example:

rtkcommand reset

See the descriptions for the above commands in the following pages.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKCOMMAND 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	USE_DEFAULTS	0	Reset to defaults	Enum	4	H
		RESET	1	Reset RTK algorithm			

2.5.51 RTKDYNAMICS Set the RTK dynamics mode *V123_RT20 or V23_RT2*

This command provides the ability to specify how the receiver looks at the data. There are three modes: STATIC, DYNAMIC, and AUTO. The STATIC mode forces the RTK software to treat the rover station as though it were stationary, regardless of the output of the motion detector.

DYNAMIC forces the software to treat the receiver as though it were in motion. If the receiver is undergoing very slow steady motion (<2.5 cm/s for more than 5 seconds), you should use DYNAMIC mode (as opposed to AUTO) to prevent inaccurate results and possible resets.

On start-up, the receiver defaults to the DYNAMIC setting.

For reliable performance the antenna should not move more than 1-2 cm when in static mode.

Abbreviated ASCII Syntax: **Message ID: 183**

RTKDYNAMICS mode

Factory Default:

rtkdynamics dynamic

ASCII Example:

rtkdynamics static

Table 33: Dynamics Mode

ASCII	Binary	Description
AUTO	0	Automatically determine dynamics mode.
STATIC	1	Static mode.
DYNAMIC	2	Dynamic mode.

Use the static option to decrease the time required to fix ambiguities and reduce the amount of noise in the position solution. If you use STATIC mode when the antenna is not static, the receiver will have erroneous solutions and unnecessary RTK resets.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKDYNAMICS 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 33*		Set the dynamics mode	Enum	4	H

2.5.52 RTKQUALITYLEVEL Choose an RTK quality mode *V123_RT20, V23_RT2*

Abbreviated ASCII Syntax: **Message ID: 844**

RTKQUALITYLEVEL mode

Factory Default:

rtkqualitylevel normal

ASCII Example:

rtkqualitylevel extra_safe

Table 34: RTK Quality Mode

ASCII	Binary	Description
NORMAL	1	Normal RTK
EXTRA_SAFE	4	Extra Safe RTK

The EXTRA_SAFE command is needed in areas where the signal is partially blocked, by trees for example, and the position solution in NORMAL mode shows NARROW_INT even though the real position solution is out by several metres. Using EXTRA_SAFE in these types of environments means the solution will be slower getting to NARROW_INT but it won't be erroneous.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKQUALITY-LEVEL 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 34*		Set the RTK quality level mode	Enum	4	H

2.5.53 RTKSOURCE Set the RTK correction source *V123_RT20, V23_RT2 or V3_HP*

This command lets you identify from which base station to accept RTK (RTCM, RTCMV3, RTCA, CMR and OmniSTAR (HP/XP)) differential corrections. This is useful when the receiver is receiving corrections from multiple base stations. See also the PSRDIFFSOURCE command on *Page 157*.

To use OmniSTAR HP/XP differential corrections, a NovAtel receiver with L-band capability and a subscription to the OmniSTAR service are required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.

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

RTKSOURCE type ID

Factory Default:

rtksource auto "any"

ASCII Examples:

1. Select only SBAS:

   rtksource none

   psrdiffsource none

   sbascontrol enable auto

2. Enable OmniSTAR HP and VBS:

   rtksource omnistar

   psrdiffsource omnistar

3. Enable RTK and 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 fallback to SBAS, the farmer could set up his receiver to use transmitted RTCM corrections when available, but fall back to SBAS. Also, if he decided to get an OmniSTAR subscription, he could switch to the

OmniSTAR corrections.

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 32, DGPS Type* on *Page 158*		ID Type	Enum	4	H
3	ID	Char [5] or ANY		ID string	Char[5]	8[a]	H+4

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

2.5.54 RTKSVENTRIES Set number of satellites in corrections *V123_RT20, V23_RT2 or V3_HP*

This command sets the number of satellites (at the highest elevation) that are transmitted in the RTK corrections from a base station receiver. Intended for RTCA, it works only with RTCAOBS or RTCAOBS2, see *Page 389*. This is useful when the amount of bandwidth available for transmitting corrections is limited.

Abbreviated ASCII Syntax: **Message ID: 92**

RTKSVENTRIES number

Factory Default:

rtksventries 12

ASCII Example:

rtksventries 7

GPS devices have enabled many transit and fleet authorities to provide Automatic Vehicle Location (AVL). AVL systems track the position of individual vehicles and relay that data back to a remote dispatcher location, that can store or better utilize the information. Consider the implementation of an AVL system within a police department, to automatically log and keep track of the location of each cruiser. Typically a fleet uses a 9600 bps connection where AVL data is relayed back to headquarters. The limited bandwidth of the radio must be shared amongst the AVL and other systems in multiple cruisers.

When operating with a low baud rate radio transmitter (9600 or lower), especially over a long distance, the AVL system could limit the number of satellites for which corrections are sent using the RTKSVENTRIES command.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKSVENTRIES 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	number	4-12		The number of SVs to use in the solution (default = 12)	ULong	4	H

2.5.55 RTKTIMEOUT Set maximum age of RTK data *V123_RT20, V23_RT2*

This command is used to set the maximum age of RTK data to use when operating as a rover station. RTK data received that is older than the specified time is ignored.

Abbreviated ASCII Syntax: **Message ID: 910**

RTKTIMEOUT delay

Factory Default:

rtktimeout 60

ASCII Example (rover):

rtktimeout 20

See the DGPSEPHEMDELAY command on *Page 99* to set the ephemeris changeover delay for base stations.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	RTKTIMEOUT 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	5 to 60 s		Maximum RTK data age (default = 60 s)	ULong	4	H

2.5.56 SAVECONFIG Save current configuration in NVM *V123*

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 497*. See also the FRESET command, *Page 120*.

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

2.5.57 SBASCONTROL Set SBAS test mode and PRN *V123_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) or RTK if the appropriate corrections are received, regardless of the current setting.

To enable the position solution corrections, you must issue the SBASCONTROL ENABLE command. The GPS receiver does not attempt to track any GEO satellites until you use the SBASCONTROL command to tell it to use either WAAS, EGNOS, or MSAS corrections.

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.

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 the GPS receiver to use a specific correction type, the GPS receiver begins to search for and track the relevant GEO PRNs for that correction type only.

You can force the GPS receiver to track a specific PRN using the ASSIGN command. You can force the GPS receiver 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 keyword [system] [prn] [testmode]

Factory Default:

sbascontrol disable auto 0 none

Abbreviated ASCII Example 1:

sbascontrol enable waas 0 zerototwo

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

Table 35: 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	Enum	4	H
		ENABLE	1	Receiver uses the SBAS corrections it receives			
3	system	See *Table 35* on *Page 171*		Choose the SBAS the receiver will use	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			

2.5.58 SEND Send an ASCII message to a COM port *V123*

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.

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

SEND port data

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.

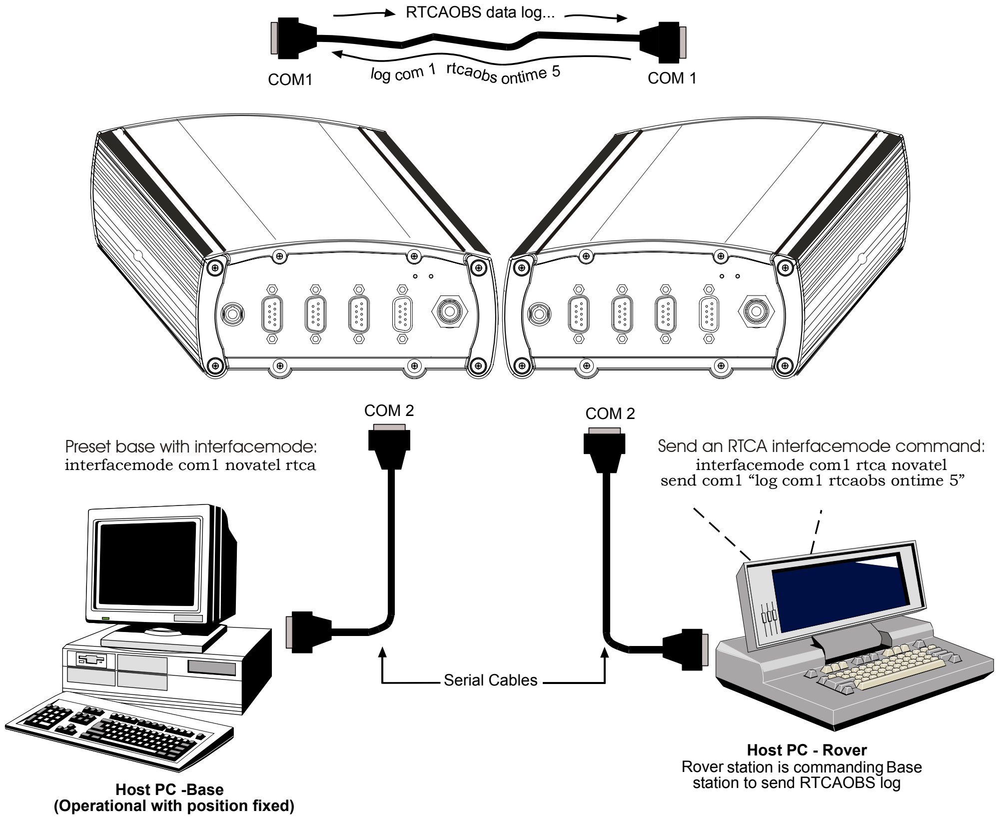

Figure 7: Using the SEND Command

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 16, COM Serial Port Identifiers* on *Page 83*		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

2.5.59 SENDHEX Send non-printable characters in hex pairs *V123*

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 16, COM Serial Port Identifiers* on *Page 83*		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

2.5.60 SETAPPROXPOS Set an approximate position *V123*

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 177*), can improve satellite acquisition times and time to first fix. For more information, please refer to the *TTFF and Satellite Acquisition* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

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 510*.

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 177*.

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

2.5.61 SETAPPROXTIME Set an approximate GPS time *V123*

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 176*) to improve time to first fix. For more information, please refer to the *TTFF and Satellite Acquisition* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

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

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

See also the SATVIS log on *Page 510*.

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 time using the SETAPPROXTIME command or RTCAEPHEM message. The RTCAEPHEM message contains GPS week and seconds and the receiver uses that GPS 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 the OEMV family commands and logs used to inject an approximated time or position into the receiver:

Approximate	Command	Log
Time	SETAPPROXTIME	RTCAEPHEM
Position	SETAPPROXPOS	RTCAREF *or* CMRREF *or* RTCM3

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 week number	Ulong	4	H
3	sec	0-604801		Number of seconds into GPS week	Double	8	H+4

2.5.62 SETDIFFCODEBIASES Set satellite differential code biases *V123*

WARNING!: **Changing the biases may negatively affect positioning accuracy. NovAtel recommends that only advanced users modify the biases.**

Use this command to set the differential code biases that correct pseudorange errors affecting the L1/L2 ionospheric corrections. Bias values are restricted to between -3 ns and +3 ns. A set of biases is included in the firmware, and use of the biases is enabled by default. See also the DIFFCODEBIASCONTROL command on *Page 104*.

The receiver uses the C/A code on L1 and the P code on L2 to calculate a dual-frequency ionospheric correction. However, the GPS clock corrections are broadcast as if the P codes on both L1 and L2 are used to calculate this correction. The biases account for the differences between the P and C/A codes on L1, and improve the estimate of the ionospheric correction.

The biases are calculated by the International GNSS Service (IGS). Calculation details, analysis, and results are available at http://www.aiub.unibe.ch/ionosphere.html. The most recent 30 day average bias values can be downloaded from http://www.aiub.unibe.ch/ionosphere/p1c1.dcb.

Abbreviated ASCII Syntax: **Message ID: 687**

SETDIFFCODEBIASES

Factory Default:

setdiffcodebiases [bias_type] [array of 40 biases (ns)]

Example:

setdiffcodebiases gps_c1p1 -0.472 -0.006 -0.482 1.154
-1.153 0.250 -1.319 -0.535 0.119 -1.945 0.522 1.425 1.489
0.090 0.0 -0.727 1.361 -0.416 -2.066 -1.347 -0.380 0.543
0.414 -0.172 0.394 0.923 -0.422 -0.326 0.481 1.937 1.753
-1.088 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETDIFF-CODE-BIASES 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	bias_type	GPS_C1P1	0	Disable the differential code bias (default)	Enum	4	H
3	biases			Array of 40 biases (ns)	Float[40]	160	4

2.5.63 SETIONOTYPE Enable ionospheric models *V123*

Set which ionospheric corrections model the receiver should use.

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

SETIONOTYPE model

Factory Default:

setionotype auto

ASCII Example:

setionotype waas

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 36* below		Choose an ionospheric corrections model (default = NONE)	Enum	4	H

Table 36: Ionospheric Correction Models

ASCII	Binary	Description
NONE	0	Don't use ionospheric modelling
BROADCAST	1	Use the broadcast model, for example Klobuchar
GRID	2	Use the SBAS/L-band model
L1L2	3	Use the L1/L2 model
AUTO	4	Automatically determine the ionospheric model to use

2.5.64 SETNAV Set start and destination waypoints *V123*

This command permits entry of one set of navigation waypoints (see *Figure 8* on *Page 181*). 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 meters. 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 8* on *Page 181* for clarification.

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

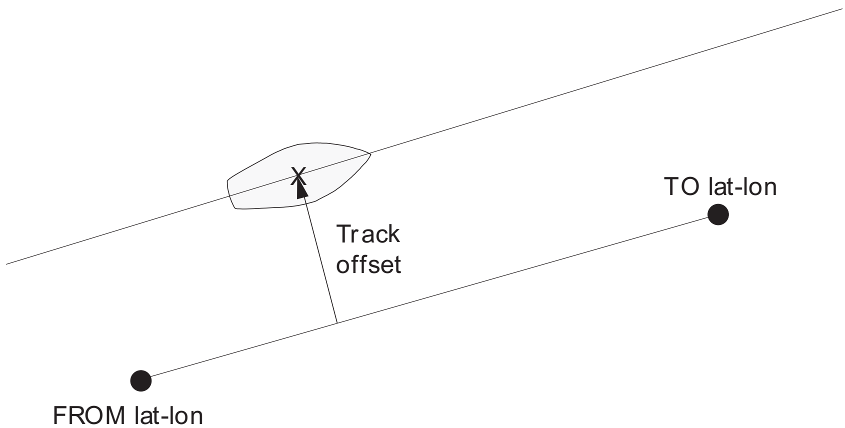

Figure 8: Illustration of SETNAV Parameters

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.

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	± 360 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	± 360 degrees		Destination longitude in units of degrees/decimal degrees	Double	8	H+24
6	track offset	± 1000 km		Waypoint great circle line offset (in kilometers); establishes offset track; positive indicates right of great circle line; negative indicates left of great circle line.	Double	8	H+32
7	from-point	6 characters maximum		ASCII station name	String [max. 6]	Variable [a]	Variable
8	to-point	6 characters maximum		ASCII station name	String [max. 6]	Variable [a]	Variable

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

2.5.65 SETRTCM16 Enter ASCII text for RTCM data stream *V123_DGPS*

The RTCM type 16 message allows ASCII text to be transferred from a GPS base station to rover GPS 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". The received ASCII text can be displayed at the rover by logging RTCM16T.

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

2.5.66 SETRTCM36 Enter ASCII text with Russian characters *V1G23_G*

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 37* on *Page 185* 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 (colour 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 436*, 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 401*, 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 37: Russian Alphabet Characters (Ch) in Decimal (Dec) and Hexidecimal (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

2.5.67 STATUSCONFIG Configure RXSTATUSEVENT mask fields *V123*

This command is used to configure the various status mask fields in the RXSTATUSEVENT log, see *Page 508*. 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 *OEMV Family Installation and Operation User Manual*.

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

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.

Table 38: 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 38*		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

2.5.68 UNASSIGN Unassign a previously assigned channel *V123*

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	0-11		Reset SV channel to automatic search and acquisition mode	ULong	4	H
3	state	See *Table 11, Channel State* on *Page 60*		Set the SV channel state (currently ignored)	Enum	4	H+4

2.5.69 UNASSIGNALL Unassign all previously assigned channels V123

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 13, Channel System* on *Page 63*		System that the SV channel is tracking	Enum	4	H

2.5.70 UNDULATION Choose undulation *V123*

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, MATCHEDPOS, OMNIHPPOS, PSRPOS and RTKPOS 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 *GPS Overview* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm for a description of the relationships in *Figure 9*.

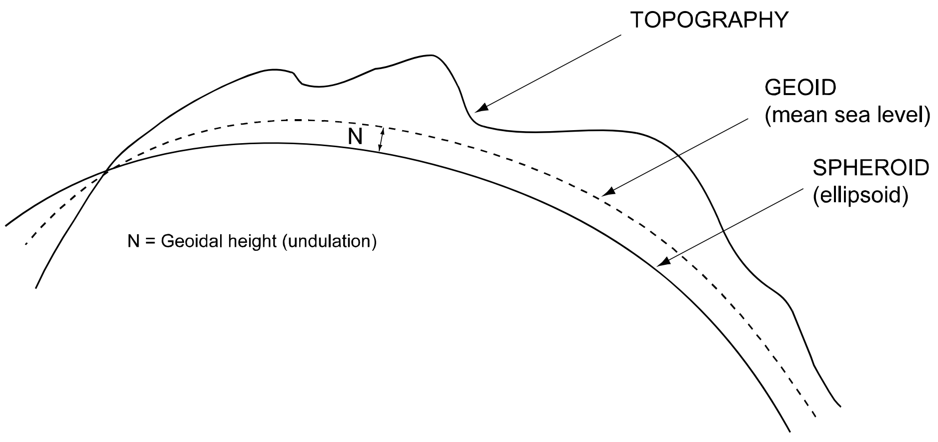

Figure 9: Illustration of Undulation

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

2.5.71 UNLOCKOUT Reinstate a satellite in the solution *V123*

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

2.5.72 UNLOCKOUTALL Reinstate all previously locked out satellites *V123*

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.

2.5.73 UNLOG Remove a log from logging control *V123*

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 Name	Binary Value	Description	Field Type	Binary Bytes	Binary Offset
1	UNLOG (binary) header	(See *Table 4, Binary Message Header Structure* on *Page 21*)	This field contains the message header.	-	H	0
2	port	See *Table 5* on *Page 23* (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 25*) 0 = Original Message 1 = Response Message	Message type of log	Char	1	H+6
5	Reserved			Char	1	H+7

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 5* on *Page 23* (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

2.5.74 UNLOGALL Remove all logs from logging control V123

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 5 on Page 23* (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			

2.5.75 USERDATUM Set user-customized datum *V123*

This command permits entry of customized ellipsoidal datum parameters. This command is used in conjunction with the DATUM command, see *Page 92*. If used, the command default setting for USERDATUM is WGS84.

When the USERDATUM command is entered, the USEREXPDATUM command, see *Page 198*, 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 OEMV family 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 meters	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 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 axis. These values are the rotation from WGS84 to your datum. A positive sign is for clockwise rotation and a negative sign is for counter 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

2.5.76 USEREXPDATUM Set custom expanded datum *V123*

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 63*. If you use this command without specifying any parameters, the command defaults to WGS84. If you enter a USERDATUM command, see *Page 196*, 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 0.00000000 0 0.000000000 0.000000000
0.000000000 0.000000000 0.000000000 0.000000000 0.0000 00000
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 island is moving several centimeters 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 meters	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 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 WGS84 to your datum. A positive sign for clockwise rotation and a negative sign for counter 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

2.5.77 UTMZONE Set UTM parameters *V123*

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.

1. 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.
2. 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 meters, 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 meters.

Table 39: 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 39 above*			Enum	4	H
3	parameter				Enum	4	H+4

2.5.78 WAASECUTOFF Set SBAS satellite elevation cut-off *V123_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 = 0.0)	Float	4	H

2.5.79 WAASTIMEOUT Set WAAS position time out *V123_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 99* 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 40* below		Time out mode (default = AUTO)	Enum	4	H
3	delay	2 to 1000 s		Maximum SBAS position age (default = 600 s)	Double	8	H+4
4	Reserved				Double	8	H+12

Table 40: 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, see *Page 135*, 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.

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

The following table outlines the log types and the valid triggers to use:

Table 41: 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.

1. The OEMV family of 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.
2. The following logs do not support the ONNEXT trigger: GPSEPHEM, RAWEPHEM, RAWGPSSUBFRAME, RAWWAASFRAME, RXSTATUSEVENT and WAAS9.
3. Asynchronous logs, such as MATCHEDPOS, 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.
4. Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

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 20 Hz logging, the minimum logging period is 1/20 Hz or 0.05 s. The following are valid examples for a synchronous, or asynchronous log, on a receiver that can log at rates up to 20 Hz:

`log bestpos 0.05`	*[20 Hz]*
`log bestpos 0.1 0.05`	*[10 Hz]*
`log bestpos ontime 1 0.05`	*[1 Hz]*
`log bestpos ontime 1 0.1`	
`log bestpos ontime 1 0.90`	
`log avepos ontime 1 0.95`	
`log avepos ontime 2 1.35`	*[0.5 Hz]*
`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 42, starting on the following page, lists the logs by function while *Table 43* starting on *Page 214* is an alphabetical listing of logs (repeated in *Table 44* starting on *Page 220* with the logs in the order of their message IDs).

Table 42: Logs By Function

Logs	Descriptions	Type
GENERAL RECEIVER CONTROL AND STATUS		
COMCONFIG	Current COM port configuration	Polled
EXTRXHWLEVELS	Extended receiver hardware levels	Polled
LOGLIST	List of system logs	Polled
PASSCOM1, PASSXCOM1, PASSAUX, PASSUSB1	Pass-through log, also PASSCOM2, PASSCOM3, PASSXCOM2, PASSXCOM3, PASSUSB2 and PASSUSB3	Asynch
PORTSTATS	COM and, if applicable, USB port statistics	Polled
RXCONFIG	Receiver configuration status	Polled
RXHWLEVELS	Receiver hardware levels	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 [a]	Best position data	Synch
BESTUTM	Best available UTM data	Synch
BESTXYZ	Cartesian coordinates position data	Synch
BSLNXYZ	RTK XYZ baseline	Synch
DIFFCODEBIASES	Differential code biases being applied	Polled
GPGGA	NMEA, fix and position data	Synch
GPGGARTK	NMEA, global position system fix data	Synch
GPGLL	NMEA, position data	Synch

Continued on Page 207

POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL		
Logs	**Descriptions**	**Type**
GPGRS	NMEA, range residuals	Synch
GPGSA	NMEA, DOP information	Synch
GPGST	NMEA, measurement noise statistics	Synch
IONUTC	Ionospheric and UTC model information	Asynch
MATCHEDPOS [a]	Computed position	Asynch
MATCHEDXYZ	Cartesian coordinates computed position data	Asynch
MARKPOS, MARK2POS	Position at time of mark input event	Asynch
MARKTIME, MARK2TIME	Time of mark input event	Asynch
OMNIHPPOS	OmniSTAR HP/XP position data	Synch
PSRDOP	DOP of SVs currently tracking	Asynch
RTKPOS [a]	RTK low latency position	Synch
RTKVEL[b]	RTK Velocity	Synch
RTKXYZ	RTK cartesian coordinate position	Synch

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a. The RTK system in the receiver provides two kinds of position solutions. The Matched RTK position is computed with buffered observations, so there is no error due to the extrapolation of base station measurements. This provides the highest accuracy solution possible at the expense of some latency which is affected primarily by the speed of the differential data link. The MATCHEDPOS log contains the matched RTK solution and can be generated for each processed set of base station observations. The RTKDATA log provides additional information about the matched RTK solution.

   The Low-Latency RTK position is computed from the latest local observations and extrapolated base station observations. This supplies a valid RTK position with the lowest latency possible at the expense of some accuracy. The degradation in accuracy is reflected in the standard deviation and is summarized in the *GPS Overview* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm. The amount of time that the base station observations are extrapolated is provided in the "differential age" field of the position log. The Low-Latency RTK system extrapolates for 60 seconds. The RTKPOS log contains the Low-Latency RTK position when valid, and an "invalid" status when a low-latency RTK solution could not be computed. The BESTPOS log contains either the low-latency RTK, OmniSTAR HP or XP, or pseudorange-based position, whichever has the smallest standard deviation.

b. The RTK velocity is computed from successive low-latency RTK position solutions. The RTKVEL log contains the RTK velocity, when valid, and outputs an ‘invalid’ status if a low-latency RTK velocity solution cannot be computed. The BESTVEL log contains the low-latency RTK velocity when the BESTPOS log contains the low-latency RTK position.

   In a BESTVEL, PSRVEL or RTKVEL log, the actual speed and direction of the receiver antenna over ground is provided. The receiver does not determine the direction a vessel, craft, or vehicle is pointed (heading), but rather the direction of motion of the GPS antenna relative to ground.

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WAYPOINT NAVIGATION		
Logs	**Descriptions**	**Type**
BESTPOS	Best position data	Synch
BESTVEL [b]	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
OMNIHPPOS	OmniSTAR HP position data	Synch
PSRPOS	Pseudorange position	Synch
PSRVEL [b]	Pseudorange velocity	Synch
PSRXYZ	Pseudorange cartesian coordinate position	Synch
CLOCK INFORMATION, STATUS, AND TIME		
CLOCKMODEL	Range bias information	Synch
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
TIMESYNC	Synchronize time between receivers	Synch
POST PROCESSING DATA		
GPSEPHEM	Decoded GPS ephemeris information	Asynch
IONUTC	Ionospheric and UTC model information	Asynch

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POST PROCESSING DATA		
Logs	**Descriptions**	**Type**
RAWEPHEM	Raw ephemeris	Asynch
RANGE	Satellite range information	Synch
RANGECMP	Compressed version of the RANGE log	Synch
RANGEGPSL1	L1 version of the RANGE log	Synch
RTKDATA	RTK related data such as baselines and satellite counts.	Asynch
TIME	Receiver clock offset information	Synch
SATELLITE TRACKING AND CHANNEL CONTROL		
ALMANAC	Current decoded almanac data	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
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
OMNIVIS	OmniSTAR satellite visibility list	Synch
PSRDOP	DOP of SVs currently tracking	Asynch
RANGE	Satellite range information	Synch

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SATELLITE TRACKING AND CHANNEL CONTROL		
Logs	**Descriptions**	**Type**
RANGEGPSL1	L1 version of the RANGE log	Synch
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
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

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SATELLITE TRACKING AND CHANNEL CONTROL		
Logs	**Descriptions**	**Type**
WAAS24	Mixed fast/slow corrections	Asynch
WAAS25	Long-term slow satellite corrections	Asynch
WAAS26	Ionospheric delay corrections	Asynch
WAAS27	SBAS service message	Asynch
WAAS32	CDGPS fast correction slots 0-10	Asynch
WAAS33	CDGPS fast correction slots 11-21	Asynch
WAAS34	CDGPS fast correction slots 22-32	Asynch
WAAS35	CDGPS fast correction slots 39-50	Asynch
WAAS45	CDGPS slow corrections	Asynch
WAASCORR	SBAS range corrections used	Synch
DIFFERENTIAL BASE STATION		
ALMANAC	Current almanac information	Asynch
BESTPOS	Best position data	Synch
BESTVEL	Velocity data	Synch
BSLNXYZ	RTK XYZ baseline	Asynch
CMRDATADESC	Base station description	Synch
CMRDATAOBS	Base station satellite observations	Synch
CMRDATAREF	Base station position	Synch
GPGGA	NMEA, position fix data	Synch
GPGGARTK	NMEA, global position system fix data	Synch
LBANDINFO	L-band configuration information	Synch
LBANDSTAT	L-band status information	Synch

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DIFFERENTIAL BASE STATION		
Logs	**Descriptions**	**Type**
MATCHEDPOS	Computed Position – Time Matched	Asynch
OMNIHPPOS	OmniSTAR HP/XP position data	Synch
PSRPOS	Pseudorange position	Synch
PSRVEL	Pseudorange velocity	Synch
RANGE	Satellite range information	Synch
RANGECMP	Compressed version of the RANGE log	Synch
RAWLBANDFRAME	Raw L-band frame data	Asynch
RAWLBANDPACKET	Raw L-band data packet	Asynch
REFSTATION	Base station position and health	Asynch
RTCADATA1	Differential GPS corrections	Synch
RTCADATA2OBS	Base station observations 2	Synch
RTCADATAEPHEM	Ephemeris and time information	Synch
RTCADATAOBS	Base station observations	Synch
RTCADATAREF	Base station parameters	Synch
RTKDATA	RTK related data such as baselines and satellite counts	Asynch
RTKPOS	RTK low latency position	Synch
RTCA, RTCM, RTCMV3 or CMR data logs, for example CMRDATADESC, RTCADATA1, RTCMDATA1 and RTCM1001. See also *Table 43* starting below for a complete list of logs in alphabetical order.		

Table 43: OEMV Family 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
BSLNXYZ	686	RTK XYZ baseline
CLOCKMODEL	16	Current clock model matrices
CLOCKSTEERING	26	Clock steering status
CMRDATADESC	389	Base station description information
CMRDATAOBS	390	Base station satellite observation information
CMRDATAREF	391	Base station position information
CMRPLUS	717	CMR+ output message
COMCONFIG	317	Current COM port configuration
DIFFCODEBIASES	914	Differential code biases being applied
EXTRXHWLEVELS	843	Extended receiver hardware levels
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
LBANDINFO	730	L-band configuration information
LBANDSTAT	731	L-band status information
LOGLIST	5	A list of system logs
MARKPOS, MARK2POS	181, 615	Position at time of mark input event
MARKTIME, MARK2TIME	231, 616	Time of mark input event
MATCHEDPOS	96	RTK Computed Position – Time Matched
MATCHEDXYZ	242	RTK Time Matched cartesian coordinate position

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NovAtel Format Logs		
Datatype	**Message ID**	**Description**
NAVIGATE	161	Navigation waypoint status
OMNIHPPOS	495	OmniSTAR HP/XP position data
OMNIVIS	860	OmniSTAR satellite visibility list
PASSCOM1, PASSCOM2, PASSCOM3,PASSXCOM1, PASSXCOM2, PASSXCOM3 PASSAUX, PASSUSB1, PASSUSB2, PASSUSB3	233, 234, 235, 405, 406, 795 690, 607, 608, 609	Pass-through logs
PORTSTATS	72	COM or USB port statistics
PSRDOP	174	DOP of SVs currently tracking
PSRPOS	47	Pseudorange position information
PSRTIME	881	Time offsets from the pseudorange filter
PSRVEL	100	Pseudorange velocity information
PSRXYZ	243	Pseudorange cartesian coordinate position
RANGE	43	Satellite range information
RANGECMP	140	Compressed version of the RANGE log
RANGEGPSL1	631	L1 version of the RANGE log
RAWALM	74	Raw almanac
RAWEPHEM	41	Raw ephemeris
RAWGPSSUBFRAME	25	Raw subframe data
RAWGPSWORD	407	Raw navigation word
RAWLBANDFRAME	732	Raw L-band frame data
RAWLBANDPACKET	733	Raw L-band data packet
RAWWAASFRAME	287	Raw SBAS frame data
REFSTATION	175	Base station position and health
RTCADATA1	392	Type 1 Differential GPS Corrections
RTCADATA2OBS	808	Type 7 Base Station Observations 2
RTCADATAEPHEM	393	Type 7 Ephemeris and Time Information
RTCADATAOBS	394	Type 7 Base Station Observations
RTCADATAREF	395	Type 7 Base Station Parameters
RTCMDATA1	396	Type 1 Differential GPS Corrections
RTCMDATA3	402	Type 3 Base Station Parameters
RTCMDATA9	404	Type 9 Partial Differential GPS Corrections
RTCMDATA15	397	Type 15 Ionospheric Corrections

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NovAtel Format Logs		
Datatype	**Message ID**	**Description**
RTCMDATA16	398	Type 16 Special Message
RTCMDATA1819	399	Type18 and Type 19 Raw Measurements
RTCMDATA2021	400	Type 20 and Type 21 Measurement Corrections
RTCMDATA22	401	Type 22 Extended Base Station Parameters
RTCMDATA23	663	Type 23 Antenna Type Definition
RTCMDATA24	664	Type 24 Antenna Reference Point (ARP)
RTCMDATA31	868	Type 31 GLONASS Differential Corrections
RTCMDATA32	878	Type 32 GLONASS Base Station Parameters
RTCMDATA36	879	Type 36 Special Message
RTCMDATA59	403	Type 59N-0 NovAtel Proprietary: RT20 Differential
RTCMDATA1001	784	L1-Only GPS RTK Observables
RTCMDATA1002	785	Extended L1-Only GPS RTK Observables
RTCMDATA1003	786	L1/L2 GPS RTK Observables
RTCMDATA1004	787	Extended L1/L2 GPS RTK Observables
RTCMDATA1005	788	RTK Base Station ARP
RTCMDATA1006	789	RTK Base Station ARP with Antenna Height
RTCMDATA1007	856	Extended Antenna Descriptor and Setup
RTCMDATA1008	857	Extended Antenna Reference Station Description
RTCMDATA1009	897	GLONASS L1-Only RTK
RTCMDATA1010	898	Extended GLONASS L1-Only RTK
RTCMDATA1011	899	GLONASS L1/L2 RTK
RTCMDATA1012	900	Extended GLONASS L1/L2 RTK
RTCMDATA1019	901	GPS Ephemerides
RTCMDATA1020	902	GLONASS Ephemerides
RTKDATA	215	RTK specific information
RTKPOS	141	RTK low latency position data
RTKVEL	216	RTK velocity
RTKXYZ	244	RTK cartesian coordinate position data
RXCONFIG	128	Receiver configuration status
RXHWLEVELS	195	Receiver hardware levels
RXSTATUS	93	Self-test status
RXSTATUSEVENT	94	Status event indicator
SATVIS	48	Satellite visibility

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NovAtel Format Logs		
Datatype	**Message ID**	**Description**
SATXYZ	270	SV position in ECEF Cartesian coordinates
TIME	101	Receiver time information
TIMESYNC	492	Synchronize time between receivers
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
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
WAAS32	696	CDGPS fast correction slots 0-10
WAAS33	697	CDGPS fast correction slots 11-21
WAAS34	698	CDGPS fast correction slots 22-32
WAAS35	699	CDGPS fast correction slots 39-50
WAAS45	700	CDGPS slow corrections
WAASCORR	313	SBAS range corrections used

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NovAtel Format Logs		
Datatype	**Message ID**	**Description**
CMR Format Logs [a]		
CMRDESC	310	Base station description information
CMROBS	103	Base station satellite observation information
CMRREF	105	Base station position information
CMRPLUS	717	CMR+ output message
RTCA Format Logs [a]		
RTCA1	10	Type 1 Differential GPS Corrections
RTCAEPHEM	347	Type 7 Ephemeris and Time Information
RTCAOBS	6	Type 7 Base Station Observations
RTCAOBS2	805	Type 7 Base Station Observations II
RTCAREF	11	Type 7 Base Station Parameters
RTCM Format Logs [a]		
RTCM1	107	Type 1 Differential GPS Corrections
RTCM3	117	Type 3 Base Station Parameters
RTCM9	275	Type 9 Partial Differential GPS Corrections
RTCM15	307	Type 15 Ionospheric Corrections
RTCM16	129	Type16 Special Message
RTCM16T	131	Type16T Special Text Message
RTCM1819	260	Type18 and Type 19 Raw Measurements
RTCM2021	374	Type 20 and Type 21 Measurement Corrections
RTCM Format Logs [a]		
RTCM22	118	Type 22 Extended Base Station Parameters
RTCM23	665	Type 23 Antenna Type Definition
RTCM24	667	Type 24 Antenna Reference Point (ARP)
RTCM31	864	Type 31 Differential GLONASS Corrections
RTCM32	873	Type 32 GLONASS Base Station Parameters
RTCM36	875	Type 36 Special Message
RTCM36T	877	Type 36T Special Text Message
RTCM59	116	Type 59N-0 NovAtel Proprietary: RT20

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RTCMV3 Format Logs [a]		
RTCM1001	772	L1-Only GPS RTK Observables
RTCM1002	774	Extended L1-Only GPS RTK Observables
RTCM1003	776	L1/L2 GPS RTK Observables
RTCM1004	770	Extended L1/L2 GPS RTK Observables
RTCM1005	765	RTK Base Station ARP
RTCM1006	768	RTK Base Station ARP with Antenna Height
RTCM1007	852	Extended Antenna Descriptor and Setup
RTCM1008	854	Extended Antenna Reference Station Description and Serial Number
RTCM1009	885	GLONASS L1-Only RTK
RTCM1010	887	Extended GLONASS L1-Only RTK
RTCM1011	889	GLONASS L1/L2 RTK
RTCM1012	891	Extended GLONASS L1/L2 RTK
RTCM1019	893	GPS Ephemerides
RTCM1020	895	GLONASS Ephemerides
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
GPGGARTK	259	GPS Fix Data with Extra Precision
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. CMR, 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 44: OEMV Family 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
96	MATCHEDPOS	RTK Computed Position – Time Matched
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
141	RTKPOS	RTK low latency position data
161	NAVIGATE	Navigation waypoint status
172	AVEPOS	Position averaging
174	PSRDOP	DOP of SVs currently tracking
175	REFSTATION	Base station position and health
181	MARKPOS	Position at time of mark input event
195	RXHWLEVELS	Receiver hardware levels
206	VALIDMODELS	Model and expiry date information for receiver

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NovAtel Format Logs		
Message ID	**Datatype**	**Description**
215	RTKDATA	RTK specific information
216	RTKVEL	RTK velocity
231	MARKTIME	Time of mark input event
233, 234, 235	PASSCOM1, PASSCOM2, PASSCOM3	Pass-through logs
241	BESTXYZ	Cartesian coordinate position data
242	MATCHEDXYZ	RTK Time Matched cartesian coordinate position data
243	PSRXYZ	Pseudorange cartesian coordinate position
244	RTKXYZ	RTK cartesian coordinate position data
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
389	CMRDATADESC	Base station description information
390	CMRDATAOBS	Base station satellite observation information
391	CMRDATAREF	Base station position information

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NovAtel Format Logs		
Message ID	**Datatype**	**Description**
392	RTCADATA1	Type 1 Differential GPS Corrections
393	RTCADATAEPHEM	Type 7 Ephemeris and Time Information
394	RTCADATAOBS	Type 7 Base Station Observations
395	RTCADATAREF	Type 7 Base Station Parameters
396	RTCMDATA1	Type 1 Differential GPS Corrections
397	RTCMDATA15	Type 15 Ionospheric Corrections
398	RTCMDATA16	Type 16 Special Message
399	RTCMDATA1819	Type18 and Type 19 Raw Measurements
400	RTCMDATA2021	Type 20 and Type 21 Measurement Corrections
401	RTCMDATA22	Type 22 Extended Base Station Parameters
402	RTCMDATA3	Type 3 Base Station Parameters
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
492	TIMESYNC	Synchronize time between receivers
495	OMNIHPPOS	OmniSTAR HP/XP position data
607, 608, 609	PASSUSB1, PASSUSB2, PASSUSB3	Pass-through logs (for receivers that support USB)
615	MARK2POS	Time of mark input event
616	MARK2TIME	Position at time of mark input event
631	RANGEGPSL1	L1 version of the RANGE log
663	RTCMDATA23	Type 23 Antenna Type Definition
664	RTCMDATA24	Type 24 Antenna Reference Point (ARP)
686	BSLNXYZ	RTK XYZ baseline
690	PASSAUX	Pass-through log for AUX port
696	WAAS32	CDGPS fast correction slots 0-10
697	WAAS33	CDGPS fast correction slots 11-21
698	WAAS34	CDGPS fast correction slots 22-32
699	WAAS35	CDGPS fast correction slots 39-50
700	WAAS45	CDGPS slow corrections

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NovAtel Format Logs		
Message ID	**Datatype**	**Description**
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
730	LBANDINFO	L-band configuration information
731	LBANDSTAT	L-band status information
732	RAWLBANDFRAME	Raw L-band frame data
733	RAWLBANDPACKET	Raw L-band data packet
784	RTCMDATA1001	L1-Only GPS RTK Observables
785	RTCMDATA1002	Extended L1-Only GPS RTK Observables
786	RTCMDATA1003	L1/L2 GPS RTK Observables
787	RTCMDATA1004	Extended L1/L2 GPS RTK Observables
788	RTCMDATA1005	RTK Base Station ARP
789	RTCMDATA1006	RTK Base Station ARP with Antenna Height
897	RTCMDATA1009	GLONASS L1-Only RTK
898	RTCMDATA1010	Extended GLONASS L1-Only RTK
899	RTCMDATA1011	GLONASS L1/L2 RTK
900	RTCMDATA1012	Extended GLONASS L1/L2 RTK
901	RTCMDATA1019	GPS Ephemerides
902	RTCMDATA1020	GLONASS Ephemerides
792	GLORAWEPHEM	Raw GLONASS ephemeris data
795	PASSXCOM3	Pass through log
808	RTCADATA2OBS	Type 7 Base Station Observations 2
843	EXTRXHWLEVELS	Extended receiver hardware levels
856	RTCMDATA1007	Extended Antenna Descriptor and Setup
857	RTCMDATA1008	Extended Antenna Reference Station Description and Serial Number

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860	OMNIVIS	OmniSTAR satellite visibility list
868	RTCMDATA31	Type 31 GLONASS Differential Corrections
878	RTCMDATA32	Type 32 GLONASS Base Station Parameters
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
900	RTCMDATA1012	Extended GLONASS L1/L2 RTK
901	RTCMDATA1019	GPS Ephemerides
902	RTCMDATA1020	GLONASS Ephemerides
914	DIFFCODEBIASES	Differential code biases being applied
CMR Format Logs [a]		
103	CMROBS	Base station satellite observation information
105	CMRREF	Base station position information
310	CMRDESC	Base station description information
717	CMRPLUS	CMR+ output message
RTCA Format Logs [a]		
6	RTCAOBS	Type 7 Base Station Observations
10	RTCA1	Type 1 Differential GPS Corrections
11	RTCAREF	Type 7 Base Station Parameters
347	RTCAEPHEM	Type 7 Ephemeris and Time Information
805	RTCAOBS2	Type 7 Base Station Observations 2
RTCM Format Logs [a]		
107	RTCM1	Type 1 Differential GPS Corrections
116	RTCM59	Type 59N-0 NovAtel Proprietary: RT20 Differential
117	RTCM3	Type 3 Base Station Parameters
118	RTCM22	Type 22 Extended Base Station Parameters
129	RTCM16	Type16 Special Message
131	RTCM16T	Type16T Special Text Message
260	RTCM1819	Type18 and Type 19 Raw Measurements
275	RTCM9	Type 9 Partial Differential GPS Corrections

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RTCM Format Logs [a]		
307	RTCM15	Type 15 Ionospheric Corrections
374	RTCM2021	Type 20 and Type 21 Measurement Corrections
665	RTCM23	Type 22 Extended Base Station Parameters
667	RTCM24	Type 23 Antenna Type Definition
864	RTCM31	Type 31 Differential GLONASS Corrections
873	RTCM32	Type 32 GLONASS Base Station Parameters
875	RTCM36	Type 36 Special Message
877	RTCM36T	Type 36T Special Text Message
RTCMV3 Format Logs [a]		
765	RTCM1005	RTK Base Station ARP
768	RTCM1006	RTK Base Station ARP with Antenna Height
770	RTCM1004	Extended L1/L2 GPS RTK Observables
772	RTCM1001	L1-Only GPS RTK Observables
774	RTCM1002	Extended L1-Only GPS RTK Observables
776	RTCM1003	L1/L2 GPS RTK Observables
852	RTCM1007	Extended Antenna Descriptor and Setup
854	RTCM1008	Extended Antenna Reference Station Description and Serial Number
885	RTCM1009	GLONASS L1-Only RTK
887	RTCM1010	Extended GLONASS L1-Only RTK
889	RTCM1011	GLONASS L1/L2 RTK
891	RTCM1012	Extended GLONASS L1/L2 RTK
893	RTCM1019	GPS Ephemerides
895	RTCM1020	GLONASS Ephemerides
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

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NMEA Format Data Logs		
226	GPVTG	Track Made Good and Ground Speed
227	GPZDA	UTC Time and Date
259	GPGGARTK	GPS Fix Data with Extra Precision
521	GPGGALONG	GPS Fix Data, Extra Precision and Undulation
859	GLMLA	NMEA GLONASS Almanac Data

a. CMR, RTCA, RTCM and RTCMV3 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 *V123*

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 on Almanac data, refer to the GPS SPS Signal Specification. (Refer to the appendix on *Standards and References* in the *GPS+ Reference Manual*.)

The OEMV family of 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 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 an ellipse, 0<e<1 is a parabola 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, meters	Double	8	H+84
15	incl-angle	Angle of inclination relative to 0.3 π, radians	Double	8	H+92
16	SV config	Satellite configuration	Ulong	4	H+100
17	health-prn	SV health from 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 *V123*

When position averaging is underway, the various fields in the AVEPOS log contain the parameters being used in the position averaging process. *Table 53* 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 152.* Refer also to the *Height Relationships* and *Pseudorange Algorithms* sections of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

1. 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 357*.
2. 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 45: 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 meter, 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 meter 68% of the time. For a more realistic accuracy, double the one sigma value (one meter) and the result is 95% reliability (error is less than two meters 95% of the time). Generally, GPS heights are 1.5 times poorer than horizontal positions. See also *Page 303* 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 45*)	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 *V123*

This log contains the best available combined GPS and inertial navigation system (INS - if available) position 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.

With the system operating in an RTK mode, this log reflects the latest low-latency solution for up to 60 seconds after reception of the last base station observation. After this 60 second period, the position reverts to the best solution available; the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudorange differential solutions continue for the time specified in the DGPSTIMEOUT command, see *Page 101*.

See also the table footnote for position logs on *Page 208* as well as the MATCHEDPOS, PSRPOS and RTKPOS logs, on *Pages 335, 357* and *490* respectively.

Message ID: 42

Log Type: Synch

Recommended Input:

log bestposa ontime 1

See *Section 2.1, Command Formats* on *Page 32* 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,NARROW_INT,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
```

Dual frequency GPS receivers offer two major advantages over single frequency equipment. 1) Ionospheric errors that are inherent in all GPS observations can be modelled and significantly reduced by combining satellite observations made on two different frequencies, and 2) Observations on two frequencies allow for faster ambiguity resolution times.

In general, dual frequency GPS receivers provide a faster, more accurate, and more reliable solution than single frequency equipment. They do, however, cost significantly more to purchase, thus it is important for potential GPS buyers to carefully consider their current and future needs.

Table 46: Position or Velocity Type

Type (binary)	Type (ASCII)	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command
2	FIXEDHEIGHT	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
20	OMNISTAR [a]	OmniSTAR VBS position (L1 sub-meter)
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
51	RTK_DIRECT_INS [b]	RTK status where the RTK filter is directly initialized from the INS filter
52	INS [b]	INS calculated position corrected for the antenna
53	INS_PSRSP [b]	INS pseudorange single point solution - no DGPS corrections
54	INS_PSRDIFF [b]	INS pseudorange differential solution
55	INS_RTKFLOAT [b]	INS RTK floating point ambiguities solution
56	INS_RTKFIXED [b]	INS RTK fixed ambiguities solution
64	OMNISTAR_HP [a]	OmniSTAR HP/XP position (L1/L2 decimeter)
65	OMNISTAR_XP [a]	OmniSTAR XP position
66	CDGPS [a]	Position solution using CDGPS correction

a. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details.

b. Output only by the BESTPOS and BESTVEL logs when using an inertial navigation system such as NovAtel's SPAN products. Please visit our website, refer to your *SPAN for OEMV User Manual*, or contact NovAtel for more information.

Table 47: Solution Status

Solution Status		Description
(Binary)	(ASCII)	
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	INS solution status values [a]	
18	PENDING	When a FIX POSITION command is entered, the receiver computes its own position and determines if the fixed position is valid [b]
19	INVALID_FIX	The fixed position, entered using the FIX POSITION command, is not valid
20	UNAUTHORIZED	Position type is unauthorized - HP or XP on a receiver not authorized for it

a. Output only when using an inertial navigation system such as NovAtel's SPAN products. Please visit our website, refer to your *SPAN for OEMV User Manual*, or contact NovAtel for more information.

b. 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 48: Signal-Used Mask

Bit	Mask	Description
0	0x01	GPS L1 used in Solution
1	0x02	GPS L2 used in Solution
2	0x04	GPS L5 used in Solution
3	0x08	Reserved
4	0x10	GLONASS L1 used in Solution
5	0x20	GLONASS L2 used in Solution
6-7	0x40-0x80	Reserved

Table 49: Extended Solution Status

Bit	Mask	Description
0	0x00000001	AdVance RTK Verified 0 = Not Verified 1 = Verified
1	0x00000006	Pseudorange Iono Correction 01 = GNSS Broadcast 10 = SBAS Broadcast 11 = Multi-frequency Computed 00 = Unknown [a]
4	0xFFFFFFF8	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 47* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46* on *Page 232*	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 21, Datum Transformation Parameters* on *Page 94*)	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	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+66
18	#multi	Number of multi frequency observations in solution	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status (see *Table 49, Extended Solution Status* on *Page 234*)	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 48* on *Page 234*)	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 *V123*

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

See also the UTMZONE command on *Pages 200* and the BESTPOS log on *Page 231*.

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,NARROW_INT,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 47, Solution Status* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46, Position or Velocity Type* on *Page 232*	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 21, Datum Transformation Parameters* on *Page 94*)	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	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+74
20	#multi	Number of multi frequency observations in solution	Uchar	1	H+75
21	Reserved		Uchar	1	H+76

Continued on Page 238

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
22	ext sol stat	Extended solution status	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 48* on *Page 234*)	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 *V123*

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. See also the table footnote for velocity logs on *Page 208*.

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 360*. If BESTPOS is from RTK, the BESTVEL velocity type is the same as for RTKVEL, see *Page 492*. If BESTPOS is from OMNIHPPOS, the BESTVEL velocity type is OMNISTAR_HP or OMNISTAR_XP.

The RTK, OmniSTAR HP and OmniSTAR XP velocities are typically computed from the average change in position over the time interval or the RTK Low Latency filter. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the BESTVEL time tag. The velocity latency to be subtracted from the time tag is normally half the time between filter updates. Under default operation, the positioning filters are updated at a rate of 2 Hz. This average velocity translates into a velocity latency of 0.25 seconds.

The latency can be reduced by increasing the update rate of the positioning filter being used by requesting the BESTVEL or BESTPOS messages at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.05 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

Velocities based on delta phase are noisier at faster rates because they are derived by dividing the phase difference by the delta time (which is getting smaller at higher rates). Doppler-based velocity is not effected.

While you are standing still, your velocity may jump several centimeters 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, OMNISTAR, CDGPS, 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:

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

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 meters 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 47, Solution Status* on *Page 233*	Enum	4	H
3	vel type	Velocity type, see *Table 46, Position or Velocity Type* on *Page 232*	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 meters 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 meters 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 *V123*

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 10, Page 245* for a definition of the ECEF coordinates.

See also the BESTPOS and BESTVEL logs, on *Pages 231 and 236* respectively.

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,NARROW_INT,-1634531.5683,-3664618.0326,4942496.3270,
0.0099,0.0219,0.0115,SOL_COMPUTED,NARROW_INT,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
```

According to classic GPS theory, one civilian receiver operating in single point mode (no assistance from other sources) will have an accuracy of ±20 to 30 meters horizontally. This allows hikers and recreational users to place themselves on a map with some degree of certainty, but in terms of surveying, this is not considered accurate. If Selective Availability (SA) were to return, which may be employed by the US military to intentionally degrade the user's position, the accuracy would degrade to ±100 meters. Logging data and averaging for 24 hours may yield results in the order of 1 to 5 meters horizontally.

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 47, Solution Status* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46, Position or Velocity Type* on *Page 232*	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 47, Solution Status* on *Page 233*	Enum	4	H+44
11	vel type	Velocity type, see *Table 46, Position or Velocity Type* on *Page 232*	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 Page 244

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
24	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+106
25	#multi	Number of multi frequency observations in solution	Uchar	1	H+107
26	Reserved		Char	1	H+108
27	ext sol stat	Extended solution status	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 48* on *Page 234*)	Hex	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

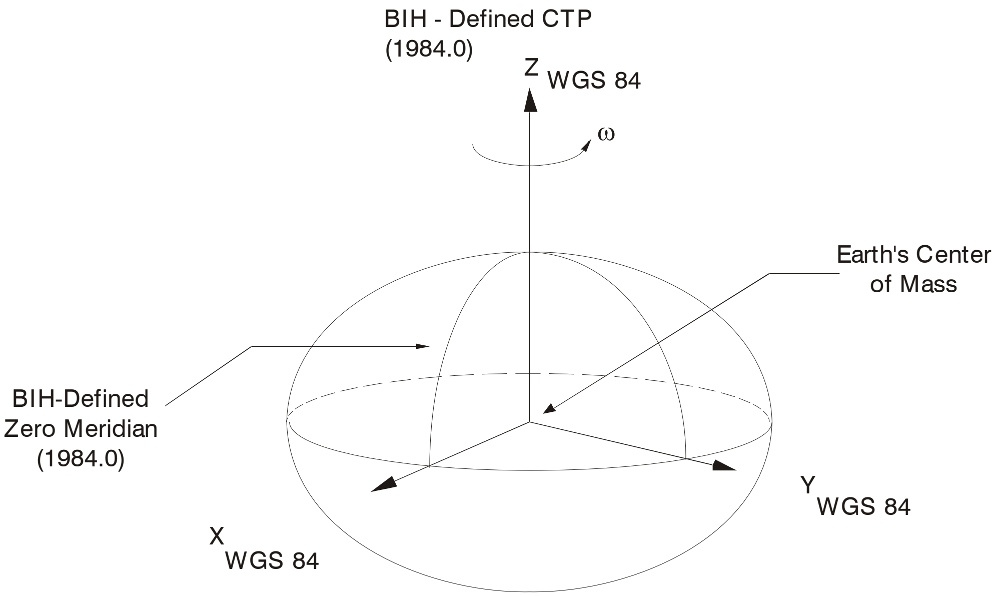
- Definitions - *

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 10: The WGS84 ECEF Coordinate System

3.3.7 BSLNXYZ RTK XYZ Baseline *V123_RT20, V23_RT2 or V3_HP*

This log contains the receiver's RTK baseline in ECEF coordinates. The position status field indicates whether or not the corresponding data is valid. See *Figure 10, Page 245* for a definition of the ECEF coordinates.

The BSLNXYZ log comes from time matched base and rover observations like the MATCHEDXYZ log on *Page 337*.

Asynchronous logs, such as BSLNXYZ, 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: 686
Log Type: Asynch

Recommended Input:

log bslnxyza onchanged

ASCII Example:

```
#BSLNXYZA,COM1,0,59.5,FINESTEERING,1419,340033.000,00000040,5b48,2724;
SOL_COMPUTED,NARROW_INT,0.0012,0.0002,-0.0004,0.0080,0.0160,0.0153,
"AAAA",12,12,12,12,0,01,0,33*1a8a1b65
```

The BSLNXYZ log contains offset values in the ECEF frame from base to rover:

Base position (in ECEF) + Offset values (in ECEF) = Rover position (in ECEF)

You can use the position information in the BESTXYZ log from the rover and subtract the offset values from the BSLNXYZ log, to yield the position information of the base in ECEF coordinates.

Be careful of where you the want vector to originate and point to. Our ECEF positions are referenced to the WGS84 ellipsoid, regardless of the use of the DATUM or USERDATUM commands.

Consider the impact of the base station and the roving GPS receivers being separated by large distances.

For this discussion, we assume that when we talk about large distances, we are referring to distances greater than 1000 km (600 miles). Typically, for this type of baseline length only code data is used in a differential system. Carrier-phase data is typically used for distances much shorter than 1000 kilometers. (The advantage of using carrier-phase data, to produce centimeter-level accuracies is greatly reduced when large distances are involved.)

GPS operates in a similar fashion as conventional surveying tools such as electronic distance measuring instruments (EDMs). This means that there is a constant and a proportional error associated with computed positions. The proportional error depends on the distance the base and rover receivers are apart. Therefore, the larger the distance, the lower the accuracy. We also have to take into account the quality of the data being received. Better receivers generally provide cleaner signals and thus better accuracy.

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.

Also, the principal of DGPS positioning assumes that there are common errors at the base and rover stations. These errors include: atmospheric errors, satellite clock and ephemeris errors. Typically, in a differential GPS survey, a receiver occupies a survey control marker at a known location referred to as the base station. The base station collects GPS data and computes a position. This position is then compared against the published coordinates. The difference between these two positions in the way of range errors to the satellites are your differential corrections. Usually, these corrections are then passed to your rover unit(s) for use in computing the rover's differentially corrected positions. However, the further apart the base and rover receivers are, the less their errors are in common. Thus, the differential corrections computed at your base are less applicable at your rover's location at large distances.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BSLNXYZ header	Log header		H	0
2	sol status	Solution status, see *Table 47, Solution Status* on *Page 233*	Enum	4	H
3	bsln type	Baseline type, see *Table 46, Position or Velocity Type* on *Page 232*	Enum	4	H+4
4	B-X	Baseline X-coordinate (m)	Double	8	H+8
5	B-Y	Baseline Y-coordinate (m)	Double	8	H+16
6	B-Z	Baseline Z-coordinate (m)	Double	8	H+24
7	B-X σ	Standard deviation of B-X (m)	Float	4	H+32
8	B-Y σ	Standard deviation of B-Y (m)	Float	4	H+36
9	B-Z σ	Standard deviation of B-Z (m)	Float	4	H+40
10	stn ID	Base station identification	Char[4]	4	H+44
11	#SVs	Number of satellite vehicles tracked	Uchar	1	H+48
12	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+49
13	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+50
14	#multi	Number of multi frequency observations in solution	Uchar	1	H+51
15	Reserved		Uchar	1	H+52
16	ext sol stat	Extended solution status	Hex	1	H+53
17	Reserved		Hex	1	H+54
18	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 48* on *Page 234*)	Hex	1	H+55
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+56
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.8 CLOCKMODEL Current Clock Model Status *V123*

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

The following symbols are used throughout this section:

B = range bias (m)

BR = range bias rate (m/s)

SAB = Gauss-Markov process representing range bias error due to 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 50: 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 an 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 50, Clock Model Status* on *Page 249*	Enum	4	H
3	reject	Number of rejected range bias measurements	Ulong	4	H+4
4	noise time	GPS time of last noise addition	GPSec	4	H+8
5	update time	GPS time of last update	GPSec	4	H+12
6	parameters	Clock correction parameters (a 1x3 array of length 3), listed left-to-right	Double	8	H+16
7				8	H+24
8				8	H+32
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 (meters)	Double	8	H+112
19	range bias rate	Last instantaneous measurement of the range bias rate (m/s)	Double	8	H+120
20	change	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 CLOCKSTEERING Clock Steering Status *V123*

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 time. If for some reason this is not desired, this behavior can be disabled using the CLOCKADJUST command, see *Page 74*.

If the CLOCKADJUST command is ENABLED, and the receiver is configured to use an external reference frequency (set in the EXTERNALCLOCK command, see *Page 109*, for an external clock - TCXO, OCXO, RUBIDIUM, CESIUM, or USER), then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command, see *Page 117*.

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
```

To configure the receiver to use an external reference oscillator, see the EXTERNALCLOCK command on *Page 109.*

Table 51: Clock Source

Binary	ASCII	Description
0	INTERNAL	The receiver is currently steering its internal VCTCXO using an internal VARF signal
1	EXTERNAL	The receiver is currently steering an external oscillator using the external VARF signal

Table 52: 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 currently selected oscillator (INTERNAL or EXTERNAL).

a. These states are only seen if you force the receiver to do a clock steering calibration using the CLOCKCALIBRATE command, see *Page 76*. With the CLOCKCALIBRATE command, you can force the receiver to calibrate the slope and center pulse width, of the currently selected 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 51, Clock Source* on *Page 252.*	Enum	4	H
3	steeringstate	Steering state, see *Table 52, Steering State* on *Page 253*.	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 246*.	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)	-	-	-

3.3.10 CMR Standard Logs *V123_RT20 or V23_RT2*

CMROBS BASE STATION SATELLITE OBSERVATION INFORMATION
Message ID: 103

CMRREF BASE STATION POSITION INFORMATION
Message ID: 105

CMRDESC BASE STATION DESCRIPTION INFORMATION
Message ID: 310

CMRPLUS CMR+ OUTPUT INFORMATION
Message ID: 717

The Compact Measurement Record (CMR) Format, is a standard communications protocol used in Real-Time Kinematic (RTK) systems to transfer GPS carrier phase and code observations from a base station to one or more rover stations.

1. 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.
2. CMRDATA logs output the details of the above logs if they have been sent.
3. No guarantee is made that the OEMV will meet its performance specifications if non-NovAtel equipment is used.
4. Trimble rovers must receive CMRDESC messages from a base.

The Compact Measurement Record (CMR) message format was developed by Trimble Navigation Ltd. as a proprietary data transmission standard for use in RTK applications. In 1996, Trimble publicly disclosed this standard and allowed its use by all manufacturers in the GPS industry[1].

The NovAtel implementation allows a NovAtel rover receiver to operate in RTK mode while receiving pseudorange and carrier phase data via CMR messages (version 3.0) from a non-NovAtel base-station receiver. The NovAtel receiver can also transmit CMR messages (version 3.0). The station ID must be ≤ 31 when transmitting CMR corrections. The CMRPLUS output message distributes the base station information over 14 updates, see *Page 265*.

The message lengths of the four CMR messages are as follows:

CMROBS = 6 *(frame)* + 6 *(header)* + (8*L1 channels) + (7*L2 channels) = (192 bytes max.)

CMRREF = 6 *(frame)* + 6 *(header)* + 19 = (31 bytes)

CMRDESC = 6 (*frame*) + 6 (*header*) + (variable: 26 to 75) = (38 bytes minimum; 88 bytes max.)

CMRPLUS = 6 (*frame*) + 3 (*header*) + 7 = (16 bytes)

1. Talbot, N.C. (1996) "Compact Data Transmission Standard for High-Precision GPS". ION GPS-96 Conference Proceedings, Kansas, MO, Sept. 1996, Vol. I, pp. 861-871

Using AdVance RTK with CMR Format Messages

To enable receiving CMR messages, follow these steps:

1. Issue the COM command, see *Page 82*, to the rover receiver to set its serial port parameters to the proper bit rate, parity, and so on.
2. Issue the “INTERFACEMODE COMn CMR” command to the rover receiver, where “COMn” refers to the communication port that is connected to the data link. See also *Page 130*.

Assuming that the base station is transmitting valid data, your rover receiver begins to operate in AdVance RTK mode. To send CMR messages, periodically transmit the three following CMR messages at the base station:

- A CMROBS message that contains base station satellite observation information, and should be sent once every 1 or 2 seconds.
- A CMRREF message that contains base station position information, and should be sent once every 10 seconds. Also, the rover receiver automatically sets an approximate position from this message if it does not already have a position. Therefore, this message can be used in conjunction with an approximate time to improve TTFF, refer to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual.*
- A CMRDESC message that contains base station description information and should be sent once every 10 seconds. However, it should be interlinked with the CMRREF message.

---

1. For CMR, the station ID must be less than 31 (refer to the DGPSTXID and RTKSOURCE commands on *Pages 102* and *166* respectively).
2. CMRDESC is logged with an offset of 5 to allow interleaving with CMRREF. Note that Trimble rovers must receive CMRDESC messages from a base.
3. Novatel CMR Type 2 messages are for compatibility only. When received, a Type 2 message is discarded. For transmission, all fields are permanently set as follows:

Record Length	=	33 bytes
Short Station ID	=	"cref"
COGO Code	=	""
Long Station ID	=	"UNKNOWN"

Example Input:

```
interfacemode com2 none CMR
fix position 51.113 -114.044 1059.4
log com2 cmrobs ontime 1
log com2 cmrref ontime 10
log com2 cmrdesc ontime 10 5
```

3.3.11 CMRDATADESC Base Station Description *V123_RT20 or V23_RT2*

See *Section 3.3.10, CMR Standard Logs* starting on *Page 255* for information on CMR standard logs.

Message ID: 389

Log Type: Synch

Recommended Input:

log cmrdatadesca ontime 10 5

ASCII Example:

```
#CMRDATADESCA,COM1,0,76.5,FINESTEERING,1117,162906.461,00100020,b467,399;
2,0,147,39,3,0,2,
FALSE,FALSE,0,TRUE,0,180000,1,0,33,32,32,32,32,99,114,101,102,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,8,85,78,75,78,79,87,78,0*482add29
```

where the bolded 33 in the example above represents the total length of the records that follow:

Short ID:

```
32,32,32,32,99,114,101,102, (8 bytes)
```

COGO Code:

```
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, (16 bytes)
```

ID Length:

```
8, (1 byte)
```

Long ID:

```
85,78,75,78,79,87,78,0 (8 bytes)
```

Here are some CMR terminology facts:

- In the CMR format description, the base station description log is referred to as Type 2
- COGO is an acronym for coordinate geometry (COordinate GeOmetry)

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CMRDATA-DESC header	Log header	-	H	0
2	CMR header	Synch character for the message	Ulong	4	H
3		Message status	Ulong	4	H+4
4		CMR message type	Ulong	4	H+8
5		Message body length	Ulong	4	H+12
6		Version	Ulong	4	H+16
7		Station ID	Ulong	4	H+20
8		Message Type	Ulong	4	H+24
9	battery	Is the battery low? 0 = FALSE 1 = TRUE	Enum	4	H+28
10	memory	Is memory low? 0 = FALSE 1 = TRUE	Enum	4	H+32
11	Reserved		Ulong	4	H+36
12	L2	Is L2 enabled? 0 = FALSE 1 = TRUE	Enum	4	H+40
13	Reserved		Ulong	4	H+44
14	epoch	Epoch time (milliseconds)	Ulong	4	H+48
15	motion	Motion state 0 = UNKNOWN 1 = STATIC 2 = KINEMATIC	Ulong	4	H+52
16	Reserved		Ulong	4	H+56
17	rec length	Record length (bytes). The length altogether of the four fields that follow.	Double	8	H+60
18	short ID	Short station ID. A sequence of eight numbers.	Uchar[8]	8	H+68
19	code	COGO code. A sequence of 16 numbers.	Uchar[16]	16	H+76
20	ID length	Long ID length. The length of the long ID field that follows.	Ulong	4	H+92
21	long ID	Long station ID, variable length, see field #20	Uchar[50]	52[a]	H+96
22	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+148
23	[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

3.3.12 CMRDATAOBS Base Station Satellite Observations *V123_RT20 or V23_RT2*

See *Section 3.3.10, CMR Standard Logs* starting on *Page 255* for information on CMR standard logs.

Message ID: **390**

Log Type: **Synch**

Recommended Input:

log cmrdataobsa ontime 2

ASCII Example:

```
#CMRDATAOBSA,COM1,0,74.0,FINESTEERING,1117,162981.000,00100020,b222,399;
2,0,147,93,3,0,0,
10,21000,3,0,10,
3,FALSE,TRUE,TRUE,8684073,-505,10,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,368,-512,11,1,
15,FALSE,TRUE,TRUE,11936394,129,11,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,270,78,12,1,
18,FALSE,TRUE,TRUE,5334926,186,11,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,164,164,12,1,
21,FALSE,TRUE,TRUE,10590427,-770,10,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,
366,-850,11,1,
17,FALSE,TRUE,TRUE,3262859,32,11,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,325,216,12,1,
26,FALSE,TRUE,TRUE,211264,1213,10,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,390,1069,10,1,
23,FALSE,TRUE,TRUE,8098,209,11,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,265,236,12,1,
28,FALSE,TRUE,TRUE,5090047,-160,6,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,535,-227,9,1,
31,FALSE,TRUE,TRUE,1857322,-1027,7,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,
513,-1063,8,1,
9,FALSE,TRUE,TRUE,51623,-1245,6,1,TRUE,TRUE,TRUE,TRUE,TRUE,0,
599,-1244,9,1*9fe706b0
```

The CMRDATAOBS log is analogous to the RTCADATAOBS logs when using RTCA messages. In the CMR format description, the CMRDATAOBS log is referred to as Type 0.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CMRDATA-OBS header	Log header	-	H	0
2	CMR header	Synch character for the message	Ulong	4	H
3		Message status	Ulong	4	H+4
4		CMR message type	Ulong	4	H+8
5		Message body length	Ulong	4	H+12
6		Version	Ulong	4	H+16
7		Station ID	Ulong	4	H+20
8		Message Type	Ulong	4	H+24
9	#sv	Number of SVs	Ulong	4	H+28
10	epoch	Epoch time (milliseconds)	Ulong	4	H+32
11	clock bias	Is clock bias valid? 0 = NOT VALID 3 = VALID	Ulong	4	H+36
12	clock offset	Clock offset (nanoseconds)	Long	4	H+40
13	# obs	Number of satellite observations with information to follow	Ulong	4	H+44
14	prn	Satellite PRN number	Ulong	4	H+48
15	code flag	Is code P Code? 0 = FALSE 1 = TRUE	Enum	4	H+52
16	L1	Is L1 phase valid? 0 = FALSE 1 = TRUE	Enum	4	H+56
17	L2	Is L2 present? 0 = FALSE 1 = TRUE	Enum	4	H+60
18	L1 psr	L1 pseudorange (1/8 L1 cycles)	Ulong	4	H+64
19	L1 carrier	L1 carrier-code measurement (1/256 L1 cycles)	Long	4	H+68
20	L1 S/N_0	L1 signal-to-noise density ratio	Ulong	4	H+72
21	L1 slip	L1 cycle slip count (number of times that tracking has not been continuous)	Ulong	4	H+76

Continued on Page 261

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
22	L2 code	Is L2 code available? 0 = FALSE 1 = TRUE	Enum	4	H+80
23	Code type	Is code X-correlation? 0 = FALSE 1 = TRUE	Enum	4	H+84
24	L2 c valid	Is L2 code valid? 0 = FALSE 1 = TRUE	Enum	4	H+88
25	L2 p valid	Is L2 phase valid? 0 = FALSE 1 = TRUE	Enum	4	H+92
26	phase full	Is phase full? 0 = FALSE 1 = TRUE	Enum	4	H+96
27	Reserved		Ulong	4	H+100
28	L2 r offset	L2 range offset (1/100 meters)	Long	4	H+104
29	L2 c offset	L2 carrier offset (1/256 cycles)	Long	4	H+108
30	L2 S/N_0	L2 signal-to-noise density ratio	Ulong	4	H+112
31	L2 slip	L2 cycle slip count (number of times that tracking has not been continuous)	Ulong	4	H+116
32...	Next PRN offset = H+48 + (#prns x 72)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.13 CMRDATAREF Base Station Position *V123_RT20 or V23_RT2*

See *Section 3.3.10, CMR Standard Logs* starting on *Page 255* for information on CMR standard logs. See also *Figure 10* on *Page 245* for a definition of the ECEF coordinates.

Message ID: **391**

Log Type: **Synch**

Recommended Input:

log cmrdatarefa ontime 10

ASCII Example:

```
#CMRDATAREFA,COM1,0,70.0,FINESTEERING,1269,147115.000,00100000,5db6,1516;2,0,
147,25,3,0,1,FALSE,FALSE,0,TRUE,0,234000,1,0,-1634529233.1026337146759033,
0,-3664611941.5660152435302734,0,-2054717277,0,15,0*c21a9c26
```

The CMRDATAREF log is analogous to the RTCADATAREF log when using RTCA messages. In the CMR format description, the CMRDATAREF log is referred to as Type 1.

Table 53: Position Accuracy

Code	Position Accuracy
0	Unknown
1	5 km
2	1 km
3	500 m
4	100 m
5	50 m
6	10 m
7	5 m
8	1 m
9	50 cm
10	10 cm
11	5 cm
12	1 cm
13	5 mm
14	1 mm
15	Exact

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CMRDATAREF header	Log header	-	H	0
2	CMR header	Synch character for the message	Ulong	4	H
3		Message status	Ulong	4	H+4
4		CMR message type	Ulong	4	H+8
5		Message body length	Ulong	4	H+12
6		Version	Ulong	4	H+16
7		Station ID	Ulong	4	H+20
8		Message Type	Ulong	4	H+24
9	battery	Is the battery low? 0 = FALSE 1 = TRUE	Enum	4	H+28
10	memory	Is memory low? 0 = FALSE 1 = TRUE	Enum	4	H+32
11	Reserved		Ulong	4	H+36
12	L2	Is L2 enabled? 0 = FALSE 1 = TRUE	Enum	4	H+40
13	Reserved		Ulong	4	H+44
14	epoch	Epoch time (milliseconds)	Ulong	4	H+48
15	motion	Motion state: 0 = UNKNOWN 1 = STATIC 2 = KINEMATIC	Ulong	4	H+52
16	Reserved		Ulong	4	H+56
17	ECEF-X	Reference ECEF-X position (millimeters)	Double	8	H+60
18	ant hgt	Antenna height (millimeters)	Ulong	4	H+68
19	ECEF-Y	Reference ECEF-Y position (millimeters)	Double	8	H+72
20	e offset	Easting offset (millimeters)	Ulong	4	H+80
21	ECEF-Z	Reference ECEF-Z position (millimeters)	Double	8	H+84
22	n offset	Northing offset (millimeters)	Ulong	4	H+92

Continued on Page 264

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
23	pos acc	Position accuracy relative to WGS84, see *Table 53, Position Accuracy* on *Page 262*	Ulong	4	H+96
24	Reserved		Ulong	4	H+100
25	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+104
26	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.14 CMRPLUS CMR+ Output Message *V123_RT20 or V23_RT2*

The CMRPLUS message distributes the base station information over 14 updates. For example, if you log:

CMRPLUS ontime 1

the receiver outputs the complete base station information in 14 seconds.

Refer to the chapter on *Message Formats* in the *OEMV Family Installation and Operation User Manual* for information on CMR standard logs.

Message ID: 717

Log Type: Asynch

Recommended Input:

log cmrplusa ontime 1

ASCII Example:

```
#CMRPLUSA,COM1,0,83.0,FINESTEERING,1317,318534.915,00180040,30aa,1855;
2,0,148,10,0,4,14,1b,00,00,00,00,62,61*64e0c9ea
```

The CMRPLUS log can be used in place of the CMRREF log. The advantage of the CMRPLUS log is that it requires less transmission bandwidth because of the way the information is spread over 14 separate updates. This may be especially useful in difficult communication environments, for example, when a radio repeater is required.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	CMRPLUS header	Log header	-	H	0
2	CMR header	Synch character for the message	Ulong	4	H
3		Message status	Ulong	4	H+4
4		CMR message type	Ulong	4	H+8
5		Message body length	Ulong	4	H+12
6		Version	Ulong	4	H+16
7		Station ID	Ulong	4	H+20
8		Message Type	Ulong	4	H+24
9	stnID	Station ID	Ulong	4	H+28
10	page	Current page index	Ulong	4	H+32
11	#pages	Maximum number of page indexes	Ulong	4	H+36
12	data	Data for this page	Uchar[7]	8 [a]	H+40
13	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+104
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.15 COMCONFIG Current COM Port Configuration *V123*

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,
COM3,9600,N,8,1,N,OFF,ON,NOVATEL,NOVATEL,ON*9d4b21b6
```

COM1 on the OEMV-3 is user-configurable for RS-422. Refer to the *Technical Specifications* appendix and the *User-Selectable Port Configuration* section of the *OEMV Family 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 16, COM Serial Port Identifiers* on *Page 83*	Enum	4	H+4
4	baud	Communication baud rate	Ulong	4	H+8
5	parity	See *Table 17, Parity* on *Page 83*	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 18, Handshaking* on *Page 84*	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 30, Serial Port Interface Modes* on *Page 131*	Enum	4	H+36
12	tx type	The status of the transmit interface mode, *Table 30, Serial Port Interface Modes* on *Page 131*	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)				
15	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+(#port x44)
16	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.16 DIFFCODEBIASES Differential code biases being applied *V123*

This log outputs the differential code biases that are being applied to the L1/L2 ionospheric corrections.

Message ID: **914**

Log Type: **Polled**

Recommended Input:

log diffcodebiases once

ASCII example:

```
#DIFFCODEBIASESA,COM1,0,61.5,UNKNOWN,0,4294967.295,004c0000,15ba,35548;
1,GPS_C1P1,-0.472,-0.006,-0.482,1.154,-1.153,0.250,-1.319,-0.535,0.119,
-1.945,0.522,1.425,1.489,0.090,0.000,-0.727,1.361,-0.416,-2.066,-1.347,
-0.380,0.543,0.414,-0.172,0.394,0.923,-0.422,-0.326,0.481,1.937,1.753,
-1.088,0.000,0.000,0.000,0.000,0.000,0.000,0.000,0.000*417eef8e0
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	DIFFCODE-BIASES header	Log header		H	0
2	#bias_sets	Number of sets of bias code arrays	Long	4	H
3	bias_type	Bias type (there is currently only one type): 0 = GPS_C1P1	Enum	4	H+4
4	bias_array	Array of 40 biases (ns)	Float[40]	160	H+8
5	next bias_sets offset = H + 4 + (#bias_sets x 164)				
6	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#bias _sets x 164)
7	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.17 EXTRXHWLEVELS Extended Receiver Hardware Levels *V3_G*

This log contains extended receiver environmental and voltage parameters. The EXTRXHWLEVELS log is for OEMV-3-based GLONASS products only. Its fields display zeroes for other receivers.

Message ID: **843**
Log Type: **Polled**

Recommended Input:

log extrxhwlevelsa ontime 60

Abbreviated ASCII Example:

```
#EXTRXHWLEVELSA,COM1,0,77.0,FINESTEERING,1415,404242.050,00000020,a536,2616;
3.325,1.803,2.833,0.000,-0.031,6.104e-04,0.000,0.000,0.000,0.000*54a4d596
```

Refer also to the OEMV-3 technical specifications in *Appendix A* of the *OEMV Family Installation and Operation User Manual* for comparisons.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	EXTRXHW-LEVELS header	Log header		H	0
2	system volt	Receiver system voltage (V)	Float	4	H
3	MINOS volt	MINOS chip voltage (V)	Float	4	H+4
4	L-band volt	L-band voltage (V)	Float	4	H+8
5	L5 volt	Receiver supply voltage (V)	Float	4	H+12
6	Reserved		Float	4	H+16
7			Float	4	H+20
8			Float	4	H+24
9			Float	4	H+28
10			Float	4	H+32
11			Float	4	H+36
12	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+40
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.18 GLMLA NMEA GLONASS Almanac Data *V1G23_G*

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# $_{\text{To match NovAtel format logs or GLONASS status website}}$ = 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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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 (PZ90), 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	$t\lambda$	GLONASS Time of ascending node equator crossing, in seconds [c]	hhhhhhh	031887
13	λ	Longitude of ascending node equator crossing (PZ90), 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	Course 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)

- [5][4][3][2][1]: carrier frequency number of satellite
- [7][6]: spare bits
- [8]: 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.

3.3.19 GLOALMANAC Decoded Almanac *V1G23_G*

The GLONASS almanac reference time and week are in GPS 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 274*)
- 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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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 Week, in weeks	Ulong	4	H+4
4	time	GPS 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 (PZ90), 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 (PZ90), 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)	-	-	-

3.3.20 GLOCLOCK GLONASS Clock Information *V1G23_G*

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 time is continuous and does not include any of the leap second adjustments to UTC applied since 1980. The result is that GPS 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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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 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	The Kp scale summarizes the global level of geomagnetic activity. A Kp of 0 to 4 is below storm levels (5 to 9).	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

3.3.21 GLOEPHEMERIS GLONASS Ephemeris Data *V1G23_G*

GLONASS ephemeris information is available through the GLOEPHEMERIS log. GLONASS ephemerides are referenced to the SGS-90 geodetic datum, and GLONASS coordinates are reconciled internally through a position filter and output to WGS84.

GLONASS measurements can be used for post-processed positioning solutions or in user-designed programs. NovAtel plans to offer GLONASS positioning in the future. In the meantime, OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also www.novatel.com for details.

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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

Table 54: GLONASS Ephemeris Flags Coding

N 0 (Nibble Number) Bit	Description	Range Values	Hex Value
lsb = 0	P1 FLAG - TIME INTERVAL BETWEEN ADJACENT iSSUE (tb) VALUES	See Table below (*Table 55*)	00000001
1			00000002
2	P2 FLAG - ODDNESS OR EVENNESS OF iSSUE (tb) VALUE	0 = even, 1 = odd	00000004
3	P3 FLAG - NUMBER OF SATELLITES WITH ALMANAC INFORMATION WITHIN CURRENT SUBFRAME	0 = four, 1 = five	00000008
4 : 31	RESERVED (N-1 through N-7)		

Table 55: *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 (in GPS time)	Ushort	2	H+6
7	e time	Reference time of ephemeris (in GPS time)	Ulong	4	H+8
8	t offset	Integer seconds between GPS and GLONASS time. A positive value implies GLONASS is ahead of GPS 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 277*.	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 (PZ90), in meters	Double	8	H+28
15	pos y	Y coordinate for satellite at reference time (PZ90), in meters	Double	8	H+36
16	pos z	Z coordinate for satellite at reference time (PZ90), in meters	Double	8	H+44
17	vel x	X coordinate for satellite velocity at reference time (PZ90), in meters/s	Double	8	H+52
18	vel y	Y coordinate for satellite velocity at reference time (PZ90), in meters/s	Double	8	H+60

Continued on Page 280

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
19	vel z	Z coordinate for satellite velocity at reference time (PZ90), in meters/s	Double	8	H+68
20	LS acc x	X coordinate for lunisolar acceleration at reference time (PZ90), in meters/s/s	Double	8	H+76
21	LS acc y	Y coordinate for lunisolar acceleration at reference time (PZ90), in meters/s/s	Double	8	H+84
22	LS acc z	Z coordinate for lunisolar acceleration at reference time (PZ90), in meters/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 54, GLONASS Ephemeris Flags Coding* on *Page 278*	Ulong	4	H+140
31	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+144
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.22 GLORAWALM Raw GLONASS Almanac Data *V1G23_G*

This log contains the undecoded 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,
0c18000000000000000006,0,
0d00000000000000000652,0,
0e000000000000000000d0,0*b516623b
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	GLORAWALM header	Log header		H	0
2	week	GPS Week, in weeks	Ulong	4	H
3	time	GPS 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.

3.3.23 GLORAWEPHEM Raw GLONASS Ephemeris Data *V1G23_G*

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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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 Week, in weeks	Ulong	4	8
6	time	GPS 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.

3.3.24 GLORAWFRAME Raw GLONASS Frame Data *V1G23_G*

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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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 Week, in weeks	Ulong	4	H+6
6	time	GPS 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.

3.3.25 GLORAWSTRING Raw GLONASS String V1G23_G

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
```

Refer to the GLONASS Overview section in the *GPS+ Reference Manual* available on our website at http://www.novatel.ca/support/docupdates.htm.

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.

3.3.26 GPALM Almanac Data *V123_NMEA*

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. Following a receiver reboot, this log outputs null data in all fields until a valid almanac is obtained. 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, refer to ARINC in the Standards and References section of the *GPS+ Reference Manual* available on our website. Refer also to NMEA contact information there.

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 usage box that applies to all NMEA logs on *Page 291*.

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

3.3.27 GPGGA GPS Fix Data and Undulation *V123_NMEA*

Time, position and fix-related data of the GPS receiver. For greater precision, but with the loss of the undulation fields, use the GPGGARTK log (see *Page 293*). See also *Table 58, Position Precision of NMEA Logs* on *Page 297*.

Below are tables that show how many GPS and/or GLONASS satellites you need to obtain a fixed ambiguity solution, *Table 56* below, and how many you need to keep a fixed ambiguity solution, see *Table 57* on *Page 291*.

This log outputs null data in all fields until a valid almanac is obtained.

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
```

Table 56: To Obtain a Fixed Ambiguity Solution

	#GPS Satellites							
#GLO Satellites	1	2	3	4	5	6	7	8
1	No	No	No	Float	**Fix**	**Fix**	**Fix**	**Fix**
2	No	No	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
3	No	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
4	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
5	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
6	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
7	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
8	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**

Table 57: To Maintain a Fixed Ambiguity Solution

	#GPS Satellites							
#GLO Satellites	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	No	No	No	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
2	No	No	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
3	No	Fix	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
4	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
5	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
6	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
7	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
8	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**

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, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS, or CDGPS 4 = RTK fixed ambiguity solution (RT2), see also *Table 57* on *Page 291* 5 = RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP 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 = meters)	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 = meters)	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).

b. The maximum age reported here is limited to 99 seconds.

3.3.28 GPGGALONG Fix Data, Extra Precision and Undulation *V123_NMEA*

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 58, Position Precision of NMEA Logs* on *Page 297.*

This log outputs null data in all fields until a valid almanac is obtained.

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 usage box that applies to all NMEA logs on *Page 291*.

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, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS, or CDGPS 4 = RTK fixed ambiguity solution (RT2), see also *Table 57* on *Page 291* 5 = RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP 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 = meters)	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 = meters)	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.

3.3.29 GPGGARTK Global Position System Fix Data *V123_NMEA*

Time, position and fix-related data of the GPS receiver. This is output as a GPGGA log but the GPGGARTK log differs from the normal GPGGA log by its extra precision. In order for the position to be output with this extra precision, the undulation fields are unavailable (see the GPGGA log on *Page 290*). See also *Table 58, Position Precision of NMEA Logs* on *Page 297.*

This log outputs null data in all fields until a valid almanac is obtained.

Message ID: 259

Log Type: Synch

Recommended Input:

log gpggartk ontime 1

Example:

```
$GPGGA,135324.00,5106.9791988,N,11402.3002127,W,2,09,1.0,1047.606,M,,,04,AAAA
*1C
```

The GPGGARTK log is ideal for RTK positioning applications where mm-level position precision is required.

See also the GPGGA usage box that applies to all NMEA logs on *Page 291*.

Field	Structure	Field Description	Symbol	Example
1	$GPGGA	Log header		$GPGGA
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	220147.50
3	lat	Latitude (DDmm.mm)	llll.ll	5106.7194489
4	lat dir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.358902 0
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, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS, or CDGPS 4 = RTK fixed ambiguity solution (RT2), see also *Table 57* on *Page 291* 5 = RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP 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	08
9	hdop	Horizontal dilution of precision	x.x	0.9
10	alt	Antenna altitude above/below mean sea level	x.x	1080.406
11	units	Units of antenna altitude (M = meters)	M	M
12	null	(This field not available on OEMV family receivers)		*(empty when no differential data is present)*
13	null	(This field not available on OEMV family receivers)		
14	age	Age of Differential GPS data (in seconds) [b]	xx	
15	stn ID	Differential base station ID, 0000-1023	xxxx	
16	*xx	Checksum	*hh	*48
17	[CR][LF]	Sentence terminator		[CR][LF]

a. An indicator of 9 has been temporarily set for WAAS. The NMEA standard for WAAS has not been decided yet.

b. The maximum age reported here is limited to 99 seconds.

3.3.30 GPGLL Geographic Position *V123_NMEA*

Latitude and longitude of present vessel position, time of position fix, and status.

Table 58 compares the position precision of selected NMEA logs.

This log outputs null data in all fields until a valid almanac is obtained.

If the NMEATALKER command, see *Page 149*, 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 58: 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
GPGGARTK	7	7	3
GPGLL	7	7	N/A
GPRMC	7	7	N/A

Please see the GPGGA usage box that applies to all NMEA logs on *Page 291*.

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 59* on *Page 307*	a	A
9	*xx	Checksum	*hh	*1B
10	[CR][LF]	Sentence terminator		[CR][LF]

3.3.31 GPGRS GPS Range Residuals for Each Satellite *V123_NMEA*

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.

This log outputs null data in all fields until a valid almanac is obtained.

---

1. 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

2. If the NMEATALKER command, see *Page 149*, 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.

3. There is no residual information available from the OmniSTAR HP/XP service, so the GPGRS contains the pseudorange position values when using it. For the OmniSTAR VBS or CDGPS service, residual information is available.

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 usage box that applies to all NMEA logs on *Page 291*.

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 (apriori) (not used by OEMV family receiver) 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]

3.3.32 GPGSA GPS DOP and Active Satellites *V123_NMEA*

GPS receiver operating mode, satellites used for navigation and DOP values.

This log outputs null data in all fields until a valid almanac is obtained.

1. 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.
2. If the NMEATALKER command, see *Page 149*, 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 291*.

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.

3.3.33 GPGST Pseudorange Measurement Noise Statistics *V123_NMEA*

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 231*, and GPGGA, see *Page 290*, 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 357*.

This log outputs null data in all fields until a valid almanac is obtained.

If the NMEATALKER command, see *Page 149*, 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
```

---

1. Please see the GPGGA usage box that applies to all NMEA logs on *Page 291*.

2. Accuracy is based on statistics, reliability is measured in percent. When a receiver can measure height to one meter, 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 meter 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 GPSGST 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]

3.3.34 GPGSV GPS Satellites in View *V123_NMEA*

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.

This log outputs null data in all fields until a valid position is obtained.

1. 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.
2. If the NMEATALKER command, see *Page 149*, 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) in each sentence.
3. 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 usage box that applies to all NMEA logs on *Page 291*.

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 GPSGSA log on *Page 290*).	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.

3.3.35 GPRMB Navigation Information *V123_NMEA*

Navigation data from present position to a destination waypoint. The destination is set active by the receiver SETNAV command.

This log outputs null data in all fields until a valid position is obtained.

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 149*, 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 usage box that applies to all NMEA logs on *Page 291*.

Table 59: 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 59* on *Page 307*	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 meters

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 176*.

d. If range to destination exceeds 999.9 NM, display 999.9

3.3.36 GPRMC GPS Specific Information *V123_NMEA*

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 58, Position Precision of NMEA Logs* on *Page 297*.

This log outputs null data in all fields until a valid almanac is obtained.

If the NMEATALKER command, see *Page 149*, 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 usage box that applies to all NMEA logs on *Page 291*.

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 59* on *Page 307*	a	A
14	*xx	Checksum	*hh	*20
15	[CR][LF]	Sentence terminator		[CR][LF]

a. Note that this field is the actual magnetic variation East or West and is the inverse sign of the value entered into the MAGVAR command, see *Page 140* for more information.

b. Easterly variation (E) subtracts from True course and Westerly variation (W) adds to True course.

3.3.37 GPSEPHEM Decoded GPS Ephemerides *V123*

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 60: 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	56
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 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, meters	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 an ellipse, 0<e<1 is a parabola 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, meters)	Double	8	H+96
18	crs	Orbit radius (amplitude of sine, meters)	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 Page 314

Field#	Field type	Data Description	Format	Binary Bytes	Binary Offset
22	$\dot{I}$	Rate of inclination angle, radians/second	Double	8	H+136
23	ω_0	Right ascension, radians	Double	8	H+144
24	$\dot{\omega}$	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 60*.	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 ARINC in the *Standards and References* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

3.3.38 GPVTG Track Made Good And Ground Speed V123_NMEA

The track made good and speed relative to the ground.

This log outputs null data in all fields until a valid position is obtained.

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 149*, 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 usage box that applies to all NMEA logs on *Page 291*.

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 140*.	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, kilometers/hour	x.x	0.781608
9	K	Speed indicator (K = km/hr)	K	K
10	mode ind	Positioning system mode indicator, see *Table 59* on *Page 307*	a	A
11	*xx	Checksum	*hh	*7A
12	[CR][LF]	Sentence terminator		[CR][LF]

3.3.39 GPZDA UTC Time and Date *V123_NMEA*

This log outputs null data in all fields until a valid almanac is downloaded from a satellite. Any alternate almanac already in NVM is not output.

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 box that applies to all NMEA logs on *Page 291*.

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 OEMV family receivers. Fields 6 and 7 are always null.

3.3.40 IONUTC Ionospheric and UTC Data *V123*

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 *OEMV Family Installation and Operation User Manual* including IONUTC.

1. Refer to the U.S. National Geodetic Survey website 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)	-	-	-

3.3.41 LBANDINFO L-band Configuration Information *V13_VBS, V3_HP or V13_CDGPS*

This log outputs configuration information for an L-band service. In the case of using the free CDGPS service, no subscription is required and therefore the subscription fields report an UNKNOWN subscription status. See also the examples below.

✉ In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.

Message ID: **730**
Log Type: **Asynch**

Recommended Input:

log lbandinfoa ontime 1

ASCII Example 1 (OmniSTAR HP):

```
#LBANDINFOA,COM2,0,81.5,FINESTEERING,1295,152639.184,00000240,c51d,34461;
1547547,4800,c685,0,762640,EXPIRED,0,0,FIXEDTIME,1199,259199,0*8cc5e573
```

Abbreviated ASCII Example 2 (CDGPS):

```
LBANDINFO COM1 0 45.5 FINESTEERING 1297 498512.389 00000000 c51d 34486
1547547 4800 0 0 762640 UNKNOWN 0 0 UNKNOWN 0 0 0
```

Table 61: L-band Subscription Type

Binary	ASCII	Description
0	EXPIRED	The L-band subscription has expired or does not exist.
1	FIXEDTIME	The L-band subscription expires at a fixed date and time.
2	COUNTDOWN	The L-band subscription expires after the specified amount of running time.
3	COUNTDOWNOVERRUN	The COUNTDOWN subscription has expired but has entered a brief grace period. Resubscribe immediately.
16	UNKNOWN	Unknown subscription

What is the real accuracy of the Coast Guard's DGPS as compared to the commercial DGPS? The Coast Guard claims a 10 meter accuracy for their DGPS. Some commercial DGPS vendors offer 5 m (or better) accuracy. Are the commercial vendors really supplying something more accurate than the Coast Guard signal?

The real accuracy of the Coast Guard's DGPS signal is likely better than 10 meters. However, there a number of factors which are involved in determining the accuracy of a DGPS system. These include:

- your proximity to the base station which is transmitting DGPS corrections,
- the GPS receiver used by the Coast Guard,
- the GPS receiver used by the commercial DGPS services,
- your GPS receiver, and the statistical qualifier used in conjunction with the stated accuracy.

If you were to compare the Coast Guard and commercial DGPS services under the same situations, for example, a base to user proximity of 1 km and stated accuracy at 2drms (95% confidence), you would probably find that the Coast Guard's DGPS is at least equivalent to, if not better than, commercial DGPS services.

Also of note is that the Coast Guard's DPGS service is available to all users (marine, land and air), similar to a public utility without any charge. In addition, the Coast Guard's service acts as an integrity monitor, which provides an independent check of each GPS satellite's signal and reports whether it is good or bad. Commercial DGPS vendors usually have a monthly or yearly subscription fee.

All of the previous discussions have been dealing with code data. Some commercial DGPS services are now also provide high accuracy carrier-phase data along with code data. With this type of data, depending on your equipment, you will be able to achieve decimeter and even centimeter level accuracies.

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	LBANDINFO header	Log header		H	0
2	freq	Selected frequency for L-band service (kHz)	Ulong	4	H
3	baud	Communication baud rate from L-band satellite	Ulong	4	H+4
4	ID	L-band signal service ID	Ushort	2	H+8
5	Reserved		Ushort	2	H+10
6	OSN	L-band serial number	Ulong	4	H+12
7	vbs sub	L-band VBS subscription type (see *Table 61* on *Page 319*)	Enum	4	H+16
8	vbs exp week	GPS week number of L-band VBS expiration date [a]	Ulong	4	H+20
9	vbs exp secs	Number of seconds into the GPS week of L-band VBS expiration date [a]	Ulong	4	H+24
10	hp sub	OmniSTAR HP or XP subscription type (see *Table 61* on *Page 319*)	Enum	4	H+28
11	hp exp week	GPS week number of OmniSTAR HP or XP expiration date [a]	Ulong	4	H+32
12	hp exp secs	Number of seconds into the GPS week of OmniSTAR HP or XP expiration date [a]	Ulong	4	H+36
13	hp sub mode	HP or XP subscription mode if the subscription is valid: 0 = HP 1 = XP	Ulong	4	H+40
14	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
15	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. If the subscription type is COUNTDOWN, see Field #7 above, the expiration week and expiration seconds into the GPS week contain the amount of running time remaining in the subscription.

If the subscription type is COUNTDOWNOVERRUN, the expiration week and expiration seconds into GPS week count the amount of the overrun time.

3.3.42 LBANDSTAT L-band Status Information *V13_VBS, V3_HP or V13_CDGPS*

This log outputs status information for a standard L-band, OmniSTAR XP (Extra Precision) or OmniSTAR HP (High Performance) service.

In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.

Message ID: **731**

Log Type: **Asynch**

Recommended Input:

log lbandstata ontime 1

ASCII Example:

```
#LBANDSTATA,COM1,0,73.5,FINESTEERING,1314,494510.000,00000000,c797,1846;
1551488896,43.19,62.3,0.00,0082,0000,7235,11,0,0000,0001,7762,04000000,0
*93f7d2af
```

In binary, the receiver outputs 48 bytes without the checksum when the LBANDSTATB log is requested.

Table 62: L-band Signal Tracking Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x0001	Tracking State	0 = Searching, 1 = Pull-in, 2 = Tracking
	1	0x0002		
	2	0x0004	Reserved	
	3	0x0008		
N1	4	0x0010		
	5	0x0020		
	6	0x0040	Bit Timing Lock	0 = Not Locked, 1 = Locked
	7	0x0080	Phase Locked	0 = Not Locked, 1 = Locked
N2	8	0x0100	DC Offset Unlocked	0 = Good, 1 = Warning
	9	0x0200	AGC Unlocked	0 = Good, 1 = Warning
	10	0x0400	Reserved	
	11	0x0800		
N3	12	0x1000		
	13	0x2000		
	14	0x4000		
	15	0x8000	Error	0 = Good, 1 = Error

Table 63: OmniSTAR VBS Status Word

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x0001	Subscription Expired [a]	False	True
	1	0x0002	Out of Region [a]	False	True
	2	0x0004	Wet Error [a]	False	True
	3	0x0008	Link Error [a]	False	True
N1	4	0x0010	No Remote Sites	False	True
	5	0x0020	No Almanac	False	True
	6	0x0040	No Position	False	True
	7	0x0080	No Time	False	True
N2	8	0x0100	Reserved		
	9	0x0200			
	10	0x0400			
	11	0x0800			
N3	12	0x1000			
	13	0x2000			
	14	0x4000			
	15	0x8000	Updating Data	False	True

a. Contact OmniSTAR for subscription support. All other status values are updated by collecting OmniSTAR data for 20-35 minutes.

Table 64: OmniSTAR HP/XP Additional Status Word

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x0001	Solution not fully converged	False	True
	1	0x0002	OmniStar satellite list available	False	True
	2	0x0004	Reserved		
	3	0x0008			
N1	4	0x0010	HP not authorized [a]	Authorized	Unauthorized
	5	0x0020	XP not authorized [a]	Authorized	Unauthorized
	6	0x0040	Reserved		
	7	0x0080			
N2	8	0x0100			
	9	0x0200			
	10	0x0400			
	11	0x0800			
N3	12	0x1000			
	13	0x2000			
	14	0x4000			
	15	0x8000			

a. This authorization is related to the receiver model and not the OmniStar subscription. To view OmniSTAR subscription information use the LBANDINFO log, see *Page 319*.

Table 65: OmniSTAR HP/XP Status Word

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Subscription Expired [a]	False	True
	1	0x00000002	Out of Region [a]	False	True
	2	0x00000004	Wet Error [a]	False	True
	3	0x00000008	Link Error [a]	False	True
N1	4	0x00000010	No Measurements	False	True
	5	0x00000020	No Ephemeris	False	True
	6	0x00000040	No Initial Position	False	True
	7	0x00000080	No Time Set	False	True
N2	8	0x00000100	Velocity Error	False	True
	9	0x00000200	No base stations	False	True
	10	0x00000400	No Mapping Message	False	True
	11	Reserved			
N3-N5	12-23				
N6	24-25				
	26	0x04000000	Static Initialization Mode	False	True
	27	Reserved			
N7	28-30				
	31	0x80000000	Updating Data	False	True

a. Contact OmniSTAR for subscription support. All other status values are updated by collecting the OmniSTAR data for 20-35 minutes.

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	LBANDSTAT header	Log header		H	0
2	freq	Measured frequency of L-band signal (Hz)	Ulong	4	H
3	C/No	Carrier to noise density ratio C/No = $10[\log_{10}(S/N_0)]$ (dB-Hz)	Float	4	H+4
4	locktime	Number of seconds of continuous tracking (no cycle slipping)	Float	4	H+8
5	Reserved		Float	4	H+12
6	tracking	Tracking status of L-band signal (see *Table 62* on *Page 323*)	Hex	2	H+16
7	VBS status	Status word for OmniSTAR VBS (see *Table 63* on *Page 324*)	Hex	2	H+18
8	#bytes	Number of bytes fed to the standard process	Ulong	4	H+20
9	#good dgps	Number of standard updates	Ulong	4	H+24
10	#bad data	Number of missing standard updates	Ulong	4	H+28
11	Reserved (the *hp status 1* field is obsolete and has been replaced by the longer OmniSTAR HP Status field. The shorter legacy status here is maintained for backward compatibility)		Hex	2	H+32
12	hp status 2	Additional status pertaining to the HP or XP process (see *Table 64* on *Page 325*)	Hex	2	H+34
13	#bytes hp	Number of bytes fed to the HP or XP process	Ulong	4	H+36
14	hp status	Status from the HP or XP process (see *Table 65* on *Page 326*)	Hex	4	H+40
15	Reserved		Hex	4	H+44
16	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
17	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.43 LOGLIST List of System Logs *V123*

Outputs a list of log entries in the system. The following tables show the binary ASCII output. See also the RXCONFIG log on *Page 497* 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,
COM3,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 Service regarding software concerns, we suggest you log the following logs for 30 minutes to a file: RXSTATUSB, RAWEPHEMB, RANGEB, BESTPOSB, RXCONFIGA and VERSIONB. Use the LOGLIST log to see what logs your receiver is outputting.

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 = 20	Long	4	H
3	port	Output port, see *Table 5, Detailed Serial Port Identifiers* on *Page 23*	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 25*) 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+34
11...	Next log offset = H + 4 + (#logs x 34)				
variable	xxxx	32-bit CRC	Hex	4	H+4+(#logs x 34)

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 = 20	Long
3	port	Output port, see *Table 5, Detailed Serial Port Identifiers* on *Page 23*	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	-

3.3.44 MARKPOS, MARK2POS Position at Time of Mark Input Event *V123*

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 and MARK2POS is generated when a pulse occurs on a MK2I input. Refer to the *Technical Specifications* appendix in the *OEMV Family 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 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 333*.

Message ID: **181 (MARKPOS)** and **615 (MARK2POS)**

Log Type: **Asynch**

Recommended Input:

log markposa onnew

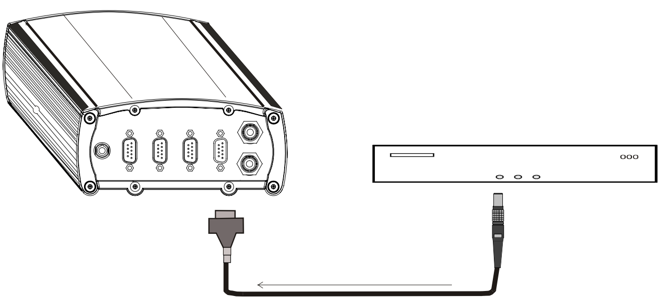
Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

Abbreviated ASCII Example:

```
SOL_COMPUTED,NARROW_INT,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 on 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/ MARK2POS header	Log header		H	0
2	sol status	Solution status (see *Table 47* on *Page 233*)	Enum	4	H
3	pos type	Position type (see *Table 46* on *Page 232*)	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 21, Datum Transformation Parameters* on *Page 94*)	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	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+66
18	#multi	Number of multi frequency observations in solution	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status	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 48* on *Page 234*)	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

3.3.45 MARKTIME, MARK2TIME Time of Mark Input Event V123

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 and MARK2POS is generated when a pulse occurs on a MK2I input. Refer to the *Technical Specifications* appendix in the *OEMV Family 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.

1. Use the ONNEW trigger with this or the MARKPOS logs.
2. 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) and 616 (MARK2TIME)**
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 143*.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	MARKTIME/ MARK2TIME header	Log header		H	0
2	week	GPS 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 Time. To derive GPS time, use the following formula: GPS 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 time from UTC time, computed using almanac parameters. UTC time is GPS time plus the current UTC offset plus the receiver clock offset. UTC time = GPS time + offset + UTC offset[a]	Double	8	H+28
7	status	Clock model status, see *Table 50, Clock Model Status* on *Page 249*	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.

3.3.46 MATCHEDPOS Matched RTK Position *V123_RT20, V23_RT2 or V3_HP*

This log represents positions that have been computed from time matched base and rover observations. There is no base extrapolation error on these positions because they are based on buffered measurements; they lag real time by some amount depending on the latency of the data link. If the rover receiver has not been enabled to accept RTK differential data, or is not actually receiving data leading to a valid solution, this is shown in fields #2 (*sol status*) and #3 (*pos type*).

This log provides the best accuracy in static operation. For lower latency in kinematic operation, see the RTKPOS or BESTPOS logs. The data in the logs changes only when a base observation (RTCM, RTCMV3, RTCA, CMRPLUS or CMR) changes.

A good message trigger for this log is "ONCHANGED". Then, only positions related to unique base station messages are produced, and the existence of this log indicates a successful link to the base.

Asynchronous logs, such as MATCHEDPOS, 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: **96**
Log Type: **Asynch**

Recommended Input:

log matchedposa onchanged

ASCII Example:

```
#MATCHEDPOSA,COM1,0,63.0,FINESTEERING,1419,340034.000,00000040,2f06,2724;
SOL_COMPUTED,NARROW_INT,51.11635908660,-114.03833102484,1063.8400,-16.2712,
WGS84,0.0140,0.0075,0.0174,"AAAA",0.000,0.000,12,12,12,12,0,01,0,33*feac3a3a
```

Measurement precision is different from the position computation precision. Measurement precision is a value that shows how accurately the actual code or carrier phase is measured by the GPS receiver. Position precision is a value that shows the accuracy of the position computation that is made from the code and/or carrier phase measurements.The P-code L2 measurement precision is not as good as the C/A measurement precision because the NovAtel GPS receiver is a civilian grade GPS device, and thus does not have direct access to the decrypted military L2 P(Y) code. This means that our semi-codeless P-code L2 measurements are noisier than the civilian band L1 C/A code measurements. Refer to the *OEMV Installation and Operation Manual* for the technical specification of the OEMV card.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	MATCHEDPOS header	Log header		H	0
2	sol status	Solution status (see *Table 47* on *Page 233*)	Enum	4	H
3	pos type	Position type (see *Table 46* on *Page 232*)	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 21* on *Page 94*)	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	Reserved		Float	4	H+56
14			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	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+66
18	#multi	Number of multi frequency observations in solution	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status	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 48* on *Page 234*)	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

3.3.47 MATCHEDXYZ Matched RTK Cartesian Position *V123_RT20, V23_RT2 or V3_HP*

This log contains the receiver's matched position in ECEF coordinates. It represents positions that have been computed from time matched base and rover observations. There is no base station extrapolation error on these positions because they are based on buffered measurements; they lag real time by some amount depending on the latency of the data link. If the rover receiver has not been enabled to accept RTK differential data, or is not actually receiving data leading to a valid solution, this is reflected by the code shown in field #2 (solution status) and #3 (position type). See *Figure 10, Page 245* for a definition of the ECEF coordinates.

This log provides the best accuracy in static operation. For lower latency in kinematic operation, see the BESTXYZ or RTKXYZ logs on *Pages 242* and *494* respectively. The data in the logs changes only when a base observation (RTCM, RTCMV3, RTCA, or CMR) changes.

The time stamp in the header is the time of the matched observations that the computed position is based on, not the current time.

Message ID: **242**

Log Type: **Asynch**

Recommended Input:

log matchedxyza onchanged

Asynchronous logs, such as MATCHEDXYZ, 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:

```
#MATCHEDXYZA,COM1,0,62.5,FINESTEERING,1419,340035.000,00000040,b8ed,2724;
SOL_COMPUTED,NARROW_INT,-1634531.5703,-3664618.0321,4942496.3280,0.0080,
0.0159,0.0154,"AAAA",12,12,12,12,0,01,0,33*e4b84015
```

A good message trigger for this log is "onchanged". Then, only positions related to unique base station messages are produced, and the existence of this log indicates a successful link to the base station.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	MATCHEDXYZ header	Log header		H	0
2	P-sol status	Solution status, see *Table 47, Solution Status* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46, Position or Velocity Type* on *Page 232*	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
18	stn ID	Base station ID	Char[4]	4	H+44
22	#SVs	Number of satellite vehicles tracked	Uchar	1	H+48
23	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+49
24	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+50
25	#multi	Number of multi frequency observations in solution	Uchar	1	H+51
26	Reserved		Char	1	H+52
27	ext sol stat	Extended solution status	Hex	1	H+53
28	Reserved		Hex	1	H+54
29	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 48* on *Page 234*)	Hex	1	H+55
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+56
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

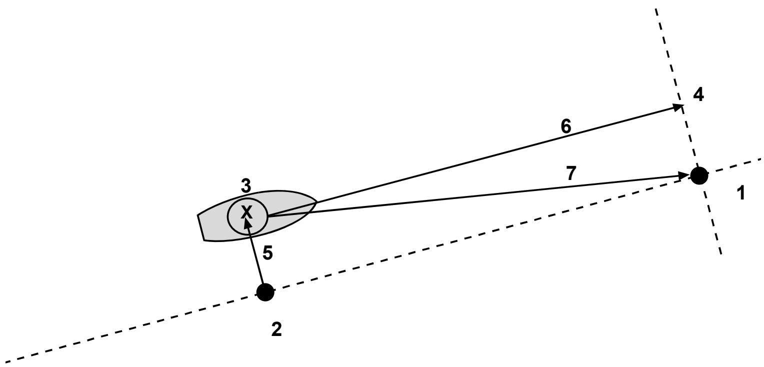
3.3.48 NAVIGATE User Navigation Data *V123*

This log reports the status of the waypoint navigation progress. It is used in conjunction with the SETNAV command, see *Page 176*.

See *Figure 11, 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 11: Navigation Parameters

Table 66: Navigation Data Type

Navigation Data Type Binary	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 47, Solution Status* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46, Position or Velocity Type* on *Page 232*	Enum	4	H+4
4	vel type	Velocity type, see *Table 46, Position or Velocity Type* on *Page 232*	Enum	4	H+8
5	nav type	Navigation data type (see *Table 66, Navigation Data Type* on *Page 339*).	Enum	4	H+12
6	distance	Straight line horizontal distance from current position to the destination waypoint, in meters (see *Figure* on *Page 339).* 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 meters. 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 meters. 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 week number at time of arrival at the "TO" waypoint along track arrival perpendicular based on current position and speed, in units of GPS 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 Page 342

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)	-	-	-

3.3.49 NMEA Standard Logs *V123_NMEA*

GLMLA	**GLONASS ALMANAC DATA**
GPALM	**ALMANAC DATA**
GPGGA	**GLOBAL POSITION SYSTEM FIX DATA AND UNDULATION**
GPGGALONG	**GPS FIX DATA, EXTRA PRECISION AND UNDULATION**
GPGGARTK	**GPS FIX DATA**
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, see the appendix on *Standards and References* in the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm. 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 usage box that applies to all NMEA logs on *Page 291*.

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.

3.3.50 OMNIHPPOS OmniSTAR HP/XP Position *V3_HP*

Outputs L-band Extra Performance (XP) or High Performance (HP) position information.

In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Installation and Operation Manual*.

Message ID: 495
Log Type: Synch

Recommended Input:

log omnihpposa ontime 1

ASCII Example:

```
#OMNIHPPOSA,COM1,0,67.5,FINESTEERING,1419,320435.000,00000000,808d,2724;
SOL_COMPUTED,OMNISTAR_HP,51.11635489609,-114.03819540112,1063.8314,-16.2713,
WGS84,0.1258,0.2135,0.2342,"1000",8.000,0.000,13,10,10,10,0,00,0,03*e8510806
```

OmniSTAR HP/XP service is particularly useful for agricultural machine guidance and many surveying tasks. It operates in real time, and without the need for local Base Stations or telemetry links. It usually has a 2-sigma (95%) horizontal error under 10 centimeters and a 99% horizontal error of less than 15 centimeters.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	OMNIHPPOS header	Log header		H	0
2	sol status	Solution status, see *Table 47* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46* on *Page 232*	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 21, Datum Transformation Parameters* on *Page 94*)	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	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+66
18	#multi	Number of multi frequency observations in solution	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status	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 48* on *Page 234*)	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

3.3.51 OMNIVIS Omnistar Satellite Visibility List *V3_HP or V13_VBS*

This log contains OmniSTAR satellite and visibility information.

For local OmniSTAR beams, the satellite with the smallest local ellipsoid distance is the best one to use. For global beams, the satellite with the highest elevation is the best one. See also the *Usage Box* below.

Message ID: 860
Log Type: Synch

Recommended Input:

log omnivisa ontime 1

```
#OMNIVISA,COM1,0,60.5,FINESTEERING,1419,396070.000,00000020,0041,2710;
TRUE,8,
10,0,"MSVW_",0,0.000,1536782000,1200,c685,-1.16,-90.00,
11,0,"MSVC_",0,0.000,1534741000,1200,c685,8.28,-90.00,
12,0,"MSVE_",0,0.000,1530359000,1200,c685,22.97,-90.00,
8,0,"AMSAT",0,0.000,1535137500,1200,c685,34.87,31.09,
7,0,"EASAT",0,0.000,1535152500,1200,c685,91.01,-41.76,
3,0,"AFSAT",0,0.000,1535080000,1200,c685,110.73,-41.76,
4,0,"APSAT",0,0.000,1535137500,1200,2873,185.25,-40.66,
13,0,"OCSAT",0,0.000,1535185000,1200,2873,235.91,-18.57*b35c9cdf
```

ASCII Example 2:

```
#OMNIVISA,COM1,0,62.5,FINESTEERING,1419,334202.000,00000020,0041,2710;
FALSE,0*9e0f9078
```

Local Beams:	When the value is negative, the user is inside the local beam footprint and a signal should be available. Beams with small positive values may be available but their availability is not guaranteed.
Global Beams:	Any beams above 0 degrees are visible, however the tracking may be marginal for elevations less than 10 degrees.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	OMNIVIS header	Log header		H	0
2	valid	Is the list of satellites valid? 0 = FALSE 1 = TRUE	Bool	4	H
3	#recs	Number of records to follow	Ulong	4	H+4
4	link ID	Satellite link ID	Uchar	1	H+8
5	app flag	Time of applicability flag: 0 = Valid Now 1 = Invalid 2 = Valid Until 3 = Valid After 4-7 = Reserved	Uchar	1	H+9
6	sat name	Satellite name	String	6	H+10
7	app week	Time of applicability week	Ulong	4	H+16
8	app sec	Time of applicability (s into the week)	Ulong	4	H+20
9	freq	Satellite broadcast frequency (Hz)	Ulong	4	H+28
10	bit rate	Satellite data bit rate	Ushort	2	H+32
11	service id	Satellite service ID	Hex	2	H+34
12	ellip dist	Local ellipsoid distance parameter	Float	4	H+36
13	global elev	Global beam elevation (degrees)	Float	4	H+40
14	Next port offset = H + 8 + (#recs x 32)				
15	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+8+ (#recs x 32)
16	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.52 PASSCOM, PASSXCOM, PASSAUX, PASSUSB Redirect Data *V123*

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 bi-directional communications with other devices such as a modem, terminal or another receiver. See also the *INTERFACEMODE* command on *Page 130*.

There are several pass-through logs. PASSCOM1, PASSCOM2, PASSCOM3, PASSXCOM1, PASSXCOM2, PASSXCOM3 and PASSAUX allow for redirection of data that is arriving at COM1, COM2, COM3, virtual COM1, virtual COM2 or AUX, respectively. The AUX port is available on OEMV-2-based and OEMV-3-based products. 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, COM3, AUX, 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 weeks and seconds.

PASSCOM1 Message ID:233

PASSCOM2 Message ID:234

PASSCOM3 Message ID:235

PASSXCOM1 Message ID: 405

PASSXCOM2 Message ID: 406

PASSXCOM3 Message ID: 795

PASSUSB1 Message ID: 607

PASSUSB2 Message ID: 608

PASSUSB3 Message ID: 609

PASSAUX Message ID: 690

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:

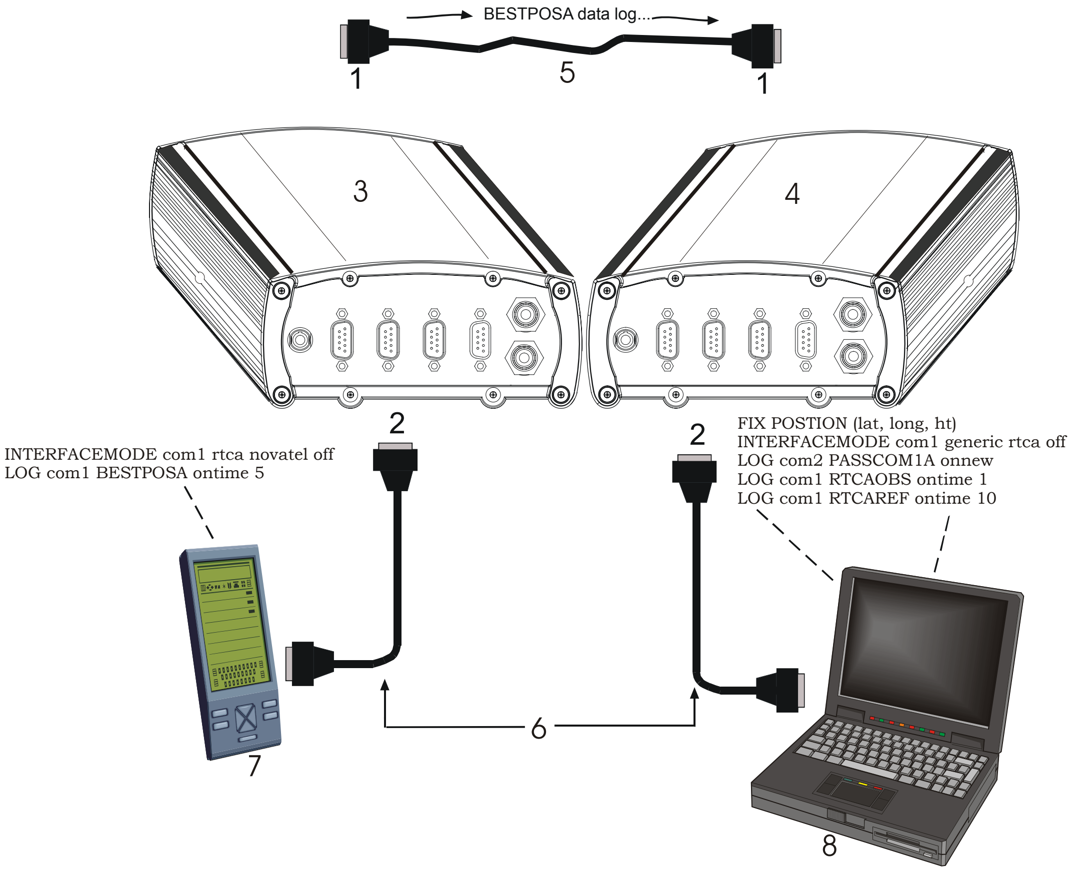
```
#PASSCOM2A,COM1,0,59.5,FINESTEERING,1337,400920.135,00000000,2b46,1984;
80,#BESTPOSA,COM3,0,80.0,FINESTEERING,1337,400920.000,00000000,4ca6,1899;
SOL_COMPUT*f9dfab46
#PASSCOM2A,COM1,0,64.0,FINESTEERING,1337,400920.201,00000000,2b46,1984;
80,ED,SINGLE,51.11636326036,-114.03824210485,1062.6015,-16.2713,WGS84,
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 OEMV family 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 12: 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>.

Note that the time interval between the first character received and the terminating <LF> can be calculated by differencing the two GPS 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 130*.

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)	-	-	-

3.3.53 PORTSTATS Port Statistics *V123*

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,
COM3,0,1,0,0,0,0,0,0,0,
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 16, COM Serial Port Identifiers* on *Page 83*	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)	-	-	-

3.3.54 PSRDOP Pseudorange DOP *V123*

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.

1. 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
2. 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)	-	-	-

3.3.55 PSRPOS Pseudorange Position *V123*

This log contains the pseudorange position 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 1 to 5 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 47, Solution Status* on *Page 233*)	Enum	4	H
3	pos type	Position type (see *Table 46, Position or Velocity Type* on *Page 232*)	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 21, Datum Transformation Parameters* on *Page 94*)	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 49, Extended Solution Status* on *Page 234*)	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 48* on *Page 234*)	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

3.3.56 PSRTIME Time Offsets from the Pseudorange Filter *V123*

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	NavigationSystem 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)	-	-	-

3.3.57 PSRVEL Pseudorange Velocity *V123*

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. See also the table footnote for velocity logs on *Page 208*.

All velocities from the pseudorange filter are calculated from the doppler. The instantaneous doppler velocity includes velocity types of DOPPLER_VELOCITY, PSRDIFF, OMNISTAR, WAAS, or CDGPS when the position type is SINGLE.

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: **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 centre. The control centre's coordinates are known but the vehicles are on the move. Using the control centre'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 47, Solution Status* on *Page 233*	Enum	4	H
3	vel type	Velocity type, see *Table 46, Position or Velocity Type* on *Page 232*	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 meters 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 meters 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)	-	-	-

3.3.58 PSRXYZ Pseudorange Cartesian Position and Velocity *V123*

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 10, Page 245* 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 47, Solution Status* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46, Position or Velocity Type* on *Page 232*	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 47, Solution Status* on *Page 233*	Enum	4	H+44
11	vel type	Velocity type, see *Table 46, Position or Velocity Type* on *Page 232*	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 Page 364

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 49, Extended Solution Status* on *Page 234*)	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 48* on *Page 234*)	Hex	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.59 RANGE Satellite Range Information *V123*

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.

If both the L1 and L2 signals are being tracked for a given PRN, two entries with the same PRN appear in the range logs. As shown in *Table 70, Channel Tracking Status* on *Page 368*, these entries can be differentiated by bit 20, which is set if there are multiple observables for a given PRN, and bits 21-22, which denotes whether the observation is for L1 or L2. This is to aid in parsing the data.

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,
6,0,23359926.375,0.167,-95654966.812027,0.019,-2757.355,36.7,19960.461,
01309c0b,
21,0,20200269.147,0.038,-106153137.954409,0.008,-86.289,49.5,13397.470,
08109c44,
21,0,20200268.815,0.056,-82716721.366921,0.008,-67.242,46.1,13391.980,
01309c4b,
16,0,23945650.428,0.091,-125835245.287192,0.024,-2385.422,41.9,10864.640,
08109c64,
16,0,23945651.399,0.148,-98053428.283142,0.028,-1858.773,37.7,10859.980,
01309c6b,
.
.
.
44,12,19388129.378,0.335,-103786179.553598,0.012,975.676,36.6,3726.656,
18119e24,
44,12,19388136.659,0.167,-80722615.862096,0.000,758.859,42.7,3714.860,
10b19e2b,
43,8,20375687.399,0.253,-108919708.904476,0.012,-2781.090,39.1,10629.934,
18119e84,
43,8,20375689.555,0.177,-84715349.232514,0.000,-2163.074,42.2,10619.916,
10b19e8b*fd2d3125
```

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 to the question 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 one base receiver at a known location and one or more rover receivers at unknown locations. As the position of the base receiver is accurately known, we can determine the extent of the error that is present in GPS at any given instant. This can be performed by either of the two methods previously described. We counter the effects of a number of biases present in GPS including: ionospheric and tropospheric errors, ephemeris errors, and receiver and satellite clock errors.

You could choose either method depending on your application and the accuracy required.

Table 67: Tracking State

State	Description	State	Description
0	L1 Idle	7	L1 Frequency-lock loop
1	L1 Sky search	8	L2 Idle
2	L1 Wide frequency band pull-in	9	L2 P-code alignment
3	L1 Narrow frequency band pull-in	10	L2 Search
4	L1 Phase lock loop	11	L2 Phase lock loop
5	L1 Reacquisition	19	L2 Steering
6	L1 Steering		

Table 68: 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 69: Channel Tracking Example

	N7				N6				N5				N4			
0x	0				8				1				0			
Bit #	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Binary[a]	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Data	Chan. Assignment	Reserved (R)			Primary L1	R	Signal Type					Grouping	R	Satellite System		
Value	Automatic				Primary		L1 C/A					Grouped		GPS		

	N3				N2				N1				N0			
0x	9				C				0				4			
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary[a]	1	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0
Data	Correlator Spacing			Code locked flag	Parity flag	Phase lock flag	Channel Number					Tracking State				
Value	PAC			Locked	Known	Locked	Channel 0					L1 Phase Lock Loop				

a. For a complete list of hexadecimal and binary equivalents please refer to the appendix on *Unit Conversion* in the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

Table 70: Channel Tracking Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Tracking state	0-11, see *Table 67, Tracking State* on *Page 367*
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010		
	5	0x00000020	SV channel number	0-n (0 = first, n = last) n depends on the receiver
	6	0x00000040		
	7	0x00000080		
N2	8	0x00000100		
	9	0x00000200		
	10	0x00000400	Phase lock flag	0 = Not locked, 1 = Locked
	11	0x00000800	Parity known flag	0 = Not known, 1 = Known
N3	12	0x00001000	Code locked flag	0 = Not locked, 1 = Locked
	13	0x00002000	Correlator type	0-7, see *Table 68, Correlator Type* on *Page 367*
	14	0x00004000		
	15	0x00008000		
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	Grouping [a]	0 = Not grouped, 1 = Grouped
	21	0x00200000	Signal type	Dependant on satellite system above: GPS: 0 = L1 C/A 5 = L2 P 9 = L2 P codeless 17 = L2C GLONASS: 0 = L1 C/A 4 = L1 P 5 = L2 P SBAS: 0 = L1 C/A Other: 19 = OmniSTAR 23 = CDGPS
	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

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Nibble #	Bit #	Mask	Description	Range Value
N7	28	0x10000000	Carrier phase measurement [b]	0 = Half Cycle Not Added, 1 = Half Cycle Added
	29	Reserved		
	30	0x40000000	PRN lock flag [c]	0 = PRN Not Locked Out,
	31	0x80000000	Channel assignment	0 = Automatic, 1 = Forced

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

b. This bit is zero until the parity is known and the parity known flag (bit 11) is set to 1.

c. A PRN can be locked out using the LOCKOUT command, see also *Page 134*.

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 [a]	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 *70, Channel Tracking Status* on *Page 368* and the example in *Table 69*)	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)	-	-	-

a. Satellite PRNs may have two lines of observations, one for the L1 frequency and the other for L2.

3.3.60 RANGECMP Compressed Version of the RANGE Log *V123*

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,
0b9c3001225bf58f334a130bb1e2bed473062fa609020000,
449c1008340400e0aaa9a109a7535bac2015cf71c6030000,
4b9c300145030010a6a9a10959c2f09120151f7166030000,
...
0b9d301113c8ffefc284000c6ea051dbf3089da1a0010000,
249d1018c6b7f67fa228820af2e5e39830180ae1a8030000,
2b9d301165c4f8ffb228820a500a089f31185fe0a8020000,
449d1018be18f41f2aacad0a1a934efc40074ecf88030000,
4b9d301182b9f69f38acad0a3e3ac28841079fcb88020000,
849d101817a1f95f16d7af0a69fbe1fa401d3fd064030000,
8b9d30112909fb2f20d7af0a9f24a687521ddece64020000,
249e1118af4e0470f66d4309a0a631cd642cf5b821320000,
2b9eb110a55903502f6e4309ee28d1ad032c7cb7e1320000,
849e1118b878f54f4ed2aa098c35558a532bde1765220000,
8b9eb110abcff71f5ed2aa09cb6ad0f9032b9d16c5220000*0eeead18
```

Consider the case where commercial vehicles are leaving a control centre. The control centre's coordinates are known but the vehicles are on the move. Using the control centre'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. OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also www.novatel.com for details.

Table 71: Range Record Format (RANGECMP only)

Data	Bit(s) first to last	Length (bits)	Scale Factor	Units
Channel Tracking Status	0-31	32	see *Table 70, Channel Tracking Status* on *Page 368*	-
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 [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 and L2 carrier waves at a satellite-specific frequency, refer to the GPS+ Reference Manual for more details 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. Lock time rolls over after 2,097,151 seconds.

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 71* on *Page 371*	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)	-	-	-

3.3.61 RANGEGPSL1 L1 Version of the RANGE Log *V123*

This log is identical to the RANGE log, see *Page 365,* except that it only includes L1 GPS observations.

Message ID: **631**

Log Type: **Synch**

Recommended Input:

log rangegpsl1a ontime 30

ASCII Example:

```
#RANGEGPSL1A,COM1,0,57.0,FINESTEERING,1337,404766.000,00000000,5862,1984;
10,
14,0,21773427.400,0.037,-114420590.433332,0.006,-2408.171,49.9,14963.280,
18109c04,
22,0,24822942.668,0.045,-130445851.055756,0.009,-3440.031,48.0,22312.971,
08109c24,
25,0,20831000.299,0.033,-109468139.214586,0.006,1096.876,50.7,7887.840,
08109c44,
1,0,20401022.863,0.032,-107208568.887106,0.006,-429.690,51.1,10791.500,
18109c64,
24,0,23988223.932,0.074,-126058964.619453,0.013,2519.418,43.8,493.550,
18109c84,
11,0,22154466.593,0.043,-116423014.826717,0.007,-1661.273,48.4,11020.952,
08109ca4,
5,0,24322401.516,0.067,-127815012.260616,0.012,-1363.596,44.6,6360.282,
18109cc4,
20,0,22294469.347,0.043,-117158267.467388,0.008,2896.813,48.5,4635.968,
08109ce4,
30,0,23267589.649,0.051,-122271969.418761,0.009,822.194,47.0,4542.270,
08109d04,
23,0,24975654.673,0.058,-131247903.805678,0.009,3395.097,45.9,406.762,
18109d24*be4b7d70
```

Since the RANGEGPSL1 log includes only L1 GPS observations, it is smaller in size than the RANGE log which contain entries for both L1 and L2. Use the RANGEGPSL1 log when data throughput is limited and you are only interested in GPS L1 range data. For L1 only models, RANGE and RANGEGPSL1 logs are identical.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RANGEGPSL1 header	Log header		H	0
2	# obs	Number of L1 observations with information to follow	Long	4	H
3	PRN	Satellite PRN number of range measurement (GPS: 1 to 32)	UShort	2	H+4
4	Reserved		UShort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	psr std	Pseudorange measurement standard deviation (m)	Float	4	H+16
7	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+20
8	adr std	Estimated carrier phase standard deviation (cycles)	Float	4	H+28
9	dopp	Instantaneous carrier Doppler frequency (Hz)	Float	4	H+32
10	C/No	Carrier to noise density ratio C/No = $10[\log_{10}(S/N_0)]$ (dB-Hz)	Float	4	H+36
11	locktime	Number of seconds of continuous tracking (no cycle slipping)	Float	4	H+40
12	ch-tr-status	Tracking status (see *70, Channel Tracking Status* on *Page 368*)	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)	-	-	-

3.3.62 RAWALM Raw Almanac Data *V123*

This log contains the undecoded almanac subframes as received from the satellite. For more information on Almanac data, refer to the GPS SPS Signal Specification (refer to the *Standards and References* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

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
```

The OEMV family of receivers automatically saves 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, see ARINC in the *Standards/References* appendix in the *GPS+ Reference Manual*.

3.3.63 RAWEPHEM Raw Ephemeris *V123*

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 1 to 5 meter accuracy 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/GPS/GPS.html

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)	-	-	-

3.3.64 RAWGPSSUBFRAME Raw Subframe Data V123

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
,4,8b04e483f3b17ee037a3732fe0fc8ccf074303ebdf2f6505f5aaaaaaaa9,2*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

3.3.65 RAWGPSWORD Raw Navigation Word *V123*

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 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)	-	-	-

3.3.66 RAWLBANDFRAME Raw L-band Frame Data *V13_CDGPS*

This log contains the raw L-band frame data if you are tracking CDGPS. The RAWLBANDPACKET is output for OmniSTAR tracking.

1. In addition to a NovAtel receiver with L-band capability, use of the free CDGPS service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
2. Please use the RAWLBANDPACKET log for raw OmniSTAR frame data, see *Page 384*.

Message ID: **732**

Log Type: **Asynch**

Recommended Input:

log rawlbandframea onnew

ASCII Example:

```
#RAWLBANDFRAMEA,COM2,0,73.5,FINESTEERING,1295,152802.068,00000040,4f80,34461;
9,1a1e,600,f6,00,62,35,c8,cd,34,e7,6a,a1,37,44,8f,a8,24,71,90,d0,5f,94,2d,94,
3c,74,9c,f0,12,a3,4c,a7,30,aa,b6,2e,27,dd,dc,24,ba,d3,76,8d,76,d9,e7,83,1a,c8
,81,b0,62,1c,69,88,23,70,2a,06,c0,fc,f8,80,2c,72,f1,2e,6b,c2,5b,ec,03,70,d3,f
3,fe,ef,37,3d,17,37,1b,cf,be,af,d1,02,15,96,d1,f6,58,56,ac,bd,a3,11,12,d0,3d,
11,27,8a,87,28,0c,0f,52,70,b3,2f,0c,0c,62,2d,b8,69,6c,52,10,df,7d,bb,08,d6,ca
,a9,5e,77,66,96,c2,a0,63,3b,98,34,bc,d5,47,64,e0,00,37,10,4a,f7,c1,b6,83,8f,0
6,94,21,ff,b4,27,15,b0,60,40,02,b4,af,9c,9d,c2,d4,ea,95,68,86,0f,0a,9d,2d,36,
52,68,65,b8,a2,0b,00,21,80,64,8a,72,ff,59,b7,79,b9,49,fd,f5,3c,48,1c,2f,77,f1
,b2,9e,58,0a,81,05,1f,00,7b,00,1e,68,c9,a3,12,56,b8,2a,32,df,d9,ea,03,9b,16,c
6,17,2f,33,b3,5f,c4,f9,d2,97,75,64,06,52,a1,b2,3a,4b,69,e7,eb,0f,97,d3,e6,bf,
de,af,37,c6,10,13,9b,dc,c9,e3,22,80,78,3f,78,90,d5,9f,d3,5f,af,1f,7a,75,ef,77
,8e,de,ac,00,32,2e,79,fb,3f,65,f3,4f,28,77,b4,6d,f2,6f,31,24,b2,40,76,37,27,b
c,95,33,15,01,76,d5,f1,c4,75,16,e6,c6,ab,f2,fe,34,d9,c3,55,85,61,49,e6,a4,4e,
8b,2a,60,57,8a,e5,77,02,fc,9c,7d,d4,40,4c,1d,11,3c,9b,8e,c3,73,d3,3c,0d,ff,18
.
.
.
,7a,21,05,cb,12,f6,dd,c3,df,69,62,f5,70*3791693b
```

The data signal is structured to perform well in difficult, or foliated conditions, so the service is available more consistently and has a higher degree of service reliability.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWLBANDFRAME header	Log header		H	0
2	frame#	Frame number (maximum = 9)	Ushort	2	H+2
3	channelcode	10-bit channel code word	Ushort	2	H+4
4	data	Raw L-band frame data	Uchar[1200]	1200	H+6
5	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+1206
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.67 RAWLBANDPACKET Raw L-band Data Packet *V13_VBS or V3_HP*

This log contains the raw L-band packet data. The RAWLBANDPACKET log is only output for OmniSTAR tracking. If you are tracking CDGPS, only the RAWLBANDFRAME log is output.

In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.

Message ID: 733
Log Type: Asynch

Recommended Input:

log rawlbandpacketa onnew

ASCII Example:

```
#RAWLBANDPACKETA,COM2,0,77.0,FINESTEERING,1295,238642.610,01000040,c5b1,34461
;9,07,de,3a,f9,df,30,7b,0d,cb*7e5205a8
```

OmniSTAR currently has several high-powered satellites in use around the world. They provide coverage for most of the Earth's land areas. Subscriptions are sold by geographic area. Any regional OmniSTAR service center can sell and activate subscriptions for any area. They may be arranged prior to travelling to a new area, or after arrival. Contact OmniSTAR at www.omnistar.com for further details.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RAWLBANDPACKET header	Log header		H	0
2	#recs	Number of records to follow	Ulong	4	H
3	data	Raw L-band data packet.	Uchar[128]	128	H +4
4	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+128
5	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.68 RAWWAASFRAME Raw SBAS Frame Data *V123_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,
10,5328360984c80130644dc53800c004b124400000000000000000000000,29*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	RAAWWAASFRAME 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

3.3.69 REFSTATION Base Station Position and Health *V123_RT20 or V23_RT2*

This log contains the ECEF Cartesian position of the base station as received through the RTCM, RTCMV3, RTCA, or CMR message. It also features a time tag, the health status of the base station, and the station ID. This information is set at the base station using the FIX POSITION command and the DGPSTXID command. See *Figure 10, Page 245* for a definition of the ECEF coordinates.

The base station health, Field #6, may be one of 8 values (0 to 7). Values 0 through 5 indicate the scale factor that multiply satellite UDRE one-sigma differential error values. Below are values 0 to 5 and their corresponding UDRE scale factors:

0: 1 (Health OK) 1: 0.75 2: 0.5 3: 0.3 4: 0.2 5: 0.1

The base station health field only applies to RTCM base stations. A value of 6 means that the base station transmission is not monitored and a value of 7 means that the base station is not working.

Message ID: **175**

Log Type: **Asynch**

Recommended Input:

log refstationa onchanged

ASCII Example:

```
#REFSTATIONA,COM1,0,66.5,FINESTEERING,1364,490401.124,80000000,4e46,2310;
00000000,-1634532.443,-3664608.907,4942482.713,0,RTCA,"AAAA"*1e2a0508
```

Table 72: Base Station Status

Bit #	Mask	Description	Bit = 0	Bit = 1
0	0x00000001	Validity of the base station.	Valid	Invalid

Table 73: Base Station Type

Base Station Type (Binary)	(ASCII)	Description
0	NONE	Base station is not used
1	RTCM	Base station is RTCM
2	RTCA	Base station is RTCA
3	CMR	Base station is CMR
4	RTCMV3	Base station is RTCMV3

The REFSTATION log can be used for checking the operational status of a remotely located base station. You can verify that the base station is operating properly without travelling to it. This is especially useful for RTK work on long baselines.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	REFSTATION header	Log header		H	0
2	status	Status of the base station information (see *Table 72* below)	ULong	4	H
3	x	ECEF X value	Double	8	H+4
4	y	ECEF Y value	Double	8	H+12
5	z	ECEF Z value	Double	8	H+20
6	health	Base station health, see the 2nd paragraph on the previous page	Ulong	4	H+28
7	stn type	Base station type (see *Table 73, Base Station Type* on *Page 387*)	Enum	4	H+32
8	stn ID	Base station ID	Char[5]	8[a]	H+36
9	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
10	[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 RTCA Standard Logs *V123_DGPS*

RTCA1 DIFFERENTIAL GPS CORRECTIONS
Message ID: 10

RTCAEPHEM EPHEMERIS AND TIME INFORMATION
Message ID: 347

RTCAOBS BASE STATION OBSERVATIONS ***V123_RT20 or V23_RT2***
Message ID: 6

RTCAOBS2 BASE STATION OBSERVATIONS 2 ***V123_RT20 or V23_RT2***
Message ID: 805

RTCAREF BASE STATION PARAMETERS ***V123_RT20 or V23_RT2***
Message ID: 11

1. 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.
2. RTCADATA logs output the details of the above logs if they have been sent.

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]

NovAtel has defined four proprietary RTCA Standard Type 7 binary-format messages, RTCAOBS, RTCAOBS2, RTCAREF and RTCAEPHEM for base station transmissions. These can be used with either single or dual-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

RTCAREF and RTCAOBS, respectively, correspond to the RTCM Type 3 and Type 59 logs used in single-frequency-only measurements. Both are NovAtel-proprietary RTCA Standard Type 7 messages with an 'N' primary sub-label.

Refer to the *Receiving and Transmitting Corrections* section in the *OEMV Installation and Operation Manual* for more information on using these message formats for differential operation.

Input Example

1.For further information on RTCA Standard messages, you may wish to 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 interfacemode com2 none RTCA

fix position 51.1136 -114.0435 1059.4

log com2 rtcaobs ontime 1

log com2 rtcaobs2 ontime 1

log com2 rtcaref ontime 10

log com2 rtca1 ontime 5

log com2 rtcaephem ontime 10 1

3.3.71 RTCADATA1 Differential GPS Corrections *V123_DGPS*

See *Section 3.3.70* starting on *Page 389* for information on RTCA standard logs.

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 112*. The RTCA log is accepted by a receiver operating as a rover station over a COM port after an INTERFACEMODE *port* RTCA command is issued, see *Page 130*.

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 101* 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 99* 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 meters and ±4.049 m/s respectively. Any satellite which exceeds these limits are not included.

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
```

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. For GLONASS, see *Section 1.3* on *Page 26*.)	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

3.3.72 RTCADATAEPHEM Ephemeris and Time Information *V123_DGPS*

See *Section 3.3.70* starting on *Page 389* for information on 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 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), refer also to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual.*

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. Refer also to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual*.

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 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

3.3.73 RTCADATAOBS Base Station Observations *V123_RT20 or V23_RT2*

See *Section 3.3.70* starting on *Page 389* for information on RTCA standard logs.

RTCAOBS Type 7

An RTCAOBS (RTCA Base-Station Satellite Observations) message contains base station satellite observation information. It is used to provide range observations to the rover receiver, and should be sent every 1 or 2 seconds.

This log is made up of variable-length messages up to 255 bytes long. The maximum number of bits in this message is [140 + (92 x *N*)], where *N* is the maximum number of satellite record entries transmitted. Using the RTKSVENTRIES command, see *Page 168*, you can define *N* to be anywhere from 4 to 12; the default value is 12.

Message ID: **394**

Log Type: **Synch**

Recommended Input:

log rtcadataobsa ontime 2

ASCII Example:

```
#RTCADATAOBSA,COM1,0,47.0,FINESTEERING,1364,494469.000,00100000,9025,2310;
78,
1,2.027098600000000e+07,69.000000000,0,8,2,
3,3,4.000000000,-3.500000000,0.241999999,0.207000002,TRUE,180,
5,3,3,569234.000000000,-1.750000000,0.717999995,1.340999961,TRUE,180,
7,3,3,756774.600000000,-1.250000000,0.054000001,-0.119999997,TRUE,180,
30,3,3,445544.200000000,-1.250000000,0.140000001,0.344999999,TRUE,180,
4,3,3,1897221.200000000,-0.750000000,0.361999989,1.179000020,TRUE,180,
6,3,3,2883369.000000000,-0.500000000,-0.751999974,-1.922999978,TRUE,180,
10,3,3,2860119.800000000,-0.250000000,-0.546000004,-1.944000006,TRUE,
180,25,3,3,4734110.200000000,-0.750000000,0.474000007,2.013000011,
TRUE,180*dd9699f5
```

Transmission of the base station observations is necessary for the highest precision applications. The base station observations are used by the rover for carrier phase ambiguity resolution.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCADATAOBS header	Log header	-	H	0
2	des	NovAtel designator	Uchar	1	H
3	subtype	RTCA message subtype	Uchar	3 [a]	H+1
4	min psr	Minimum pseudorange	Double	8	H+4
5	sec	Seconds into the GPS week	Float	4	H+12
6	Reserved		Long	4	H+16
7	#ids	Number of Transmitter IDs with information to follow	Ulong	4	H+20
8	trans ID	Transmitter ID	Uchar	1	H+24
9	L1 lock	L1 lock flag	Uchar	1	H+25
10	L2 lock	L2 lock flag	Uchar	2 [b]	H+26
11	L1 psr	L1 pseudorange offset (2/10 m)	Double	8	H+28
12	L2 psr	L2 pseudorange offset (1/4 m)	Double	8	H+36
13	L1 ADR	L1 carrier phase offset, accumulated Doppler range (2/1000 m)	Float	4	H+44
14	L2 ADR	L2 carrier phase offset, accumulated Doppler range (3/1000 m)	Float	4	H+48
15	L2 encrypt	L2 not encrypted? 0 = FALSE 1 = TRUE	Enum	4	H+52
16	Reserved		Long	4	H+56
17...	Next id offset = H+24 + (#ids x 36)				
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 2 bytes of padding are added to maintain 4-byte alignment

b. In the binary log case, an additional 1 byte of padding is added to maintain 4-byte alignment

3.3.74 RTCADATA2OBS Base Station Observations 2 *V123_RT20 or V23_RT2*

See *Section 3.3.70* starting on *Page 389* for information on RTCA standard logs.

RTCAOBS2 Type 7

An RTCAOBS2 (RTCA Base-Station Satellite Observations subtype 2) message supports GPS, Glonass and L1/L2 RTK differential operation. It contains base station satellite observation information. It is used to provide range observations to the rover receiver, and should be sent every 1 or 2 seconds.

The RTCAOBS2 message is the same as the RTCAOBS message except for the determination of the L1 pseudorange offset for each transmitter. The L1 ADR, L2 PSR and L2 ADR are all calculated the same as RTCAOBS. Instead of determining the minimum pseudorange, as in RTCAOBS, RTCAOBS2 relies on a constellation specific nominal offset and the receiver GPS time bias. The nominal offset values for some different satellite types are shown in *Table 74* below.

Table 74: RTCAOBS2 Satellite Type Offsets

Satellite Type	Nominal Offset
GPS	23,000 km
Glonass	22,000 km
Pseudolite	0 km

Message ID: **808**
Log Type: **Synch**

Recommended Input:

log rtcadata2obsa ontime 2

ASCII Example:

```
#RTCADATA2OBSA,COM1,0,63.5,FINESTEERING,1416,508872.000,00140008,e0c5,2690;
78,3,0.000000000,72.000000000,0,13,
44,135,0,-2809276.000000000,-0.102000000,5.877472455e-39,0.000000000,TRUE,43,
21,131,0,-2763150.200000000,-0.016000000,5.877472455e-39,0.000000000,TRUE,19,
18,227,0,-2284827.400000000,0.090000000,5.877472455e-39,0.000000000,TRUE,84,
60,118,0,-1049837.400000000,0.074000000,5.877472455e-39,0.000000000,TRUE,201,
26,30,0,-1406884.400000000,0.062000000,5.877472455e-39,0.000000000,TRUE,184,
43,30,0,-984645.600000000,0.040000000,5.877472455e-39,0.000000000,TRUE,184,
22,217,0,-651966.600000000,-0.002000000,5.877472455e-39,0.000000000,TRUE,23,
24,0,0,-205779.800000000,0.070000000,5.877472455e-39,0.000000000,TRUE,0,
3,223,0,-407386.400000000,-0.048000000,5.877472455e-39,0.000000000,FALSE,60,
45,114,0,-53743.200000000,-0.088000000,5.877472455e-39,0.000000000,TRUE,176,
7,126,0,263919.200000000,-0.020000000,5.877472455e-39,0.000000000,TRUE,
250,6,34,0,1336444.200000000,-0.102000000,5.877472455e-39,0.000000000,
TRUE,209,
19,206,0,1943816.400000000,-0.048000000,5.877472455e-39,0.000000000,TRUE,217
*afe9ae2e
```

Transmission of the base station observations is necessary for the highest precision applications. The base station observations are used by the rover for carrier phase ambiguity resolution.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCADATA2-OBS header	Log header	-	H	0
2	des	NovAtel designator	Uchar	1	H
3	subtype	RTCA message subtype	Uchar	3 [a]	H+1
4	GPStimebias	Receiver GPS time bias	Double	8	H+4
5	sec	Seconds into the GPS week	Float	4	H+12
6	Reserved		Long	4	H+16
7	#ids	Number of Transmitter IDs with information to follow	Ulong	4	H+20
8	trans ID	Transmitter ID	Uchar	1	H+24
9	L1 lock	L1 lock flag	Uchar	1	H+25
10	L2 lock	L2 lock flag	Uchar	2 [b]	H+26
11	L1 psr	L1 pseudorange offset (2/10 m)	Double	8	H+28
12	L2 psr	L2 pseudorange offset (1/4 m)	Double	8	H+36
13	L1 ADR	L1 carrier phase offset, accumulated Doppler range (2/1000 m)	Float	4	H+44
14	L2 ADR	L2 carrier phase offset, accumulated Doppler range (3/1000 m)	Float	4	H+48
15	L2 encrypt	L2 not encrypted? 0 = FALSE 1 = TRUE	Enum	4	H+52
16	Reserved		Long	4	H+56
17...	Next id offset = H+24 + (#ids x 36)				
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 2 bytes of padding are added to maintain 4-byte alignment

b. In the binary log case, an additional 1 byte of padding is added to maintain 4-byte alignment

3.3.75 RTCADATAREF Base Station Parameters *V123_RT20 or V23_RT2*

See *Section 3.3.70* starting on *Page 389* for information on RTCA standard logs.

RTCAREF Type 7

An RTCAREF (RTCA Base Station Position Information) message contains base station position information, and should be sent once every 10 seconds. Each message is 24 bytes (192 bits) long.

If RTCA-format messaging is being used, the optional *station id* field that is entered using the DGPSTXID command, see *Page 102*, can be any 4-character string combining numbers and upper-case letters, and enclosed in double quotation marks (for example, "RW34"). The station ID is reported at the rover receiver, in its position log.

Message ID: **395**

Log Type: **Synch**

Recommended Input:

log rtcadatarefa ontime 10

ASCII Example:

```
#RTCADATAREFA,COM1,0,47.5,FINESTEERING,1364,494600.601,00100000,44de,2310;
78,0,-1634531.401490912,-3664616.874355976,4942495.215668959,0*646a495c
```

The rover receiver automatically sets an approximate position from the RTCADATAREF message if it does not already have a position. Therefore this message can be used in conjunction with an approximate time to improve TTFF. Refer to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual* for more information on TTFF.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCADATAREF header	Log header	-	H	0
2	des	NovAtel designator.	Uchar	1	H
3	subtype	RTCA message subtype	Uchar	3[a]	H+1
4	X pos	Base station X coordinate position (mm)	Double	8	H+4
5	Y pos	Base station Y coordinate position (mm)	Double	8	H+12
6	Z pos	Base station Z coordinate position (mm)	Double	8	H+20
7	Reserved		Uchar	4[b]	H+28
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+32
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

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

3.3.76 RTCM Standard Logs *DGPS*

RTCM1 DIFFERENTIAL GPS CORRECTIONS ***V123_DGPS***
Message ID: 107

RTCM3 BASE STATION PARAMETERS ***V123_RT20 or V23_RT2***
Message ID: 117

RTCM9 PARTIAL DIFFERENTIAL GPS CORRECTIONS ***V23_DGPS***
MESSAGE ID: 275 (OEMV-2 with external oscillator or OEMV-3)

RTCM15 IONOSPHERIC CORRECTIONS ***V123_DGPS***
Message ID: 307

RTCM16 SPECIAL MESSAGE ***V123_DGPS***
Message ID: 129

RTCM16T SPECIAL TEXT MESSAGE, see also *Page 183* ***V123_DGPS***
Message ID: 131

RTCM1819 RAW MEASUREMENTS ***V123_RT20 or V23_RT2***
Message ID: 260

RTCM2021 MEASUREMENT CORRECTIONS ***V123_RT20 or V23_RT2***
Message ID: 374

RTCM22 EXTENDED BASE STATION ***V123_RT20 or V23_RT2***
Message ID: 118

RTCM23 ANTENNA TYPE DEFINITION ***V123_RT20 or V23_RT2***
Message ID: 665

RTCM24 ANTENNA REFERENCE POINT (ARP) ***V123_RT20 or V23_RT2***
Message ID: 667

RTCM31 DIFFERENTIAL GLONASS ***V1G23_G and V123_RT20 or V23_RT2***
Message ID: 864

RTCM32 GLONASS BASE PARAMETERS ***V1G23_G and V123_RT20 or V23_RT2***
Message ID: 873

RTCM36 SPECIAL EXTENDED MESSAGE ***V1G23_G***
Message ID: 875

RTCM36T SPECIAL EXTENDED MESSAGE, see also *Page 184* ***V1G23_G***
Message ID: 877

RTCM59 TYPE 59N-0 PROPRIETARY DIFFERENTIAL ***V123_RT20 or V23_RT2***
Message ID: 116

RTCM59GLO PROPRIETARY GLONASS DIFFERENTIAL ***V1G23_G and V123_DGPS***
Message ID: 903

1. 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.
2. RTCMDATA logs output the details of the above logs if they have been sent.

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 *OEMV Installation and Operation Manual* for more information on 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 *Standards/References* section of the *GPS+ Reference Manual* for reference information.

RTCM SC-104[1] Type 3 & 59 messages can be used for base station transmissions in differential systems. However, since these messages do not include information on the L2 component of the GPS signal, they cannot be used with RT-2 positioning. Regardless of whether single or dual-frequency receivers are used, the RT-20 positioning algorithm is used. This is for a system in which both the base and rover stations utilize NovAtel receivers.

Note that 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.

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, 3, 9, 16, 18, 19, 22, 31, 32 and 36 messages are known as the RTCM1, RTCM3, RTCM9, RTCM16, RTCM18, RTCM19, RTCM22, RTCM23, RTCM24, RTCM31, RTCM32 and RTCM36 logs, respectively, while Type 59N-0 messages are listed in the RTCM59 log.

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.

1. For further information on RTCM SC-104 messages, you may wish to refer to:

   RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.3

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

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
fix position 51.1136 -114.0435 1059.4
log com2 rtcm3 ontime 10
log com2 rtcm22 ontime 10 1
log com2 rtcm1819 ontime 1
log com2 rtcm31 ontime 2
log com2 rtcm32 ontime 2
log com2 rtcm1 ontime 5
```

3.3.77 RTCMDATA1 Differential GPS Corrections *V123_DGPS*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

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 its INTERFACEMODE command set. Refer to the *Receiving and Transmitting Corrections* section in the *OEMV Installation and Operation Manual* for more information on 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 99*. After the time out, the base station begins to transmit the Type 1 messages based on the new ephemeris.

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
```

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, see *REFSTATION on Page 387*	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. For GLONASS, see *Section 1.3* on *Page 26*.)	Ulong	4	H+36
12	psr corr	Scaled pseudorange correction (meters)	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)	-	-	-

3.3.78 RTCMDATA3 Base Station Parameters *V123_RT20 or V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM3 Base Station Parameters (RTK)

This log contains the GPS position of the base station expressed in rectangular ECEF coordinates based on the center of the WGS-84 ellipsoid. It follows the RTCM SC-104 Standard for a Type 3 message. This log uses four RTCM data words following the two-word header, for a total frame length of six 30-bit words (180 bits maximum). This message must be sent at least once every 30 seconds, although it is recommended that it is sent once every 10 seconds.

Also, the rover receiver automatically sets an approximate position from this message if it does not already have a position. Therefore, this message can be used in conjunction with an approximate time to improve TTFF, refer to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual.*

Structure:

Type 3 messages contain the following information:

- Scale factor
- ECEF X-coordinate
- ECEF Y-coordinate
- ECEF Z-coordinate

The receiver only transmits the RTCM Type 3 when the position is fixed by the FIX POSITION command, see *Page 112*.

This log is intended for use when operating in RTK mode.

Message ID: **402**
Log Type: **Synch**

Recommended Input:

log rtcmdata3a ontime 10

ASCII Example:

```
#RTCMDATA3A,COM1,0,72.0,FINESTEERING,1420,506793.276,00180020,61e6,1899;
3,0,4655,0,0,6,-163496421.7426230311393738,-366468552.3169214129447937,
494229879.5281358957290649*0f343499
```

Use this log to see what base station information is being received by your rover receivers.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA3 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, see *REFSTATION* on *Page 387*	Ulong	4	H+20
8	ECEF-X	Base station ECEF X-coordinate (1/100 m)	Double	8	H+24
9	ECEF-Y	Base station ECEF Y-coordinate (1/100 m)	Double	8	H+32
10	ECEF-Z	Base station ECEF Z-coordinate (1/100 m)	Double	8	H+40
11	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.79 RTCMDATA9 Partial Differential GPS Corrections *V23_DGPS*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs. This log is the same as the RTCMDATA1 log but there are only corrections for a maximum of 3 satellites.

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 Type 9 corrections with an OEMV-2 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. Only OEMV-2 receivers with an external oscillator or OEMV-3 receivers, with or without an external oscillator, can generate Type 9 messages. All OEMV family receivers can accept Type 9 messages.

NovAtel recommends a high-stability clock such as the PIEZO Model 2900082 whose 2-sample (Allan) variance meets the following stability requirements:

3.24×10^{-24} s^2/s^2 between 0.5 - 2.0 seconds, and

1.69×10^{-22} T s^2/s^2 between 2.0 - 100.0 seconds

An external clock, such as an OCXO, requires approximately 10 minutes to warm up and become fully stabilized after power is applied. Do not broadcast RTCM Type 9 corrections during this warm-up period.

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)

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
```

A base station transmitting RTCM Type 9 corrections 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.

NovAtel recommends a high-stability clock such as a PIEZO model whose 2-sample (Allan) variance meets the following stability requirements:

- 3.24×10^{-24} s^2/s^2 between 0.5 - 2.0 seconds

and

- 1.69×10^{-22} T s^2/s^2 between 2.0 - 100.0 seconds

An external clock such as an OCXO requires approximately 10 minutes to warm up and become fully stabilized after power is applied. Do not broadcast RTCM Type 9 corrections during this warm-up period. See also the EXTERNALCLOCK command on *Page 109*.

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, see *REFSTATION on Page 387*	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)	-	-	-

3.3.80 RTCMDATA15 Ionospheric Corrections *V123_DGPS*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM15 Ionospheric Corrections

RTCM Type 15 messages are designed to support the broadcast of ionospheric delay and rate of change measurements for each satellite as determined by the base station receiver. This message is used to improve the ionospheric de-correlation that would otherwise be experienced by a rover at a long distance from the base station. This log is designed to work 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 are designed to enable the rover to continuously remove the ionospheric component from received pseudorange corrections. The delay and rate terms are added exactly like Type 1 corrections to provide the total ionospheric delay at a given time, and the total ionospheric delay 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 and have the INTERFACEMODE command set before the data can be correctly logged. You must also log the RTCM Type 1 corrections. See *Pages 112* and *130* respectively.

When operating as a rover station, the receiver COM port receiving the RTCM data must have its INTERFACEMODE command set.

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
```

The RTCMDATA15 message provides data that enables you to continually remove the ionosphere components from received pseudorange corrections. The *ion rate* and *ion delay* fields can be added just like Type 1 corrections to provide an "iono-free" data collection.

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, see *REFSTATION on Page 387*	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: 1-32 and SBAS: 120 to 138. For GLONASS, see *Section 1.3* on *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)	-	-	-

3.3.81 RTCMDATA16 Special Message *V123_DGPS*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM16 Special Message

This log contains a special ASCII message that can be displayed on a printer or cathode ray tube. The base station wishing to log this message out to rover stations that are logged onto a computer, must use the SETRTCM16T command to set the required ASCII text message. 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 497*. The received ASCII text can be displayed at the rover by logging RTCM16T ONNEW.

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 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
```

Message Type 16 is a special ASCII message capable of being displayed on a printer or CRT. 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, see *REFSTATION on Page 387*	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

3.3.82 RTCMDATA1819 Raw Measurements *V123_RT20 or V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM18 and RTCM19 Raw Measurements (RTK)

RTCM18 provides uncorrected carrier phase measurements and RTCM19 provides uncorrected pseudorange measurements. The measurements are not corrected by the ephemerides contained in the satellite message.

The messages have similar formats. Word 3, the first data word after the header, contains a GPS TIME OF MEASUREMENT field which is used to increase the resolution of the MODIFIED Z-COUNT in the header. Word 3 is followed by pairs of words containing the data for each satellite observed. Appropriate flags are provided to indicate L1 C/A or P-code **or** L2 cross correlated or P-code measurements. The carrier smoothing interval for pseudoranges and pseudorange corrections is also furnished, for a total frame length of six 30 bit words (180 bits maximum).

RTCM18 and RTCM19 messages follow the RTCM SC-104 Standard for Type 18 and Type 19 messages.

For RTK, you may periodically transmit a set of RTCM Type 18 and RTCM Type 19 together with an RTCM Type 3 message and an RTCM Type 22 message.

Message ID: **399**

Log Type: **Synch**

Recommended Input:

log rtcmdata1819a ontime 2

ASCII Example:

```
#RTCMDATA1819A,COM1,1,80.0,FINESTEERING,1415,317696.000,00140040,f337,2616;
18,1000,1493,0,0,6,
2,0,200000,5,
1,1,0,2,0,1,7017922,
1,1,0,30,0,1,12485535,
1,1,0,4,0,1,-8421345,
1,1,0,5,0,1,4072787,
1,1,0,12,0,1,3227209,
19,1000,1493,0,0,6,
2,0,200000,5,
1,1,0,2,2,3,1025891090,
1,1,0,30,2,3,1098334724,
1,1,0,4,2,3,1051480779,
1,1,0,5,2,3,1028271427,
1,1,0,12,2,3,1029484966*dce6f781
```

RTCMDATA1819 and RTCM2021 logs contain data useful for surveying and highly accurate positioning and/or navigation.

This data provides support for RTK applications using real-time interferometric techniques to resolve integer ambiguities. (An interferometer is, in aerospace for example, an instrument that utilizes the interference of waves for precise determinations.)

RTCM Message Type 18 provides carrier phase measurements, while RTCM Message Type 19 provides pseudorange measurements.

RTCM Message Types 20 and 21 contain the same data as Types 18 and 19 except that the values of Types 20 and 21 are corrected by the ephemerides contained in the satellite message.

Table 75: RTCM1819 Data Quality Indicator

Code	Pseudorange Error
0	≤ 0.020 m
1	≤ 0.030 m
2	≤ 0.045 m
3	≤ 0.066 m
4	≤ 0.099 m
5	≤ 0.148 m
6	≤ 0.220 m
7	≤ 0.329 m
8	≤ 0.491 m
9	≤ 0.732 m
10	≤ 1.092 m
11	≤ 1.629 m
12	≤ 2.430 m
13	≤ 3.625 m
14	≤ 5.409 m
15	> 5.409 m

Table 76: RTCM1819 Smoothing Interval

Code	Smoothing Interval (Minutes)
0	0 to 1
1	1 to 5
2	5 to 15
3	Undefined smoothing interval

Table 77: RTCM1819 Multipath Indicator

Code	Multipath Error
0	≤ 0.100 m
1	≤ 0.149 m
2	≤ 0.223 m
3	≤ 0.332 m
4	≤ 0.495 m
5	≤ 0.739 m
6	≤ 1.102 m
7	≤ 1.644 m
8	≤ 2.453 m
9	≤ 3.660 m
10	≤ 5.460 m
11	≤ 8.145 m
12	≤ 12.151 m
13	≤ 18.127 m
14	> 18.127 m
15	Undetermined multipath

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA-1819 header	Log header	-	H	0
2	RTCM header (for RTCM18)	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, see *REFSTATION on Page 387*	Ulong	4	H+20
8	freq	Frequency indicator where 0 = L1 2 = L2 (1 is reserved for future use)	Ulong	4	H+24
9	Reserved		Ulong	4	H+28
10	GNSS time	Global Navigation Satellite System (GNSS) time of measurement (microseconds)	Long	4	H+32
11	#obs	Number of observations with information to follow	Long	4	H+36
12	multi bit	Multiple message indicator	Ulong	4	H+40
13	code	Is code P Code? 0 = FALSE 1 = TRUE	Ulong	4	H+44
14	sat type	Satellite type 0 = GPS 1 = GLONASS	Ulong	4	H+48
15	PRN/slot	PRN number for GPS satellites (satellite number 32 is indicated by 0); slot number for GLONASS satellites, see also *Section 1.3* on *Page 26*.	Ulong	4	H+52
16	quality	Data quality indicator, see *Table 75, RTCM1819 Data Quality Indicator* on *Page 418*	Ulong	4	H+56
17	continuity	Cumulative loss of continuity indicator with a loss of lock counter	Ulong	4	H+60
18	phase	Carrier phase (1/256 cycles)	Long	4	H+64

Continued on Page 421

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
19...	Next RTCM18 observation offset = H+40 + (#obs x 28)				
variable	RTCM header (for RTCM19)	RTCM message type	Ulong	4	variable
		Base station ID	Ulong	4	
		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris	Ulong	4	
		Sequence number	Ulong	4	
		Length of frame	Ulong	4	
		Base station health, see *REFSTATION on Page 387*	Ulong	4	
variable	freq	Frequency indicator where 0 = L1 2 = L2 (1 is reserved for future use)	Ulong	4	variable
	smooth	Smoothing interval, see *Table 76, RTCM1819 Smoothing Interval* on *Page 418*	Ulong	4	
	GNSS time	GNSS time of measurement (μs)	Long	4	
	#obs	Number of observations with information to follow	Ulong	4	
variable	multi bit	Multiple message indicator	Ulong	4	variable
	code	Is code P Code? 0 = FALSE 1 = TRUE	Ulong	4	
	sat type	Satellite type 0 = GPS 1 = GLONASS	Ulong	4	
	prn	Satellite PRN/slot number	Ulong	4	
	quality	Data quality indicator, see *Table 75, RTCM1819 Data Quality Indicator* on *Page 418*	Ulong	4	
	multipath	Multipath indicator, see *Table 77, RTCM1819 Multipath Indicator* on *Page 419*	Ulong	4	
	range	Pseudorange (2/100 m)	Ulong	4	
variable...	Next RTCM19 observation offset = variable				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.83 RTCMDATA2021 Measurement Corrections *V123_RT20 or V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM20 and RTCM21 Measurement Corrections (RTK)

RTCM20 provides carrier phase corrections and RTCM21 provides pseudorange corrections. Types 20 and 21 are corrected by the ephemerides contained in the satellite message and are therefore referred to as 'corrections'.

Message Type 21 is very similar to the standard Type 1 message, but has additional measurement quality information, and can be used to support cross-correlation receivers. Message Type 21 is also useful in non-kinematic applications requiring high accuracy and integrity.

See the section above for the message format of the Type 18 and 19 messages that are similar to the Type 20 and 21 messages.

Message ID: **400**

Log Type: **Synch**

Recommended Input:

log rtcmdata2021a ontime 10

ASCII Example:

```
#RTCMDATA2021A,COM1,1,84.0,FINESTEERING,1415,317796.000,00140040,ade1,2616;
20,1000,1660,0,0,6,
0,0,0,6,
0,0,0,2,0,1,2,221,
0,0,0,4,0,1,129,244,
0,0,0,5,0,1,208,108,
0,0,0,30,0,1,227,196,
0,0,0,12,0,1,73,269,
0,0,0,24,0,1,13,130,
21,1000,1660,0,0,6,
0,0,0,6,
0,0,0,2,0,0,0,3,2,136,
0,0,0,0,4,0,0,0,3,129,
226,-1,0,0,0,5,0,0,0,3,
208,-195,1,0,0,0,30,0,0,0,
3,227,-55,1,0,0,0,12,0,0,
0,3,73,1,1,0,0,0,24,0,0,0,3,13,-1309,8*e1b9072c
```

RTCM Message Types 20 and 21 contain the same data as Types 18 and 19 except that the values of Types 20 and 21 are corrected by the ephemerides contained in the satellite message. See also the usage box for Types 18 and 19 on *Page 417*.

Table 78: RTCM2021 Data Quality Indicator

Code	Pseudorange Error
0	≤ 0.1 m
1	≤ 0.25 m
2	≤ 0.5 m
3	≤ 1.0 m
4	≤ 2.0 m
5	≤ 3.5 m
6	≤ 5 m
7	> 5

Table 79: RTCM2021 Multipath Indicator

Code	Multipath Error
0	≤ 0.1 m
1	≤ 0.25 m
2	≤ 0.5 m
3	≤ 1.0 m
4	≤ 2.5 m
5	≤ 5 m
6	> 5 m
7	Undetermined multipath

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA2021 header	Log header	-	H	0
2	RTCM header (for RTCM20)	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, see *REFSTATION on Page 387*	Ulong	4	H+20
8	freq	Frequency indicator 0 = L1 2 = L2	Ulong	4	H+24
9	Reserved		Ulong	4	H+28
10	GNSS time	Global Navigation Satellite System (GNSS) time of measurement (μs)	Long	4	H+32
11	#obs	Number of observation with information to follow	Long	4	H+36
12	multi bit	Multiple message indicator	Ulong	4	H+40
13	code	Is code P Code? 0 = FALSE 1 = TRUE	Ulong	4	H+44
14	sat type	Satellite type 0 = GPS 1 = GLONASS	Ulong	4	H+48
15	PRN/slot	PRN number for GPS satellites (satellite number 32 is indicated by 0); slot number for GLONASS satellites, see also *Section 1.3* on *Page 26*.	Ulong	4	H+52
16	quality	Data quality indicator, see *Table 78, RTCM2021 Data Quality Indicator* on *Page 423*	Ulong	4	H+56
17	continuity	Cumulative loss of continuity indicator with a loss of lock counter	Ulong	4	H+60
18	IODE	Issue of ephemeris data	Ulong	4	H+64
19	phase	Carrier phase correction (1/256 cycles)	Long	4	H+68

Continued on Page 425

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
20...	Next RTMC20 observation offset = H+40 + (#obs x 32)				
variable	RTCM header (for RTCM21)	RTCM message type	Ulong	4	vari-able
		Base station ID	Ulong	4	
		Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.	Ulong	4	
		Sequence number	Ulong	4	
		Length of frame	Ulong	4	
		Base station health, see *REFSTATION on Page 387*	Ulong	4	
variable	freq	Frequency indicator	Ulong	4	vari-able
	Reserved		Ulong	4	
	GNSS time	GNSS time of measurement	Long	4	
	#obs	Number of observations to follow	Ulong	4	
variable	multi bit	Multiple message indicator			var-iable
	code	Is code P Code? 0 = FALSE 1 = TRUE	Ulong	4	
	sat type	Satellite type 0 = GPS 1 = GLONASS	Ulong	4	
	prn	Satellite PRN/slot number	Ulong	4	
	corr scale	Pseudorange correction scale factor 0 = 0.02 1 = 0.32	Ulong	4	
	rate scale	Pseudorange rate correction scale factor 0 = 0.002 1 = 0.032	Ulong	4	
	quality	Data quality indicator, see *Table 78, Page 423*	Ulong	4	
	multipath	Multipath indicator, see *Table 79, Page 423*	Ulong	4	
	IODE	Issue of ephemeris data	Ulong	4	
	range corr	Pseudorange correction (scaled)	Long	4	
	range rate	Pseudorange range correction rate (scaled)	Long	4	

Continued on Page 426

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
variable	Next RTCM21 observation offset = variable				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.84 RTCMDATA22 Extended Base Station *V123_RT20 V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM22 RTCM Extended Base Station Parameters (RTK)

Message Type 22 provides firstly, a means of achieving sub-millimeter precision for base station coordinates, and secondly, base station antenna height above a base, which enables mobile units to reference measured position to the base directly in real time.

The first data word of message Type 22 provides the corrections to be added to each ECEF coordinate. Note that the corrections may be positive or negative.

The second data word, which may not be transmitted, provides the antenna L1 phase center height expressed in integer and fractional centimeters, and is always positive. It has the same resolutions as the corrections. The range is about 10 meters. The spare bits can be used if more height range is required.

Message ID: **401**

Log Type: **Synch**

Recommended Input:

log rtcmdata22a ontime 10

ASCII Example:

```
#RTCMDATA22A,COM1,0,72.0,FINESTEERING,1420,506931.895,00180020,79fa,1899;
22,0,4886,0,0,6,66,-81,-121,0,TRUE,0,0,0,0*2a49ce1b
```

RTCM Message Type 22 can be used to achieve sub-millimeter precision for base station coordinates in kinematic applications.

Further, if a base station antenna is for example, above a monument, it can be used to provide height. This enables mobile units (rovers) to reference measured positions to the monument directly in real time.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA22 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, see *REFSTATION on Page 387*	Ulong	4	H+20
8	L1 ECEF-X	L1 ECEF ΔX correction (1/256 cm)	Long	4	H+24
9	L1 ECEF-Y	L1 ECEF ΔY correction (1/256 cm)	Long	4	H+28
10	L1 ECEF-Z	L1 ECEF ΔZ correction (1/256 cm)	Long	4	H+32
11	Reserved		Ulong	4	H+36
12	height stat	No height flag where 0 = FALSE 1 = TRUE	Enum	4	H+40
13	phase center	Antenna L1 phase center height (1/256 cm)	Ulong	4	H+44
14	L2 ECEF-X	L2 ECEF ΔX correction (1/256 cm)	Long	4	H+48
15	L2 ECEF-Y	L2 ECEF ΔY correction (1/256 cm)	Long	4	H+52
16	L2 ECEF-Z	L2 ECEF ΔZ correction (1/256 cm)	Long	4	H+56
17	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+60
18	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.85 RTCMDATA23 Antenna Type Definition *V123_RT20 V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM23 RTCM Antenna Type Definition Record (RTK)

Message Type 23 provides information on the antenna type used at the base station. The RTCM commission uses an equipment-naming downloadable table from the International GPS Service Central Bureau (IGS CB): ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab. This table provides a unique antenna descriptor for antennas used for high-precision surveying type applications.

The service provider uses the *setup ID* parameter to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. A non-zero value specifies a particular setup, or calibration, table for the specific antenna in use at the base station. Increase the number whenever a change occurs at the station that affects the antenna phase center variations. Depending on the change of the phase center variations due to a setup change, a change in the *setup ID* would mean that you should check with the service provider to see if the antenna phase center variation in use is still valid. The provider must make appropriate information available to users.

The *ant ser#* field is the individual antenna serial number as issued by the manufacturer of the antenna. A possible duplication of the antenna serial number is not possible, because together with the antenna descriptor, only one antenna with the particular number is available. In order to avoid confusion, the antenna serial number should be omitted when the record is used together with reverse reduction to model type calibration values, because it cannot be allocated to a real physical antenna.

Message ID: **663**

Log Type: **Synch**

Recommended Input:

log rtcmdata23a ontime 5

ASCII Example:

```
#RTCMDATA23A,COM1,0,80.5,COARSESTEERING,1399,253488.880,005c0002,3188,35143;
23,0,2481,0,0,6,0,0,1,9,"arbitrary",1,0,6,"values"*f84ed3a0
```

In order to produce RTCM23 or RTCM24 messages from a base receiver, the receiver must have a fixed position (or be properly set to operate as a moving base station). The receiver must also have a BASEANTENNAMODEL command sent to it, see *Page 71*. Provided these conditions are met, you can log RTCM23 and RTCM24 from the base station. If an RTCM24 log, or request for an RTCM24 log, is detected at the base, the rover station ARP parameter is set to 1. Otherwise it is set to 0.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA23 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, see *REFSTATION on Page 387*	Ulong	4	H+20
8	Reserved		Ulong	4	H+24
9	ARP	Antenna Reference Point	Ulong	4	H+28
10	ser flag	Serial flag	Ulong	4	H+32
11	#chars	Length of antenna descriptor (number of characters)	Ulong	4	H+36
12	ant descrp	Antenna descriptor	Uchar [31]	32 [a]	H+40
13	setup ID	Setup ID	Ulong	4	H+72
14	Reserved		Ulong	4	H+76
15	#chars2	Length of antenna serial number (characters)	Ulong	4	H+80
16	ant ser#	Antenna serial number	Uchar [31]	31	H+84
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, additional bytes of padding may be added to maintain 4-byte alignment.

3.3.86 RTCMDATA24 Antenna Reference Point (ARP) *V123_RT20 V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM24 RTCM Antenna Reference Point Parameter (RTK)

Message 24 has been introduced to replace messages 3 and 22 for RTK operation. The L1 phase center is not a point in space that can be used as a standard reference. The location of the L1 phase center depends on the antenna setup and calibration. Therefore, the location of the L1 phase center may vary between different calibration tables for the same antenna model. Message Type 24 solves this by utilizing the ARP, which is used throughout the International GPS Service (IGS).

Message 24 contains the coordinates of the installed antenna's ARP in the GNSS coordinate system Earth-Center-Earth-Fixed (ECEF) coordinates. Local datums are not supported. The coordinates refer to a physical point on the antenna (typically the bottom of the antenna mounting surface).

BASEANTENNAMODEL and ANTENNAMODEL commands set the data, see *Pages 71* and *56* respectively. ECEF coordinates correspond to the currently calculated base station coordinates with the L1 phase centre offsets applied and will soon reflect the ARP, calculated from the base and rover sets of user antenna model parameters.

Reserved fields are set to 0, the *sys ind* field defaults to GPS, and the *ant ht* field is set to 0 by default. This follows current implementation of RTCM22 messages.

RTCM24 data can be viewed at the base by requesting the RTCMDATA24 log.

If a rover receives RTCM24, RTCM1005, or RTCM1006 data, containing antenna offset information but does not have the same antenna type as the base station, the position is offset. Provided the two receivers have matching antenna models, the output rover positions reflect position of the ARP.

Message ID: **664**

Log Type: **Synch**

Recommended Input:

log rtcmdata24a ontime 5

ASCII Example:

```
#RTCMDATA24A,COM1,0,69.5,FINESTEERING,1399,324863.216,00140002,7f9c,35143;
24,0,1438,0,0,6,-1.634520219862042e+10,0,-3.664622976254215e+10,0,
4.942560083379813e+10,0,0,0,0*b3fd5787
```

In the example, log RTCM24 from the base before you log RTCMDATA24 at a rover:

`interfacemode com2 none rtcm` *Set the COM2 interface mode to RTCM*

`log com2 RTCM24 ontime 5.0` *Output RTCM24 messages from COM2 every 5 s*

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA24 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, see *REFSTATION on Page 387*	Ulong	4	H+20
8	ECEF_X	ECEF ΔX correction (1/256 cm)	Double	8	H+24
9	Reserved		Ulong	4	H+32
10	ECEF_Y	ECEF ΔY correction (1/256 cm)	Double	8	H+36
11	Reserved		Ulong	4	H+44
12	ECEF_Z	ECEF ΔZ correction (1/256 cm)	Double	8	H+48
13	sys ind	System indicator	Ulong	4	H+56
14	ant flag	Antenna flag	Ulong	4	H+60
15	ant ht	Antenna height	Ulong	4	H+64
16	Reserved		Ulong	4	H+68
17	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
18	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.87 RTCMDATA31 GLONASS Differential Corrections *V1G23_G and V123_RT20 or V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

✉ 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.

RTCM31 Differential GLONASS Corrections (RTK)

Message Type 31 provides differential GLONASS corrections.

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
```

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, see *REFSTATION* on *Page 387*	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)	-	-	-

3.3.88 RTCMDATA32 GLONASS Base Station Parameters *V1G23_G and V123_RT20 or V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM31 GLONASS Base Station Parameters (RTK)

Message Type 32 provides GLONASS base station parameters in ECEF coordinates.

Message ID: 878
Log Type: Synch

Recommended Input:

log rtcmdata32a ontime 2

ASCII Example:

```
#RTCMDATA32A,COM1,0,41.0,FINESTEERING,1417,159021.845,00140000,4231,2698;
32,1000,1036,0,0,6,-109917613.9246512502431870,
-164379942.4939256608486176,247124922.7021482884883881*3d24c470
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA32 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, see *REFSTATION on Page 387*	Ulong	4	H+20
8	ECEF-X	ECEF ΔX correction (1/100 m)	Double	8	H+24
9	ECEF-Y	ECEF ΔY correction (1/100 m)	Double	8	H+32
10	ECEF-Z	ECEF ΔZ correction (1/100 m)	Double	8	H+40
17	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+48
18	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.89 RTCMDATA36 Special Message *V1G23_G*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

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 497*. 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 37* on *Page 185*, can be sent with each RTCM Type 36 message frame.

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
```

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, see *REFSTATION on Page 387*	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

3.3.90 RTCMDATA59 Type 59N-0 NovAtel RT20 *V123_RT20 or V23_RT2*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

RTCM59 Type 59N-0 NovAtel Proprietary Message (RTK)

RTCM Type 59 messages are reserved for proprietary use by RTCM base station operators.

Each message is variable in length, limited only by the RTCM maximum of 990 data bits (33 words maximum). The first eight bits in the third word (the word immediately following the header) serve as the message identification code, in the event that the base station operator wishes to have multiple Type 59 messages.

NovAtel has defined only a Type 59N-0 message to date; it is used for operation in receivers capable of operating in RT-20 Carrier Phase Differential Positioning Mode. This log is primarily used by a base station to broadcast its RT-20 observation data (delta pseudorange and accumulated Doppler range) to rover RT-20 – capable receivers. Type 59N messages should be sent once every 2 seconds.

1. The PORTSTATS log, see *Page 353*, is very useful for monitoring the serial data link, as well as differential data decode success.
2. This log is intended for use when operating in RT-20 mode.

Message ID: **403**
Log Type: **Synch**

Recommended Input:

log rtcmdata59a ontime 10

ASCII Example:

```
#RTCMDATA59A,COM1,0,71.0,FINESTEERING,1420,506996.000,00180020,7dc7,1899;
59,0,4993,0,0,6,78,20506229,2,0,8,26,3,39864503,-167,19,3,20437804,-40,
3,3,16170184,-41,18,3,1213739,-123,21,3,13601473,-50,9,3,23627155,-171,
14,3,26086086,-151,22,3,5,-182*9c414d63
```

RTCM Message Type 59 is a message type reserved for private use by operators who communicate proprietary information.

NovAtel receivers make use of this Message Type 59 for RT20 differential positioning. The RTCMDATA59 log can be used to observe data being used by a rover that is performing RT-20 level positioning and RTCM corrections.

For example, the German SAPOS (Satellitenpositionierungsdienst der Deutschen Landesvermessung) and ASCOS (Satelliten-Referenzdienst der E.ON Ruhrgas AG) correction networks send their FKP RTK correction parameters (using their own message format) through RTCM message Type 59. FKP is an acronym for Flachen Korrectur Parameter (Plane Correction Parameter).

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA-59 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, see *REFSTATION, Page 387*	Ulong	4	H+20
8	subtype	Message subtype	Char	4[a]	H+24
9	min psr	Minimum pseudorange (m)	Long	4	H+28
10	time offset	Time difference between the Z-count time and the measurement time where Z-count time from subframe 1 of the ephemeris (0.1 s / lsb)	Long	4	H+32
10	Reserved		Ulong	4	H+36
11	#prn	Number of PRNs with information to follow	Ulong	4	H+40
12	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+44
13	lock	Lock time: 0 = <20 seconds 1 = 20-40 seconds 2 = 40-80 seconds 3 = >80 seconds	Ulong	4	H+48
14	psr	Pseudorange correction (1/10 m)	Ulong	4	H+52
15	adr	Accumulated Doppler (ADR) correction (1/1000 m)	Long	4	H+56
16...	Next PRN offset = H+44 + (#prns x 16)				
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

3.3.91 RTCMDATA59GLO NovAtel Proprietary GLONASS Differential Corrections *V1G23_G and V123_DGPS*

See *Section 3.3.76* starting on *Page 401* for information on RTCM standard logs.

The Type 31 format, see *Page 433*, 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.

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
```

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, see *REFSTATION* on *Page 387*	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.

3.3.92 RTCMV3 RTCMV3 Standard Logs *V123_RT20 V23_RT2*

RTCM1001 L1-ONLY GPS RTK OBSERVABLES *V123_RT20 V23_RT2*

Message ID: 772

RTCM1002 EXTENDED L1-ONLY GPS RTK OBSERVABLES *V123_RT20 V23_RT2*

Message ID: 774

RTCM1003 L1 AND L2 GPS RTK OBSERVABLES *V123_RT20 V23_RT2*

Message ID: 776

RTCM1004 EXTENDED L1 AND L2 GPS RTK OBSERVABLES *V123_RT20 V23_RT2*

Message ID: 770

RTCM1005 STATIONARY RTK BASE STATION ANTENNA REFERENCE POINT (ARP) *V123_RT20 V23_RT2*

Message ID: 765

RTCM1006 STATIONARY RTK BASE STATION ARP WITH ANTENNA HEIGHT *V123_RT20 V23_RT2*

Message ID: 768

RTCM1007 EXTENDED ANTENNA DESCRIPTOR AND SETUP INFORMATION *V123_RT20 V23_RT2*

Message ID: 852

RTCM1008 EXTENDED ANTENNA REFERENCE STATION DESCRIPTION AND SERIAL NUMBER *V123_RT20 V23_RT2*

Message ID: 854

RTCM1009 GLONASS L1-ONLY RTK *V123_RT20 V23_RT2*

Message ID: 885

RTCM1010 EXTENDED GLONASS L1-ONLY RTK *V123_RT20 V23_RT2*

Message ID: 887

RTCM1011 GLONASS L1/L2 RTK *V123_RT20 V23_RT2*

Message ID: 889

RTCM1012 EXTENDED GLONASS L1/L2 RTK *V123_RT20 V23_RT2*

Message ID: 891

RTCM1019 GPS EPHEMERIDES *V123_RT20 V23_RT2*

Message ID: 893

RTCM1020 GLONASS EPHEMERIDES *V123_RT20 V23_RT2*

Message ID: 895

1. At the base station, choose to send either an RTCM1005 or RTCM1006 message to the rover station. Then select one of the observable messages (RTCM1001, RTCM1002, RTCM1003 or RTCM1004) to send from the base.
2. RTCM1007 and RTCM1008 data is set using the BASEANTENNAMODEL command, see *Page 71*. If you have set a base station ID, it is detected and set. Other values are also taken from a previously entered BASEANTENNAMODEL command.
3. In order to set up logging of RTCM1007 or RTCM1008 data, it is recommended to first use the INTERFACEMODE command to set the interface mode of the port transmitting RTCMV3 messages to RTCMV3, see *Page 130*. Providing the base has a fixed position, see FIX on *Page 112*, and its BASEANTENNAMODEL command set, you can log out RTCM1007 messages.
4. 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.
5. RTCMDATA logs output the details of the above logs if they have been sent.

RTCM SC-104 is a more efficient alternative to the documents entitled "RTCM Recommended Standards for Differential NAVSTAR GPS Service, Version 2.x”. Version 3.0, consists primarily of messages designed to support real-time kinematic (RTK) operations. The reason for this emphasis is that RTK operation involves broadcasting a lot of information, and thus benefits the most from a more efficient data format.

The RTCM SC-104 standards have been adopted by NovAtel for implementation into the receiver. The receiver can easily be integrated into positioning systems around the globe because it is capable of utilizing RTCM Version 3.0 formats.

The initial Version 3.0 document describes messages and techniques for supporting GPS. However, the format accommodates modifications to these systems (for example, new signals), and to new satellite systems that are under development. In addition, augmentation systems that utilize geostationary satellites with transponders operating in the same frequency bands are now in the implementation stages. Generically they are called Satellite-Based Augmentation Systems (SBAS), and they have been designed to be interoperable (for example WAAS, EGNOS, MSAS).

Message types contained in the current Version 3.0 standard have been structured in different groups. Transmit at least one message type from each of Goups 1 to 3:

Group 1 - Observations:

RTCM1001	L1-Only GPS RTK
RTCM1002	Extended L1-Only GPS RTK
RTCM1003	L1 And L2 GPS RTK
RTCM1004	Extended L1and L2 GPS RTK
RTCM1009	L1-Only GLONASS RTK
RTCM1010	Extended L1-Only GLONASS RTK
RTCM1011	L1/L2 GLONASS RTK
RTCM1012	Extended L1/L2 GLONASS RTK

Group 2 - Base Station Coordinates:

RTCM1005	RTK Base Antenna Reference Point (ARP)
RTCM1006	RTK Base ARP with Antenna Height

Group 3 - Antenna Description:

RTCM1007	Extended Antenna Descriptor and Setup Information
RTCM1008	Extended Antenna Reference Station Description and Serial Number

Group 4 - Auxiliary Operation Information:

RTCM1019	GPS Ephemerides
RTCM1020	GLONASS Ephemerides

Example Input:

```
interfacemode com2 none RTCMV3
fix position 51.1136 -114.0435 1059.4
baseantennamodel 702 NVH05410007 1 user
log com2 rtcm1005 ontime 3
log com2 rtcm1002 ontime 5
log com2 rtcm1006 ontime 1
log com2 rtcm1007 ontime 10
log com2 rtcm1008 ontime 10
```

RTCM1001-RTCM1004GPS RTK Observables *V123_RT20 V23_RT2*

RTCM1001, RTCM1002, RTCM1003 and RTCM1004 are GPS real-time kinematic (RTK) messages, which are based on raw data. From these data, valid RINEX files can be obtained. As a result, this set of messages offers a high level of interoperability and compatibility with standard surveying practices. Refer also to the *PC Software and Firmware* section of the *OEMV Installation and Operation Manual* for details on the logs that Convert4 converts to RINEX.

The Type 1001 Message supports single-frequency RTK operation. It does not include an indication of the satellite carrier-to-noise ratio as measured by the base station.

The Type 1002 Message supports single-frequency RTK operation, and includes an indication of the satellite carrier-to-noise (C/No) as measured by the base station. Since the C/No does not usually change from measurement to measurement, this message type can be mixed with the Type 1001, and used primarily when a satellite C/No changes, thus saving broadcast link throughput.

The Type 1003 Message supports dual-frequency RTK operation, but does not include an indication of the satellite carrier-to-noise (C/No) as measured by the base station.

The Type 1004 Message supports dual-frequency RTK operation, and includes an indication of the satellite carrier-to-noise (C/No) as measured by the base station. Since the C/No does not usually change from measurement to measurement, this message type can be mixed with the Type 1003, and used only when a satellite C/No changes, thus saving broadcast link throughput.

RTCM1005 & RTCM1006 RTK Base Antenna Reference Point (ARP)

Message Type 1005 provides the earth-centered, earth-fixed (ECEF) coordinates of the antenna reference point (ARP) for a stationary base station. No antenna height is provided.

Message Type 1006 provides all the same information as Message Type 1005, but additionally provides the height of the ARP.

These messages are designed for GPS operation, but are equally applicable to future satellite systems, and system identification bits are reserved for them.

Message Types 1005 and 1006 avoid any phase center problems by utilizing the ARP, which is used throughout the International GPS Service (IGS). They contain the coordinates of the installed antenna's ARP in Earth-Center-Earth-Fixed (ECEF) coordinates - datum definitions are not yet supported. The coordinates always refer to a physical point on the antenna, typically the bottom of the antenna mounting surface.

RTCM1007 & RTCM1008 Extended Antenna Descriptions

Message Type 1007 provides an ASCII descriptor of the base station antenna. The International GPS Service (IGS) Central Bureau convention is used most of the time, since it is universally accessible.

Message Type 1008 provides the same information, plus the antenna serial number, which removes any ambiguity about the model number or production run.

IGS limits the number of characters to 20 at this time. The antenna setup ID is a parameter for use by the service provider to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. The antenna serial number is the individual antenna serial number as issued by the manufacturer of the antenna.

RTCM1009-RTCM1012 GLONASS RTK Observables

Message Types 1009 through 1012 provide the contents of the GLONASS RTK messages, which are based on raw data. You can obtain complete RINEX files from this data. This set of messages offers a high level of interoperability and compatibility with standard surveying practices. When using these messages, you should also use an ARP message (Type 1005 or 1006) and an Antenna Descriptor message (Type 1007 or 1008). If the time tags of the GPS and GLONASS RTK data are synchronized, the Synchronized GNSS flag can be used to connect the entire RTK data block.

RTCM1019-RTCM1020 GPS and GLONASS Ephemerides

Message Type 1019 contains GPS satellite ephemeris information. Message Type 1020 contains GLONASS ephemeris information. These messages can be broadcast in the event that an anomaly in ephemeris data is detected, requiring the base station to use corrections from previously good satellite ephemeris data. This allows user equipment just entering the differential system to use corrections being broadcast from that ephemeris. Broadcast this message (Type 1019 or 1020) every 2 minutes until the satellite broadcast is corrected, or until the satellite drops below the coverage area of the base station.

These messages can also be used to assist receivers to quickly acquire satellites. For example, if you access a wireless service with this message, it can utilize the ephemeris information immediately rather than waiting for a satellite to be acquired and its almanac data processed.

3.3.93 RTCMDATA1001 L1-Only GPS RTK Observables *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: **784**
Log Type: **Synch**

Recommended Input:

log rtcmdata1001a ontime 10 3

ASCII Example:

```
#RTCMDATA1001A,COM1,0,82.0,FINESTEERING,1317,239228.000,00180040,c279,1855;
0,0,239228000,0,8,0,0,8,21,0,14513926,8707,127,2,0,3705361,5040,127,16,0,
7573721,3555,124,29,0,5573605,-11078,127,26,0,2996771,-17399,99,6,0,9341652,
-329,127,10,0,13274623,2408,127,30,0,3355111,18860,127*ec698c2a
```

Message Type 1001 contains the shortest version of a message for GPS observations, namely L1-only observables. Message Type 1002 contains additional information that enhances performance. If throughput is not limited and the additional information is available, it is recommended to use the longer version of messages.

Table 80: SBAS PRN Codes

SBAS Code	GPS/GLONASS Satellite ID	SBAS Code	GPS/GLONASS Satellite ID
120	40	130	50
121	41	131	51
122	42	132	52
123	43	133	53
124	44	134	54
125	45	135	55
126	46	136	56
127	47	137	57
128	48	138	58
129	49		

Table 81: Carrier Smoothing Interval of Code Phase

Indicator		Smoothing Interval
ASCII	Binary	
0	000	No smoothing
1	001	< 30 s
2	010	30-60 s
3	011	1-2 min.
4	100	2-4 min.
5	101	4-8 min.
6	110	>8 min.
7	111	Unlimited smoothing interval

Table 82: Lock Time Indicator

Indicator (i) [a]	Minimum Lock Time (s)	Range of Indicated Lock Times
0-23	i	0 ≤ lock time < 24
24-47	i · 2 - 24	24 ≤ lock time < 72
48-71	i · 4 - 120	72 ≤ lock time < 168
72-95	i · 8 - 408	168 ≤ lock time < 360
96-119	i · 16 - 1176	360 ≤ lock time < 744
120-126	i · 32 - 3096	744 ≤ lock time < 937
127	---	lock time ≥ 937

a. Determining Loss of Lock: In normal operation, a cycle slip is evident when the Minimum Lock Time (s) has decreased in value. For long time gaps between messages, such as from a radio outage, extra steps should be taken on the rover to safeguard against missed cycle slips.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1001 header	Log header	-	H	0
2	RTCMV3 observations header	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time in ms from the beginning of the GPS week, which begins at midnight GMT on Saturday night/Sunday morning, measured in GPS time (as opposed to UTC)	Ulong	4	H+4
5		GNSS message flag: 0 = No further GNSS observables referenced to the same epoch time. The receiver begins to process data immediately after decoding the message. 1 = The next message contains observables from another GNSS source referenced to the same epoch time	Uchar	1	H+8
6		Number of GPS satellite signals processed (the number of satellites in the message and not necessarily equal to the number of satellites visible to the base station)	Uchar	1	H+9
7		Smoothing indicator 0 = Divergence-free smoothing not used 1 = Divergence-free smoothing used	Uchar	1	H+10
8		Smoothing interval, see *Table 81* on *Page 447*. This is the integration period over which base station pseudorange code phase measurements are averaged using carrier phase information. Divergence-free smoothing may be continuous over the entire period that the satellite is visible.	Uchar	1	H+11
9	#prns	Number of PRNs with information to follow	Ulong	4	H+12
10	PRN	PRN #, for SBAS see *Table 80, Page 446*	Uchar	1	H+16
11	code-ind	GPS L1 code indicator 0 = C/A code 1 = P(Y) code direct	Uchar	1	H+17
12	psr	GPS L1 pseudorange (m)	Ulong	4	H+18

Continued on Page 449

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
13	phase-pseudo	GPS L1 (phaserange - pseudorange) Range: -262.1435 to +262.1435 m	Long	4	H+22
14	locktime-ind	GPS L1 continuos tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	2 [a]	H+26
15...	Next PRN offset = H+16 + (#prns x 12)				
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 byte of padding is added to maintain 4-byte alignment

3.3.94 RTCMDATA1002 Extended L1-Only GPS RTK Observables *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: 785

Log Type: Synch

Recommended Input:

log rtcmdata1002a ontime 7

ASCII Example:

```
#RTCMDATA1002A,COM1,0,79.0,FINESTEERING,1317,239318.000,00180040,adb2,1855;
0,0,239318000,0,9,0,0,9,21,0,12261319,-9236,127,0,202,
2,0,6623657,4517,127,0,171,16,0,5632627,1876,127,0,179,
29,0,3064427,-10154,127,0,177,26,0,14721908,-21776,105,0,164,
6,0,9384778,1113,127,0,205,18,0,9594701,-1176,27,0,184,
10,0,14876991,8629,127,0,202,30,0,6417059,20243,127,0,195*e7d3c54d
```

Message Type 1002 contains additional information to Message Type 1001, see *Page 446*, that enhances performance. If throughput is not limited and the additional information is available, it is recommended to use the longer version of messages.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1002 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GPS satellite signals processed (0-31)	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81* on *Page 447*.	Uchar	1	H+11
9	#prns	Number of PRNs with information to follow	Ulong	4	H+12
10	prn#	PRN #, for SBAS see *Table 80, Page 446*	Uchar	1	H+16
11	code-ind	GPS L1 code indicator 0 = C/A code 1 = P(Y) code direct	Uchar	1	H+17
12	psr	GPS L1 pseudorange (m)	Ulong	4	H+18
13	phase-pseudo	GPS L1 (phaserange - pseudorange) Range: -262.1435 to +262.1435 m	Long	4	H+22
14	locktime-ind	GPS L1 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+26
15	amb	GPS L1 PSR modulus ambiguity (m). The integer number of full pseudorange modulus divisions (299,792.458 m) of the raw L1 pseudorange measurement.	Uchar	1	H+27
16	C/No	GPS L1 carrier-to-noise ratio (dBHz). The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed.	Uchar	4[a]	H+28
17...	Next PRN offset = H+16 + (#prns x 16)				
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

3.3.95 RTCMDATA1003 L1/L2 GPS RTK Observables *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: 786

Log Type: Synch

Recommended Input:

log rtcmdata1003a ontime 7

ASCII Example:

```
#RTCMDATA1003A,COM1,0,79.0,FINESTEERING,1317,239386.000,00180040,a38c,1855;
0,0,239386000,0,9,0,0,9,
21,0,10569576,-8901,127,0,-176,-7752,127,
2,0,8831714,3717,127,0,-163,7068,127,
16,0,4189573,-1118,127,0,-108,-1273,127,
29,0,1181151,-10116,127,0,-61,-11354,127,
26,0,12256552,-15107,109,0,24,-18232,109,
6,0,9442835,1961,127,0,-116,2536,127,
18,0,7145333,-3326,54,0,-17,-304,54,
10,0,1125215,13933,127,0,-148,12353,127,
30,0,8737848,20418,127,0,-48,19592,127*2286a5ab
```

Message Type 1003 provides minimum data for L1/L2 operation, while Message Type 1004 provides the full data content. The longer observation messages do not change very often, and can be sent less often.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1003 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GPS satellite signals processed (0-31)	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81* on *Page 447*.	Uchar	1	H+11
9	#prns	Number of PRNs with information to follow	Ulong	4	H+12
10	prn#	PRN #, for SBAS see *Table 80, Page 446*	Uchar	1	H+16
11	L1code-ind	GPS L1 code indicator 0 = C/A code 1 = P(Y) code direct	Uchar	1	H+17
12	L1psr	GPS L1 pseudorange (m)	Ulong	4	H+18
13	L1 phase-pseudo	GPS L1 (phaserange - pseudorange) Range: -262.1435 to +262.1435 m	Long	4	H+22
14	L1locktime-ind	GPS L1 lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+26
15	L2code-ind	GPS L2 code indicator 0 = C/A or L2C code 1= P(Y) code direct 2= P(Y) code cross-correlated 3= Correlated P/Y	Uchar	1	H+27
16	L1L2psrdiff	GPS L2-L1 pseudorange difference (m)	Short	2	H+28
17	L2phase-L1pseudo	GPS L2 phaserange - L1 pseudorange Range: -262.1435 m to +262.1435 m	Long	4	H+30
18	L1L2 locktime-ind	GPS L2 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	2 [a]	H+34
19...	Next PRN offset = H+16 + (#prns x 20)				
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 byte of padding is added to maintain 4-byte alignment

3.3.96 RTCMDATA1004 Expanded L1/L2 GPS RTK Observables

V123_RT20 V23_RT2

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: **787**

Log Type: **Synch**

Recommended Input:

log rtcmdata1004a ontime 7

ASCII Example:

```
#RTCMDATA1004A,COM1,0,83.5,FINESTEERING,1317,238497.000,00180040,5500,1855;
0,0,238497000,0,7,0,0,7,
21,0,3492634,1536,98,0,202,0,-169,1904,96,175,
2,0,10314064,-3500,99,0,195,0,-192,-1385,96,165,
16,0,9713480,7187,65,0,164,0,-80,6159,65,148,
29,0,11686252,1601,95,0,163,0,-24,932,94,164,
6,0,10511647,3261,99,0,206,0,-115,3375,96,188,
10,0,1964375,2688,99,0,200,0,-120,2779,96,178,
30,0,9085068,4078,98,0,190,0,-50,2990,96,167*f91c8c6d
```

Message Type 1004 provides fuller data content than Message Type 1003, see *Page 452*. The longer observation messages do not change very often, and can be sent less often.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1004 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GPS satellite signals processed (0-31)	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81* on *Page 447*	Uchar	1	H+11
9	#prns	Number of PRNs with information to follow	Ulong	4	H+12
10	prn#	PRN #, for SBAS see *Table 80, Page 446*	Uchar	1	H+16
11	L1code-ind	GPS L1 code indicator 0 = C/A code 1 = P(Y) code	Uchar	1	H+17
12	L1psr	GPS L1 pseudorange (m)	Ulong	4	H+18
13	L1 phase-pseudo	GPS L1 (phaserange - pseudorange) Range: -262.1435 to +262.1435 m	Long	4	H+22
14	L1lcktm-ind	GPS L1 lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+26
15	L1amb	GPS L1 PSR modulus ambiguity (m). The integer number of full pseudorange modulus divisions (299,792.458 m) of the raw L1 pseudorange.	Uchar	1	H+27
16	L1C/No	GPS L1 carrier-to-noise ratio (dBHz). The base station's estimate of the satellite’s signal. A value of 0 indicates that the C/No measurement is not computed.	Uchar	1	H+28
17	L2code-ind	GPS L2 code indicator: 0 = C/A or L2C code 1 = P(Y) code direct 2 = P(Y) code cross-correlated 3 = Correlated P(Y)	Uchar	1	H+29
18	L1L2psrdiff	GPS L2-L1 pseudorange difference (m)	Short	4 [a]	H+30

Continued on Page 456

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
19	L2phase-L1pseudo	GPS L2 phaserange - L1 pseudorange Range: -262.1435 m to +262.1435 m	Long	4	H+34
20	L2lcktm-ind	GPS L2 lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+38
21	L2 C/No	GPS L2 carrier-to-noise ratio (dBHz). The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed.	Uchar	1	H+39
22...	Next PRN offset = H+16 + (#prns x 24)				
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 2 bytes of padding are added to maintain 4-byte alignment

3.3.97 RTCMDATA1005 Base Station Antenna Reference Point (ARP) *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

In order to produce RTCM1005 or RTCM1006 messages from a base receiver, it must have a fixed position (or be properly set to operate as a moving base station). However, the RTCM1005 or RTCM1006 message only incorporate antenna offsets if a BASEANTENNAMODEL command has been sent to the receiver. Once a BASEANTENNAMODEL command has been set, the ARP values are reflected in the RTCM1005 and RTCM1006 logs.

See also the BASEANTENNAMODEL command on *Page 71* and the MOVINGBASESTATION command on *Page 147*.

If a rover receives RTCM24, RTCM1005, or RTCM1006 data, containing antenna offset information but does not have the same antenna type as the base station, the position is offset. Provided the two receivers have matching antenna models, the output rover positions reflect position of the ARP.

Message ID: **788**
Log Type: **Synch**

Recommended Input:

log rtcmdata1005a ontime 3

ASCII Example:

```
#RTCMDATA1005A,COM1,0,84.5,FINESTEERING,1317,238322.885,00180040,0961,1855;
0,0,0,1,0,0,0,-16349783637,0,-36646792121,0,49422987955*7dbd6160
```

Message Types 1005 and 1006 are designed for GPS operation, but are equally applicable to GLONASS and the future Galileo.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1005 header	Log header	-	H	0
2	msg#	Message number	Ushort	2	H
3	ID	Base station ID	Ushort	2	H+2
4	Reserved		Uchar	1	H+4
5	GPSind	GPS indicator 0 = No GPS service supported 1 = GPS service supported	Uchar	1	H+5
6	GLOind	GLONASS indicator 0 = No GLONASS service supported 1 = GLONASS service supported	Uchar	1	H+6
7	GALind	Galileo indicator 0 = No Galileo service supported 1 = Galileo service supported	Uchar	1	H+7
8	Reserved		Uchar	1	H+8
9	ECEF-X	Base station ECEF X-coordinate (1/10000 m)	Double	8	H+9
10	Reserved		Uchar	1	H+17
11	ECEF-Y	Base station ECEF Y-coordinate (1/10000 m)	Double	8	H+18
12	Reserved		Uchar	2 [a]	H+26
13	ECEF-Z	Base station ECEF Z-coordinate (1/10000 m)	Double	8	H+28
14	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+36
15	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

3.3.98 RTCMDATA1006 Base Station ARP with Antenna Height *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

In order to produce RTCM1005 or RTCM1006 messages from a base receiver, it must have a fixed position (or be properly set to operate as a moving base station). However, the RTCM1005 or RTCM1006 message only incorporate antenna offsets if a BASEANTENNAMODEL command has been sent to the receiver. Once a BASEANTENNAMODEL command has been set, the ARP values are reflected in the RTCM1005 and RTCM1006 logs.

See also the BASEANTENNAMODEL command on *Page 71* and the MOVINGBASESTATION command on *Page 147*.

If a rover receives RTCM24, RTCM1005, or RTCM1006 data, containing antenna offset information but does not have the same antenna type as the base station, the position is offset. Provided the two receivers have matching antenna models, the output rover positions reflect position of the ARP.

Message ID: **789**
Log Type: **Synch**

Recommended Input:

log rtcmdata1006a ontime 3

ASCII Example:

```
#RTCMDATA1006A,COM1,0,80.5,FINESTEERING,1317,239459.744,00180040,7583,1855
;0,0,0,1,0,0,0,-16349783637,0,-36646792121,0,49422987955,0*5a466fb5
```

Message Types 1005 and 1006 are designed for GPS operation, but are equally applicable to GLONASS and the future Galileo.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1006 header	Log header	-	H	0
2	msg#	Message number	Ushort	2	H
3	ID	Base station ID	Ushort	2	H+2
4	Reserved		Uchar	1	H+4
5	GPSind	GPS indicator 0 = No GPS service supported 1 = GPS service supported	Uchar	1	H+5
6	GLOind	GLONASS indicator 0 = No GLONASS service supported 1 = GLONASS service supported	Uchar	1	H+6
7	GALind	Galileo indicator 0 = No Galileo service supported 1 = Galileo service supported	Uchar	1	H+7
8	Reserved		Uchar	1	H+8
9	ECEF-X	Base station ECEF X-coordinate (1/10000 m)	Double	8	H+9
10	Reserved		Uchar	1	H+17
11	ECEF-Y	Base station ECEF Y-coordinate (1/10000 m)	Double	8	H+18
12	Reserved		Uchar	2 [a]	H+26
13	ECEF-Z	Base station ECEF Z-coordinate (1/10000 m)	Double	8	H+28
14	anthgt	Antenna height	Ushort	4 [b]	H+36
15	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+40
16	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

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

3.3.99 RTCMDATA1007 Extended Antenna Descriptor and Setup Information *V123_RT20 V23_RT2*

RTCM1007 information is set using the BASEANTENNAMODEL command, see *Page 71*. If you have set a base station ID, it is detected and set. Other values are also taken from a previously entered BASEANTENNAMODEL command.

Message Type 1007 provides information on the antenna type used at the base station. The RTCM commission uses an equipment-naming downloadable table from the International GPS Service Central Bureau (IGS CB): ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab. This table provides a unique antenna descriptor for antennas used for high-precision surveying type applications.

The service provider uses the *setup ID* parameter to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. A non-zero value specifies a particular setup, or calibration, table for the specific antenna in use at the base station. Increase the number whenever a change occurs at the station that affects the antenna phase center variations. Depending on the change of the phase center variations due to a setup change, a change in the *setup ID* would mean that you should check with the service provider to see if the antenna phase center variation in use is still valid. The provider must make appropriate information available to users.

In order to set up logging of RTCM1007 data, it is recommended to first use the INTERFACEMODE command to set the interface mode of the port transmitting RTCMV3 messages to RTCMV3, see *Page 130*. Providing the base has a fixed position, see FIX on *Page 112*, and its BASEANTENNAMODEL command is set, you can log out RTCM1007 messages.

Message ID: **856**

Log Type: **Synch**

Recommended Input:

log rtcmdata1007a ontime 10

ASCII Example:

```
#RTCMDATA1007A,COM1,0,73.5,FINESTEERING,1423,309496.883,00180000,1d56,2748;
0,0,3,"702",1*c6f5de3d
```

Log RTCM1007 from the base before you log RTCMDATA1007 at a rover.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1007 header	Log header	-	H	0
2	msg#	Message number	Ushort	2	H
3	base ID	Base station ID	Ushort	2	H+2
4	#chars	Length of antenna descriptor (number of characters)	Ulong	4	H+4
5	ant descrp	Antenna descriptor	Char[31]	31 [a]	H+8
6	setupID	Setup identification	Uchar	1	H+39
7	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+40
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. Additional bytes of padding may be added to maintain 4-byte alignment

3.3.100 RTCMDATA1008 Extended Antenna Descriptor and Setup Information *V123_RT20 V23_RT2*

RTCM1008 information is set using the BASEANTENNAMODEL command, see *Page 71*. If you have set a base station ID, it is detected and set. Other values are also taken from a previously entered BASEANTENNAMODEL command.

Message Type 1008 provides information on the antenna type used at the base station. The RTCM commission uses an equipment-naming downloadable table from the International GPS Service Central Bureau (IGS CB): ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab. This table provides a unique antenna descriptor for antennas used for high-precision surveying type applications.

The service provider uses the *setup ID* parameter to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. A non-zero value specifies a particular setup, or calibration, table for the specific antenna in use at the base station. Increase the number whenever a change occurs at the station that affects the antenna phase center variations. Depending on the change of the phase center variations due to a setup change, a change in the *setup ID* would mean that you should check with the service provider to see if the antenna phase center variation in use is still valid. The provider must make appropriate information available to users.

In order to set up logging of RTCM1008 data, it is recommended to first use the INTERFACEMODE command to set the interface mode of the port transmitting RTCMV3 messages to RTCMV3, see *Page 130*. Providing the base has a fixed position, see FIX on *Page 112*, and its BASEANTENNAMODEL command is set, you can log out RTCM1007 messages.

Message ID: **857**

Log Type: **Synch**

Recommended Input:

log rtcmdata1008a ontime 10

ASCII Example:

```
#RTCMDATA1008A,COM1,0,69.0,FINESTEERING,1423,309565.095,00180000,d8c6,2748;
0,0,3,"702",1,11,"NVH05410007"*e89f1a17
```

Log RTCM1008 from the base before you log RTCMDATA1008 at a rover.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1008 header	Log header	-	H	0
2	msg#	Message number	Ushort	2	H
3	base ID	Base station ID number	Ushort	2	H+2
4	#chars	Length of antenna descriptor (number of characters)	Ulong	4	H+4
5	ant descrp	Antenna descriptor	Char[31]	32[a]	H+8
6	setupID	Setup identification	Uchar	1	H+40
7	#chars2	Length of antenna serial number (characters)	Ulong	4	H+41
8	ant ser#	Antenna serial number	Char [31]	31	H+45
9	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+76
10	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. Additional bytes of padding may be added to maintain 4-byte alignment

3.3.101 RTCMDATA1009 GLONASS L1-Only RTK *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: **897**

Log Type: **Synch**

Recommended Input:

log rtcmdata1009a ontime 3

ASCII Example:

```
#RTCMDATA1009A,COM1,0,68.5,FINESTEERING,1432,313977.000,00100000,58cf,35602;
0,0,65563000,0,4,0,0,
4,
7,0,12,3853223,295,96,
21,0,15,22579496,-8,95,
6,0,8,28671345,-9,97,
14,0,11,10195220,-403,96*4ea61d07
```

RTCM1009 supports single-frequency RTK operation, but does not include an indication of the satellite carrier-to-noise (C/No) as indicated by the base station.

Table 83: GLONASS L1 and L2 Frequencies

Frequency Indicator	Channel #	L1 Frequency, MHz	L2 Frequency, MHz
0	-07	1598.0625	1242.9375
1	-06	1598.6250	1243.3750
2	-05	1599.1875	1243.8125
3	-04	1599.7500	1244.2500
4	-03	1600.3125	1244.6875
5	-02	1600.8750	1245.1250
6	-01	1601.4375	1245.5625
7	00	1602.0	1246.0
8	01	1602.5625	1246.4375
9	02	1603.125	1246.875
10	03	1603.6875	1247.3125
11	04	1604.25	1247.75
12	05	1604.8125	1248.1875
13	06	1605.375	1248.625
14	07	1605.9375	1249.0625
15	08	1606.5	1249.5
16	09	1607.0625	1249.9375
17	10	1607.625	1250.375
18	11	1608.1875	1250.8125
19	12	1608.75	1251.25
20	13	1609.3125	1251.6875

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1009 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GLONASS satellite signals processed	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81* on *Page 447*.	Uchar	1	H+11
9	#rec	Number of records with information to follow	Ulong	4	H+12
10	satID	GLONASS sateliite ID (slot# 1-24)	Uchar	1	H+16
11	GLOcode	GLONASS L1 code indicator 0 = C/A code 1 = P code	Uchar	1	H+17
12	GLOfreq	GLONASS frequency indicator (0-20), see *Table 83* on *Page 466*	Uchar	1	H+18
13	GLOpsr	GLONASS L1 pseudorange Range: 0 to +599584.92 m	Ulong	4	H+19
14	phase-pseudo	GLONASS L1 phaserange - L1 pseudorange Range: -262.1435 to +262.1435 m	Long	4	H+23
15	locktime-ind	GLONASS L1 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+27
16...	Next record offset = H+16 + (#recs x 12)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.102 RTCMDATA1010 Extended L1-Only GLONASS RTK *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: 898

Log Type: Synch

Recommended Input:

log rtcmdata1010a ontime 3

ASCII Example:

```
#RTCMDATA1010A,COM1,0,63.5,FINESTEERING,1432,313982.000,00100000,3b2a,35602;
0,0,65568000,0,4,0,0,
4,
7,0,12,3689203,306,96,39,175,
21,0,15,22641632,35,96,33,192,
6,0,8,28599532,9,97,32,194,
14,0,11,10250494,-433,96,37,179*b9747504
```

Message Type 1010 supports single-frequency RTK operation, and includes an indication of the satellite C/No measured by the base. Since C/No does not usually change from measurement to measurement, this message type can be mixed with Type 1009 and used only when a satellite C/No changes, saving broadcast link throughput.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1010 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GLONASS satellite signals	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81*, *Page 447*	Uchar	1	H+11
9	#recs	Number of GLONASS records to follow	Ulong	4	H+12
10	satID	GLONASS sateliite ID (slot# 1-24)	Uchar	1	H+16
11	GLOcode	GLONASS L1 code indicator 0 = C/A code 1 = P code	Uchar	1	H+17
12	GLOfreq	GLONASS frequency indicator (0-20), see *Table 83* on *Page 466*	Ulong	4	H+18
13	GLOpsr	GLONASS L1 pseudorange Range: 0 to +599584.92 m	Long	4	H+22
14	phase-pseudo	GLONASS L1 phaserange - L1 pseudorange; Range: ±262.1435	Long	4	H+26
15	locktime-ind	GLONASS L1 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+30
16	amb	GLONAS L1 PSR modulus ambiguity. The full pseudorange modulus divisions integer (599584.916 m) of the raw L1 pseudorange measurement. Range: 0 to +76147284.332	Uchar	1	H+31
17	C\No	GLONASS L1 carrier-to-noise ratio. The base station's estimate of the satellite’s signal. A value of 0 indicates that the C/No measurement is not computed. Range: 0 to +63.75 dB-Hz	Uchar	4[a]	H+32
17...	Next record offset = H+16 + (#recs x 20)				
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

3.3.103 RTCMDATA1011 GLONASS L1/L2 RTK *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: **899**

Log Type: **Synch**

Recommended Input:

log rtcmdata1011a ontime 3

ASCII Example:

```
#RTCMDATA1011A,COM1,0,70.5,FINESTEERING,1432,313985.000,00100000,35bd,35602;
0,0,65571000,0,4,0,0,
4,
7,0,12,3590806,357,96,0,-2,361,94,
21,0,15,22679016,35,96,0,74,154,94,
6,0,8,28556501,-9,97,0,-185,-126,94,
14,0,11,10283759,-463,97,0,171,-824,95*5e265573
```

The RTCM Type 1011 Message supports dual-frequency RTK operation but does not include an indication of the satellite C/No measured by the base station.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1011 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GLONASS satellite signals (0-31)	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81*, *Page 447*	Uchar	1	H+11
9	#rec	Number of records with information to follow	Ulong	4	H+12
10	satID	GLONASS sateliite ID (slot# 1-24)	Uchar	1	H+16
11	GLOcode	GLONASS L1 code indicator 0 = C/A code 1 = P code	Uchar	1	H+17
12	GLOfreq	GLONASS frequency indicator (0-20), see *Table 83* on *Page 466*	Ulong	4	H+18
13	GLOpsr	GLONASS L1 pseudorange Range: 0 to +599584.92 m	Long	4	H+22
14	phase-pseudo	GLONASS L1 phaserange - L1 pseudorange Range: -262.1435 to +262.1435 m	Uchar	1	H+26
15	locktime-ind	GLONASS L1 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+27
16	GLOcodeL2	GLONASS L2 code indicator 0 = C/A code 1 = P code	Uchar	1	H+28
17	L1L2psrdiff	GLONASS L2-L1 pseudorange difference; Range: ±163.82 m	Short	2	H+29
18	L2phase-L1pseudo	GLONASS L2 phaserange - L1 pseudorange; Range: ±262.1435 m	Long	4	H+31
19	L2locktime-ind	GLONASS L2 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+35
20...	Next record offset = H+16 + (#recs x 20)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.104 RTCMDATA1012 Extended GLONASS L1/L2 RTK *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

Message ID: **900**

Log Type: **Synch**

Recommended Input:

log rtcmdata1012a ontime 3

ASCII Example:

```
#RTCMDATA1012A,COM1,0,52.5,FINESTEERING,1432,407880.000,00000000,ee92,35602;
0,0,73066000,0,5,0,0,
5,
7,0,12,421564,185,108,34,193,0,-35,33,108,176,0,
8,0,13,22564562,69,108,32,193,0,150,-100,108,188,0,
1,0,14,5214900,271,107,38,135,0,189,886,106,161,0,
24,0,9,21406829,160,109,36,187,0,139,84,108,159,0,
10,0,11,18616094,202,109,35,186,0,215,329,108,181,0*4b04eecb
```

Message Type 1012 supports dual-frequency RTK operation, and includes an indication of the satellite C/No as measured by the base station.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTCMDATA1012 header	Log header	-	H	0
2	RTCMV3 observations header, see the RTCM-DATA1001 log on *Page 446* for details	Message number	Ushort	2	H
3		Base station ID	Ushort	2	H+2
4		GPS epoch time (ms)	Ulong	4	H+4
5		GNSS message flag	Uchar	1	H+8
6		Number of GLONASS satellite signals processed	Uchar	1	H+9
7		Smoothing indicator	Uchar	1	H+10
8		Smoothing interval, see *Table 81* on *Page 447*.	Uchar	1	H+11
9	#recs	Number of records with information to follow	Ulong	4	H+12
10	satID	GLONASS sateliite ID (slot# 1-24)	Uchar	1	H+16
11	GLOcode	GLONASS L1 code indicator 0 = C/A code 1 = P code	Uchar	1	H+17
12	GLOfreq	GLONASS frequency indicator (0-20), see *Table 83* on *Page 466*	Uchar	2 [a]	H+18
13	GLOpsr	GLONASS L1 pseudorange Range: 0 to +599584.92 m	ULong	4	H+20
14	phase-pseudo	GLONASS L1 phaserange - L1 pseudorange Range: -262.1435 to +262.1435 m	Long	4	H+24
15	locktime-ind	GLONASS L1 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+28
16	amb	GLONAS L1 PSR modulus ambiguity. The full pseudorange modulus divisions integer (599584.916 m) of the raw L1 pseudorange measurement. Range: 0 to +76147284.332	Uchar	1	H+29
17	C\No	GLONASS L1 carrier-to-noise ratio. The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. Range: 0 to +63.75 dB-Hz	Uchar	1	H+30

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Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
18	GLOcodeL2	GLONASS L2 code indicator 0 = C/A code 1 = P code	Uchar	1	H+31
19	L1L2psrdiff	GLONASS L2-L1 pseudorange difference; Range: ±163.82 m	Short	4 [b]	H+32
20	L2phase-L1pseudo	GLONASS L2 phaserange - L1 pseudorange; Range: ±262.1435 m	Long	4	H+36
21	L2locktime-ind	GLONASS L2 continuous tracking lock time indicator, see *Table 82* on *Page 447*	Uchar	1	H+40
22	GLO L2 C\No	GLONASS L2 carrier-to-noise ratio. The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. Range: 0 to +63.75 dB-Hz	Uchar	1	H+41
23	Reserved		UShort	2	H+42
24...	Next record offset = H+16 + (#recs 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 byte of padding is added to maintain 4-byte alignment

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

3.3.105 RTCMDATA1019 GPS Ephemeris *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

All data fields have the same number of bits, scale factors and units as defined in the GPS SPS Signal Specification, Sections 2.4.3 and 2.4.4.

Message ID: **901**
Log Type: **Synch**

Recommended Input:

log rtcmdata1019a ontime 3

ASCII Example:

```
#RTCMDATA1019A,COM1,0,70.5,FINESTEERING,1432,313994.864,00100000,f837,3560
2;
1019,3,408,0,1,775,112,19800,0,48,161191,112,516,14603,1364270492,428,
80926891,4761,2702050848,19800,-109,-991856009,-60,632629735,6099,
504327378,-23427,-9,0,0,0*dba8a7f4
```

Message Type 1019 contains only GPS ephemeris information, see Message Type 1020 starting on *Page 479* for GLONASS ephemeris information.

Table 84: SV Accuracy

Index Value (m)	Standard Deviations (m)	Index Value (m)	Standard Deviations (m)
0	2.0	8	64.0
1	2.8	9	128.0
2	4.0	10	256.0
3	5.7	11	512.0
4	8	12	1024.0
5	11.3	13	2048.0
6	16.0	14	4096.0
7	32.0	15	8192.0

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
1	RTCMDATA-1019 header	Log header	-	-	H	0
2	message#	Message number Range: 0 to 4095	-	Ushort	2	H
3	PRN#	Satellite PRN#, for SBAS see *Table 80, Page 446* Range: 1 to 63	-	Uchar	2 [a]	H+2
4	week	GPS week number Range: 0 to 1023	1 week	Ushort	2	H+4
5	SV accur index	SV Accuracy (m), see *Table 84* on *Page 475*	-	Uchar	1	H+6
6	GPSCodeOnL2	GPS code on L2 0 = Reserved 1 = P code 2 = C/A code 3 = L2C	1	Uchar	1	H+7
7	IDOT	Rate of inclination angle, semi-circles/second	2^{-43}	Short	2	H+8
8	IODE	Issue of ephemeris data Range: 0-255 (unitless)	1	Uchar	2 [a]	H+10
9	TOC	SV clock correction term Maximum: 604784 s	2^{4}	Ushort	2	H+12
10	AF2	Clock aging parameter, s/s^2	2^{-55}	Char	2 [a]	H+14
11	AF1	Clock aging parameter, s/s	2^{-43}	Short	4 [b]	H+16
12	AF0	Clock aging parameter, seconds	2^{-31}	Long	4	H+20
13	IODC	Issue of data, clock Range: 0-1023 (unitless)	1	Ushort	2	H+24
14	Crs	Orbit radius (amplitude of sine, meters)	2^{-5}	Short	2	H+26
15	ΔN	Mean motion difference, semi-circles/second	2^{-43}	Short	4 [b]	H+28
16	M_0	Mean anomaly of reference time, semi-circles	2^{-31}	Long	4	H+32
17	Cuc	Argument of latitude (amplitude of cosine, radians)	2^{-29}	Short	4 [b]	H+36

Continued on Page 477

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
18	ecc	Eccentricity, dimensionless - 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. (unitless)	2^{-33}	Ulong	4	H+40
19	Cus	Argument of latitude (amplitude of sine, radians)	2^{-29}	Short	4 [b]	H+44
20	$(A)^{1/2}$	Square root of the semi-major axis	2^{-19}	Ulong	4	H+48
21	toe	Reference time for ephemeris, seconds	2^{4}	Ushort	2	H+52
22	Cic	Inclination (amplitude of cosine, radians)	2^{-29}	Short	2	H+54
23	ω_0	Right ascension, radians	2^{-31}	Long	4	H+56
24	Cis	Inclination (amplitude of sine, radians)	2^{-29}	Short	4 [b]	H+60
25	I_0	Inclination angle at reference time, radians	2^{-31}	Long	4	H+64
26	Crc	Orbit radius (amplitude of cosine, meters)	2^{-5}	Short	4 [b]	H+68
27	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.	2^{-31}	Long	4	H+72
28	$\mathring{\omega}$	Rate of right ascension, radians/second	2^{-43}	Long	4	H+76
29	tgd	Estimated group delay difference, seconds	2^{-31}	Char	1	H+80
30	SV health	The six-bit health indication given by bits 17 through 22 of word three refers to the transmitting satellite. The MSB indicates a summary of the health of the navigation data, where: 0 = all navigation data is OK 1 = some or all navigation data is not OK	1	Uchar	1	H+81

Continued on Page 478

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
31	L2Pflag	GPS L2 P flag, subframe 1, word 4, bit 1: 0 = L2 P-code NAV data ON 1 = L2 P-code NAV data OFF	1	Uchar	1	H+82
32	fit interval	GPS fit interval, subframe 2, word 10, bit 17: 0 = Curve-fit interval is 4 hours 1 = Curve-fit is greater than 4 hours	1	Uchar	1	H+83
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 byte of padding is added to maintain 4-byte alignment
b. In the binary log case, two additional bytes of padding are added to maintain 4-byte alignment

3.3.106 RTCMDATA1020 GLONASS Ephemeris *V123_RT20 V23_RT2*

This log is available at the base station. See *Section 3.3.92* starting on *Page 442* for information on RTCM Version 3.0 standard logs.

All data fields have the same number of bits, scale factors and units defined in the 5th edition of the GLONASS ICD, which contains the most recent information about GLONASS-M navigation data.

Message ID: **902**
Log Type: **Synch**

Recommended Input:

log rtcmdata1020a ontime 3

ASCII Example:

```
#RTCMDATA1020A,COM1,0,71.0,FINESTEERING,1432,313998.350,00100000,48c9,35602;
1020,6,8,0,0,0,2329,0,1,73,2911974,-27323203,0,-379009,-15756135,0,1761261,
41395090,-2,1,-2,3,0,227246,-15,0,1,15,1267,1,1,1267,-2958,3,-1032,0,0
*cfbf1816
```

Message Type 1020 contains only GLONASS ephemeris information, see Message Type 1019 starting on *Page 475* for GPS ephemeris information.

Table 85: GLONASS Ephemeris Word P1

Word P1	Time Interval [a]
00	0
01	30
10	45
11	60

a. Time interval between adjacent values of tb in minutes

Table 86: M-Satellite User Range Accuracy

F_T	Accuracy σ (m)	F_T	Accuracy σ (m)	F_T	Accuracy σ (m)
0	1	6	10	12	128
1	2	7	12	13	256
2	2.5	8	14	14	512
3	4	9	16	15	Reserved
4	5	10	32		
5	7	11	64		

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
1	RTCMDATA-1020 header	Log header		-	H	0
2	message#	Message number Range: 0 to 4095	-	Ushort	2	H
3	satID	GLONASS sateliite ID (slot# 1-24)	-	Uchar	1	H+2
4	GLOfreq	GLONASS frequency indicator (0-20), see *Table 83* on *Page 466*	1	Uchar	1	H+3
5	alm health	GLONASS almanac health: 0 = non-operability of satellite. 1 = operability of satellite	-	Uchar	1	H+4
6	alm health ind	Almanac health availability indicator (depends on whether an almanac has been received yet or not): 0 = Almanac health is not available 1 = Almanac health is available	-	Uchar	1	H+5
7	P1	Word P1 is a data updating flag. It indicates a time interval between two adjacent values of the *tb* parameter (in minutes) in both current and previous frames as indicated in *Table 85* on *Page 479*.	-	Uchar	2 [a]	H+6
8	Tk	Time of frame start (since start of GLONASS day). The number of hours elapsed occupies the 5 MSB, the minutes occupies the next 6 bits and the number of thirty-second intervals occupies the LSB: Bits 11 to 17: 0 - 23 (hours) Bits 6 to 1 : 0 - 59 (minutes) Bit 0 : 0 - 1 (30-second intervals)	-	Ushort	2	H+8
9	Bn MSB	Word Bn is the health flag: 0 = GOOD 1 = BAD Both the second and third bits of this word are not used.	-	Uchar	1	H+10
10	P2	Word P2 is a flag of oddness (1) or evenness (0) of the value of *tb* (for intervals of 30 or 60 minutes)	-	Uchar	1	H+11

Continued on Page 481

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
11	tb	Time to which GLONASS navigation data are referenced. Range: 1 - 95 (minutes)	15 mins.	Uchar	4 [b]	H+12
12	Xn(tb)1	GLONASS ECEF-X component of satellite velocity vector in PZ-90 datum Range: ±4.3 km/s	$\pm2^{-20}$ km/s	Long	4	H+16
13	Xn(tb)	GLONASS ECEF-X component of satellite coordinates in PZ-90 datum Range: ±27000 km	$\pm2^{-11}$ km	Long	4	H+20
14	Xn(tb)2	GLONASS ECEF-X component of satellite acceleration in PZ-90 datum Range: $\pm6.2\text{x}10^{-9}$ km/s	$\pm2^{-30}$ km/s^2	Char	4 [b]	H+24
15	Yn(tb)1	GLONASS ECEF-Y component of satellite velocity vector in PZ-90 datum Range: ±4.3 km/s	$\pm2^{-20}$ km/s	Long	4	H+28
16	Yn(tb)	GLONASS ECEF-Y component of satellite coordinates in PZ-90 datum Range: ±27000 km	$\pm2^{-11}$ km	Long	4	H+32
17	Yn(tb)2	GLONASS ECEF-Y component of satellite acceleration in PZ-90 datum Range: $\pm6.2\text{x}10^{-9}$ km/s	$\pm2^{-30}$ km/s^2	Char	4 [b]	H+36
18	Zn(tb)1	GLONASS ECEF-Z component of satellite velocity vector in PZ-90 datum Range: ±4.3 km/s	$\pm2^{-20}$ km/s	Long	4	H+40
19	Zn(tb)	GLONASS ECEF-Z component of satellite coordinates in PZ-90 datum Range: ±27000 km	$\pm2^{-11}$ km	Long	4	H+44
20	Zn(tb)2	GLONASS ECEF-Z component of satellite acceleration in PZ-90 datum Range: $\pm6.2\text{x}10^{-9}$ km/s	$\pm2^{-30}$ km/s^2	Char	1	H+48

Continued on Page 482

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
21	P3	The Word P3 flag indicates the number of satellites the almanac is transmitting within the given frame: 1 = five satellites 0 = four satellites	-	Uchar	1	H+49
22	γ(tb)	GLONASS relative deviation of predicted satellite carrier frequency from the nominal value. Range: $\pm 2^{-30}$	2^{-40}	Short	2	H+50
23	M P	Word P for the GLONASS-M satellite is a technological parameter that indicates the satellite operation mode in respect of time parameters[c]: 0 = τ_C parameter relayed from control segment, τ_{GPS} parameter relayed from control segment 1 = τ_C parameter relayed from control segment, τ_{GPS} parameter calculated on-board the GLONASS-M satellite 2 = τ_C parameter calculated on-board the GLONASS-M satellite, τ_{GPS} parameter relayed from control segment 3 = τ_C parameter calculated on-board the GLONASS-M satellite, τ_{GPS} parameter calculated on-board the GLONASS-M satellite	-	Uchar	1	H+52
24	M I_n 3rd	GLONASS-M 3rd string Word I_n: 0 = the nth satellite is healthy 1 = the nth satellite is not healthy	-	Uchar	3 [d]	H+53
25	τ_{tb}	GLONASS correction time relative to GLONASS system time. Range: $\pm 2^{-9}$ s	2^{-30}	Long	4	H+56
26	M $\Delta\tau$	GLONASS time difference between the navigation RF signal transmitted in L2 sub-band and navigation RF signal transmitted in L1 sub-band. Range: $\pm 13.97 \times 10^{-9}$ s	2^{-30}	Char	1	H+60
27	E	The age of GLONASS navigation data. Range: 0 to 31 days	1 day	Uchar	1	H+61

Continued on Page 483

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
28	M P4	Word P4 for the GLONASS-M satellite is a flag to show that ephemeris parameters are present. 1 = Updated ephemeris or frequency/time parameters have been uploaded by the control segment 0 = No parameters have been uploaded by the control segment	-	Uchar	1	H+62
29	M F_T	GLONASS-M predicted satellite user range at time t_b. Range: 0 to 15, see *Table 86* on *Page 479*	-	Uchar	1	H+63
30	M Nt	GLONASS-M current data number Range: 1 to 1461 days	1 day	Ushort	2	H+64
31	M type?	Type of GLONASS satellite 1 = Valid GLONASS-M data 0 = Not valid GLONASS-M data and may contain arbitrary values	-	Uchar	1	H+66
32	GLOavail	This flag determines the availability of additional GLONASS data fields 132-136: 1 = Available 0 = Unavailable	-	Uchar	1	H+67
33	N^A	GLONASS calendar day within a four-year period to which τ_C is referenced Range: 1 to 1461	1 day	Ushort	4 [d]	H+68
34	τ_C	τ_C is the difference between GLONASS time and UTC time. This parameter is referenced to the beginning of the day N^A. Range: ±1 s	2^{-31}	Long	4	H+72
35	M N4	GLONASS four-year interval number starting from 1996 Range: 1 to 31	4-year interval	Uchar	4 [b]	H+76
36	M τ_{GPS}	GLONASS-M τ_{GPS} is the correction to GPS time relative to GLONASS time. Range: $\pm 1.9 \times 10^{-3}$ s	2^{-31}	Long	4	H+80

Continued on Page 484

Field #	Field type	Data Description	Scale Factor	Format	Binary Bytes	Binary Offset
37	M I_n 5th	GLONASS-M 5th string Word I_n: 0 = the nth satellite is healthy 1 = the nth satellite is not healthy	-	Uchar	1	H+84
38	Reserved		-	Char	1	H+85
vari-able	xxxx	32-bit CRC (ASCII and Binary only)	-	Hex	4	variable
vari-able	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

a. In the binary log case, an additional byte of padding is 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

c. τ_C is the GLONASS time scale correction to UTC(SU) time. τ_{GPS} is the correction to GPS time relative to GLONASS time: $T_{GPS} - T_{GLO} = \Delta T + \tau_{GPS}$ where ΔT is the integer part, and τ_{GPS} is the fractional part of the difference between the system time scales expressed in seconds.

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

3.3.107 RTKDATA RTK Solution Parameters *V123_RT20 V23_RT2*

This is the "RTK output" log, and it contains miscellaneous information regarding the RTK solution. It is based on the matched update. Note that the length of the log messages vary depending on the number of common satellites (on both rover and base stations) in the solution, a quantity represented by *#sv* in the field numbers.

See also the BESTPOS log (the best available position computed by one receiver) and the MATCHEDPOS log (positions that have been computed from time matched base and rover observations), on *Pages 231* and *331* respectively.

See *Figure 10, Page 245* for a definition of the ECEF coordinates

Message ID: 215

Log Type: Asynch

Recommended Input:

log rtkdataa 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:

```
#RTKDATAA,COM1,0,61.0,FINESTEERING,1419,340038.000,00000040,d307,2724;
SOL_COMPUTED,NARROW_INT,00000103,12,12,12,12,0,01,0,33,HNAV,0,
6.3126e-05,5.3089e-05,-4.4002e-05,
5.3089e-05,2.5408e-04,-4.2023e-05,
-4.4002e-05,-4.2023e-05,2.3526e-04,
0.0000,0.0000,0.0000,0.0000,0.0000,0.0000,
22,12,
1,NARROW_INT,-0.000102415,
3,NARROW_INT,0.000007917,
9,NARROW_INT,0.000485239,
11,NARROW_FLOAT,-0.001025980,
14,NARROW_INT,0.000196952,
18,NARROW_INT,0.000621116,
19,NARROW_INT,-0.000129004,
21,NARROW_INT,0.002786725,
39,NARROW_FLOAT,-0.003358357,
56,NARROW_FLOAT,-0.002554488,
22,REFERENCE,0.000000000,
41,REFERENCE,0.000000000*6fe4101f
```

Consider the appropriate observation times when using dual frequency receivers.

One primary advantage of dual frequency equipment is the ability to observe baselines using much shorter occupation times. It is difficult to state exactly what this occupation time should be since every observation session is different. Keep the following factors in mind when determining how long a station should be occupied (occupation time refers to the simultaneous observation time at both base and rover):

- The distance between rover and base station. As the distance between the base and rover receivers increases, the occupation times should also increase.
- Sky visibility at each of the base and rover receiver. The accuracy and reliability of differential GPS 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). See also the SATVIS log on *Page 510*.
- Time of day. The location and number of satellites in the sky is constantly changing. As a result, some periods in the day are slightly better for GPS data collection than others. Use the SATVIS log to monitor the satellite constellation at a particular place and time.
- Station environment. It is good practice to observe the site conditions surrounding the station to be occupied. Water bodies, buildings, trees, and nearby vehicles can generate noise in the GPS data. Any of these conditions may warrant an increased occupation time.

Table 87: Searcher Type

Searcher Type (binary)	Searcher Type (ASCII)	Description
0-4	Reserved	
5	HNAV	AdVance RTK Engine

Table 88: Ambiguity Type

Ambiguity Type (binary)	Ambiguity Type (ASCII)	Description
0	UNDEFINED	Undefined ambiguity
1	L1_FLOAT	Floating L1 ambiguity
2	IONOFREE_FLOAT	Floating ionospheric-free ambiguity
3	NARROW_FLOAT	Floating narrow-lane ambiguity
4	NLF_FROM_WL1	Floating narrow-lane ambiguity derived from integer wide-lane ambiguity
5	L1_INT	Integer L1 ambiguity
6	WIDE_INT	Integer wide-lane ambiguity
7	NARROW_INT	Integer narrow-lane ambiguity
8	IONOFREE_DISCRETE	Discrete ionospheric-free ambiguity
9-10	Reserved	
11	REFERENCE	Double-difference reference satellite (There are two references if GLONASS is being used. The residuals of the references are always 0.0.)

Table 89: RTK Information

Bit #	Mask	Description	Bit = 0	Bit = 1
0	0x00000001	RTK dynamics	Static	Dynamic
1	0x00000002	RTK dynamics mode	Auto	Forced
2	0x00000004	Severe differential ionosphere detected	No	Yes
8	0x00000100	Verification flag for AdVance RTK, see also the note box below	Not verified	Verified
3-31	0xFFFFFF8	Reserved		

The verification flag is shown in the 8th bit of Field #4 where a 1 means the AdVance RTK narrow-lane ambiguity is verified and a 0 means it has not yet been verified.

To achieve the best reliability, particularly when operating in difficult environments such as high foliage, longer baselines or unstable atmospheric conditions, the user should wait for the verified status. The verification flag provides an extra level of assurance that the ambiguity resolutions are correct.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTKDATA header	Log header		H	0
2	sol status	Solution status (see *Table 47, Solution Status* on *Page 233*)	Enum	4	H
3	pos type	Position type (see *Table 46, Position or Velocity Type* on *Page 232*)	Enum	4	H+4
4	rtk info	RTK information (see *Table 89, RTK Information* on *Page 487*)	Ulong	4	H+8
5	#SVs	Number of satellite vehicles tracked	Uchar	1	H+12
6	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+13
7	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+14
8	#multi	Number of multi frequency observations in solution	Uchar	1	H+15
9	Reserved		Uchar	1	H+16
10	ext sol stat	Extended solution status	Hex	1	H+17
11	Reserved		Hex	1	H+18
12	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 48* on *Page 234*)	Hex	1	H+19
13	search stat	Searcher status, normally ANAV (see *Table 87, Searcher Type* on *Page 486*)	Enum	4	H+20
14	Reserved		Ulong	4	H+24
15-23	[C]	The C_{xx},C_{xy},C_{xz},C_{yx},C_{yy},C_{yz},C_{zx},C_{zy} and C_{zz} components in $(meters)^2$, of the ECEF position covariance matrix (3x3).	Float	36	H+28
24	Reserved		Double	8	H+64
25			Double	8	H+72
26			Double	8	H+80
27			Float	4	H+88
28			Float	4	H+92
29			Float	4	H+96
30	ref PRN	Base PRN	Ulong	4	H+100

Continued on Page 489

Field #	Field type	Data Description	Format	Binar y Bytes	Binary Offset
31	# SV	Number of SVs to follow	Long	4	H+104
32	PRN	Satellite PRN number of range measurement	Ulong	4	H+108
33	amb	Ambiguity type (see *Table 88, Ambiguity Type* on *Page 487*)	Enum	4	H+112
34	res	Residual (m)	Float	4	H+116
35...	Next SV offset = H + 108 + (obs x 12)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+108+ (12xobs)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.108 RTKPOS RTK Low Latency Position Data *V123_RT20 V23_RT2*

This log contains the low latency RTK position computed by the receiver, along with two 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. This log is recommended for kinematic operation. Better accuracy can be obtained in static operation with the MATCHEDPOS log.

With the system operating in an RTK mode, this log reflects if the solution is a good RTK low latency solution (from extrapolated base station measurements) or invalid. A valid RTK low latency solution is computed for up to 60 seconds after reception of the last base station observation. The degradation in accuracy, due to differential age, is reflected in the standard deviation fields, and is summarized in the *GPS Overview* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm. See also the DGPSTIMEOUT command on *Page 101*.

Message ID: **141**

Log Type: **Synch**

Recommended Input:

log rtkposa ontime 1

ASCII Example:

```
#RTKPOSA,COM1,0,54.5,FINESTEERING,1419,340040.000,00000040,176e,2724;
SOL_COMPUTED,NARROW_INT,51.11635911294,-114.03833103654,1063.8336,-16.2712,
WGS84,0.0179,0.0096,0.0174,"AAAA",1.000,0.000,12,11,11,11,0,01,0,33*0adb3e47
```

Consider the case of a racing car on a closed circuit requiring RTK operation. In this situation, you would have to send live data to the pits using a radio link.

RTK operation enables live cm-level position accuracy. When answers are required right in the field, the base station must transmit its information to the rover in real-time. For RTK operation, extra equipment such as radios are required to be able to transmit and receive this information. The base station has a corresponding base radio and the rover station has a corresponding rover radio.

Post-processing can provide post-mission position and velocity data using raw GPS collected from the car. The logs necessary for post-processing include:

RANGECMPB ONTIME 1

RAWEPHEMB ONNEW

Above, we describe and give examples of data collection for post-processing, and real-time operation. OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also www.novatel.com.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTKPOS header	Log header		H	0
2	sol status	Solution status (see *Table 47* on *Page 233*)	Enum	4	H
3	pos type	Position type (see *Table 46* on *Page 232*)	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 21, Datum Transformation Parameters* on *Page 94*)	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	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+66
18	#multi	Number of multi frequency observations in solution	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status	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 48* on *Page 234*)	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

3.3.109 RTKVEL RTK Velocity *V123_RT20 V23_RT2*

This log contains the RTK 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 and differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. 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. See also the table footnote for velocity logs on *Page 208*.

Velocities from the RTK filter are calculated from the delta-position. In RTKVEL, the velocity type is the same as the position type.

With the system operating in an RTK mode, this log reflects if the solution is a good RTK Low Latency solution (from extrapolated base station measurements) or invalid. A valid RTK Low Latency solution is computed for up to 60 seconds after reception of the last base station observation.

The velocity is computed from consecutive RTK low latency updates. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the RTKVEL time tag. The velocity latency to be subtracted from the time tag is normally 1/2 the time between filter updates. Under default operation, the RTK low latency filter is updated at a rate of 2 Hz. This translates into a velocity latency of 0.25 seconds. The latency can be reduced by increasing the update rate of the RTK low latency filter by requesting the BESTVEL, RTKVEL, BESTPOS or RTKPOS messages at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.05 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

Message ID: **216**

Log Type: **Synch**

Recommended Input:

log rtkvela ontime 1

ASCII Example:

```
#RTKVELA,COM1,0,43.5,FINESTEERING,1364,496137.000,00100000,71e2,2310;
SOL_COMPUTED,NARROW_INT,0.250,1.000,0.0027,207.645811,0.0104,0.0*f551cc42
```

Consider the case of an unmanned aircraft. A differential base station must send data to the remote aircraft. In this type of application, the aircraft's radio may pass differential data, for example RTKVEL, to the positioning system so it can process it and generate precise position information for the flight controls.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTKVEL header	Log header		H	0
2	sol status	Solution status, see *Table 47, Solution Status* on *Page 233*	Enum	4	H
3	vel type	Velocity type, see *Table 46, Position or Velocity Type* on *Page 232*	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 meters 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 meters 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)	-	-	-

3.3.110 RTKXYZ RTK Cartesian Position and Velocity *V123_RT20 V23_RT2*

This log contains the receiver's low latency position and velocity in ECEF coordinates. The position and velocity status field's indicate whether or not the corresponding data is valid. See *Figure 10, Page 245* for a definition of the ECEF coordinates.

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.

With the system operating in an RTK mode, this log reflects if the solution is a good RTK Low Latency solution (from extrapolated base station measurements) or invalid. A valid RTK Low Latency solution is computed for up to 60 seconds after reception of the last base station observation. The degradation in accuracy due to differential age is reflected in the standard deviation fields, and is summarized in the *GPS Overview* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm. See also the DGPSTIMEOUT command on *Page 101*.

The velocity is computed from consecutive RTK low latency updates. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the RTKVEL time tag. The velocity latency to be subtracted from the time tag is normally 1/2 the time between filter updates. Under default operation, the RTK low latency filter is updated at a rate of 2 Hz. This translates into a velocity latency of 0.25 seconds. The latency can be reduced by increasing the update rate of the RTK low latency filter by requesting the BESTXYZ message at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.05 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

See also the BESTXYZ and MATCHEDXYZ logs, on *Pages 242* and *337* respectively.

Message ID: **244**

Log Type: **Synch**

Recommended Input:

log rtkxyza ontime 1

ASCII Example:

```
#RTKXYZA,COM1,0,56.0,FINESTEERING,1419,340041.000,00000040,3d88,2724;
SOL_COMPUTED,NARROW_INT,-1634531.5666,-3664618.0291,4942496.3230,0.0099,
0.0219,0.0115,SOL_COMPUTED,NARROW_INT,0.0030,0.0003,-0.0016,0.0198,0.0438,
0.0230,"AAAA",0.250,1.000,0.000,12,11,11,11,0,01,0,33*0497d146
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RTKXYZ header	Log header		H	0
2	P-sol status	Solution status, see *Table 47, Solution Status* on *Page 233*	Enum	4	H
3	pos type	Position type, see *Table 46, Position or Velocity Type* on *Page 232*	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 47, Solution Status* on *Page 233*	Enum	4	H+44
11	vel type	Velocity type, see *Table 46* on *Page 232*	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 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
24	#obs	Number of single and multi frequency observations in solution	Uchar	1	H+106

Continued on Page 496

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
25	#multi	Number of multi frequency observations in solution	Uchar	1	H+107
26	Reserved		Char	1	H+108
27	ext sol stat	Extended solution status	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 48* on *Page 234*)	Hex	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.111 RXCONFIG Receiver Configuration *V123*

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 328* 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,AUX2,0*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,MARKPOSA,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)	-	-	-

3.3.112 RXHWLEVELS Receiver Hardware Levels V3

This log contains the receiver environmental and voltage parameters. *Table 90* provides some of the minimum, maximum and typical parameters of OEMV-3-based products.

This log outputs null fields from OEMV-1-based and OEMV-2-based products.

Message ID: **195**
Log Type: **Polled**

Recommended Input:

log rxhwlevelsa ontime 60

ASCII Example:

```
#RXHWLEVELSA,COM1,0,82.5,FINESTEERING,1364,490216.808,00000008,863c,2310;
31.563,0.000,1.352,11.763,4.996,0.000,0.000,0.000,0.000,0.000*76927cb1
```

Refer also to the OEMV-3 technical specifications in *Appendix A* of the *OEMV Family Installation and Operation User Manual* for comparisons.

Table 90: Receiver Hardware Parameters

	Temp. (°C)	Antenna Current	Core Voltage [a]	Supply Voltage	RF Voltage	Internal LNA Voltage	GPAI	LNA Voltage
Min	-40	0	1.30	4.5	4.55	4.55	0	0
Max	100 [b]	0.10	1.65	18	5.25	5.25	2.5	30
Typical	40	0.04	1.37	12	5	5	0	5

a. The shown voltage levels are for OEMV-3 cards.

b. The board temperature is about 15°C higher than the ambient temperature. Bit 1, in *Table 92, Receiver Status* on *Page 503*, turns on as a warning when the board temperature is above 100°C and a hazardous temperature error message is generated at 110°C.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RXHWLEVELS header	Log header		H	0
2	temp	Board temperature (degrees celsius)	Float	4	H
3	ant current	Approximate internal antenna current (A)	Float	4	H+4
4	core volt	CPU core voltage (V)	Float	4	H+8
5	supply volt	Receiver supply voltage (V)	Float	4	H+12
6	rf volt	5V RF supply voltage (V)	Float	4	H+16
7	int lna volt	Internal LNA voltage level (V)	Float	4	H+20
8	GPAI	General purpose analog input (V)	Float	4	H+24
9	Reserved		Float	4	H+28
10			Float	4	H+32
11	lna volt	LNA voltage (V) at OEM card output	Float	4	H+36
12	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+40
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.113 RXSTATUS Receiver Status *V123*

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 186*.

1. Field #4, the receiver status word as represented in *Table 92*, is also in Field #8 of the header. See the *ASCII Example* below and *Table 92* on *Page 503* for clarification.
2. Refer also to the chapter on *Built-In Status Tests* in the *OEMV Family 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 186* 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 193*.

Table 91: 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	Thermometer status	OK	Error
	9	0x00000200	Temperature status (as compared against acceptable limits)	OK	Error
	10	0x00000400	MINOS5 status	OK	Error
	11	0x00000800	PLL RF1 hardware status - L1	OK	Error
N3	12	0x00001000	PLL RF2 hardware status - L2	OK	Error
	13	0x00002000	RF1 hardware status - L1	OK	Error
	14	0x00004000	RF2 hardware status - L2	OK	Error
	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 Page 503

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 OEMV card may also be indicated by a flashing red LED.

Table 92: Receiver Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x00000001	Error flag, see *Table 91, Receiver Error* on *Page 502*	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 58*	Powered	Not powered
N1	4	0x00000010	Reserved		
	5	0x00000020	Antenna open flag [a]	OK	Open
	6	0x00000040	Antenna shorted flag [a]	OK	Shorted
	7	0x00000080	CPU overload flag [a]	No overload	Overload
N2	8	0x00000100	COM1 buffer overrun flag	No overrun	Overrun
	9	0x00000200	COM2 buffer overrun flag	No overrun	Overrun
	10	0x00000400	COM3 buffer overrun flag	No overrun	Overrun
	11	0x00000800	USB buffer overrun flag [b]	No overrun	Overrun

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Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
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 112*	Not fixed	Fixed
	21	0x00200000	Clock steering status	Enabled	Disabled
	22	0x00400000	Clock model flag	Valid	Invalid
	23	0x00800000	OEMV card external oscillator flag	Disabled	Enabled
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 is only available on OEMV-3 products (not on OEMV-1 or OEMV-2 where it is set to 0).

b. 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 93: 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 94: Auxiliary 2 Status

Nibble #	Bit #	Mask	Description	Bit = 0	Bit = 1
N0	0	0x0000001	Reserved		

Table 95: 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 91, Receiver Error* on *Page 502*). 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 92, Receiver Status* on *Page 503*)	ULong	4	H+8
5	rxstat pri	Receiver status priority mask, which can be set using the STATUSCONFIG command (*see Page 186)*	ULong	4	H+12
6	rxstat set	Receiver status event set mask, which can be set using the STATUSCONFIG command (*see Page 186)*	ULong	4	H+16
7	rxstat clear	Receiver status event clear mask, which can be set using the STATUSCONFIG command (*see Page 186)*	ULong	4	H+20
8	aux1stat	Auxiliary 1 status word (see *Table 93, Auxiliary 1 Status* on *Page 505*)	ULong	4	H+24
9	aux1stat pri	Auxiliary 1 status priority mask, which can be set using the STATUSCONFIG command (*see Page 186)*	ULong	4	H+28
10	aux1stat set	Auxiliary 1 status event set mask, which can be set using the STATUSCONFIG command (*see Page 186)*	ULong	4	H+32
11	aux1stat clear	Auxiliary 1 status event clear mask, which can be set using the STATUSCONFIG command (*see Page 186)*	ULong	4	H+36
12	aux2stat	Auxiliary 2 status word (see *Table 94, Auxiliary 2 Status* on *Page 505*)	ULong	4	H+40
13	aux2stat pri	Auxiliary 2 status priority mask, which can be set using the STATUSCONFIG command (*see Page 186)*	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

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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 95, Auxiliary 3 Status* on *Page 505*)	ULong	4	H+56
17	aux3stat pri	Auxiliary 3 status priority mask, which can be set using the STATUSCONFIG command (*see Page 186)*	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)	-	-	-

3.3.114 RXSTATUSEVENT Status Event Indicator *V123*

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 186*.

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 193*.

See also the chapter on *Built-In Status Tests* in the *OEMV Family 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,"COM3 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 501*, 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 yellow 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 96: Status Word

Word (binary)	Word (ASCII)	Description
0	ERROR	Receiver Error word, see *Table 91* on *Page 502*
1	STATUS	Receiver Status word, see *Table 92* on *Page 503*
2	AUX1	Auxiliary 1 Status word, see *Table 93* on *Page 505*
3	AUX2	Auxiliary 2 Status word see *Table 94* on *Page 505*
4	AUX3	Auxiliary 3 Status word see *Table 95* on *Page 505*

Table 97: 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 96* above)	Enum	4	H
3	bit position	Location of the bit in the status word (see *Table 92* starting on *Page 503 for the receiver status* table or the auxiliary status tables on *Page 505*)	Ulong	4	H+4
4	event	Event type (see *Table 97* 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)	-	-	-

3.3.115 SATVIS Satellite Visibility *V123*

Satellite visibility log with additional satellite information.

1. 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.
2. 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. Refer also to the *GLONASS* chapter of the *GPS+ Reference Manual* available from our website at http://www.novatel.com/support/docupdates.htm.

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*a0b7cc0b
```

Consider 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 355*, 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.	Double	8	H+36
11	app dop	Apparent Doppler for this receiver - the same as Theoretical Doppler above but with clock drift correction added.	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 ARINC in the *Standards and References* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/support/docupdates.htm.

3.3.116 SATXYZ SV Position in ECEF Cartesian Coordinates *V123*

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 10* on *Page 245*.

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 OEMV family use 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)	-	-	-

3.3.117 TIME Time Data *V123*

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 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 155*, 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 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
```

Consider the case where you used the ADJUST1PPS command, see *Page 50*, to synchronize two receivers in a primary/secondary relationship to a common external clock. You can use the TIME log after the clock model has stabilized at state 0, to monitor the time difference between the Primary and Secondary receivers.

The header of the TIME log gives you the GPS time (the week number since January 5th, 1980) and the seconds into that week. The TIME log outputs the UTC offset (offset of GPS time from UTC time) and the receiver clock offset from GPS 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 time = 1432 (GPS week), 235661.000 (GPS seconds) from the header.

From the UTC offset row in the TIME log description on *Page 516*:

UTC time = GPS 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 50* on *Page 249*	Enum	4	H
3	offset	Receiver clock offset, in seconds from GPS time. A positive offset implies that the receiver clock is ahead of GPS time. To derive GPS time, use the following formula: GPS time = receiver time - offset	Double	8	H+4
4	offset std	Receiver clock offset standard deviation.	Double	8	H+12
5	utc offset	The offset of GPS time from UTC time, computed using almanac parameters. UTC time is GPS time plus the current UTC offset plus the receiver clock offset: UTC time = GPS 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	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.

3.3.118 TIMESYNC Synchronize Time Between GPS Receivers *V123*

The TIMESYNC log is used in conjunction with the ADJUST1PPS command, see *Page 50*, to synchronize the time between GPS receivers.

Refer also to the *Transfer Time Between Receivers* section in the *OEMV Family Installation and Operation User Manual.*

Message ID: 492
Log Type: Synch

Recommended Input:

log timesynca ontime 1

ASCII Example:

```
#TIMESYNCA,COM1,0,46.0,FINESTEERING,1337,410095.000,00000000,bd3f,1984;
1337,410095000,FINESTEERING*aa2025db
```

The time data embedded in this log represents the time of the most recent 1PPS signal. This log should be issued from a communications port within 200 ms, of the last 1PPS event. See *Figure 1, 1PPS Alignment* on *Page 51* for an illustration.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	TIMESYNC header	Log header		H	0
2	week	GPS week number	Ulong	4	H
3	ms	Number of milliseconds into the GPS week	Ulong	4	H+4
4	time status	GPS Time Status, see *Table 7, GPS Time Status* on *Page 27*	Enum	4	H+8
5	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+12
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

3.3.119 TRACKSTAT Tracking Status *V123*

This log provides channel tracking status information for each of the receiver parallel channels.

If both the L1 and L2 signals are being tracked for a given PRN, two entries with the same PRN appear in the tracking status log. As shown in *Table 70, Channel Tracking Status* on *Page 368* these entries can be differentiated by bit 20, which is set if there are multiple observables for a given PRN, and bits 21-22, which denote whether the observation is for L1 or L2. This is to aid in parsing the data.

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,
1,0,11309c0b,21836083.168,-1746.788,42.616,1141.780,0.000,OBSL2,0.000,
30,0,18109c24,24248449.644,-2588.133,45.237,939.380,-0.493,GOOD,0.519,
30,0,11309c2b,24248452.842,-2016.730,38.934,939.370,0.000,OBSL2,0.000,
...
14,0,18109da4,24747286.206,-3236.906,46.650,1121.760,-0.609,GOOD,0.514,
14,0,11309dab,24747288.764,-2522.270,35.557,1116.380,0.000,OBSL2,0.000,
0,0,0c0221c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,0c0221e0,0.000,0.000,0.047,0.000,0.000,NA,0.000*255a732e
```

The OEMV-3 with L-band and HP/XP requires the following minimum number of satellites for the following operations:

- single point = 4 GPS satellites
- RTK, including HP/XP = 5 GPS satellites

Extra satellites provide additional redundancy, which is good to have. Note that the default cut-off angle is 5 degrees, and single point positioning utilizes all available GPS satellites in the position solution.

RTK solutions, including HP/XP, only use GPS satellites that are above the RTK elevation angle, (usually 12.5 degrees). So, although there could be more than 5 GPS satellites in view, if there are not at least 5 GPS satellites above 12.5 degrees then an RTK solution may not be possible.

Table 98: 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
13	OBSL2	L2 observation is ignored and not used in the solution
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 47, Solution Status* on *Page 233*)	Enum	4	H
3	pos type	Position type (see *Table 46, Position or Velocity Type* on *Page 232*)	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 70, Channel Tracking Status* on *Page 368*)	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 98, Range Reject Code* on *Page 519*)	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)	-	-	-

3.3.120 VALIDMODELS Valid Model Information *V123*

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,"ME3",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 69*, to add a model and the MODEL command, see *Page 145*, to change the currently active model. See the VERSION log on *Page 522* 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

3.3.121 VERSION Version Information *V123*

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 101, VERSION Log: Field Formats* on *Page 523* for details on the format of key fields.

See also the VALIDMODELS log on *Page 521*.

Message ID: **37**

Log Type: **Polled**

Recommended Input:

log versiona once

ASCII Example:

```
#VERSIONA,COM1,0,71.5,FINESTEERING,1362,340308.478,00000008,3681,2291;
1,GPSCARD,"L12RV","DZZ06040010","OEMV2G-2.00-2T","3.000A19","3.000A9",
"2006/Feb/ 9","17:14:33"*5e8df6e0
```

Unlike the OEM4 family, there is no need for an extra OmniSTAR Interface Board (I-Board) on L-band capable OEMV receivers. If you have an OmniSTAR subscription and the receiver is tracking an OmniSTAR satellite, the OmniSTAR serial number can be found in the LBANDINFO log, see *Page 319*.

The VERSION log is a useful log as a first communication with your receiver. When you connect to your receiver using CDU or HyperTerminal, log the VERSION log and check that the output makes sense. Also, ensure that you have the receiver components you expected.

Table 99: Model Designators

L	1 L-band Channel with CDGPS, VBS and/or HP capability
G	12 L1 or 12 L1/L2 GLONASS channels, frequencies to match GPS configuration
R	Receive RT2 and/or RT20 corrections
I	Synchronized Position Attitude Navigation (SPAN)
S	Reduces positions and measurement rates to 5 Hz, disables VARF and EVENT signals
A	Application Program Interface (API)

Table 100: Component Types

Binary	ASCII	Description
0	UNKNOWN	Unknown component
1	GPSCARD	OEMV family component
2	CONTROLLER	Data collector
3	ENCLOSURE	OEM card enclosure
4-6	Reserved	
7	IMUCARD	IMU card
981073920 (0x3A7A0000)	DB_HEIGHTMODEL	Height/track model data
981073921 (0x3A7A0001)	DB_USERAPP	User application firmware
981073925 (0x3A7A0005)	DB_USERAPPAUTO	Auto-starting user application firmware

a. Please refer to the Acronyms section in the *GPS+ Reference Manual* available from our website at http://www.novatel.com/support/docupdates.htm.

Table 101: VERSION Log: Field Formats

Field Type	Field Format (ASCII)	Description
hw version	P-RS-CCC	P = hardware platform (for example, OEMV) R = hardware revision (for example, 3.00) S = processor revision (for example, A) [a] CCC = COM port configuration (for example, 22T) [b]
sw version, boot version	VV.RRR[Xxxx]	VV = major revision number RRR = minor revision number X = Special (S), Beta (B), Internal Development (D, A) xxx = number
comp date	YYYY/MM/DD	YYYY = year MM = month DD = day (1 - 31)
comp time	HH:MM:SS	HH = hour MM = minutes SS = seconds

a. 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 (valid for COM1 of the OEMV-2 only). Therefore, the example is for a receiver that uses RS-232 for COM 1 and COM 2 and LV-TTL for COM 3.

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 100, Component Types* on *Page 523*)	Enum	4	H+4
4	model	A base model name plus designators where there are 4 possible base names: L12: 20 Hz positions and measurements, RT2/20 base, 14 GPS L1/L2 and 2 SBAS channels L1: 20 Hz positions and measurements, RT20 base, 14 GPS L1 and 2 SBAS channels N12: 20 Hz positions, no measurements, 14 GPS L1/L2 and 2 SBAS channels N1: 20 Hz positions, no measurements, 14 GPS L1 and 2 SBAS channels The model designators are shown in *Table 99* on *Page 522*	Char[16]	16	H+8
5	psn	Product serial number	Char[16]	16	H+24
6	hw version	Hardware version, see *Table 101, VERSION Log: Field Formats* on *Page 523*	Char[16]	16	H+40
7	sw version	Firmware software version, see *Table 101*	Char[16]	16	H+56
8	boot version	Boot code version, see *Table 101*	Char[16]	16	H+72
9	comp date	Firmware compile date, see *Table 101*	Char[12]	12	H+88
10	comp time	Firmware compile time, see *Table 101*	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)	-	-	-

3.3.122 WAAS0 Remove PRN from Solution *V123_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 170*.

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)	-	-	-

3.3.123 WAAS1 PRN Mask Assignments *V123_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 (WAAS32, WAAS33, WAAS34, WAAS35 and WAAS45 for CDGPS). 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,ffeffffe0000000000000000000004004000000000000000000000,2*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 on 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

3.3.124 WAAS2 Fast Correction Slots 0-12 *V123_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 170* 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 on fast correction slots 0-12.

Table 102: Evaluation of UDREI

UDREI [a]	UDRE meters	$\sigma^2_{i.udre}$ meters^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 Page 530

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 102, Evaluation of UDREI* on *Page 528*
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)	-	-	-	-

3.3.125 WAAS3 Fast Corrections Slots 13-25 *V123_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 170* 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 on 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 Page 533

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 102, Evaluation of UDREI* on *Page 528*
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)	-	-	-	-

3.3.126 WAAS4 Fast Correction Slots 26-38 *V123_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 170* 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 on 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	-

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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 102, Evaluation of UDREI* on *Page 528*
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)	-	-	-	-

3.3.127 WAAS5 Fast Correction Slots 39-50 *V123_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 170* 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 on 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	-

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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 102, Evaluation of UDREI* on *Page 528*
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)	-	-	-	-

3.3.128 WAAS6 Integrity Message *V123_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*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 on 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 102, Evaluation of UDREI* on *Page 528*
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	

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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 102, Evaluation of UDREI* on *Page 528*
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	

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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 102, Evaluation of UDREI* on *Page 528*
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)	-	-	-	-

3.3.129 WAAS7 Fast Correction Degradation *V123_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*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 on 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

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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

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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)	-	-	-

3.3.130 WAAS9 GEO Navigation Message *V123_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)	-	-	-

3.3.131 WAAS10 Degradation Factor *V123_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 on 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)	-	-	-	-

3.3.132 WAAS12 SBAS Network Time and UTC *V123_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 time.

Message ID: 293

Log Type: Asynch

Recommended Input:

log WAAS12a onchanged

ASCII Example:

Not available at time of print.

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 on 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 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

3.3.133 WAAS17 GEO Almanac Message *V123_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 *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

3.3.134 WAAS18 IGP Mask *V123_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 on 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

3.3.135 WAAS24 Mixed Fast/Slow Corrections *V123_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 102* on *Page 528*. 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*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 102* on *Page 528*
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 Page 559

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	-

3.3.136 WAAS25 Long-Term Slow Satellite Corrections *V123_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	-

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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	-

3.3.137 WAAS26 Ionospheric Delay Corrections *V123_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)	-	-	-	-

3.3.138 WAAS27 SBAS Service Message *V123_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

ASCII Example:

Not available at time of print.

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 on 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)	-	-	-	-

3.3.139 WAAS32 CDGPS Fast Correction Slots 0-10 *V13_CDGPS*

WAAS32 are fast corrections for slots 0-10 in the mask of WAAS1 for CDGPS, see *Page 526.*

Message ID: **696**
Log Type: **Asynch**

Recommended Input:

log WAAS32a onchanged

ASCII Example:

```
#WAAS32A,COM2,0,70.5,FINE,1295,153284.000,00000240,18e9,34461;209,0,0,
-8097,0,0,0,0,-947,0,-2128,0,2570,14,0,14,14,14,14,0,14,0,14,0*58778ae5
```

The CDGPS data signal is structured to perform well in difficult, or foliated conditions, so the service is available more consistently. The network has a high degree of service reliability. The corrections signal has been structured around an open broadcast protocol so that additional hardware and software developers can easily extend the value of the data. The service is available on a cost-free basis.

For example, when tree harvesting, a boom operator can know exactly where he is in the forest at any given time of the day or night. In one application, the position of the antenna is shown on a screen and has a buffer ring around it which corresponds to the reach of the boom. The operator knows how close he can go to the boundary without crossing it. As well, he is able to flag obstacles or danger points in the harvest area for reference later and by other operators. The data is downloadable for post-processing and analysis later.

Table 103: Evaluation of CDGPS UDREI

UDREI	UDRE meters
0	0.01
1	0.02
2	0.03
3	0.05
4	0.10
5	0.15
6	0.20
7	0.25
8	0.30
9	0.35
10	0.40
11	0.45
12	0.50
13	0.60
14	Not Monitored
15	Do Not Use

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS32 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodp	Issue of PRN mask data	Ulong	4	H+4	-
4	prc0	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 0-10)	Long	4	H+8	-
5	prc1		Long	4	H+12	-
6	prc2		Long	4	H+16	-
7	prc3		Long	4	H+20	-
8	prc4		Long	4	H+24	-
9	prc5		Long	4	H+28	-
10	prc6		Long	4	H+32	-
11	prc7		Long	4	H+36	-
12	prc8		Long	4	H+40	-
13	prc9		Long	4	H+44	-
14	prc10		Long	4	H+48	-
15	udre0	udre(i): User differential range error indicator for the prn in slot i (i = 0-10)	Ulong	4	H+52	See *Table 103, Evaluation of CDGPS UDREI* on *Page 568*
16	udre1		Ulong	4	H+56	
17	udre2		Ulong	4	H+60	
18	udre3		Ulong	4	H+64	
19	udre4		Ulong	4	H+68	
20	udre5		Ulong	4	H+72	
21	udre6		Ulong	4	H+76	
22	udre7		Ulong	4	H+80	
23	udre8		Ulong	4	H+84	
24	udre9		Ulong	4	H+88	
25	udre10		Ulong	4	H+92	
26	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+96	-
27	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.140 WAAS33 CDGPS Fast Correction Slots 11-21 *V13_CDGPS*

WAAS33 are fast corrections for slots 11-21 in the mask for CDGPS.

Message ID: **697**

Log Type: **Asynch**

Recommended Input:

log WAAS33a onchanged

ASCII Example:

```
#WAAS33A,COM2,0,47.5,FINE,1295,158666.000,01000240,b23e,34461;209,0,0,
-3343,0,0,0,-533,0,0,0,0,0,14,0,14,14,14,0,14,14,14,14,14*6d890f5f
```

Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS33 message can be logged to view the data breakdown of WAAS frame 33 which contains information on CDGPS fast correction slots 11-21.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS33 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodp	Issue of PRN mask data	Ulong	4	H+4	-
4	prc11	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 11-21)	Long	4	H+8	-
5	prc12		Long	4	H+12	-
6	prc13		Long	4	H+16	-
7	prc14		Long	4	H+20	-
8	prc15		Long	4	H+24	-
9	prc16		Long	4	H+28	-
10	prc17		Long	4	H+32	-
11	prc18		Long	4	H+36	-
12	prc19		Long	4	H+40	-
13	prc20		Long	4	H+44	-
14	prc21		Long	4	H+48	-
15	udre11	udre(i): User differential range error indicator for the prn in slot i (i = 11-21)	Ulong	4	H+52	See *Table 103, Evaluation of CDGPS UDREI* on *Page 568*
16	udre12		Ulong	4	H+56	
17	udre13		Ulong	4	H+60	
18	udre14		Ulong	4	H+64	
19	udre15		Ulong	4	H+68	
20	udre16		Ulong	4	H+72	
21	udre17		Ulong	4	H+76	
22	udre18		Ulong	4	H+80	
23	udre19		Ulong	4	H+84	
24	udre20		Ulong	4	H+88	
25	udre21		Ulong	4	H+92	
26	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+96	-
27	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.141 WAAS34 CDGPS Fast Correction Slots 22-32 *V13_CDGPS*

WAAS34 are fast corrections for slots 22-32 in the mask of WAAS1 for CDGPS, see *Page 526*.

Message ID: **698**

Log Type: **Asynch**

Recommended Input:

log WAAS34a onchanged

ASCII Example:

```
#WAAS34A,COM2,0,73.0,FINE,1295,226542.000,00000040,1be8,34461;209,0,5879,0,0,
0,0,2687,0,10922,10922,10922,10922,0,14,14,14,14,0,14,15,15,15,15*3aeb74be
```

Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS34 message can be logged to view the data breakdown of WAAS frame 34 which contains information on CDGPS fast correction slots 22-32.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS34 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodp	Issue of PRN mask data	Ulong	4	H+4	-
4	prc22	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 22-32)	Long	4	H+8	-
5	prc23		Long	4	H+12	-
6	prc24		Long	4	H+16	-
7	prc25		Long	4	H+20	-
8	prc26		Long	4	H+24	-
9	prc27		Long	4	H+28	-
10	prc28		Long	4	H+32	-
11	prc29		Long	4	H+36	-
12	prc30		Long	4	H+40	-
13	prc31		Long	4	H+44	-
14	prc32		Long	4	H+48	-
15	udre22	udre(i): User differential range error indicator for the prn in slot i (i = 22-32)	Ulong	4	H+52	See *Table 103, Evaluation of CDGPS UDREI* on *Page 568*
16	udre23		Ulong	4	H+56	
17	udre24		Ulong	4	H+60	
18	udre25		Ulong	4	H+64	
19	udre26		Ulong	4	H+68	
20	udre27		Ulong	4	H+72	
21	udre28		Ulong	4	H+76	
22	udre29		Ulong	4	H+80	
23	udre30		Ulong	4	H+84	
24	udre31		Ulong	4	H+88	
25	udre32		Ulong	4	H+92	
26	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+96	-
27	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.142 WAAS35 CDGPS Fast Correction Slots 33-43 *V13_CDGPS*

WAAS35 are fast corrections for slots 33-43 in the mask of WAAS1 for CDGPS, see *Page 526*.

Message ID: **699**

Log Type: **Asynch**

Recommended Input:

log WAAS35a onchanged

ASCII Example:

```
This message is not being broadcast by CDGPS at the time of publication.
```

Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS35 message can be logged to view the data breakdown of WAAS frame 35 which contains information on CDGPS fast correction slots 33-43.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS35 header	Log header		H	0	
2	prn	Source PRN of message	Ulong	4	H	-
3	iodp	Issue of PRN mask data	Ulong	4	H+4	-
4	prc33	prc(i): Fast corrections (-2048 to +2047) for the prn in slot i (i = 33-43)	Long	4	H+8	-
5	prc34		Long	4	H+12	-
6	prc35		Long	4	H+16	-
7	prc36		Long	4	H+20	-
8	prc37		Long	4	H+24	-
9	prc38		Long	4	H+28	-
10	prc39		Long	4	H+32	-
11	prc40		Long	4	H+36	-
12	prc41		Long	4	H+40	-
13	prc42		Long	4	H+44	-
14	prc43		Long	4	H+48	-
15	udre33	udre(i): User differential range error indicator for the prn in slot i (i = 33-43)	Ulong	4	H+52	See *Table 103, Evaluation of CDGPS UDREI* on *Page 568*
16	udre34		Ulong	4	H+56	
17	udre35		Ulong	4	H+60	
18	udre36		Ulong	4	H+64	
19	udre37		Ulong	4	H+68	
20	udre38		Ulong	4	H+72	
21	udre39		Ulong	4	H+76	
22	udre40		Ulong	4	H+80	
23	udre41		Ulong	4	H+84	
24	udre42		Ulong	4	H+88	
25	udre43		Ulong	4	H+92	
26	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+96	-
27	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.143 WAAS45 CDGPS Slow Corrections *V13_CDGPS*

Each WAAS45 message contains a 2-bit IODP indicating the associated 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 CDGPS satellite (PRN 209) of the first bit of the message block.

Message ID: **700**

Log Type: **Asynch**

Recommended Input:

log WAAS45a onchanged

ASCII Example:

```
#WAAS45A,COM2,0,73.0,FINE,1295,228498.000,00000040,c730,34461;209,23,32,197,
-116,206,-1,-6,-3,-5546,3488,25,148,262,-312,867,4,3,0,2513,3488,0*02d6e0d5
```

Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS45 message can be logged to view the data breakdown of WAAS frame 45 which contains information on CDGPS slow corrections.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset	Scaling
1	WAAS45 header	Log header		H	0	-
2	prn	Source PRN of message	Ulong	4	H	-
3	mask1	Index into PRN mask (Type 1)	Ulong	4	H+4	-
4	iode1	Issue of ephemeris data	Ulong	4	H+8	-
5	dx1	Delta x (ECEF)	Long	4	H+12	0.125
6	dy1	Delta y (ECEF)	Long	4	H+16	0.125
7	dz1	Delta z (ECEF)	Long	4	H+20	0.125
8	ddx	Delta delta x (ECEF)	Long	4	H+24	2^{-11}
9	ddy	Delta delta y (ECEF)	Long	4	H+28	2^{-11}
10	ddz	Delta delta z (ECEF)	Long	4	H+32	2^{-11}
11	$da^{f0}1$	Delta a^{f0} clock offset	Long	4	H+36	2^{-31}
12	$t_0 1$	Applicable time of day	Ulong	4	H+40	16
13	mask2	Second index into PRN mask (Type 1)	Ulong	4	H+44	-
14	iode2	Second issue of ephemeris data	Ulong	4	H+48	-
15	dx1	Delta x (ECEF)	Long	4	H+52	0.125
16	dy1	Delta y (ECEF)	Long	4	H+56	0.125
17	dz1	Delta z (ECEF)	Long	4	H+60	0.125
18	ddx	Delta delta x (ECEF)	Long	4	H+64	2^{-11}
19	ddy	Delta delta y (ECEF)	Long	4	H+68	2^{-11}
20	ddz	Delta delta z (ECEF)	Long	4	H+72	2^{-11}
21	$da^{f0}2$	Delta a^{f0} clock offset	Long	4	H+76	2^{-31}
22	$t_0 2$	Applicable time of day	Ulong	4	H+80	16
23	iodp	Issue of PRN mask data	Ulong	4	H+84	-
24	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+88	-
25	[CR][LF]	Sentence terminator (ASCII only)	-	-	-	-

3.3.144 WAASCORR SBAS Range Corrections Used *V123_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 dependant 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 104* outlines the various responses.

Table 104: 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.

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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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