GG12™ W

Reference Manual

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1

Introduction

The GG12W™ is the first Magellan GPS+SBAS receiver designed to be certified for aviation. This new member of the Magellan GPS+SBAS family of products features ten independent channels capable of receiving L1 carrier and C/A code signals from GPS satellites and two channels dedicated to SBAS satellites. The GG12W OEM receiver board can be integrated with Technical Standard Order flight management systems, ground-based reference stations for GPS aircraft landing systems (SCAT I and LAAS), and other avionic systems.

The GG12W was developed to meet RTCA DO-178B Level B, RTCA DO-160E and DO-229D requirements for FAA qualification.

In order to receive GPS and SBAS signals, the antenna on your receiver must have a direct line of sight to the satellites. One of the primary advantages of the GG12W GPS+SBAS receiver architecture is the increased satellite coverage. GPS+SBAS technology can maintain high performance levels in areas with limited satellite visibility. In addition, powerful anti-jamming capabilities allow the GG12W to perform well in noisy RF environments.

To take advantage of the increased satellite availability, the GG12W has twelve configurable channels for L1 GPS. Each channel can be programmed to track GPS satellites.

Table 1.1. GG12W Technical Specifications

Time to First Fix (50% / 95%)	
Hot Start	25 seconds (50%) - 35 seconds (95%)
Warm Start	80 seconds (50%) - 95 seconds (95%)
Cold Start	150 seconds (50%) - 225 seconds (95%)
Positioning Mode	
Autonomous Position	3 meters (CEP 50%) 5 meters (95%)
SBA Differential Position	1 meter (CEP) 3 meters (95%)
Velocity Accuracy	0.1 knots (95%)
Position Latency	90 ms [1]
Dynamics	
Acceleration	10g max.
Speed	1,000 knots
Altitude	60,000 ft
Vibration	DO-160E
Dimensions & Weight	
Size	4.275” x 3.25” x 0.608”
Weight	3.8 ounces
Power Requirements	
Power Consumption	Operational: 0.29 A@+5.0 V DC (1.45 W) Backup Battery Current: 1 μA@3.6 V DC (B batt_in)
Voltage	5 volts regulated (±5%) DC input; 50 mV point to point ripple
External Wiring	30 gauge (minimum)
Back-up Battery Drain	Typical current draw at room temperature is less than 3 μA. Maximum value in temperature range is less than 15 μA.
Environmental Tolerances	
Operating Temperature Range	-30° C to +70° C
Storage Temperature Range	-40° C to +85° C

1 The time delay from the instant a message is time-tagged to when the receiver finishes it’s transmission at 115,200 baud. Latency specification is for certain messages. Latency of other messages under different conditions may yield different results

Functional Description

Upon application of power, the GG12W runs a self-test of internal memory and periodically self-tests various functions during normal operation. Test results are stored in memory and can be obtained by issuing the query command $PASHQ,BIT.

After self-test, the GG12W initializes its battery-backed RAM. If the battery-backed RAM fails self-test (for example, due to a low power condition), the GG12W resets itself and reports the loss of stored data, then initializes the 12 channels and begins searching for all satellites within its antenna's field of view. The GG12W can track up to 10 GPS and two SBAS satellites simultaneously. The GG12W locks onto the signals being generated by the satellites and begins downloading information on the orbital positions (ephemeris data) and the orbit schedules (almanac data) for each GPS and SBAS satellite. This data is automatically stored in battery-backed memory. Once the ephemeris data are collected for at least four satellites, the GG12W can compute its own position.

The GG12W calculates three-dimensional position and velocity when tracking four satellites. By also holding the altitude fixed, the GG12W can calculate a 2D position with three satellites.

The GG12W can compute up to five independent measurements every second, with no interpolation or extrapolation from previous solutions. The position and velocity computations are performed using all twelve channels simultaneously. The GG12W uses an instantaneous Doppler measurement technique to compute velocity, independent of the previous position computation. All computations for position, velocity, and direction of travel are referenced to the World Geodetic System WGS-84 ellipsoid.

Hardware Description

The horizontal dimensions of the GG12W receiver are shown in Figure 1.1. Functionally, the GG12W has two major sections: the radio frequency (RF) section, which decodes incoming GPS signals, and the digital section, which converts the decoded information to a digital format and then processes it.

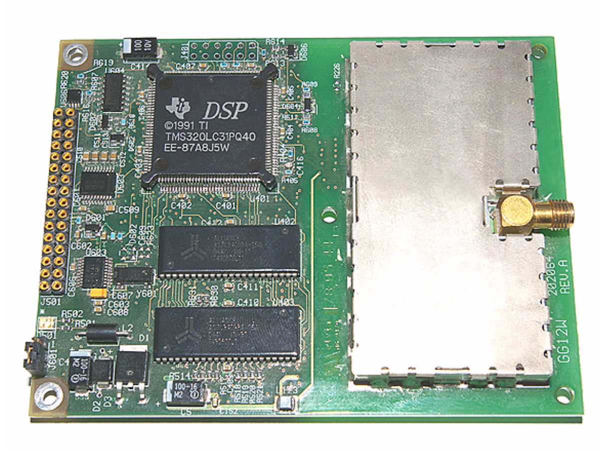

Figure 1.1. GG12W Receiver

The GG12W has two bi-directional RS-232 serial ports embedded in the J501 connector. J501 is a 32-pin dual inline (2 x 16) header connector. The RF input port is a coaxial SMA connector. Satellite data from a GPS+SBAS antenna and LNA is sent to the RF port through a coaxial antenna cable. The GG12W sends power to the antenna and LNA through the same coaxial cable, eliminating the need of separate power for the antenna. Power consumption for the antenna and LNA is approximately 150 milliwatts (depending upon model and manufacturer).

A two-color LED is mounted on the GG12W board to indicate status for power and satellite tracking. The LED flashes red to indicate power status and green to indicate satellite tracking status. A green flash occurs for each satellite being tracked.

An external LED can be connected to the board by wiring the common cathode to ground and wiring the anodes to LED-GRN (pin 22) and LED-RED (pin 21).

Pins 21 and 22 are routed to the processor through 100 ohm resistors in series.

Connections for Power and I/O

All power and input/output (I/O) connections are made at the J501 connector. J501 is a 32-pin male dual inline (DIN) header connector. In addition to connections for power and serial communication, J501 hosts connections for a back-up battery, manual reset, timing pulse output, and input for photogrammetric events. Figure 1.2 below lists the pin assignments for the J501 connector.

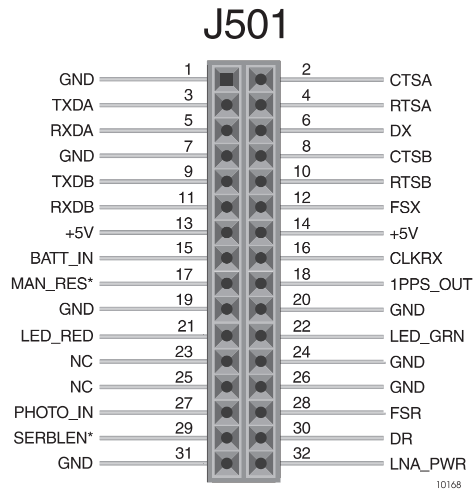

Figure 1.2. J501 Pin Assignments

CAUTION

To avoid damaging the GG12W board, turn off your power supply while connecting or disconnecting cables to the J501 connector. When connecting to J501, ensure that pin 1 of the cable is mated pin 1 of the connector.

Table 1.2. J501 Pin Descriptions

Pin	Code	Pin
1	GND	Ground connection for serial port A
2	CTSA	RS-232 port A clear to send
3	TXDA	RS-232 port A transmit data
4	RTSA	RS-232 port A request to send
5	RXDA	RS-232 port A receive data
6	DX	Magellan internal use only (leave floating)
7	GND	Ground connection for serial port B
8	CTSB	RS-232 port B clear to send
9	TXDB	RS-232 port B transmit data

Table 1.2. J501 Pin Descriptions (continued)

Pin	Code	Pin
10	RTSB	RS-232 port B request to send
11	RXDB	RS-232 port B receive data
12	FSX	Magellan internal use only (leave floating)
13	+5V	+5 VDC input
14	+5V	+5 VDC input
15	BATT_IN	Back-up battery (2.5-3.5 volt) input for memory and real-time clock
16	CLKRX	Magellan internal use only (leave floating)
17	MAN_RES	Manual hardware reset (connect to ground)
18	1PPS_OUT	Timing pulse output (TTL) synchronized to GPS time
19	GND	GG12W chassis common ground
20	GND	GG12W chassis common ground
21	LED_RED	Anode connection for External LED
22	LED_GRN	Anode connection for External LED
23	NC	Null connection
24	GND	GG12W chassis common ground
25	NC	Null connection
26	GND	GG12W chassis common ground
27	PHOTO_IN	Photogrammetry pulse input
28	FSR	Magellan internal use only (leave floating)
29	SERBLEN	Magellan internal use only (leave floating)
30	DR	Magellan internal use only (leave floating)
31	GND	GG12W chassis common ground
32	LNA_PWR	+5 VDC input for the low-noise amplifier

CAUTION

- **If pin 15 (BATT_IN) is not used, it should be connected to ground (GND)**
- **If pin 17 (MAN_RES) is not used, it should be left floating**
- **If pin 17 (MAN_RES) is used, the hardware reset can be triggered by pulling pin 17 to ground (GND) using a switch, or driving pin 17 to ground with an open-collector gate**

RF Connector

The RF connector is a standard 50-ohm SMA female coaxial connector wired for connection via coaxial cabling to a GPS+SBAS antenna with integral LNA. The SMA connector shell is connected to the GG12W common ground. The SMA center pin provides +5 VDC to power the LNA (maximum 100 mA draw) and accepts 1575-1616 MHz RF input from the antenna; the RF and DC signals share the same path.

CAUTION

The GG12W may be damaged if the center pin of the RF connector is not isolated from DC ground. Provide a DC block between the center pin and ground. The DC block should have the following characteristics:

- **VSWR 1.15 maximum**
- **Insertion loss 0.2 db maximum**
- **5 VDC maximum**

Antenna

The GG12W is designed to work with an active antenna and low-noise amplifier (LNA). An external LNA power source can be used (pin 32 on connector J501) by moving the jumper J601 from position 2-3 to position 1-2 (closest to J501). The gain of the antenna/preamplifier minus the loss of the cable and connectors should be between 20 and 30 dB. Connect the antenna cable directly to the antenna connector on the GG12W.

- If the antenna/LNA gain minus the RF network loss is between +20 dB and + 35 dB, the GG12W has good SNR and jam immunity.
- If the antenna/LNA gain minus the RF network loss is between +13 dB and + 20 dB, the GG12W has good jam immunity but it may be some SNR degradation (up to 2.5 dB).
- If the antenna/LNA gain minus the RF network loss is between +35 dB and + 45 dB, the GG12W has good SNR but it may be some jam immunity degradation.

A line amplifier should be used if the antenna/LNA gain minus the network loss is less than 20dB.

Antenna Requirements: Based on the antenna specification in RTCA/DO-228A and reasonable installation loss, the following assumptions are made for the derivation:

- Minimum antenna gain (passive element) at 2° elevation angle is -5.5 dB and antenna gain at boresight is 3 dB. The LNA/filter gain is 29.5 ± 3 dB; noise figure of the preamplifier is 2 dB (the equivalent noise temperature is 169.6 °K). Note that the system sky and antenna noise density Nsky, antenna of -174.7 dBm/Hz has accounted for the 2 dB noise figure of the antenna preamplifier, as well as the sky noise temperature of 75K.
- Antenna out-of-band rejection is 30 dB.
- 1-dB compression point of the antenna is 10 dBm.
- Loss in the cable between the antenna and the receiver port is between 3 and 13 dB.

Receiver Options

The GG12W supports a variety of internal options. The commands and features available to you depend upon the options installed in the receiver. For example, if the Timing Pulse Output option is not installed, you cannot use the set command **$PASHS,PPS** to configure and enable the output of a timing pulse.

Table 1.3 lists the available options. Each option is represented by a letter or number presented in a specific order. You can verify the installed options by issuing the **$PASHQ,RID** query command to the receiver through an external handheld controller or PC, as described in Table 1.3 .

The RID response message lists the installed options in a 14 character alphanumeric string:

$PASHR,RID,GG,FC00,55OPU__L_GM__Y*08

A letter or number displayed in the response message indicates an installed option. The presence of a dash (-) instead of a letter or number indicates an option that is not installed. An underscore (_) indicates a reserved option slot.

Table 1.3. GG12W Receiver Options

Option	Description
5 = 5 Hz 2 = 2 Hz	Position update rate
5 = 5 Hz 2 = 2 Hz	Raw measurement update rate
O	Raw data output
P	Carrier phase
U	Differential - remote station
L	Pulse per second (1 PPS)
G	Geoidal height
M	Magnetic variation
Y	SBAS

2

Getting Started

This chapter discusses basic operation of the GG12W, including hardware connections, power-up, serial port configuration, and status monitoring. Figure 2.1 shows the hardware connections.

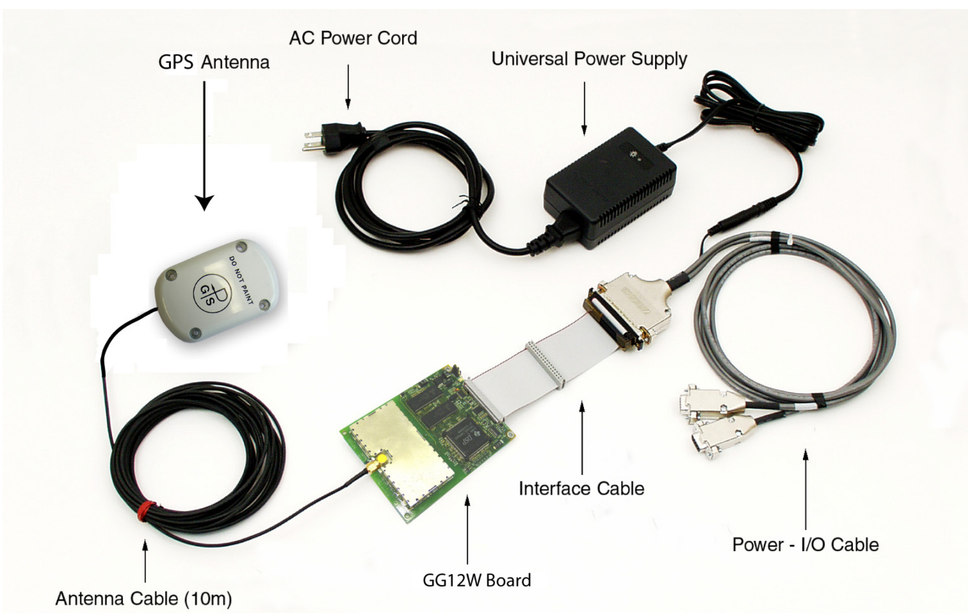

Figure 2.1. GG12W Hardware Connections

Antenna Connection

Attach the SMA connector on the antenna cable to the SMA connector on the GG12W board. Attach the TNC connector on the other end of the antenna cable to the TNC connector on the antenna. In order to receive satellite signals, the antenna must be placed in an open area with no obstructions overhead, such as the roof of a building.

Power Connection

If you plan to use the GG12W with equipment not supplied by Magellan, it must meet the hardware specifications described in Table 1.1.

Applying power to the power input pins on the J501 connector starts GG12W operation. Removing power from the power input pins on J501 stops GG12W operation. Connect any controller devices or data logging equipment to the input/output ports of the GG12W by way before applying power.

1. Connect the female DIN32 connector on cable assembly 730094 to the male DIN32 (J501) connector on the GG12W before applying power.
2. Connect the power cable to the power supply. On power-up, the status LED (D501) lights red and continues to flash red to indicate that the unit is on but is not yet computing positions. When the GG12W's automatic search results in a satellite acquisition, the status LED flashes green between the red power status flashes. Every satellite lock-on produces a green flash. A short green flash indicates the satellite is locked but not being used to compute positions; a long green flash indicates the receiver has locked on the satellite and is using it to compute positions. Once the GG12W locks to enough satellites to compute a position, the duration of the red flash also increases to indicate that positions are being computed.

CAUTION
To avoid damaging the GG12W, always turn off the power supply before connecting to or disconnecting from the J501 connector.

Receiver Initialization

It is a good idea to initialize the receiver before turning it on for the first time or if a system malfunction occurs. Initialization clears the receiver's internal memory and restores the default parameter settings. Issue the command below to initialize the GG12W:

$PASHS,INI,5,5,1<CR><LF>

This command sets the baud rate for both of the GG12W's serial ports to 9600, clears the receiver's internal memory, and restores the default parameter settings.

Satellite Tracking

When the GG12W is powered on for the first time, or when the power and back-up battery have been disconnected, the receiver has no almanac or ephemeris data in its memory, and set to the default parameters. In these cases, the GG12W assigns 12 elements from a 32-element table of satellite ID numbers to its 12 channels as it begins searching for GPS satellites. If no ephemeris data are in memory, or if the data are older than four hours, at least 48 seconds are needed to collect data. The GG12W synchronizes its clock to GPS time within six seconds of locking an SV. After three or four satellites are locked and the ephemeris data collected, the GG12W computes its first position. The GG12W continuously updates almanac, ephemeris, and position data in its battery-backed memory to help optimize satellite reacquisition and time to first fix when the unit is next powered on.

At the next power-up, if the almanac and ephemeris data are available in battery-backed memory, and if the ephemeris data are less than four hours old, the GG12W restricts its satellite search to those satellites that should be visible based on this information. Under these conditions, the GG12W on average recomputes position in 25 seconds (50%) (this is called a hot start). If the almanac and ephemeris data are available in battery-backed memory, but the ephemeris data are more than four hours old, the GG12W needs 80 seconds (50%) on average to compute a position (warm start). If almanac and ephemeris data and a valid position are not available at power-up, the GG12W needs 150 seconds (50%) on average to compute position (cold start).

In hot and warm start, after receiver turn-on and before the first computed position, the receiver assigns all 12 channels to GPS satellites in order to compute the first position as soon as possible. Once the first position has been computed, from this point and on - GG12W will permanently allocate 10 channels for GPS and 2 channels for SBAS satellites.

Receiver Communication

After the GG12W has power, you must issue commands to get data from it or to change the GG12W's operating parameters. The two RS-232 ports (A and B) can receive command messages from an external control device, send response messages to an external control device (such as a PC), and output data to a separate data logging device. The steps below describe how to send commands to and receive responses from the GG12W using an IBM-compatible personal computer. You can interface with the GG12W using Evaluate™ software or standard communication programs such a ProComm or Hyperterminal. To begin, simply connect port A or B of the GG12W interface cable to COM1 on the computer.

The GG12W's serial ports support full-duplex communication. The default protocol for transmitting or receiving data is 9600 baud, eight data bits, no parity, and one stop bit (8N1). In order for the GG12W to communicate with another device, the baud rate setting of the GG12W serial port and the serial port on the device with which it is interfaced must be the same.

DEFAULT SETTINGS	
Default parameters for GG12W serial ports A and B are shown below:	
Baud Rate	**9600**
Data Bits	**8**
Stop Bits	**1**
Parity	**None**

After connecting to the COM port and starting the communications program, you are now ready to send commands. Letters in the command string are typed in upper case and are sent to the receiver by pressing **<CR><LF>**. The commands used with the GG12W are divided into two groups: "Set" commands allow you to change the GG12W's operating parameters and begin with the command string **$PASHS**. "Query" commands allow you request information from the GG12W, such as the current operating parameters, current position, or differential GPS status. Query commands begin with the command string **$PASHQ**. The GG12W responds to query and set commands by issuing an acknowledgement of a change in operating parameters or by issuing the specific information requested through a query. All set and query commands end with the CR/LF characters. Some programs, like HyperTerminal, require users to enable this feature. All GG12W responses begin with the string **$PASHR**, for Magellan proprietary messages, or **$GP...** for NMEA standard messages.

To become familiar with GG12W messages, try sending a few common commands to it and observe the responses:

1. Assuming that you are still connected to port A, enter the following command to query the GG12W for the communication parameters of the serial port to which you are currently connected:

   $PASHQ,PRT

   The response message displays:

   ```
   $PASHR,PRT,A,5<CR><LF>
   ```

   The letter A in the response message indicates that the PC is connected to port A of the GG12W; the number 5 indicates that port A is using the default data rate of 9600 baud.

2. Enter the following command to set the GG12W to output comprehensive position information from port A once per second:

   $PASHS,NME,POS,A,ON,1

   After entering this command, the GG12W outputs a message similar to the one shown below once per second:

   ```
   $PASHR,POS,0,09,002701.00,3721.08661,N,12156.11611,W,00054.41,,
   047.27,000.44,-000.13,02.0,01.1,01.7,01.2,FC00*25<CR><LF>
   ```

   This data string contains 3D position, velocity, direction of travel, differential GPS status, and values for dilution of precision.

3. Enter the following command to set the GG12W to output comprehensive satellite tracking information from port A once every five seconds:

   $PASHS,NME,SAT,A,ON,5

   After entering this command, the GG12W will output a message like the one shown below at five-second intervals:

   ```
   $PASHR,SAT,03,03,103,56,60,U,23,225,61,39,U,16,
   045,02,21,U*6E<CR><LF>
   ```

   This data string contains the number of satellites locked, the PRN number, elevation, azimuth, and signal strength for each locked satellite, and also indicates whether a given satellite is used (U) or not used (-) to compute positions. See Chapter 4 for details on the commands and responses supported by the GG12W.

4. Enter the command below to disable the output of the POS and SAT messages:

   $PASHS,NME,ALL,A,OFF.

3

Operation

This chapter describes GG12W operation, including command format, serial port configuration, operational status, satellite system modes, position modes, differential mode, and other aspects of receiver functionality.

System Setup

If you are using equipment other than Magellan-supplied equipment with the GG12W, it must comply with hardware specifications listed in “Hardware Description” section on page 3.

Applying power to the power input pins on the J501 connector starts GG12W operation. Before applying power, connect any controller devices or data logging equipment to the input/output pins on the J501 connector. Cutting the flow of power to the power input pins on connector J501 stops GG12W operation.

CAUTION
To avoid damaging the GG12W, the power harness should always be connected to or disconnected from the J501 connector before the power supply is turned on

Message Formats

The GG12W’s two RS-232 ports (A and B) can receive command messages from an external control device (such as a personal computer), and send response messages to an external control device or a data logging device.

GG12W Input Messages

With the exception of differential correction messages, GG12W input messages are comprised of set command messages and query command messages. These messages comply with the format defined in the NMEA 0183 standard to the following extent:

- Input messages are ASCII byte strings following a dollar sign character ($).
- Data fields are separated by commas.
- An optional checksum can be added to the end of the input message. The character delimiter for the checksum is an asterisk (*). The hexadecimal checksum is computed by exclusive OR-ing (XOR) all of the bytes in the message between, but not including, the dollar sign and the asterisk.
- Messages end with the standard NMEA message terminator characters, **<CR><LF>** (carriage return/line feed).

Input messages deviate from the NMEA standard as follows:

- Message headers are Magellan proprietary.
- Message identifiers are Magellan proprietary.

All Set and Query command messages must be composed in uppercase characters. All command messages are sent by pressing **<CR><LF>**. A valid set command causes the GG12W to return the **$PASHR,ACK*3D** (acknowledge) response message. A set command containing a valid $PASHS header followed by character combinations unrecognized by the GG12W causes the receiver to respond with **$PASHR,NAK*30**, a “not acknowledge” response message indicating that the command is invalid. Valid query messages are acknowledged by return of the requested information. A query command containing a valid $PASHQ header followed by character combinations unrecognized by the GG12W also causes the receiver to respond with **$PASHR,NAK*30.**

GG12W Message Output

The GG12W can be programmed to output data to another device at regular intervals. Output messages include standard NMEA messages, Magellan NMEA-style messages, raw data messages, and ACK/NAK messages. With the exception of raw data messages, the data messages output by the GG12W comply with NMEA 0183 standards:

- NMEA ASCII byte strings following a dollar sign ($) character
- Headers are standard NMEA or Magellan proprietary NMEA
- Message IDs are standard NMEA or Magellan proprietary NMEA
- Standard NMEA messages and Magellan NMEA-style messages contain hexadecimal checksum bytes
- Data items are separated by commas; successive commas indicate inapplicable or missing data (null fields)
- Messages end with **<CR><LF>**, the standard NMEA message terminator characters

Output messages deviate from the NMEA standard as follows:

- Most message headers are Magellan proprietary.
- Most message identifiers are Magellan proprietary.
- Some messages exceed the maximum length of eighty characters as prescribed by NMEA

Raw data messages use Magellan proprietary headers and message identifiers, but the data in these messages is presented in binary format.

Serial Port Configuration

The GG12W receiver has two RS-232 serial ports that support two-way, full-duplex communication. On initial power-up, or after issuing the **$PASHS,RST** (restore defaults) command, the protocol for transmitting or receiving data is 9600 baud, eight data bits, no parity, and one stop bit (8N1).

In order for the GG12W to communicate with another device, the baud rate setting of the GG12W serial port and the serial port on the device with which it is interfaced must be the same.The baud rate setting of the GG12W's ports can be changed by issuing the **$PASHS,SPD** (set port speed) command. The data rate for each port can be set independently. You can select any standard data rate from 300 to 115,200 baud, but the settings for data bit, stop bit and parity are always 8N1. If you need to change the baud rate on one of the GG12W's serial ports, you should change the baud rate of the GG12W port first, and then change the baud rate of the external control device to match the new baud rate setting on the GG12W port.

Checking GG12W Status

Four query commands are available which prompt the GG12W to output messages containing current parameter settings:

$PASHQ,NMO,A (NMEA message output parameters, port A)

$PASHQ,NMO,B (NMEA message output parameters, port B)

$PASHQ,PPR (position computation parameters)

$PASHQ,RWO,A (raw data message output parameters, port A)

$PASHQ,RWO,B (raw data message output parameters, port B)

For more information on these commands, see Chapter 4.

On initial power-up, or after issuing the **command $PASHS,RST** (restore defaults), the GG12W reverts to its default parameter settings. The response to the query command $PASHQ,NMO,A shown below contains the default parameter settings for NMEA message output on port A:

```
$PASHR,NMO,A,5,100.0,14,LTN,000.0,ZDA,000.0,POS,000.0,GGA,000.0
,VTG,000.0,GSA,000.0,GSV,000.0,SAT,000.0,RRE,000.0,RMC,000.0,
GST,000.0,CHS,000.0,DAT,000.0,INF,000.0*67<CR><LF>
```

This message contains the three-letter identifier for each NMEA and Magellan NMEA-style message supported by the GG12W (LTN, POS…GST). Each message is followed by a field containing the setting for the output interval. The zeroes (000.0) appearing in the output interval fields indicate that all messages are disabled for output by default.

The response to the query command $PASHQ,PPR shown below contains the default settings for GG12W position computation parameters:

```
$PASHR,PPR,1,0,40,4,4,5,N,N,N,GPS*1C<CR><LF>
```

This message contains the settings for the PDOP, HDOP, VDOP, and position elevation masks (40,4,4,5). It also contains settings for position mode (1), fixed altitude mode(0), and satellites system mode (GPS).

The response shown below to the query command $PASHQ,RWO,A contains the default parameter settings for the output of raw data messages on port A:

```
$PASHR,RWO,A,5,001.0,12,PBN,000.0,UN1,000.0,UN2,000.0,MCA,000.0
,UN3,000.0,UN4,000.0,MBN,000.0,XYZ,000.0,SNV,000.0,SAL,000.0,
SNW,000.0,SAW,000.0*71<CR><LF>
```

Like the NMO message, the RWO message contains the three-letter identifiers for each raw data message supported by the GG12W (MCA, MBN…SAW). Each message is again followed by a field containing the setting for output interval. As indicated by the zero values in these fields, all raw data messages are disabled for output by default.

GG12W Operating Parameters

You can choose different settings for the parameters controlling GG12W operation, including position modes, fixed altitude modes, and more. For example, you can set the receiver to output NMEA messages or raw data messages at regular intervals. You can control if and when the GG12W computes 2D positions.

If you want to keep any of your new parameter settings, you must save them before cycling power to the receiver. Cycling power to the receiver without saving new settings causes the factory default settings to be restored for all GG12W operating parameters.

You can also restore the factory default settings for all operating parameters by issuing the command **$PASHS,RST**.

Saving Parameter Settings

When you change GG12W operating parameters, you can save the new settings by issuing the following command:

$PASHS,SAV,Y

You can verify that your new settings are in effect by issuing the query commands mentioned above to prompt the GG12W for its current status. The response messages output for each query displays the new settings instead of the default parameters.

Position Modes

You can set the GG12W to compute positions in four different modes. The position mode setting determines the conditions under which the receiver can calculate a 2D or 3D position. Use the set command $PASHS,PMD to change the position mode.

- Position Mode 0

This mode sets the GG12W to compute 3D positions only. The GG12W must track at least four satellites with elevations equal to or above the position elevation mask to compute a position. The receiver stops computing positions if the number of satellites being tracked falls below four. Two-dimensional (2D) positions are not computed in this mode.

- Position Mode 1 (default)

The receiver computes 3D positions when tracking four or more satellites. When the number of satellites being tracked drops to three, the GG12W automatically begins computing a 2D position and holds the altitude to a fixed value. See the next section for information on fixed altitude modes. The receiver stops computing positions if the number of satellites being tracked falls below three.

- Position Mode 2

This mode sets the GG12W to compute 2D positions only; the altitude is held to a fixed value regardless of the number of satellites being tracked. The receiver must be tracking at least three satellites with elevations equal to or above the position elevation mask to compute a position. The receiver stops computing positions if the number of satellites being tracked falls below three.

- Position Mode 3

The following conditions must be met in order for the receiver to compute 3D positions: it must be tracking four or more satellites with elevations equal to or above the position elevation mask, and the calculated HDOP value must be less than the HDOP mask setting. If the GG12W is tracking four or more satellites with elevations equal to or above the elevation mask, but the calculated HDOP is greater than the HDOP mask, the receiver computes 2D positions and holds the altitude to a fixed value. To compute 2D positions, the GG12W must be tracking at least three satellites with elevations equal to or above the elevation mask, and the calculated HDOP value must be higher than the HDOP mask setting. If the receiver is tracking three satellites and the calculated HDOP is greater than the HDOP mask, or if the number of satellites being tracked drops below three, the receiver stops computing positions.

DEFAULT SETTING
Position Mode 1

Fixed Altitude Modes

Two modes define the altitude setting when the GG12W is in fixed altitude mode. When the GG12W is not tracking a sufficient number of satellites to compute a 3D position, it calculates a 2D position and holds the altitude to a fixed value. The **$PASHS,FIX** set command can be used to select one these modes.

- Fixed Altitude Mode 0

The most recent altitude is used. This is either the altitude entered by using the **$PASHS,ALT** set command or the altitude computed by the receiver when four or more satellites are used in the position solution and the VDOP value is below the VDOP mask, whichever is most recent.

- Fixed Altitude Mode 1

The altitude value entered through the set command **$PASHS,ALT** is used in the position fix solution.

DEFAULT SETTING	
FIX	Mode 0

On initial power-up, or after issuing the command $PASHS,RST (restore defaults), the antenna altitude value referenced in the ALT command is set to zero

Position Elevation Masks

You can set values for two elevation mask thresholds. The position elevation mask is one of the parameters that determines which satellites the receiver uses in the position computation. Data from a satellite with an elevation that is at or below the value chosen for the position elevation mask is not included in the position computation. Use the set commands **$PASHS,PEM** and **$PASHS,SBA,PEM** to change the position elevation mask settings. $PASHS,PEM is used to set the elevation mask for all GPS satellites whereas $PASHS,SBA,PEM applies a specific elevation mask to SBAS satellites only

DEFAULT SETTING	
PEM	5°
SBA,PEM	5°

Raw Data Elevation Masks

The raw data elevation mask sets the threshold to determine from which satellites the receiver can output raw measurement data. The GG12W will not output raw measurement data for a satellite with an elevation at or below the value chosen for the raw data elevation mask. Use the set commands **$PASHS,ELM** and **$PASHS,SBA,ELM** to change the settings for the raw data elevation masks. $PASHS,ELM is used to set the elevation mask for all GPS satellites whereas $PASHS,SBA,ELM applies a specific elevation mask to SBAS satellites only.

DEFAULT SETTING	
ELM	2°
SBA,ELM	2°

DOP Masks

Dilution of precision (DOP) is a measure of the error resulting from satellite geometry relative to the user's location. In short, position computations based on data from satellites that are clustered tightly together relative to your location have higher DOP levels, which increases the amount error in the position solution. Position computations based on data from satellites that are widely spaced relative to your location have lower DOP levels, which affords more accurate position solutions.

You can set mask values for three dilution of precision measurements. PDOP (Position Dilution of Precision) corresponds to the 3D position measurement (that is, latitude, longitude, and altitude, or east, north, and up). Use the command **$PASHS,PDP** to change the PDOP mask setting.

DEFAULT SETTING	
PDP	40

HDOP (Horizontal Dilution of Precision) corresponds to the horizontal component of the 3D measurement. In simplistic terms, HDOP is like PDOP without the vertical component. Use the command **$PASHS,HDP** to change the HDOP mask value.

DEFAULT SETTING	
HDP	4

VDOP (Vertical Dilution of Precision) corresponds to the vertical component of the 3D measurement. Use the command **$PASHS,VDP** to change the VDOP mask value.

DEFAULT SETTING	
VDP	**4**

Correction & Integrity Elevation Mask

You can set another elevation mask on SBAS satellites. The correction and integrity elevation mask is one of the parameters that determines which satellites the receiver uses in the correction & integrity control. Data from a satellite with an elevation that is at or below the value chosen for the elevation mask is not included in the process. Use the **$PASHS,SBA,CEM** command to set the elevation mask applied to SBAS satellites.

DEFAULT SETTING	
SBA,CEM	**5°**

Ionospheric and Tropospheric Modelling

The GG12W applies a tropospheric delay correction to each satellite pseudo-range as described in RTCA/DO-229D Section A.4.2.4.

The GG12W extends both the GPS ionospheric and DO-229D tropospheric delay correction models to two-degree elevation. The DO-229D SBAS ionospheric delay correction model is still only applicable to five-degree elevation. Any atmospheric corrections applied below two-degree elevation are optional because the position elevation mask will normally never be set below 2 degrees. This requirement does not affect atmospheric corrections applied during precision approach mode since the position elevation mask must be five degrees during precision approaches.

If the ionospheric corrections provided by the SBAS are not applied to a pseudorange, then the GG12W will decode the ionospheric coefficients in the GPS navigation message and apply the ionospheric corrections described in the IS-GPS-200D, "Navstar GPS Space Segment / Navigation User Interfaces", December 2004.

If the ionospheric corrections provided by SBAS are applied to a satellite pseudorange, the GPS ionospheric model is not used for that satellite. A tropospheric correction is also applied.

GPS satellite navigation data is continuously decoded.

Ionospheric data (subframe 4) is not used until the data is verified by reception of a second message, potentially from a different satellite, containing the same data.

Note:The GG12W can track satellites under conditions of ionospheric scintillation that could occur during solar maximum at auroral and equatorial latitudes.

NMEA Output

The GG12W can output fourteen NMEA and Magellan NMEA-style messages. Eight standard NMEA messages are available:

- GGA: 3D GPS Position message.
- GSA: DOP and Active Satellites message.
- GST: Pseudorange Error Statistics message.
- GSV: Satellites in View message.
- RMC: Recommended Minimum Position and Course message.
- RRE: Satellite Range Residuals and Position Error message.
- VTG: Course and Speed Over the Ground message.
- ZDA: Time and Date message.

Six Magellan NMEA-style messages are available:

- LTN: Position Output Latency message.
- POS: 3D Antenna Position message.
- SAT: Comprehensive Satellite Tracking Status message.
- CHS: Channel Setting Information
- DAT: SBAS Raw Data Message
- INF: SBAS Information Message

Any combination of these messages can be output through either serial port at the same time, and you can even choose to send the same message can be output through both ports.

The output interval can be set individually, or you can set a global output interval for all messages being output with the set command **$PASHS,NME,PER**. The maximum output interval is 5 Hz. Depending on the update rate option installed (5, 2 or 1 Hz), the output interval can be set to any value between 0.2 and 999 seconds. The default setting for the output interval is one second. See Chapter 4 for more information on NMEA messages and Magellan NMEA-style messages.

DEFAULT SETTING	
PER	1 second.

Raw Data Output

The GG12W has an optional feature that allows you to output raw data (also called real-time data) through serial ports A and B. Twelve different messages can be output:

- MBN: Contains measurement data for each locked satellite in the Magellan type 2 data structure.
- MCA: Contains measurement data for each locked satellite in the Magellan type 3 data structure.
- PBN: Contains position and velocity data.
- SAL: Contains GPS satellite almanac data in a proprietary format.
- SNV: Contains GPS satellite ephemeris data.
- XYZ: Contains 3D position data and range for each locked satellite.
- UN1: Abridged Position and General Data
- UN2: Abridged Measurement Data
- UN3: Satellite Corrections Data
- UN4: Satellite Navigational Status Data
- SNW: SBAS Ephemeris Data
- SAW: SBAS Almanac Data

All raw data messages are in binary format. The transmission protocol remains the same: 8 data bits, 1 stop bit, and no parity bit. Any combination of messages can be output through any of the serial ports, and the same messages can be output through different ports at the same time. The output interval is set by the **$PASHS,RCI** command, which can range between 0.2 and 999 seconds depending upon the option selected for the raw measurement update rate (5 or 2 Hz). Information on the structure and content for all the above messages can be found in “Raw Data Commands” section on page 67.

DEFAULT SETTING	
RCI	**1 second.**

SBAS Output

The GG12W has a feature that allows you to output SBAS data through serial ports A and B. Two different messages can be output:

- DAT: SBAS data message
- INF: SBAS status information message.

Timing Pulse (Optional)

When the timing pulse option [L] is installed, the GG12W can output a timing pulse synchronized with GPS time to an accuracy of ±1 microsecond. The timing pulse is a TTL-level square wave signal output on pin 18 of the J501 connector and is fed into a 75-ohm impedance. The pulse is generated by default once every second (1PPS, or 1 pulse-per-second) with no offset from GPS time and with the rising edge of the pulse synchronized to GPS time.

Use the **$PASHS,PPS** command to change the period of the pulse from 0.2 of a second up to 60 seconds, depending upon the receiver update rate, which, in turn, is dependent upon the installed position update rate and raw data update rate options. The timing pulse may be offset from GPS time within a range of -999.9999 to +999.9999 milliseconds. GPS time can be synchronized to the rising or falling edge of the square wave pulse.

DEFAULT SETTING		
PPS	**Period**	**1 second**
	Offset	**0.0000 milliseconds**
	Synchronization	**GPS time synchronized to the rising edge of the pulse**

Figure 3.1 shows timing pulse characteristics under default conditions. The pulse occurs when the signal goes high (i.e., goes from zero to five volts). The pulse is generated within ±1 microsecond of the GPS second and remains high for 1-2 milliseconds. The precision of the epoch between pulses is ±100 nanoseconds. The GG12W must be computing positions and tracking a minimum of four satellites in order for the one microsecond accuracy and 45/190 nanosecond precision to be valid.

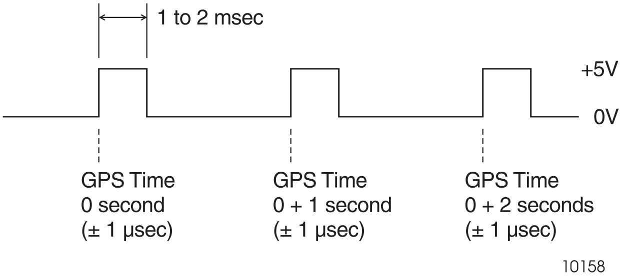

Figure 3.1. Timing Pulse Characteristics

In order to provide notification to peripheral equipment and software with respect to time tagging the occurrence of the timing pulse, it is necessary to set the output of PBN raw data message to match the period of the timing pulse. The GPS time value contained in the PBN message plus one second is the time that the next pulse will occur when the default settings are in effect (Figure 3.2). PBN time is already internally rounded to GPS time, so it is the actual time to which the navigation 1PPS pulse generation which preceded it (unless that pulse has been intentionally advanced or retarded). The latency of PBN message output is normally about 40 milliseconds after the timing pulse event.

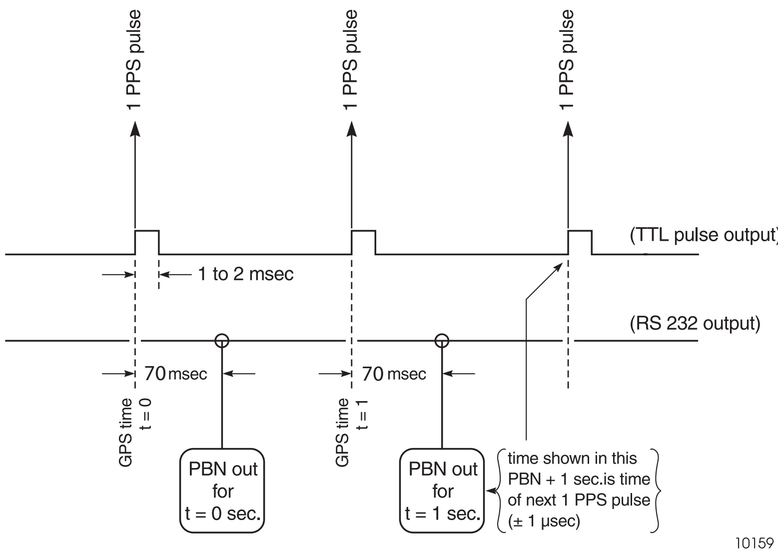

Figure 3.2. Relationship of GPS Time in PBN Record to Output of 1PPS Pulse

Operation

4

Command/Response Formats

This chapter covers the formats and content of the serial port commands through which the GG12W receiver is controlled and monitored. These serial port commands set receiver parameters and request receiver status information and other data. Use Evaluate™ software or any other standard serial communication software to communicate with the receiver. Note that the baud rate and protocol of the computer COM port must match the baud rate and protocol of the receiver port for commands and responses to be successfully transmitted and received. The communication protocol is 8 data bits, 1 stop bit, and no parity.

All messages sent by the user to the receiver are either "Set" command messages or "Query" command messages. Set commands typically change receiver parameters and initiate data output. Query commands typically request receiver status information. All set commands begin with the string **$PASHS**; all query commands begin with **$PASHQ**. **$PASHS** and **$PASHQ** are the message headers. They are required for all set or query commands. All commands must end with **<CR><LF>** (Carriage Return/Line Feed) in order to send the command to the receiver. If desired, an optional checksum may precede the **<CR><LF>** characters. All response messages also end with **<CR><LF>** characters. Please note that some messages are functional only if the appropriate option is installed.

When a command is sent to one of its serial ports, the GG12W responds by outputting a message indicating the acceptance or rejection of the command. In the case of query commands, the GG12W either outputs a response message containing data relevant to the query or sends a "NAK" response, indicating that the query command was invalid. All GG12W response messages begin with the string **$PASHR** for Magellan proprietary messages, or **$GP...** for NMEA standard messages, including status messages that are set for output at regular intervals.

GG12W serial port commands fall into four groups:

- Receiver Commands, page 33
- Raw data commands, page 67
- NMEA message commands, page 107
- SBAS messages, page 135

The following sections discuss each type of command. Within each section, the commands are listed alphabetically and described in detail. A description of the command, the command structure, the range and default states of command parameters, and an example of how a given command is used are presented for each command. These parameters may be either characters or numbers depending upon the command. Table 4.1 lists symbols and the types of data represented by them that we will use to illustrate message structures in the ASCII format:

Table 4.1. Command Parameter Symbols

Symbol	Parameter Type	Example
c	1 character ASCII	N
d	Numeric integer	3
f	Numeric real	2.45
h	hexadecimal digit	FD2C
m	mixed parameter (integer and real) for lat/lon or time	3729.12345
s	character string	
*hh	hexadecimal checksum; always preceded by an asterisk (*)	*A5

Receiver Commands

Receiver commands allow you to change or query the status of various operating parameters such as elevation mask, antenna altitude, position mode, etc. In this context, set commands are used to change GG12W operating parameters. Query commands prompt the GG12W to output status messages for parameter settings and receiver operation. If an invalid set or query command is issued, a “not acknowledged” (NAK) response is output as shown below:

```
$PASHR,NAK*30<CR><LF>
```

Set command messages can be accepted by either serial port. When the GG12W receives a valid set command message, it returns an "acknowledged" (ACK) message:

```
$PASHR,ACK*3D<CR><LF>
```

The GG12W returns a NAK message if the command is invalid.

The set command **$PASHS,SAV,Y<CR><LF>** instructs the GG12W to save user-entered operation parameters; the GG12W returns $PASHR,ACK*3D to acknowledge that the command was valid and the instruction was carried out.

The set command **$PASHS,SAV<CR><LF>** is incomplete, and would cause the GG12W to flag it as an invalid command by responding with a “not acknowledged” response:

```
$PASHR,NAK*30<CR><LF>
```

The set command message structure is shown below:

Header,Command ID,<Command Parameters>*Checksum<CR><LF>

The header field always contains **$PASHS**. The command identifier field contains a three character string and is followed by the command parameters. The checksum is strictly optional. All set commands are terminated with the **<CR><LF>** keystroke. All command string elements between the dollar sign ($) and the asterisk (*), including the command parameters, are comma delimited; that is, the header, the ID string, and the individual command parameters are separated by commas.

The set command used to set the HDOP mask value is entered as shown below:

$PASHS,HDP,6<CR><LF>

Query commands are used to request current GPS information and receiver status information such as port, baud rate, position information, and tracking information. Query command messages can be sent to either serial port on the GG12W. Some query commands allow you to designate the port from which the response message is sent. The GG12W acknowledges a valid query command message by sending the requested response message through the specified port. If the port is not specified in the query command, the response is sent from the same port which received the query. The requested information is sent once each time the command is issued and is not repeated.

The query command message format is shown below:

$PASHQ,xxx,<optional query parameter>*hh<CR><LF>

Table 4.2 lists the query command elements.

Table 4.2. Query Command Structure

Field	Description
$	NMEA message start character
PASHQ	Proprietary Magellan header for query messages
xxx	Message identifier
<optional query parameter>	Designates the data port from which the query response message is to be sent
*	Checksum delimiter
hh	Hexadecimal checksum value (checksum is optional)

The query command **$PASHQ,PRT<CR><LF>** instructs the GG12W to output a response message indicating the connected serial port and baud rate:

```
$PASHR,PRT,A,5*56<CR><LF>
```

The query command **$PASHQ,PR<CR><LF>** is incomplete, and causes the GG12W to flag it as an invalid message by outputting the NAK response.

Table 4.3 lists the receiver commands. The commands are listed alphabetically by function, and then alphabetically within each function. The commands are described in detail in the pages following Table 4.3.

Table 4.3. Receiver Commands

Function	Command	Description	Page
Antenna Position	$PASHS,ALT $PASHS,POS $PASHQ,POS	Set ellipsoidal height of antenna Set antenna position Query current antenna position	page 36 page 47 page 47
Clock Parameters	$PASHQ,DUG	Query for GPS/UTC time difference	page 40
Dilution of Precision (DOP)	$PASHS,HDP $PASHS,PDP $PASHS,VDP	Set HDOP mask for position computation Set PDOP mask for position computation Set VDOP mask for position computation	page 42 page 45 page 66
GPS ionospheric data	$PASHQ,ION	Query for GPS ionospheric data	page 44

Table 4.3. Receiver Commands (continued)

Function	Command	Description	Page
Memory	$PASHS,INI $PASHQ,BIT $PASHS,RST $PASHS,SAV	Clear battery-backed memory Query for results of built-in test Restore default parameter settings Save parameters in battery-backed-up memory	page 42 page 36 page 59 page 59
Position Computation	$PASHS,FIX $PASHS,PEM $PASHS,PMD	Set fixed altitude mode Set elevation mask for position computation Set position computation mode	page 41 page 46 page 46
Receiver Configuration	$PASHS,CHM $PASHS,POP $PASHQ,PPR $PASHQ,PRT $PASHQ,RID $PASHQ,RIO $PASHS,SPD $PASHS,UTS	GPS/SBAS Acquis. & Re-Acquis. Parameters Set the receiver’s internal update rate for position and raw measurements Query current position computation parameters Query port baud rate Query receiver identification (Format 1) Query receiver identification (Format 2) Set baud rate of serial port Synchronize Measurements With GPS Time	page 38 page 47 page 50 page 54 page 55 page 57 page 59 page 65
Satellite Tracking Parameters	$PASHS,SVP $PASHQ,SVP $PASHS,SVS $PASHQ,SVS $PASHS,USE $PASHS,USP	Include/exclude satellites for position computation Query for satellites enabled/disabled for position computation Include/exclude specific satellites for acquisition and tracking Query for satellites enabled/disabled for acquisition and tracking Include/exclude satellites for acquisition and tracking Include/exclude satellites for position computation	page 60 page 60 page 62 page 62 page 63 page 64
Timing Pulse Output	$PASHS,PPS $PASHQ,PPS	Set period and offset of timing pulse Query timing pulse parameters	page 52 page 52

Since they are required for all commands and responses, <CR><LF> are omitted from the examples in this chapter.

ALT: Set Ellipsoidal Height

$PASHS,ALT,f1

This command allows you to set the ellipsoidal height of the antenna, where f1 can be any value from -99999.99 to **+**99999.99. The GG12W uses the altitude value set through this command when it is computing 2D positions.

Examples

Enter the following command to set the ellipsoidal height of the antenna to +100.25 meters:

$PASHS,ALT,+100.25<CR><LF>

Enter the following command to set the ellipsoidal height of the antenna to -30.1 meters:

$PASHS,ALT,-30.1 <CR><LF>

DEFAULT SETTING	
ALT	00000.00 meters

BIT: Query for Results of Built-in Tests

$PASHQ,BIT[,c1]

This command allows you to query the results of the GG12W self-test routine, also called the built-in test. The c1 parameter is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,BIT

The GG12W runs the built-in test each time it is turned on and periodically while it is operating. The built-in test routine essentially is a series of queries used to ascertain the status of several critical components and parameters. For example, the built-in test checks whether receiver parameters stored in non-volatile memory have been corrupted by querying for a checksum. If the returned checksum does not match one in a list of acceptable checksum values, the GG12W notes a failure in the BIT response message. The response message is output in the format:

```
$PASHR,BIT,c1,c2,c3*hh<CR><LF>
```

Table 4.4 outlines the response message.

Table 4.4. $PASHR,BIT Format

Parameter	Description	Range
c1	Indicates whether the battery in the real-time clock component has failed	P(ass) F(ail)
c2	Indicates whether the receiver parameter settings stored in non-volatile memory have been corrupted	P(ass) F(ail)
c3	Indicates whether a fatal failure has occurred. Fatal failures include the following items: • Failures in volatile and non-volatile memory • Firmware checksum failures • Failures in serial port A or B	P(ass) F(ail)
*hh	Checksum	2-character hex

Typical BIT message:

```
$PASHR,BIT,P,P,P*57<CR><LF>
```

Table 4.5 outlines the response message.

Table 4.5. Typical BIT Message

Field	Description
$PASHR,BIT	Header
P	Indicates that the battery in the real-time clock is functioning properly
P	Indicates that the response to the query for receiver parameters has returned a valid checksum
P	Indicates that no fatal failures have been reported
*57	Checksum

NOTE: The GPS battery status is in the inverse meaning. That is, 'P' means test failed, 'F' means test passed. The internal GPS battery test is not immediately run after the unit is powered on. This test is run within 100 seconds after turn on. Until this test is run, the GG12W reports 'P'. After this test is run, GG12W reports actual battery test status in the inverse meaning. This test is then repeated every 100 seconds.

CHM: GPS/SBAS Acquisition & Re-Acquisition Parameters

$PASHS,CHM,s1,s2,d3<CR><LF>

This command allows you to set the parameters related to the channel monitor acquisition & re-acquisition.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.6. $PASHS,CHM Command Format

Setting parameter	Description	Range
s1	Satellite system GPS or SBAS	'GPS' , 'SBA'
s2	Acquisition or Re-acquisition	'ACQ' , 'REA'
d3	Interval value in seconds	1 - 300

GPS satellites acquisition time interval:

During GPS satellite channel assignment, when a channel fails to acquire a specific GPS satellite after a user configurable GPS channel assignment acquisition interval, the GPS channel shall be allocated to the next usable, but currently unused, GPS satellite, in the order of the list of usable GPS satellites.

The command to set this GPS acquisition interval is:

$PASHS,CHM,GPS,ACQ,d3

Where d3 is the GPS satellites acquisition interval. It can be in the range 1-300 seconds. Default is 60 seconds.

GPS satellites re-acquisition time interval:

When a loss of lock occurs on a GPS channel for a satellite used in the navigation solution, the receiver shall continue to allocate the GPS channel to that satellite for a user configurable re-acquisition interval.

The command to set this interval is:

$PASHS,CHM,GPS,REA,d3

Where d3 is the GPS satellites re-acquisition interval. It can be in the range 1-300 seconds. Default is 60 seconds.

SBAS satellites acquisition time interval:

If a channel fails to acquire a specific GEO PRN signal after the user-configurable interval, the GEO PRN channel shall be reassigned to the next usable, but currently unused, GEO PRN signal in the order of the list of usable GEO PRN signals.

The command to set this interval is:

$PASHS,CHM,SBA,ACQ,d3

Where d3 is the SBAS satellites acquisition interval. It can be in the range 1-300 seconds. Default is 60 seconds.

SBAS satellites re-acquisition time interval:

If a loss of lock occurs on a SBAS PRN channel for a satellite used in the navigation solution, the receiver shall continue to assign the SBAS PRN channel to that PRN signal for a user-configurable re-acquisition interval.

The command to set this interval is:

$PASHS,CHM,SBA,REA,d3

Where d3 is the SBAS satellites re-acquisition interval. It can be in the range 1-300 seconds. Default is 60 seconds.

$PASHQ,CHM[,c1]

This command returns the four current settings for the acquisition & re-acquisition parameters. “c1” is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

Examples: $PASHQ,CHM<CR><LF>

Requests $PASHR,CHM message to be sent out on the current port.

$PASHQ,CHM,B<CR><LF>

Requests $PASHR,CHM message to be sent out on port B.

$PASHR,CHM

The response message is output in the ASCII format:

```
$PASHR,CHM,d1,d2,d3,d4*hh<CR><LF>
```

Commands

Table 4.7 outlines the response message.

Table 4.7. $PASHR,CHM Message Format

Parameters	Description	Range
d1	GPS satellites acquisition interval (sec)	1 – 300
d2	GPS satellites re-acquisition interval (sec)	1 – 300
d3	SBAS satellites acquisition interval (sec)	1 – 300
d4	SBAS satellites re-acquisition interval (sec)	1 – 300
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Example: $PASHQ,CHM,B<CR><LF>

Response: $PASHR,CHM,60,60,60,60*hh<CR><LF>

DUG: Query for GPS/UTC Time Difference

$PASHQ,DUG[,c1]

This command allows you to query the time difference between UTC time and GPS time; c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,DUG

The response message is output in the format:

```
$PASHR,DUG,<Binary Data String + Checksum><CR><LF>
```

Table 4.8 outlines the response message.

Table 4.8. $PASHR,DUG Format

Binary Type	Size	Content
unsigned short	2	Reference week
unsigned short	2	Reference time
unsigned short	2	GPS-UTC time (seconds)
unsigned short	2	GPS week number when the last leap second was added to GPS time.

Table 4.8. $PASHR,DUG Format (continued)

Binary Type	Size	Content
unsigned short	2	Julian day number when the last leap second was added to GPS time (1 to 365).
unsigned short	2	GPS-UTC time difference after correction (seconds)
unsigned short	2	Word checksum
Total bytes 14		

A time step, or leap second, was added to UTC on 12-31-05. GPS time was not physically adjusted, and is now fourteen seconds ahead of UTC. The time change is reflected in the navigation messages generated by the individual satellites as of January 1, 1999.

FIX: Set Fixed Altitude Mode

$PASHS,FIX,d1

This command allows you to set the fixed altitude mode, where d1 is 0 or 1. The GG12W uses a fixed value for the altitude when the receiver is in 2D position mode or when there are not enough visible satellites to compute a 3D position. You can view the current setting for fixed altitude mode by entering the query command **$PASHQ,PPR** and checking field d2. See also Fixed Altitude Modes on page 23.

Example

Enter the following command to set the GG12W in fixed altitude mode 1:

$PASHS,FIX,1<CR><LF>

DEFAULT SETTING	
FIX	Mode 0

HDP: Set HDOP Mask Value

$PASHS,HDP,d1

This command allows you to set the mask value for the Horizontal Dilution of Precision (HDOP), where d1 is a number between 0 and 99. If the HDOP value computed by the GG12W is higher than the HDOP mask value, the receiver will automatically go into fixed altitude mode. You can view the current HDOP mask value by entering the query command $PASHQ,PPR and checking field d4.

Example

Enter the following command to set an HDOP mask value of 6:

$PASHS,HDP,6<CR><LF>

DEFAULT SETTING	
HDP	4

INI: Initialize the Receiver

$PASHS,INI,d1,d2,d3

This command allows you to clear receiver memory and reset serial port baud rates, where d1 and d2 are baud rate setting codes for ports A and B, and d3 is the memory reset code. Table 4.9 and Table 4.10 below contain the code numbers and the settings associated with them.

Table 4.9. Serial Port Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
0	300	5	9600
1	600	6	19200
2	1200	7	38400
3	2400	8	56800
4	4800	9	115200

Table 4.10. Memory Reset Codes

Reset Memory Code	Action
0	No memory reset
1	Resets internal memory (battery-backed RAM)
2	Resets external memory (or PCMCIA card)
3	Resets internal and external memory
5	Performs warm start (clears ephemeris but not almanacs or position/time)
6	Performs special kind of start (clears ephemeris, time and position but not almanacs)

Table 4.11. Memory Reset Codes, Detailed Action

Reset Code / Action	0	1	2	3	5	6
Clears receiver parameters in BBU		•		•		
Clears ephemeris		•		•	•	•
Clears almanac		•		•		
Clears latest position		•		•		•
Clears RTC time		•		•		•
Resets channels	•	•		•	•	•
Restarts processor	•	•		•	•	•
Clears receiver parameters in RAM		•		•	•	•

Note: The command will always initialize all ports, even though fewer ports may be present in the field. Unused ports must be set to null (,,) or the initialization will not be performed (NAK). If a port that is present receives a null (,,) port initialization in this command, its speed is left at the current value.

Note: In a receiver where external memory (such as PCMCIA data card) is present, several minutes may be required to initialize the external memory. Do not turn the receiver off until you have verified that the external memory has finished initializing.

Example

Enter the following command to set Port A with a baud rate of 4800, Port B with a baud rate of 19200, and reset internal memory:

$PASHS,INI,4,6,1<CR><LF>

ION: Query Ionospheric Data

$PASHQ,ION[,c1]

This command allows you to query for current ionospheric data generated by the GPS satellites, where c1 is the optional output serial port. If an output port is not designated, the response is output from the same port that received the query.

$PASHR,ION

The response message is output in binary format:

```
$PASHR,ION,structure<CR><LF>
```

Where structure is as described in Table 4.12:

Table 4.12. $PASHR,ION Format

Type	Size	Contents
float	4	a0: Ionospheric parameter (seconds).
float	4	a1: Ionospheric parameter (sec. per semicircle).
float	4	a2: Ionospheric parameter (sec. per semicircle).
float	4	a3: Ionospheric parameter (sec. per semicircle).
float	4	b0: Ionospheric parameter (seconds).
float	4	b1: Ionospheric parameter (sec. per semicircle).
float	4	b2: Ionospheric parameter (sec. per semicircle).
float	4	b3: Ionospheric parameter (sec. per semicircle).
double	8	A1: Constant and first-order terms of polynomial.
double	8	A2: Constant and first-order terms of polynomial.
unsigned long	4	tot: Reference time for UTC data=0.. 604799 seconds
short	2	Wnt: UTC reference week number 0.. 1023
short	2	DtLS: Delta time due to leap seconds, in seconds.
short	2	WNLSF: Week number (0.. 1023) when leap second becomes effective.
short	2	DN: Day number (0.. 7) when leap second becomes effective.
short	2	DtLSF: Delta time between GPS and UTC, in seconds.
short	2	WN: GPS week number (0.. 1023)
unsigned long	4	tow: Time of week, in seconds (0.. 604799).
short	2	bulwn: GPS week number, same as WN (0.. 1023).

Table 4.12. $PASHR,ION Format (continued)

Type	Size	Contents
unsigned long	4	bultow: Time of week, same as tow (0.. 1023).
short	2	Word checksum, computed by breaking the structure into 37 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total characters = 76 bytes		

The GG12W does not calculate ionospheric parameters on its own. The ionosphereic data shown in Table 4.12 are obtained from subframe 4 of the GPS navigation message.

PDP: Set PDOP Mask Value

$PASHS,PDP,d1

This command allows you to set the mask value for the Position Dilution of Precision (PDOP), where d1 is a number between 0 and 99. The receiver stops computing positions when the calculated PDOP value exceeds the PDOP mask value. You can view the current PDOP mask setting by entering the query command **$PASHQ,PPR** and checking field d3.

Example

Enter the following command to set the PDOP mask to 30:

$PASHS,PDP,30<CR><LF>

DEFAULT SETTING	
PDP	40

PEM: Set Position Elevation Mask Value

$PASHS,PEM,d1

This command allows you to set elevation mask for position computation, where d1 is 0 to 90 degrees. Default is 5 degrees. A satellite with elevation that is less than the elevation mask setting is excluded from position computations. You can view the current position elevation mask value with the **$PASHQ,PPR** query command and checking the PEM field.

Example

Enter the following command to set the elevation mask to 15 degrees:

$PASHS,PEM,15<CR><LF>

DEFAULT SETTING	
PEM	5°

Although the GG12W does not use satellites in the position computation which have gone below the position elevation mask (PEM), you can still obtain raw data from these satellites as long as they are not below the raw data elevation mask (ELM).

PMD: Set Position Mode

$PASHS,PMD,d1

This command allows you to set the position mode. The position mode determines the minimum number of satellites required to compute a position, whether the receiver switches automatically from 2-D to 3-D positioning or is manually locked in 2-D or 3-D positioning mode, and, in 2-D mode, whether the altitude used is the most recently computed “good” altitude or a fixed altitude value set by the ALT command. Enter 0, 1, 2, or 3 for d1. You can view the current position mode by entering the query command $PASHQ,PPR and checking the PMD field. See the section in chapter 3 entitled “Position Modes” for more information on the position mode settings. See also Position Modes on page 22.

Example

Enter the following command to select Position Mode 3:

$PASHS,PMD,3<CR><LF>

DEFAULT SETTING	
PMD	1

POP: Set Position & Raw Data Update Rate

$PASHS,POP,d1

This command allows you to set the GG12W's internal update rate for position and raw data, where d1 is 1, 2 or 5 (Hz). One indicates that position and raw data will be computed internally once per second; two indicates that position and raw data will be computed internally twice per second; five indicates that position and raw data will be computed internally five times per second. The default is 2. Changes made to the POP setting are not saved with the **$PASHS,SAV,Y** command.

DEFAULT SETTING	
POP	2

POS: 3-D Antenna Position

$PASHS,POS,m1,c2,m3,c4,f5

This command allows you to optimize the GG12W's satellite search pattern by entering a 3-D antenna reference position into the receiver. This command is typically used when the receiver is turned on for the first time, or when the receiver has been moved more than 500 miles from the location in which it was last powered on. It is not necessary to use exact coordinates. Inputting approximate coordinates for your current position enables the receiver to restrict its satellite search to pattern to include only those satellites which should be visible in that particular area at that particular time. In the example above, m1 is the latitude, c2 is the latitude sector, m3 is the longitude, c4 is the longitude sector, and f5 is the altitude.

$PASHQ,POS[,c1]

This command allows you to query the receiver's current 3-D position, where c1 is the optional port designator for the output of the response message. If a port is not specified, the receiver sends the response to the current port.

$PASHR,POS

The response message is output in the format shown below:

```
$PASHR,POS,d1,d2,m3,m4,c5,m6,c7,f8,,f9,f10,f11,f12,f13,f14,f15,
s16*hh<CR><LF>
```

Table 4.13 outlines the response message.

Table 4.13. $PASHR,POS Message Format

Parameter	Description	Range
d1	Raw/differential position •0: Raw; position is not differentially corrected •1: Position is differentially corrected. Position is marked as differential if all satellites used in position solution have full SBAS corrections. Otherwise position is marked as autonomous (raw)	0, 1
d2	Indicates the number of satellites used in computing positions	0-12
m3	Current time (UTC)	00-235959.50
m4	Current latitude measured in degrees, minutes, and decimal minutes (ddmm.mmmmm)	0°-90°
c5	Latitude sector	N / S
m6	Current longitude measured in degrees, minutes, and decimal minutes (dddmm.mmmmm)	0°-180°
c7	Longitude sector	E / W
f8	Current altitude in meters referenced to the WGS-84 ellipsoid. In 2-D positioning mode, this field contains the fixed altitude value	-30000.000 to +30000.000
,,	Reserved data field.	
f9	Course over the ground (ttt.tt); referenced to true north.	0.00°-359.99°
f10	Speed over the ground (knots)	000.00 to 999.99
f11	Vertical velocity (meters per second)	-999.9 to +999.9
f12	Current computed PDOP value	0.00-99.9
f13	Current computed HDOP value	00.0-99.9
f14	Current computed VDOP value	0.00-99.9
f15	Current computed TDOP value (seconds)	0.00-99.9
s16	Firmware version code	4-character ASCII
hh	Checksum	2-character hex

Typical POS response message:

```
$PASHR,POS,0,09,002701.00,3721.08661,N,12156.11611,W,
        -00054.41,,047.27,000.44,-000.13,02.0,01.1,
01.7,01.2,FC00*25<CR><LF>
```

Table 4.14 outlines the response message.

Table 4.14. Typical POS Response Message

Item	Description
$PASHR	Header.
POS	Message identifier.
0	Indicates that the position is computed autonomously (computed without the aid of differential corrections)
09	Indicates that the receiver is using nine satellites to compute a position
002701.00	UTC time reference (00:27:01.00)
3721.08661	Current latitude (37°21.08661')
N	Latitude sector
12156.11611	Current longitude (121°56.11611')
W	Longitude sector
-00054.41	Current altitude (referenced to the WGS-84 ellipsoid)
,,	Reserved data field
047.27	Current course over the ground (that is, 47.27° from true north)
000.44	Current speed over the ground (knots)
-000.13	Current vertical velocity (this indicates that the receiver is ascending at a rate of 0.13 meters per second)
02.0	Current PDOP
01.1	Current HDOP
01.7	Current VDOP
01.2	Current TDOP
FC00	Firmware version number
*25	Checksum

If the GG12W is unable to compute a position, the POS response message is in the format:

```
$PASHR,POS,0,0,000103.00,,,,,,,,,,,,,#FC00*30<CR><LF>
```

The time field indicates the time in seconds since the receiver started searching for satellites.

The GG12W uses the WGS-84 ellipsoid only.

PPR: Query for Position Computation Parameters

$PASHQ,PPR[,c1]

This command allows you to query the receiver's current position computation parameters, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PPR

The response message contains the current settings for position mode, fixed altitude mode, satellite system mode, HDOP, PDOP, VDOP, and position elevation masks, and an indicator that shows whether ionospheric modelling is enabled or disabled. The response is output in the format:

```
$PASHR,PPR,d1,d2,d3,d4,d5,d6,c7,c8,c9,s10*hh<CR><LF>
```

Table 4.15 outlines the response message.

Table 4.15. $PASHR,PPR Message Format

Field	Description	Range
d1	Position mode setting	0 - 3
d2	Fixed altitude mode setting	0, 1
d3	PDOP mask setting	0 - 99
d4	HDOP mask setting	0 - 99
d5	VDOP mask setting	0 - 99
d6	Position elevation mask (PEM) setting; measured in degrees	0 - 90
c7	Indicates whether point positioning mode is enabled or disabled (always N)	Y (enabled) N (disabled)
c8	Indicates whether unhealthy satellites are included or excluded for position computation (always N)	Y (excluded) N (included)
c9	Indicates whether ionospheric modelling is enabled or disabled	Y (enabled) N (disabled)

Table 4.15. $PASHR,PPR Message Format (continued)

Field	Description	Range
s10	Indicates the current satellite system mode	GPS
*hh	Checksum	2-character hex

Typical PPR response message:

```
$PASHR,PPR,1,0,40,4,4,5,N,N,N,GPS*1C<CR><LF>
```

Table 4.16 outlines the response message.

Table 4.16. Typical PPR Response Message

Parameter	Description
$PASHR,PPR	Header
1	Indicates that the GG12W is set in position mode 1
0	Indicates that the GG12W is set in fixed altitude mode 0
40	Indicates that the current PDOP mask setting is 40
4	Indicates that the current HDOP mask setting is 4
4	Indicates that the current VDOP mask setting is 4
5	Indicates that the current position elevation mask setting is five degrees
N	Indicates that point positioning mode is disabled
N	Indicates that unhealthy satellites are excluded from position computations
N	Indicates that ionospheric modelling is disabled
GPS	Indicates that GPS is the current satellites system mode
*1C	Checksum

PPS: Timing Pulse Parameters

$PASHS,PPS,f1,f2,c3

The GG12W can generate a timing pulse with programmable period and offset. The timing pulse is generated by default once every second (1PPS) with its rising or falling edge synchronized to the GPS time. This command allows you to change the period and the offset (from the current time scale reference) of the pulse, where f1 is the period of the pulse in seconds with a range between 0.2 and 99.95. The minimum setting depends upon the receiver update rate, which is dependent upon the installed position update rate or raw data update options. The f2 parameter is the offset from GPS time in milliseconds, with 10ns resolution (range between -999.9999 and +999.9999). The c3 parameter determines whether the GPS time is synchronized with the rising edge of the pulse (R) or the falling edge of the pulse (F).

Example

Enter the command below to configure the timing pulse output to have a period of 2 seconds, an offset of 10 milliseconds, and to be synchronized with the falling edge of the pulse:

$PASHS,PPS,2,10,F<CR><LF>

$PASHQ,PPS[,c1]

This command allows you to query for timing pulse parameters, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PPS

The response message is output in the format:

```
$PASHR,PPS,f1,f2,c3*hh <CR><LF>
```

Table 4.17 outlines the response message.

Table 4.17. $PASHR,PPS Message Format

Field	Description	Range
f1	Timing pulse output interval (seconds). Timing pulse output is disabled when this parameter is set to zero	0 - 99.95
f2	Timing pulse offset value (milliseconds)	-999.9999 to +999.9999
c3	Timing pulse synchronization point	R(ising edge) F(alling edge)
*hh	Checksum	2-character

Typical PPS response message:

```
$PASHR,PPS,1.0000,000.0000,R*58<CR><LF>
```

Table 4.18 outlines the response message.

Table 4.18. Typical PPS Response Message

Parameter	Description
1.0000	Indicates that the period of the timing pulse is set to one second
000.0000	Indicates that there is not offset from the current time scale reference
R	Indicates that the synchronization with the rising edge of the pulse
*hh	Checksum

DEFAULT SETTING	
PPS	**R**

See Timing Pulse (Optional) on page 28 for more information on the conditions surrounding the generation and accuracy of the timing pulse.

PRT: Query Serial Port Baud Rate

$PASHQ,PRT[,c1]

This command allows you to query the baud rate code of the GG12W serial port to which you are currently connected, where c1 is the optional serial port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port. Issue the query command **$PASHQ,PAR** to see the baud rate codes for both serial ports.

$PASHR,PRT

The response is output in the format:

```
$PASHR,PRT,c1,d2*hh<CR><LF>
```

Table 4.19 outlines the response message.

Table 4.19. $PASHR,PRT Message Format

Parameter	Description	Range
c1	Identifier for the serial port to which you are currently connected.	A, B
d2	Baud rate code (see Table 4.20 below).	1 - 9
hh	Checksum	2-character hex

Table 4.20 lists the baud rate codes and the corresponding baud rates:

Table 4.20. GG12W Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
0	300	5	9600
1	600	6	19200
2	1200	7	38400
3	2400	8	56800
4	4800	9	115200

DEFAULT SETTING	
PRT	**9600**

The data rate for GG12W serial ports is set by using the command SPD command.

RID: Query Receiver Identification Parameters (Format 1)

$PASHQ,RID[,c1]

This command allows you to query for receiver identification parameters, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,RID

The response message contains a receiver type code, a firmware version number, and a list of installed options; it is output in the format:

```
$PASHR,RID,s1,s2,s3*hh<CR><LF>
```

Table 4.21 outlines the response message.

Table 4.21. $PASHR,RID Message Format

Field	Description
s1	Receiver model identifier
s2	Firmware version number
s3	List of installed options
hh	Checksum

Fourteen options are available for the GG12W. Each option is represented by a letter or number in a definite order. The presence of a given option is indicated by the presence of the corresponding letter or number. A dash ("-") indicates that a given option is not installed. An underscore ("_") indicates a reserved option slot.

Table 4.22 lists the letters and numbers in conjunction with the options they represent and the options available for the GG12W:

Table 4.22. Available GG12W Options

Option	Description
[5 = 5 Hz] [2 = 2 Hz]	Position update rate
[5 = 5 Hz] [2 = 2 Hz]	Raw measurement update rate
[O]	Raw data output
[P]	Carrier phase tracking
[U]	Differential - remote station
[L]	Timing pulse output (1PPS)

Commands

Table 4.22. Available GG12W Options (continued)

Option	Description
[G]	Geoid model
[M]	Magnetic variation model
Y	SBAS

The absence of dashes in the RID response message indicate that all of the available options have been installed:

```
$PASHR,RID,GG,FC00,55OPU__L_GM__Y*08<CR><LF>
```

Table 4.23 outlines the response message.

Table 4.23. $PASHR,RID Fields

Field	Description
$PASHR	Header
RID	Message identifier
GG	Receiver type identifier
FC00	Firmware version number
5	5 Hz update rate (0.2 seconds) installed for raw data update option
5	5 Hz update rate (0.2 seconds) installed for position update option
O	Raw data output option installed
P	Carrier phase tracking option installed
U	Differential - remote station
_	Reserved option slot
_	Reserved option slot
L	Timing pulse output option installed
_	Reserved option field
G	Geoid model option installed
M	Magnetic variation model option installed
_	Reserved option field
_	Reserved option field
Y	SBAS
*08	Checksum

RIO: Query Receiver Identification Parameters (Format 2)

$PASHQ,RIO[,c1]

This command allows you to query for receiver identification parameters, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,RIO

The response message contains the receiver model name, a firmware version number, a list of installed options, and a receiver serial number. The response is output in the format:

```
$PASHR,RIO,s1,s2,s3,s4,s5*hh<CR><LF>
```

Table 4.24 outlines the response message.

Table 4.24. $PASHR,RIO Message Format

Field	Description
s1	Receiver model name (maximum 10 characters)
s2	Main processor firmware version number (maximum 10 characters)
s3	Channel Firmware version number (maximum 10 characters). This field is empty for the GG12W
s4	Option list (maximum 42 characters). ASCII characters represent options available. For option definitions, see Table 4.22
s5	Receiver serial number (maximum 20 characters). Underscores represent blank fields
*hh	Checksum. XOR of all characters between the dollar sign ($) and the asterisk (*), but not including the dollar sign and asterisk

Typical RIO response message:

```
$PASHR,RIO,GG12W,FC00,,55OPU__L_GM__Y,00000000000000000000*57
<CR><LF>
```

Table 4.25 outlines the response message.

Table 4.25. $PASHR,RIO Fields

Field	Description
$PASHR	Header
RIO	Message identifier
GG12W	Receiver model identifier
FC00	Firmware version number
,,	Reserved data field
5	5 Hz update rate (0.05 seconds) installed for raw data update option
5	5 Hz update rate (0.05 seconds) installed for position update option
O	Raw data output option installed
P	Carrier phase tracking option installed
U	Differential remote option installed
_	Reserved option field
_	Reserved option field
L	Timing pulse output option installed
_	Reserved option field
G	Geoid model option installed
M	Magnetic variation model option installed
_	Reserved option field
_	Reserved option field
Y	SBAS
000…0	Receiver serial number
*57	Checksum

See Table 4.22 for more information on available options for the GG12W.

RST: Restore Default Parameters

$PASHS,RST

This command allows you to restore GG12W parameters to their default values.

SAV: Save Parameter Settings

$PASHS,SAV,c1

This command allows you to enable or disable saving of user-entered parameters in battery-backed memory, where c1 is Y (save) or N (don't save). If c1 is set to Y, user-entered parameters are saved until default settings are restored through the RST or INI commands. If c1 is set to N, default parameter settings will be restored each time power is cycled.

User-enter parameters cannot be saved unless a back-up battery is wired to appropriate pins on the J501 connector. Without a back-up battery, user-entered parameters will be lost after each power cycle even if the SAV parameter is set to Y.

SPD: Set Serial Port Baud Rate

$PASHS,SPD,c1,d2

This command allows you to set the baud rate for the GG12W's serial ports, where c1 is port A or B and d2 is a code number between 0 and 9 corresponding to the baud rates listed in Table 4.26. The default baud rate is 9600.

Table 4.26. GG12W Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
0	300	5	9600
1	600	6	19200
2	1200	7	38400
3	2400	8	56800
4	4800	9	115200

Examples:

Enter the command as shown below to set the baud rate of port A to 19200:

$PASHS,SPD,A,6<CR><LF>

Enter the command below to set the baud rate of port B to 4800:

$PASHS,SPD,B,4<CR><LF>

If you change the baud rate of the GG12W's serial port, be sure that the serial port of the device to which the GG12W port is connected is set to the same baud rate.

Use the query command $PASHQ,PRT to obtain the baud rate setting for the GG12W serial port to which you are connected.

SVP: Include/Exclude Satellites for Position Computations

$PASHS,SVP,c1c2c3...c51

This command allows you to include and exclude specific satellites for use in position computations, where c is Y (include) or N (exclude). Unlike most of the other set commands, the c parameters are not separated by commas. A satellite which has been excluded can still be acquired and tracked, but is not used in computing positions. All satellites are included for position computation by default. The parameters c1 through c32 correspond to GPS satellites PRN numbers 1 through 32; parameters c33 through c51 correspond to SBAS satellite PRN numbers 120 through 138. It is not necessary to enter a setting for all 51 satellites when using this command.

Example

To exclude satellites 10 and 15 from the position computation, you could enter the following command:

$PASHS,SVP,YYYYYYYYYNYYYYN<CR><LF>

This command excludes satellites 10 and 15 from the position computation, but does not change the settings for satellites 16 through 51.

$PASHQ,SVP[,c1]

This command allows you to query the current SVP settings, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SVP

The response message contains a 51-character string (see below) made up of 'Y' or 'N' depending on whether to include ('Y') or exclude ('N') any SV in the position solution. Up to 51 SVs may be selected. They are entered in order of PRN number, where numbers 1 to 32 correspond to the GPS satellites, and 33 to 51 to the SBAS satellites (33 corresponds to GEO PRN 120, …, 51 corresponds to GEO PRN 138). If fewer than 51 are specified, the rest is set to N. Only characters 'Y' and 'N' are accepted.

This command is analog to $PASHS,SVS except that under this command a channel DOES continue to track satellites (NMEA message $PASHR,SAT WILL contain information about these satellites; they will be marked as unused in position computation).

```
$PASHR,SVP,c1c2c3…c51*hh<CR><LF>
```

Table 4.27 outlines the response message.

Table 4.27. $PASHR,SVP Message Format

Field	Description	Range
c1 - c51	Indicates whether a satellite is included (Y) or excluded (N) for position computations	Y, N
*hh	Checksum	2-character hex

Typical SVP message:

```
$PASHR,SVP,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
*54<CR><LF>
```

Table 4.28 outlines the response message.

Table 4.28. Typical SVP Message

Parameter	Description
$PASHR,SVP	Header
YYY…Y	Indicates that all 51 PRN numbers are included for position computations
*54	Checksum

DEFAULT SETTING	
SVP	**Y (all satellites included)**

Commands

SVS: Include/Exclude Satellites for Acquisition and Tracking

$PASHS,SVS,c1,c2,c3...c51

This command allows you to include and exclude specific satellites for acquisition and tracking, where c is Y (include) or N (exclude). Like the SVP set command, the c parameters are not separated by commas. The receiver will not track a satellite which has been excluded through this command. All satellites are included for acquisition and tracking by default. The command contains a 51-character string of 'Y' or 'N' depending on whether to include ('Y') or exclude ('N') tracking any SV. Up to 51 SVs may be selected. They are entered in order of PRN number, where numbers 1 to 32 correspond to the GPS satellites, and 33 to 51 to the SBAS satellites (33 corresponds to GEO PRN 120, …, 51 corresponds to GEO PRN 138). If fewer than 51 are specified, the rest are set to N. Only the characters 'Y' and 'N' are accepted.

This command is analog to $PASHS,SVP except that under this command a channel does NOT continue to track or attempt to acquire these satellites (NMEA message $PASHR,SAT will NOT contain information about these satellites.)

Example

To exclude satellites 4 and 7 from the position computation, enter the following command:

$PASHS,SVS,YYYNYYN<CR><LF>

This command excludes satellites 4 and 7 from being acquired and tracked, but does not change the settings for satellites 8 through 51.

$PASHQ,SVS[,c1]

This command allows you to query the current SVS settings, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SVS

The response message contains the current SVP settings for all 51 satellites. The format of the response message is nearly identical to the format used in the SVP set command:

```
$PASHR,SVS,c1c2c3…c51*hh<CR><LF>
```

Table 4.29 outlines the response message.

Table 4.29. $PASHR,SVS Message Format

Field	Description	Range
c1 - c51	Indicates whether a satellites is included (Y) or excluded (N) for acquisition and tracking	Y, N
*hh	Checksum	2-character hex

Typical SVS message:

```
$PASHR,SVS,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
*57<CR><LF>
```

Table 4.30 outlines the response message.

Table 4.30. Typical SVS Message

Parameter	Description
$PASHR,SVS	Header
YYY…Y	Indicates that all 51 PRN numbers are included for acquisition and tracking
*57	Checksum

DEFAULT SETTING	
SVS	**Y (all satellites included)**

USE: Select Satellites for Acquisition and Tracking

$PASHS,USE,d1,c2

This command can be considered a short-hand version of the SVS command. Like the SVS command the USE command allows you to exclude specific satellites from being acquired and tracked by the GG12W, where d1 is the satellite number (01 through 32 and 120 through 138) and c2 is Y (include) or N (exclude). Satellite numbers 1 through 32 correspond to GPS PRN numbers 1 through 32; satellite numbers 120 through 138 correspond to SBAS PRN numbers. All satellites are included for tracking by default.

The USE command is more direct than the SVS command. In order to exclude satellite 30 with the SVS command, you would have to enter a string with 30 characters in it, entering a Y for characters 1 through 29 and an N for character 30. To exclude satellite 30 with the USE command requires far fewer characters:

$PASHS,USE,30,N<CR><LF>

$PASHS,USE,s1,c2

This version of the USE command allows you to include or exclude satellites on a global and semi-global basis, where s1 is ALL SBA or GPS; and c2 is Y (include) or N (exclude). When s1 is ALL, you can choose to include or exclude the entire set of GPS satellites. When s1 is GPS, you can choose to include or exclude the entire set of GPS satellites. When s1 is SBA, you can choose to include or exclude the entire set of SBAS satellites.

Enter the command below to exclude all GPS satellites:

$PASHS,USE,GPS,N

DEFAULT SETTING	
USE	All satellites included

USP: Select Satellites Used in Position Computation

$PASHS,USP,d1,c2

This command can be considered a short-hand version of the SVP command. Like the SVP command, the USP command allows you to include or exclude specific satellites for position computations, where d1 is the satellite number (01 through 32 and 120 through 138) and c2 is Y (include) or N (exclude). Satellite numbers 1 through 32 correspond to GPS PRN numbers 1 through 32; satellite numbers 120 through 138 correspond to SBAS PRN numbers. All satellites are included for position computations by default.

The USP command is more direct than the SVP command. In order to exclude satellite 25 with the SVP command, you would have to enter a string with 25 characters in it, entering a Y for characters 1 through 24 and an N for character 25.

To exclude satellite 25 with the USP command requires a much shorter command string:

$PASHS,USP,25,N<CR><LF>

$PASHS,USP,s1,c2

This version of the USP command allows you to include or exclude satellites on a global and semi-global basis, where s1 is ALL, GPS, or SBA; and c2 is Y (include) or N (exclude). When s1 is ALL, you can choose to include or exclude the entire set of GPS and SBAS satellites. When s1 is GPS, you can choose to include or exclude the entire set of GPS satellites. When s1 is SBA, you can choose to include or exclude the entire set of SBAS satellites.

Example

Enter the following command to exclude all SBAS satellites:

$PASHS,USP,SBA,N <CR><LF>

DEFAULT SETTING	
USP	All satellites included

UTS: Synchronize Measurements with GPS Time

$PASHS,UTS,s1

This command allows you to set the parameter controlling the synchronisation of measurements onto GPS time. When synchronization is enabled (s1=ON), the determination of pseudo-ranges does no longer depend upon the stability of the receiver clock. With synchronization enabled, the receiver in fact operates as if it was fitted with a very-high-stability oscillator synchronized onto GPS. By default, the synchroization mode is ON. To disable this mode, run the UTS command with s1=OFF

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Example: $PASHS,UTS,ON<CR><LF>

$PASHQ,UTS[,c1]

This command allows you to query the current setting for the synchronisation of measurements with GPS time, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,UTS[,c1]

This command will return the current setting of the synchronization mode where c1 is the identification of the port to which the response is sent out. The response will be in the form:

$PASHR,UTS,s<CR><LF>

Where s is the current setting of the synchronization mode (ON or OFF).

VDP: VDOP Mask

$PASHS,VDP,d1

This command allows you to set the mask value for the Vertical Dilution of Precision (VDOP), where d1 is a number between 0 and 99. If the VDOP value computed by the GG12W is higher than the VDOP mask value, the receiver will automatically go into fixed altitude mode. You can view the current VDOP mask value by entering the query command $PASHQ,PPR and checking field d5.

Example

Enter the following command to set the VDOP mask value to 6:

$PASHS,VDP,6 <CR><LF>

DEFAULT SETTING	
VDP	4

Raw Data Commands

Raw data commands allow you to set and query raw data parameters and raw data messages, including enabling or disabling the output of raw data messages, setting thresholds for the output of raw data messages, and setting the output interval for raw data messages. All raw data messages are disabled for output by default.

The general format for the set commands controlling the output of raw messages is as follows:

$PASHS,RAW,s1,c2,s3,f4<CR><LF>

In this context, set commands are used to enable the output of raw data messages at regular intervals or to disable output of raw messages, where s1 is a three character message identifier (SNV, MBN, UN1, UN2, etc.), c2 is the port designator for message output, s3 is ON or OFF, and f4 is the numeric output interval setting supporting a range of 0.2 to 999 seconds. Query commands prompt the receiver to output the corresponding response message once only. Message output prompted by a query command occurs independently of any related message output settings.

To enable the output of the MBN message on port A at five second intervals, enter the command:

$PASHS,RAW,MBN,A,ON,5<CR><LF>

To disable the output of the MBN message on port B, enter the command:

$PASHS,RAW,MBN,B,OFF<CR><LF>

To query the MBN message and designate port B for the output of the response message, enter the command:

$PASHQ,MBN,B<CR><LF>

As with the other query commands, the port designator (B) is optional. If a port is not specified, the receiver sends the response to the current port.

To enable the output of the UN1 message on port A at 5-second intervals, enter the command:

$PASHS,RAW,UN1,A,ON,5<CR><LF>

Message Structure

Real-time messages are output in binary format:

HEADER,MESSAGE ID,DATA + CHECKSUM<CR><LF>

The header field always contains **$PASHR**. The message identifier field contains the three-character message identifier (MBN, PBN, SAL, etc.) and is followed by a field containing the binary data string. The header, identifier, and data string fields are comma delimited. Depending on the message selected, the checksum is contained in the last one or two bytes of the binary data string. All real-time messages are terminated with a Carriage Return/Line Feed **<CR><LF>** delimiter. The MBN message output is as follows:

$PASHR,MBN,<Binary Data String + Checksum><CR><LF>

Table 4.31 lists the raw data commands:

Table 4.31. Raw Data Commands

Function	Command	Description	Page
Almanac data	$PASHQ,SAL $PASHQ,SAW	Query for GPS almanac data Query for SBAS almanac data	page 88 page 89
Ephemeris data	$PASHQ,SNV $PASHQ,SNW	Query for GPS ephemeris data Query for SBAS ephemeris data	page 90 page 92
Measurement data	$PASHQ,MBN $PASHQ,MCA $PASHQ,UN2	Query for raw measurement data in the Magellan type 2 data structure Query for raw measurement data (MCA) in the Magellan type 3 data structure Query for abridged measurement data	page 70 page 73 page 98
Position data	$PASHQ,PBN $PASHQ,UN1 $PASHQ,XYZ	Query the receiver's raw position data Query for abridged position and general data Query the raw position data for each satellite being tracked	page 76 page 93 page 105
General command for controlling raw data output	$PASHS,RAW $PASHS,RAW,ALL	Enable/disable output of raw data messages Disables the output of all raw messages on an individual serial port	page 78 page 78
Raw Data Parameters	$PASHS,ELM $PASHS,MSV $PASHS,RAW $PASHS,RCI $PASHQ,RWO $PASHS,SBA,ELM	Set elevation mask for raw data output Set minimum number of satellites for raw data output. Enable/disable output of raw data messages Set output interval for raw data messages. Query for raw data parameters. Elevation mask for SBAS	page 69 page 76 page 78 page 85 page 86 page 138

Table 4.31. Raw Data Commands (continued)

Function	Command	Description	Page
Satellite Corrections Data	$PASHQ,UN3	Query for satellite corrections data	page 100
Satellite Navigational Status Data	$PASHQ,UN4	Query for satellite navigational status data	page 102

ELM: Set Elevation Mask for Output of Raw Measurements

$PASHS,ELM,d1

This command allows you to set the minimum elevation for the output of raw measurement data (MBN, MCA, etc.), where d1 is a number between 0 and 90. The receiver can be set to output raw measurement data for each satellite it is tracking that is above the elevation mask. It stops outputting raw measurement data for any satellite at or below the elevation mask. If the elevation mask is set to 10°, the receiver will output raw measurement data for all tracked satellites with an elevation higher than 10°, but will not output raw measurement data for any tracked satellites with an elevation of 10° or lower. You can view the current raw data elevation mask setting **$PASHQ,ELM** and checking the ELM field. The response is in the form:

$PASHR,ELM,2*2E<CR><LF>

Examples:

Enter the following command to set the elevation mask at ten degrees:

$PASHS,ELM,10<CR><LF>

Enter the following command to set the elevation mask at fifteen degrees:

$PASHS,ELM,15<CR><LF>

DEFAULT SETTING	
ELM	2°

MBN: Raw Measurements (Magellan Type 2 Data Structure)

$PASHQ,MBN[,c1]

This command allows you to query for raw satellite measurement data contained in the Magellan type2 data structure, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,MBN

This message does not output unless the receiver is tracking at least one satellite. The MBN message contains measurement information for doppler, carrier phase, and satellite transmit time, as well as satellite PRN number, signal strength, elevation, and azimuth. A separate MBN message is output for each satellite being tracked.

The structure of the message:

```
$PASHR,MBN,<Magellan type 2 data string + checksum><CR><LF>
```

Table 4.32 outlines the response message.

Table 4.32. $PASHR,MBN Data Message Format

Field	Bytes	Content
char [datatype]	1	Always equal to 1
char [count]	1	Number of measurement structures to follow after this one (The GG12W outputs a separate MBN data string for each satellite it is tracking)
unsigned char [svprn]	1	Satellite PRN number (1 - 32, 120 - 138)
char [chnind]	1	Channel (1 - 12) assigned to the satellite.
long [lost_lock_ctr]	4	Continuous counts accumulated from the time the satellite referenced in [svprn] is locked. This number is incremented about 500 times per second
char [polarity_known]	1	This number is either zero or five: • 0 - the satellite has just been locked • 5 - meaning the first frame of the navigation message has been found

Table 4.32. $PASHR,MBN Data Message Format (continued)

Field	Bytes	Content
unsigned char [goodbad]	1	This number indicates the quality of the position measurement: • 0 - Measurements not available; no additional data will be sent • 21 - Satellite referenced in [svprn] was not used due to low elevation • 22 - Satellite referenced in [svprn] was not used because it is unhealthy, or because differential corrections are not available for it, or because it was manually disabled by the user • 23 - Code and carrier phase were measured and the navigation measurement was obtained for the satellite referenced in [svprn], but these data were not used in the position computation • 24 - Code and carrier phase were measured and the navigation measurement was obtained for the satellite referenced in [svprn], and the data were used in the position computation
unsigned char [warning]	1	See Table 4.33 below for information on warning flags
unsigned char [ireg]	1	Signal to noise measurement (dbHz) for the satellite referenced in [svprn]
double [raw_range]	8	The fractional part of the transmit time (seconds) for the satellite referenced in [svprn]. The integer part of this number is ignored
long [doppler]	4	doppler measurement (10^{-4} Hz) for the satellite referenced in [svprn]
double [full_phase]	8	Full carrier phase (measured in cycles) of the satellite referenced in [svprn]. This data is available only if the carrier phase option is installed
short [carphase1]	2	Not available with the GG12W
short [carphase2]	2	Not available with the GG12W
unsigned short [elevation]	2	elevation in units of 0.01 degrees for the satellite referenced in [svprn]
unsigned short [azimuth]	2	Azimuth angle (degrees) of the satellite referenced in [svprn]
unsigned short [checksum]	2	The checksum is a bytewise exclusive OR (XOR)of all bytes from [datatype] to the last byte in [azimuth]
Total bytes: 40		

Commands

The MBN message is output in binary format according to the setting chosen for the recording interval ($PASHS,RCI). One MBN message is output for each locked satellite with an elevation equal to or greater than the elevation mask ($PASHS,ELM), and only if the number of locked satellites is equal to or greater than minimum satellite mask ($PASHS,MSV).

Table 4.33 outlines the response message for the MBN warning flag.

Table 4.33. MBN Warning Flag Format

Index of Bits		Description
1	2	Combination of bit 1 and bit 2: 00 - Measurement is available but was not used in the position solution 01 - Code and/or carrier phase measured, measurement was used in position solution, but position was not computed due to any reason 10 - Code and/or carrier phase measured, measurement was used in position solution, and position was computed 11 - Reserved
3		Carrier phase is potentially incorrect.
4		Pseudo-range is potentially incorrect.
5		Reserved
6		Cycle slip indicator.
7		Reserved
8		Loss of continuity (first time after re-lock, also after polarity becomes known).

MCA: Raw Measurements (Magellan Type 3 Data Structure)

$PASHQ,MCA[,c1]

This command allows you to query for raw satellite measurement data contained in the Magellan type 3 data structure, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,MCA

This message does not output unless the receiver is tracking at least one satellite. The MCA message contains some of the same measurement information as is contained in the MBN message: doppler, raw pseudorange, satellite PRN number, elevation, and azimuth. A separate MCA message is output for each satellite being tracked.

The structure of the message:

```
$PASHR,MCA,<Magellan type 3 data string + checksum><CR><LF>
```

Table 4.34 outlines the response message.

Table 4.34. $PASHR,MCA Message Format

Field	Bytes	Content
unsigned short [sequence tag]	2	Sequence ID number in units of 50 ms, modulo 30 minutes
unsigned char [left]	1	Number of remaining MCA messages to be sent for current epoch (the GG12W outputs a separate MCA message for each satellite it is tracking)
unsigned char [svprn]	1	Satellite PRN number (1 - 32, 120 -138)
unsigned char [elev]	1	Elevation angle (degrees) of the satellite referenced in [svprn]
unsigned char [azim]	1	Azimuth angle of the satellite referenced in [svprn] in increments of 2°
unsigned char [chnind]	1	Channel (1 - 12) assigned to the satellite referenced in [svprn]
Measurement data derived from the C/A code (29 bytes):		
unsigned char [warning]	1	See Table 4.35

Table 4.34. $PASHR,MCA Message Format (continued)

Field	Bytes	Content
unsigned char [goodbad]	1	Indicates the quality of the position measurement: •0 - Measurement not available; no additional data will be sent. •21 - The satellite is below the PEM elevation mask. •22 - Code and/or carrier phase has been measured. •23 - Code and/or carrier phase has been measured, and navigation message was obtained, but measurement(s) not used to compute position. •24 - Code and/or carrier phase measured, navigation message was obtained, and measurement(s) used to compute position
char [polarity_known]	1	This number is either zero or five: • 0 - the satellite has just been locked • 5 - meaning the first frame of the navigation message has been found
unsigned char [ireg]	1	Signal-to-noise measurement (db Hz) for the satellite referenced in [svprn]
unsigned char [qa_phase]	1	Not used; always zero
double [full phase]	8	Full carrier phase (measured in cycles) of the satellite referenced in [svprn]. This data is available only if the carrier phase option is installed
double [raw_range]	8	Raw range (in seconds) to the satellite referenced in [svprn] using the following formula: receiver time - transmitted time = raw range
long [doppler]	4	doppler measurement (10^{-4} Hz) for the satellite referenced in [svprn]
long [smoothing]	4	Bits 31-24 represent the [smooth_count]. They are unsigned and normalized, and indicate the amount of smoothing: • 0 - Unsmoothed • 1 - Least smoothed • 100 - Most smoothed Bits 23-0 represent [smooth_corr]. Bit 23 (most significant bit) is the sign and bits 22 through 0 are the least significant bits representing the magnitude of the correction in centimeters

Table 4.34. $PASHR,MCA Message Format (continued)

Field	Bytes	Content
unsigned short [checksum]	1	The checksum is a bytewise exclusive OR (XOR) of all bytes from sequence_tag (just after header) to the last byte in [smoothing]
Total Bytes: 37		

The MCA message is output in binary format according to the setting chosen for the recording interval ($PASHS,RCI). One MCA message is output for each locked satellite with an elevation equal to or greater than the elevation masks ($PASHS,ELM and $PASHS,SBA,ELM), and only if the number of locked satellites is equal to or greater than minimum satellite mask ($PASHS,MSV).

Table 4.35 outlines the MCA warning flag message.

Table 4.35. MCA Warning Flag Format

Index of Bits	Description
1 2	Combination of bit 1 and bit 2:
00	Code and/or carrier phase have been measured for the satellite referenced in [svprn]
01	Code and/or carrier phase have been measured, and the navigation message was obtained for the satellite referenced in [svprn], but these data were not used in the position computation
10	Code and/or carrier phase have been measured, the navigation message was obtained, and these data were used in the position computation
3	Symbols in the navigation message have not been synchronized
4	Pseudo-range measurement is not smoothed
5	Reserved
6	A loss of lock has occurred on the code and/or carrier phase of the satellite signal
7	Reserved
8	A loss of continuity has occurred (this error flag is present when the receiver has reacquired lock on the code and/or carrier phase of the satellite signal. It also occurs after the polarity becomes known)

MSV: Set Minimum Satellites for Raw Measurement Output

$PASHS,MSV,d1

This command allows you to set the minimum number of satellites the receiver is required to track in order for it to output raw measurement data (MBN, MCA, etc.), where d1 is a number between 1 and 9. The receiver will stop outputting measurement data if the number of satellites it is tracking falls below this minimum. You can view the current setting for minimum satellites by entering the query command $PASHQ,MSV and checking the MSV field. The response is in the form:

$PASHR,MSV,3*23<CR><LF>

Examples:

Enter the following command to set the minimum number of satellites to 4:

$PASHS,MSV,4<CR><LF>

Enter the following command to set the minimum number of satellites to 1:

$PASHS,MSV,1<CR><LF>

DEFAULT SETTING	
MSV	3

PBN: Raw Position Data

$PASHQ,PBN[,c1]

This command allows to query for raw position data, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PBN

The PBN message contains raw position data, including the time at which the data was received, antenna position, antenna velocity, receiver clock offset, and PDOP.

The message is output in the format:

```
$PASHR,PBN,<Raw position data + checksum><CR><LF>
```

Table 4.36 outlines the response message.

Table 4.36. $PASHR,PBN Message Format

Field	Bytes	Content
long [rcvtime]	4	Time at which the signal was received in milliseconds of the week referenced to GPS system time. This time tag is used as a reference for all time and position measurements
char [sitename]	4	4 character ASCII string entered by the user
double [navx]	8	X coordinate of the antenna position (ECEF) in meters.
double navy	8	Antenna position ECEF y coordinate in meters.
double navz	8	Antenna position ECEF z coordinate in meters.
float navt	4	Receiver clock offset (error) in meters.
float navxdot	4	The antenna x velocity in meters per second.
float navydot	4	The antenna y velocity in meters per second.
float navzdot	4	The antenna z velocity in meters per second.
float navtdot	4	Receiver clock drift in meters per second.
unsigned short PDOP	2	PDOP multiplied by 100.
checksum	2	The checksum is computed by breaking the structure into 27 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total bytes: 56		

RAW: Enable/Disable Output of Raw Data Messages

$PASHS,RAW,s1,c2,s3,d4

This command allows you to enable or disable the output of raw data messages at regular intervals, where s1 is any one of the three-letter message identifiers (MBN, PBN, MCA, UN1, etc.), c2 is the port designator for message output, s3 is ON or OFF, and d4 is the optional output rate in seconds. If no output rate is specified, then the message outputs with the current RCI. The default setting for raw message output is 000.0 (off) for all messages. Only one raw message at a time can be enabled for output in a single command line; however, all raw messages can be disabled from being output with a single command line.

Examples

Enter the following command to enable output of the MBN message on port A with an output interval of five seconds:

$PASHS,RAW,MBN,A,ON,5<CR><LF>

You can disable the output of one message without affecting the other messages being output. Enter the following command to disable the output of the MBN message while leaving the output of other messages unaffected on port A:

$PASHS,RAW,MBN,A,OFF<CR><LF>

The *global* command allows you to disable the output of all raw messages simultaneously on a single port. Enter the following command below to disable the output of all raw messages on port A:

$PASHS,RAW,ALL,A,OFF<CR><LF>

The interval for raw message output is set through the RCI command. The default setting for the raw message output interval is one second.

$PASHS,RAW,SAW,c1,s2[,f3]

Function: Enables or disables SBAS almanac data output.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.37. $PASHS,RAW,SAW Command Format

Setting parameter	Description	Range
c1	Receiver comm. port to send out the message	'A' , ' B'
s2	Turns on or off data output	"ON", "OFF"
[f3]	Optional individual raw message interval	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1 second increment from 1... 999 seconds

NOTE: If the output is set without a period, the raw message rate set by the $PASHS,RCI command is used. If a $PASHS,RCI command is sent after individual RAW message output periods were set, the previous individual message period is superseded by the most recent RCI value. Setting an individual RAW message output period affects only the serial port output of this message.

Periodic output: $PASHR,SAW,<structure><CR><LF>

For <structure> definition see $PASHR,SAW

Output format: Binary

See also: $PASHQ,SAW[,c]<CR><LF>

Example: $PASHS,RAW,SAW,B,ON<CR><LF>

Output binary SAW message on port B at period set by $PASHS,RCI command

$PASHS,RAW,SAW,A,ON,0.5<CR><LF>

Output binary SAW message on port A at 0.5 second period

Note that Almanac data is output whenever the reference time is changed (5 minutes maximum) with one satellite output at each recording interval (RCI).

$PASHS,RAW,SNW,c1,s2[,f3]

Function: Enables or disables SBAS ephemeris data output.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.38. $PASHS,RAW,SNW Message Format

Setting parameter	Description	Range
c1	Receiver comm. port to send out the message	‘A’ , ‘ B’
s2	Turns on or off data output	"ON", "OFF"
[f3]	Optional individual raw message interval	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1 second increment from 1... 999 seconds

NOTE: If the output is set without a period, the raw message rate set by the $PASHS,RCI command is used. If a $PASHS,RCI command is sent after individual RAW message output periods were set, the previous individual message period is superseded by the most recent RCI value. Setting an individual RAW message output period affects only the serial port output of this message, and not the Data Recording period.

Periodic output: $PASHR,SNW,<structure><CR><LF>

For <structure> definition see $PASHR,SNW

Output format: Binary

See also: $PASHQ,SNW[,c]<CR><LF>

Example: $PASHS,RAW,SNW,B,ON<CR><LF>
Output binary SNW message on port B at period set by $PASHS,RCI command

$PASHS,RAW,SNW,A,ON,0.5<CR><LF>
Output binary SNW message on port A at 0.5 second period

Note that Ephemeris data is output each time SBAS ephemeris is received (2 minutes maximum), with one satellite output at each requested interval.

$PASHS,RAW,UN1,c1,s2[,f3]

Function: Enables or disables UN1 data output.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.39. $PASHS,RAW,UN1 Message Format

Setting parameter	Description	Range
c1	Receiver comm. port to send out the message	'A' , ' B'
s2	Turns on or off data output	"ON", "OFF"
[f3]	Optional individual raw message interval	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1 second increment from 1... 999 seconds.

NOTE: If the output is set without a period, the raw message rate set by the **$PASHS,RCI** command is used. If a **$PASHS,RCI** command is sent after individual RAW message output periods were set, the previous individual message period is superseded by the most recent RCI value. Setting an individual RAW message output period affects only the serial port output of this message.

Periodic output: $PASHR,UN1,struct<CR><LF>

For structure definition see $PASHQ,UN1

Output format: Binary

See also: $PASHQ,UN1[,c]<CR><LF>

Example: $PASHS,RAW,UN1,B,ON<CR><LF>

Output binary UN1 message on port B at period set by $PASHS,RCI command

$PASHS,RAW,UN2, c1, s2[,f3]

Function: Enables or disables UN2 data output.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.40. $PASHS,RAW,UN2 Message Format

Setting parameter	Description	Range
c1	Receiver comm. port to send out the message	'A' , ' B'
s2	Turns on or off data output	"ON", "OFF"
[f3]	Optional individual raw message interval	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1 second increment from 1... 999 seconds.

NOTE: If the output is set without a period, the raw message rate set by the $PASHS,RCI command is used. If a $PASHS,RCI command is sent after individual RAW message output periods were set, the previous individual message period is superseded by the most recent RCI value. Setting an individual RAW message output period affects only the serial port output of this message.

Periodic output: $PASHR,UN2,structure<CR><LF>

For structure definition see $PASHQ,UN2

Output format: Binary

See also: $PASHQ,UN2[,c]<CR><LF>

Example: $PASHS,RAW,UN2,B,ON<CR><LF>

Output binary UN2 message on port B at period set by $PASHS,RCI command

$PASHS,RAW,UN3, c1, s2[,f3]

Function: Enables or disables UN3 data output.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.41. $PASHS,RAW,UN3 Message Format

Setting parameter	Description	Range
c1	Receiver comm. port to send out the message	'A' , ' B'
s2	Turns on or off data output	"ON", "OFF"
[f3]	Optional individual raw message interval	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1 second increment from 1... 999 seconds.

NOTE: If the output is set without a period, the raw message rate set by the $PASHS,RCI command is used. If a $PASHS,RCI command is sent after individual RAW message output periods were set, the previous individual message period is superseded by the more recent RCI value. Setting an individual RAW message output period affects only the serial port output of this message.

Periodic output: $PASHR,UN3,structure<CR><LF>

For structure definition see $PASHQ,UN3

Output format: Binary

See also: $PASHQ,UN3[,c]<CR><LF>

Example: $PASHS,RAW,UN3,B,ON<CR><LF>

Output binary UN3 message on port B at period set by $PASHS,RCI command

$PASHS,RAW,UN4, c1, s2[,f3]

Function: Enables or disables UN4 data output.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.42. $PASHS,RAW,UN4 Message Format

Setting parameter	Description	Range
c1	Receiver comm. port to send out the message	'A' , ' B'
s2	Turns on or off data output	"ON", "OFF"
[f3]	Optional individual raw message interval	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1 second increment from 1... 999 seconds.

NOTE: If the output is set without a period, the raw message rate set by the $PASHS,RCI command is used. If a $PASHS,RCI command is sent after individual RAW message output periods were set, the previous individual message period is superseded by the most recent RCI value. Setting an individual RAW message output period affects only the serial port output of this message.

Periodic output: $PASHR,UN4,structure<CR><LF>

For structure definition see $PASHQ,UN4

Output format: Binary

See also: $PASHQ,UN4[,c]<CR><LF>

Example: $PASHS,RAW,UN4,B,ON<CR><LF>

Output binary UN4 message on port B at period set by $PASHS,RCI command

RCI: Set Output Interval for Raw Messages

$PASHS,RCI,f1

This command allows you to set a global output interval for all raw messages, where f1 is the value for the output interval (Table 4.43). This command overrides individual settings for output interval. That is, if the SNW message is enabled for output at intervals of two seconds and the MBN message is enabled for output at intervals of ten seconds, using the RCI command to set an output interval of five seconds will reset the output interval of both messages to five seconds. You can view the current raw data output interval setting by entering the query command **$PASHQ,RWO** and checking the third field after the message identifier.

Table 4.43. Raw Data Update Rate Options and Settings

Installed Option	Option Symbol	RCI Range (seconds)	Increment
1 Hz	1	1-999	1 second
2 Hz	2	0.5-999	0.5 second from 0.5 to 1 1 second from 1 to 999
5 Hz	5	0.2-999	0.2 second from 0.2 to 1 1 second from 1 to 999

DEFAULT SETTING	
RCI	1

The GG12W is designed to synchronize raw message output with the hour rollover, so that messages output from multiple receivers can be synchronized regardless of when they were turned on. An output interval of 0.7 seconds is not allowed because it overlaps the hour rollover, which corrupts synchronization between multiple receivers.

Both GPS and SBAS almanac messages are output at interval prescribed by set command $PASHS,RCI.

Example

Enter the following command to set the global raw data output interval to 5 seconds:

$PASHS,RCI,5<CR><LF>

RWO: Query for Raw Data Message Output Parameters

$PASHQ,RWO,c1[,c2]

This command allows you to read the current output status for the raw message where c1 identifies the port requested to output the Raw message (A or B) and c2 is an optional parameter identifying the port through which the response to this command will be output (also A or B). If c2 is not defined, then the response will be output on the port defined as “c1”.

$PASHR,RWO

The response message contains the serial port identifier, the baud rate code for the serial port, the global output interval setting (RCI), the number of raw data messages available for output, the three-letter identifier for each raw data message supported by the GG12W (MCA, MBN…SAW) and the output interval for each message.

The response is output in the format (ASCII format):

```
$PASHR,RWO,c1,d2,f3,d4[,s5,d6]*hh<CR><LF>
```

Table 4.44 outlines the response message.

Table 4.44. $PASHR,RWO Message Format

Parameters	Description	Range
c1	RTCM output port	‘A’, ‘B’
d2	Port baud rate index	0 => 300 bps; 1 => 600; 2 => 1200; 3 => 2400; 4 => 4800; 5 => 9600; 6 => 19200; 7 => 38400; 8 > 57600; 9 => 115,200;
f3	Global output interval setting for raw data messages	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1-sec increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1-second increment from 1... 999 seconds.
d4	Number of pairs of output strings and period for update to follow	12
s5	3-letter string identifier	"MBN", "PBN" , "SNV", "SAL","MCA", "XYZ", “UN1”, “UN2”, “UN3”, “UN4”, “SNW”, “SAW”,

Table 4.44. $PASHR,RWO Message Format (continued)

d6	Update period for message type	0 => message not output 0.05...999 (see parameter f3)
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Typical RWO response message:

$PASHR,RWO,A,9,001.0,12,PBN,000.0,UN1,000.0,UN2,000.0,MCA,000.0,UN3,000.0,UN4,000.0,MBN,000.0,XYZ,000.0,SNV,000.0,SAL,000.0,SNW,000.0,SAW,000.0*7D<CR><LF>

Table 4.45 outlines the response message.

Table 4.45. Typical RWO Response Message

Parameter	Description
$PASHR,RWO	Header
A	Indicates that serial port A is being referenced in the response
9	This code number indicates that the data rate for port A is 115,200 baud
0001.0	Global output interval setting for raw data messages
12	Indicates that twelve raw data messages are available for output
PBN... ...SAW,000	Message identifiers and corresponding output periods
*7D	Checksum

SAL: GPS Satellite Almanac Data

$PASHQ,SAL[,c1]

This command allows you to query for GPS satellite almanac data, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAL

The GG12W does not output this message until the GG12W has completed collecting the GPS almanac for a given PRN. The receiver begins collecting the almanac data automatically, which takes about twelve minutes. A separate almanac message is output for each satellite being tracked. The SAL message contains information on satellite health, the almanac week number, and a variety of orbital measurements.

The response is output in the format:

```
$PASHR,SAL,<GPS satellite almanac data string +
checksum><CR><LF>
```

Table 4.46 outlines the response message.

Table 4.46. $PASHR,SAL Message Format

Field	Bytes	Content
short prn	2	Satellite PRN number -1.
short health	2	Satellite health.
float e	4	Eccentricity
long toa	4	Reference time for orbit (sec).
float i0	4	Inclination angle (semicircles).
float omegadot	4	Rate of right ascension (semicircles/sec).
double roota	8	Square root of semi-major axis (meters 1/2).
double omega0	8	Longitude of ascending node (semicircles).
double omega	8	Argument of perigee (semicircles).
double m0	8	Mean anomaly at reference time (semicircles).
float af0	4	Clock correction (sec).
float af1	4	Clock correction (sec/sec).
short wna	2	Almanac week number
short wn	2	Week number.
long tow	4	Seconds of GPS week.

Table 4.46. $PASHR,SAL Message Format (continued)

Field	Bytes	Content
checksum	2	The checksum is computed by breaking the structure into 34 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total Bytes: 70		

SAW: Query for SBAS Almanac Data

$PASHQ,SAW[,c1]

This command allows you to query for SBAS almanac data from the receiver, where c1 is the output serial port (“A” or “B”). If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAW

The SAW message is output in the format below:

```
$PASHR,SAW<Structure><CR><LF>
```

Table 4.47 outlines the response message.

Table 4.47. $PASHR,SAW Message Format

Type	Size in Bytes	Content
char	1	Data ID – two LSB of byte. In current signal specification format is 00
char	1	health – the meaning of this parameter is: Bit0 – Ranging On (0), Off(1) Bit1 – Corrections On (0), Off(1) Bit2 – Broadcast integrity On (0), Off(1) Bit3 – Reserved Bit 4-7 SBAS provider ID (0 – 15) as specified in DO-229D, Appendix A.4.4.12. These are: 0 WAAS 1 EGNOS 2 MSAS 3-14 Reserved.. 15 Any
long	4	t0 - Almanac data reference time within the day expressed in WAAS system time scale (seconds).
float	3*4	Satellite ECEF X, Y, Z coordinates (meters).
float	3*4	Satellite ECEF velocity X’, Y’, Z’(meters/sec).

Commands

Table 4.47. $PASHR,SAW Message Format

long	4	tow – time within week in GPS time scale when WAAS almanac was received (seconds).
char	1	wn – week number in GPS time scale when WAAS almanac was received.
char	1	Satellite number (0 - 18).
unsigned short	2	Checksum computed by breaking the structure into 18 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total	38 bytes	(51 for structure plus header and <CR><LF>)

SNV: GPS Satellite Ephemeris Data

$PASHQ,SNV[,c1]

This command allows you to query for ephemeris data from each GPS satellite being tracked, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SNV

One SNV message is output for each GPS satellite being tracked. This message does not output unless the receiver is locked on at least one GPS satellite. SNV messages contain some of the same data found in the SAL message, but also contain clock correction parameters and harmonic correction parameters.

The message is output in the format:

```
$PASHR,SNV,<Ephemeris data string + checksum><CR><LF>
```

Table 4.48 outlines the response message.

Table 4.48. $PASHR,SNV Message Format

Field	Bytes	Content
short wn	2	GPS week number.
long tow	4	Seconds of GPS week.
float tgd	4	Group delay (seconds).
long aodc	4	Clock data issue.
long toc	4	Clock data reference time in seconds.
float af2	4	Clock correction (sec/sec2).
float af1	4	Clock correction (sec/sec).
float af0	4	Clock correction (sec).
long aode	4	Orbit data issue.

Table 4.48. $PASHR,SNV Message Format (continued)

Field	Bytes	Content
float deltan	4	Mean anomaly correction (semicircles/sec).
double m0	8	Mean anomaly at reference time (semicircles).
double e	8	Eccentricity.
double roota	8	Square root of semi-major axis (meters 1/2).
long toe	4	Reference time for orbit (sec).
float cic	4	Harmonic correction term (radians).
float crc	4	Harmonic correction term (meters).
float cis	4	Harmonic correction term (radians).
float crs	4	Harmonic correction term (meters).
float cuc	4	Harmonic correction term (radians).
float cus	4	Harmonic correction term (radians).
double omega0	8	Longitude of ascending node (semicircles).
double omega	8	Argument of perigee (semicircles).
double i0	8	Inclination angle (semicircles).
float omegadot	4	Rate of right ascension (semicircles/sec).
float idot	4	Rate of inclination (semicircles/sec).
short accuracy	2	User range accuracy.
short health	2	Satellite health.
short fit	2	Curve fit interval.
char prnnum	1	Satellite PRN number minus 1 (0 to 31)
char res	1	Reserved character.
checksum	2	The checksum is computed by breaking the structure into 65 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total Bytes: 132		

Commands

SNW: Query for SBAS Ephemeris Data

$PASHQ,SNW[,c1]

This command allows you to query for SBAS ephemeris data from the receiver, where c1 is the optional output serial port ("A" or "B"). If a port is not specified, the receiver sends the response to the current port.

$PASHR,SNW

The SNW message is output in the format below.

```
$PASHR,SNW,<structure><CR><LF>
```

Table 4.49. $PASHR,SNW Message Format

Type	Size in Bytes	Content
char	1	Spare
char	1	Accuracy – the meaning of this parameter is same as in GPS.
long	4	t0 - Ephemeris data reference time within the day expressed in SBAS system time scale (seconds).
double	3*8	Satellite ECEF X, Y, Z coordinates (meters).
float	3*4	Satellite ECEF velocity X', Y', Z'(meters/sec).
float	3*4	Satellite acceleration X", Y", Z" (meters/sec/sec).
float	4	aGf0 - Time offset between satellite time scale and SBAS system time scale (seconds).
float	4	aGf1 - Time drift between satellite time scale and SBAS system time scale (seconds/seconds).
long	4	tow – time within week in GPS time scale when SBAS ephemeris was received (seconds).
char	1	wn – week number in GPS time scale when SBAS ephemeris was received.
char	1	Satellite number (0 - 18).
unsigned short	2	Checksum computed by breaking the structure into 34 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total	70 bytes	(83 for structure plus header and <CR><LF>)

UN1: Query for Abridged Position and General Data

$PASHQ,UN1[,c1]

This command allows you to query the UN1 data for one epoch, where c1 is the optional output serial port (‘A’ or ‘B’). If no port is specified, the receiver sends the response to the current port.

$PASHR,UN1

The UN1 message is output in the format below:

```
$PASHR,UN1,<structure><CR><LF>
```

Table 4.50 outlines the response message.

Table 4.50. $PASHR,UN1 Message Format

Type	Size in bytes	Units	Meaning
unsigned long	4	milliseconds	Signal received time in milliseconds of week of GPS system time. This is the time tag for all measurements and position data. This is the same as “rcvtime” in the PBN binary response message.
unsigned long	4	nanoseconds	Fraction of millisecond “RcvTime” field in nanoseconds, ranging from 0 to 999,999ns. Receive Time (ns) = RcvTime(ms) * 1,000,000 + RcvTimeFrac. For example the GPS system receive time of 507653.999844213 seconds should be represented as: Receive Time (ms): 507,653,999 (field above) Receive Time (ns): 844,213 (this field)
unsigned char	1		SBAS provider ID for the GEO signal being tracked by SBAS channel number 1. The numbering scheme is the same as specified in DO-229D for SBAS provider Data ID, where 0 is WAAS, 1 is EGNOS, 2 is MSAS, 3 – 13 are reserved, and 14 indicates that SBAS channel number 1 is either not tracking a GEO satellite or the provider ID is not known yet.
Long	4	nanoseconds	Difference between GPS time and SBAS Network time for SBAS channel number 1 at the time of applicability (time mark), to a resolution of 1 nanosecond.
unsigned char	1		SBAS provider ID for the GEO signal being tracked by SBAS channel number 2.

Commands

Table 4.50. $PASHR,UN1 Message Format (continued)

long	4	nanoseconds	Difference between GPS time and SBAS Network time for SBAS channel number 2 at the time of applicability (time mark), to a resolution of 1 nanosecond.
unsigned char	1	1	Number of GPS satellites used in the position fix computation.
unsigned char	1	1	Number of SBAS satellites used in the position fix computation.
unsigned char	1	1	Number of GPS satellites being tracked.
unsigned char	1	1	Number of SBAS satellites being tracked.
double	8	degrees (positive – North, negative – South)	WGS-84 Latitude
double	8	degrees (positive – East, negative – West)	WGS-84 Longitude
float	4	meters	Altitude (height above WGS-84 ellipsoid).
float	4	meters	Geoidal separation, such that Geoid Altitude (Mean Sea Level) = WGS-84 Altitude - Geoidal Separation.
float	4	m/s	Velocity as ground speed
unsigned short	2	0.1 degree	True track angle
float	4	m/s	Vertical velocity
unsigned short	2	0.01	HDOP multiplied by 100
unsigned short	2	0.01	VDOP multiplied by 100
unsigned short	2	0.01	PDOP multiplied by 100
unsigned short	2	0.01	TDOP multiplied by 100
unsigned short	2	0.01	GDOP multiplied by 100
float	4	meters	HPL_{SBAS}
float	4	meters	VPL_{SBAS}

Table 4.50. $PASHR,UN1 Message Format (continued)

unsigned short	2	-	Status of position computation (MSBit is 15, LSBit is 0): Bit 15: 0=Position computed. 1=Position not computed. Bit 14 (Note 1): 0=PA mode disabled. 1=PA mode enabled. Bit 13 (Note 2) Bit 12 (Note 3) Bit 11 (Note 4): 0=Position not corrected using single SBAS signal. 1=Position corrected using single SBAS signal. Bit 10 (Note 5): 0=Position not corrected using only preferred SBAS provider. 1=Position corrected using only preferred SBAS provider. Bit 9 (Note 6): 0=Valid SBAS message received in last 4 seconds. 1=No valid SBAS message received in last 4 seconds. Bit 8 (Note 7): 0=Altitude not held fixed. 1=Altitude held fixed. Bit 7 (Note 8): 0=Last computed altitude held fixed in altitude hold mode. 1=Externally supplied altitude held fixed in alt hold mode. Bit 6 0=HPL_{SBAS} not computed. 1=HPL_{SBAS} computed. Bit 5 0=VPL_{SBAS} not computed. 1=VPL_{SBAS} computed. Bit 4 (Note 9): 0=Position not fully monitored. 1=Position fully monitored. Bit 3 (Note 10): 0=Position not PA-qualified. 1=Position PA-qualified. Bit 2 (Note 11) 0=GEO scan not in progress 1=GEO scan in progress Bits 1-0 Reserved
unsigned char	1	1	Position fix update/output rate
short	2	0.01 degrees	Magnetic variation multiplied by 100. Range -179.99 to +179.99 degrees. Positive values represent Easterly variation. Negative values represent Westerly variation.
unsigned char	1	1	Reserved to make message length even
unsigned short	2		Checksum

Commands

Table 4.50. $PASHR,UN1 Message Format (continued)

Total Size:	80		

Note 1: The bit is set to 1 when the Precision Approach (PA) mode ($PASHS, SBA,PAM,ON) is selected, otherwise it is set to 0.

Note 2: Bit is reserved.

Note 3: Bit is reserved.

Note 4: This bit is set to 1 when all SBAS corrections used in the position fix computation came from the same SBAS signal (PRN code). This bit is applicable when the position fix is either fully or partially corrected. This bit is always set to 0 when the position fix is uncorrected.

Note 5: This bit is set to 1 when all SBAS corrections used in the position fix computation came from the preferred SBAS service provider. This bit is applicable when a preferred SBAS provider has been commanded. This bit is always set to 0 when the commanded SBAS provider is Any (any SBAS provider may be used).

Note 6: This bit is set to 1 when a valid SBAS message has not been received within the last four seconds from the SBAS GEO PRN data stream that is being used as the source of integrity and correction data. (DO-229D 2.1.4.11, 2.2.4.6.3, 2.2.5.6.3) This bit is used by the host during precision approach mode to determine whether to alert for loss of navigation. Refer to DO-229D sections 2.2.4.6.3 and 2.2.5.6.3. The state of this bit should have no bearing on the Receiver's position fix computation. While PA mode is enabled the Receiver must avoid having to set this bit by switching to a backup GEO (being tracked by the other GEO channel) for SBAS integrity and correction data if possible (DO-229D 2.1.4.11).

Note 7: While altitude holding is disabled, this bit is always 0. Altitude holding is enabled/disabled as specified by the $PASHS,PMD command.

Note 8: This bit is only applicable when altitude is held fixed, as indicated by Bit 11. The source of held altitude (last computed or externally supplied) is specified by the $PASHS,FIX command.

Note 9: This bit is set to 1 (fully monitored) when the position fix computation meets the following criteria:

- All satellites used for ranging are SBAS HEALTHY. (DO-229D 2.1.1.6)
- All satellites used for ranging are not GPS UNHEALTHY due to failure of parity or due to default navigation data. (DO-229D 2.1.1.6)
- SBAS fast corrections are applied to all satellites used for ranging. (DO-229D 2.1.1.4.3, J.1, J.2.2)
- SBAS long-term corrections are applied to all GPS satellites used for ranging and to all GEO satellites used for ranging that are operated by a

different provider than the one providing the corrections. (DO-229D 2.1.1.4.11, J.1, J.2.2)

- SBAS range-rate corrections are applied to all satellites used for ranging. (DO-229D 2.1.1.4.12, J.1, J.2.2)
- All satellites used for ranging have SBAS or GPS ionospheric corrections applied. (DO-229D 2.1.1.3.1, J.2.3)
- All used SBAS integrity and correction data was obtained from the preferred SBAS service provider, if a preferred SBAS service provider has been specified by the host.
- At least 4 satellites meeting the above conditions are available for position fix computation.

A position fix does not necessarily have to be fully monitored while FM mode is enabled. While FM mode is enabled and a fully monitored position fix can't be computed, the Receiver computes a position fix using the same algorithm used when FM mode is disabled. The intent is to continue to provide a position however possible, and to provide an indication of whether or not the position is fully monitored.

Note 10: This bit is set to 1 (PA-qualified) when the position fix computation meets the DO-229D criteria for precision approach:

- All satellites used for ranging are SBAS HEALTHY. (DO-229D 2.1.4.11)
- All satellites used for ranging are not GPS UNHEALTHY due to failure of parity or due to default navigation data. (DO-229D 2.1.1.6)
- All satellites used for ranging have UDREI < 12. (DO-229D 2.1.4.11)
- All satellites used for ranging have an elevation angle at or above 5 degrees. (DO-229D 2.1.4.11)
- SBAS fast corrections are applied to all satellites used for ranging. (DO-229D 2.1.1.4.3, J.1, J.2.2)
- SBAS long-term corrections are applied to all GPS satellites used for ranging and to all GEO satellites used for ranging that are operated by a

different provider than the one providing the corrections. (DO-229D 2.1.1.4.11, J.1, J.2.2)
- SBAS range-rate corrections are applied to all satellites used for ranging. (DO-229D 2.1.1.4.12, J.1, J.2.2)
- All satellites used for ranging have SBAS ionospheric corrections applied. (DO-229D 2.1.4.10.2)
- All used SBAS integrity and correction data was obtained from a single SBAS GEO. (DO-229D 2.1.1.4.10)
- All used SBAS integrity and correction data was obtained from the preferred SBAS service provider, if a preferred SBAS service provider has been specified by the host. (DO-229D 2.1.4.11).
- At least 4 satellites meeting the above conditions are available for position fix computation.

A position fix does not necessarily have to be PA-qualified while PA mode is enabled. While PA mode is enabled and a PA-qualified position fix can't be computed, the Receiver computes a position fix using the same algorithm used when PA mode is disabled. The intent is to continue to provide a position however possible, and to provide an indication of whether or not the position is PA-qualified.

Note 11: This bit is set to 1 when a Periodic, Requested, or Cold Start GEO PRN Scan is in progress, otherwise it is set to 0.

UN2: Query for Abridged Measurement Data

$PASHQ,UN2[,c1]

This command allows you to query the UN2 data for one epoch, where c1 is the optional output serial port (‘A’ or ‘B’). If no port is specified, the receiver sends the response to the current port.

$PASHR,UN2

The UN2 message is output in the format below:

```
$PASHR,UN2,<structure><CR><LF>
```

Table 4.51 outlines the response message

Table 4.51. $PASHR,UN2 Message Format

Type	Size in bytes	Units	Meaning
unsigned long	4	milliseconds	Signal received time in milliseconds of week of GPS system time. This is the time tag for all measurements and position data. This is the same as "rcvtime" in the PBN binary response message.
unsigned char	1		Number of satellites in this message
unsigned char	1		Reserved to make the whole structure length even
Structure repeated for each satellite			
unsigned char	1		Satellite ID number
unsigned char	1		Channel number
unsigned char	1		Status indicating whether the satellite was used in the position fix computation.
double	8	Meters	Satellite position as WGS-84 ECEF X at the satellite transmit time corresponding to the Receiver's time of measurement.
double	8	Meters	Satellite position as WGS-84 ECEF Y at the satellite transmit time corresponding to the Receiver's time of measurement.
double	8	Meters	Satellite position as WGS-84 ECEF Z at the satellite transmit time corresponding to the Receiver's time of measurement.
double	8	seconds	Corrected measured range, including IS-GPS-200D corrections, SBAS corrections, and DO-229D tropospheric corrections.
float	4	Meters	Range residual if the satellite is used in position fix computation.
unsigned char	1	dB-Hz	SNR

Table 4.51. $PASHR,UN2 Message Format (continued)

float	4	Meters	Square root of weighting term. The weighing term is provided for each usable satellite, even when it is not used in the position solution. When computing a fully monitored position solution, each weighting term is defined as $\omega_i = \sigma^2_i = \sigma^2_{i,flt} + \sigma^2_{i,UIRE} + \sigma^2_{i,air} + \sigma^2_{i,tropo}$. The weighting matrix is defined in the appendices of DO-229D. When computing a position solution that is not fully monitored, the weighting term for GPS ranges is defined as $\omega_i = \sigma^2_i = \sigma^2_{i,URA} + \sigma^2_{i,UIRE} + \sigma^2_{i,air} + \sigma^2_{i,tropo,}$ where $\sigma^2_{i,URA}$ is substituted for $\sigma^2_{i,flt}$ per DO-229D Section 2.1.2.2.2.2. When computing a position solution that is not fully monitored, the weighting term for GEO ranges is defined as $\omega_i = \sigma^2_i = \sigma^2_{i,URA} + \sigma^2_{i,UIRE} + \sigma^2_{i,air} + \sigma^2_{i,tropo} + (15\ meters)^2$. The 15 meters accounts for the worst-case difference between GPS time and SBAS Network time, which is 50 nanoseconds.
Structure Size:	44		
	2		Checksum

UN3: Query for Satellite Corrections Data

$PASHQ,UN3[,c1]

This command allows you to query the UN3 data for one epoch, where c1 is the optional output serial port (‘A’ or ‘B’). If no port is specified, the receiver sends the response to the current port.

$PASHR,UN3

The UN3 message is output in the format below:

```
$PASHR,UN3,<structure><CR><LF>
```

Table 4.52 outlines the response message

Table 4.52. $PASHR,UN3 Message Format

Type	Size in bytes	Units	Meaning
unsigned long	4	milliseconds	Signal received time in milliseconds of week of GPS system time. This is the time tag for all measurements and position data. This is the same as “rcvtime” in the PBN binary response message.

Table 4.52. $PASHR,UN3 Message Format (continued)

unsigned char	1		Number of satellites in this message
unsigned char	1		Reserved to make the whole structure length even
Structure repeated for each satellite			
unsigned char	1		Satellite ID number
unsigned char	1		Indication of each type of pseudo range correction that it is available to compute the corrected measured range. The correction types include the following: SBAS range rate, SBAS fast clock, SBAS long-term clock, SBAS ionospheric, GPS ionospheric, and DO-229D tropospheric. Status of applied corrections (MSBit is 7, LSBit is 0): Bit 7 - reserved Bit 6 - reserved Bit 5 0 SBAS range rate correction term is NOT available 1 SBAS range rate correction term is available Bit 4 0 SBAS fast correction term is NOT available 1 SBAS fast correction term is available Bit 3 0 SBAS long-term clock correction term is NOT available 1 SBAS fast long-term clock correction term is available Bit 2 0 SBAS ionospheric correction term is NOT available 1 SBAS ionospheric correction term is available Bit 1 0 GPS ionospheric correction term is NOT available 1 GPS ionospheric correction term is available Bit 0 0 DO-229D tropospheric correction term is NOT available 1 DO-229D tropospheric correction term is available
float	4	meters	The value of SBAS range rate correction term available to compute the corrected measured range.
float	4	meters	The value of SBAS fast correction term available to compute the corrected measured range.
float	4	meters	The value of SBAS long-term clock correction term available to compute the corrected measured range.
float	4	meters	The value of SBAS ionospheric correction term available to compute the corrected measured range.
float	4	meters	The value of GPS ionospheric correction term available to compute the corrected measured range.
float	4	meters	The value of DO-229D tropospheric correction term available to compute the fully corrected measured range.

Table 4.52. $PASHR,UN3 Message Format (continued)

unsigned char	1		PRN code of the SBAS signal source of correction data, if SBAS corrections are available to correct the measured range. If SBAS corrections are not available then this field will be meaningless (will be zero).
unsigned char	1		Reserved to make the structure size even
Structure Size:	28		
unsigned short	2		Checksum

UN4: Query for Satellite Navigational Status Data

$PASHQ,UN4[,c1]

This command allows you to query the UN4 data for one epoch, where c1 is the optional output serial port (‘A’ or ‘B’). If no port is specified, the receiver sends the response to the current port.

$PASHR,UN4

The UN4 message is output in the format below:

```
$PASHR,UN4,<structure><CR><LF>
```

Table 4.53 outlines the response message

Table 4.53. $PASHR,UN4 Message Format

Type	Size in bytes	Units	Meaning
unsigned long	4	milliseconds	Signal received time in milliseconds of week of GPS system time. This is the time tag for all measurements and position data. This is the same as “rcvtime” in the PBN binary response message.
unsigned char	1		Number of satellites in this message
unsigned char	1		Reserved to make the whole structure length even
Structure repeated for each satellite			
unsigned char	1		Satellite ID number

Table 4.53. $PASHR,UN4 Message Format (continued)

unsigned char	1		SBAS health status as specified by DO-229D (except for step errors): SBAS UNHEALTHY, SBAS UNMONITORED, or SBAS HEALTHY. Meaning: 0 - this satellite has SBAS HEALTHY status 1 - this satellite has SBAS UNMONITORED status 2 - this satellite has SBAS UNHEALTHY status
unsigned char	1		The status of each condition used to determine the DO-229D SBAS health status (MSBit is 7, LSBit is 0). Bit 7: 1 The equipment has successfully decoded a UDREI of 15, indicating that the SBAS has assessed the satellite's signal as unusable 0 Otherwise Bit 6: 1 For SBAS satellites, user range accuracy index of 15 0 Otherwise Bit 5: 1 For SBAS satellites, failure of parity on 4 successive messages 0 Otherwise Bit 4: 1 SBAS UDREI=14 ("Not Monitored") 0 Otherwise Bit 3: 1 SBAS data is not provided (satellite not in mask) 0 Otherwise Bit 2: 1 SBAS signals are not being received (affects all satellites) 0 Otherwise Bit 1: 1 SBAS data has timed out 0 Otherwise Bit 0: 1 If using long-term corrections, SBAS IOD and GPS IODE cannot be reconciled. 0 Otherwise
unsigned char	1		GPS health status as specified by DO-229D: Meaning: 0 - this satellite has GPS HEALTHY status 1 - this satellite has GPS UNMONITORED status 2 - this satellite has GPS UNHEALTHY status

Commands

Table 4.53. $PASHR,UN4 Message Format (continued)

unsigned char	1		The status of each condition used to determine the DO-229D GPS health status (MSBit is 7, LSBit is 0). Bit 7 1 6 bit health word in subframe 1: all cases where MSB="1" except when other bits are "11101", indicating that the satellite will be out of service but is not at this time (ref. 20.3.3.3.1.4 and 20.3.3.5.1.3 of ICD-GPS-200D, "Navstar GPS Space Segment / Navigation User Interfaces". 0 Otherwise Bit 6 1 Failure of parity on 5 successive words (3 seconds) 0 Otherwise Bit 5 Reserved Bit 4 1 User range accuracy index of 8 or more 0 Otherwise Bit 3 1 Bit 18 of the HOW set to 1(Ref. 20.3.3.2 of ICD-GPS-200D, "Navstar GPS Space Segment / Navigation User Interfaces".)0 Otherwise Bit 2 1 All bits in subframe 1, 2, or 3 are 0's 0 Otherwise Bit 1 1 Default navigation data is being transmitted in subframes 1, 2, or 3 (ref. 20.3.3.2 of ICD-GPS-200D, "Navstar GPS Space Segment / Navigation User Interfaces".) 0 Otherwise Bit 0 1 The preamble does not equal 8B (hexadecimal) or 139 (decimal) 0 Otherwise

Table 4.53. $PASHR,UN4 Message Format (continued)

unsigned char	1		The status of various conditions that prevent satellite from being used in position solution. The following condition codes are supported: 0 - SV isn't tracked 1 - There is no ephemeris data for this SV 2 - The SV is not used because of some unlisted reason 6 - The range smoothing counter has not reached 5sec 11 - The SV is possibly a ghost satellite 13 - The SV is disabled by SVP, USP command 15 - Too big bias error has been detected in the pseudo-range 16 - There are not enough differential corrections for the SV 18 - URA field in ephemeris indicates the SV is not fit 19 - The SV is unhealthy according to ephemeris data 20 - Range measurements are not settled yet 21 - SV is below the elevation mask 23 - SV is usable, position hasn't been computed 24 - SV is usable, position has been computed
Structure Size:	6		
unsigned short	2		Checksum

XYZ: 3D Satellite Positions

$PASHQ,XYZ[,c1]

This command allows you to query the three-dimensional position for each tracked satellite, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,XYZ

In addition to satellite positions, the XYZ message also contains the time at which the satellite signals were received and a pseudorange value which has been corrected to eliminate atmospheric delays and uncertainties resulting from the differences in velocity between the GG12W and the satellites (relativistic errors).

The XYZ message is output in the format below:

```
$PASHR,XYZ,<satellite position data string + checksum><CR><LF>
```

Commands

Table 4.54 outlines the response message.

Table 4.54. $PASHR,XYZ Message Format

Field	Bytes	Content
long [rcvtime]	4	Time at which the signal was received in milliseconds of the week referenced to GPS system time. This time tag is used as a reference for all time and position measurements
short [Total Satellites]	2	The total number of satellites appearing in the message
short [sv_1]	2	The PRN number of the satellite (1 to 32 for GPS satellites, 120 to 138 for SBAS satellites) being tracked on channel 1 of the GG12W
double [satx_1]	8	The x coordinate of the satellite being tracking on channel 1 of the GG12W; referenced to WGS-84
double [saty_1]	8	The y coordinate of the satellite being tracking on channel 1 of the GG12W; referenced to WGS-84
double [satz_1]	8	The z coordinate of the satellite being tracking on channel 1 of the GG12W; referenced to WGS-84
double [range_1]	8	The corrected pseudorange of the satellite referenced in [sv_1]
(These rows are repeated for each channel that is tracking a satellite. That is, if the GG12W is tracking seven satellites, these rows are repeated seven times; if the GG12W is tracking twelve satellites, these rows are repeated twelve times.)		
checksum	2	The checksum is computed by breaking the structure into unsigned shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: minimum = 42; maximum = 416		

NMEA Commands

NMEA commands allow you to set the output parameters for NMEA messages and Magellan NMEA-style messages. These commands can be sent to the GG12W through either serial port. All NMEA messages and Magellan NMEA-style messages are disabled by default. The general format for the set commands used to control the NMEA message output is as follows:

$PASHS,NME,s1,c2,s3[,f4]

In this context, set commands are used to enable the output of NMEA messages at regular intervals or to disable message output, where s1 is a three character message identifier (GGA, VTG, SAT, etc.), c2 is the port designator (A or B) for message output, s3 is ON or OFF and f4 is the message output rate. Query commands prompt the receiver to output the corresponding response message once only. Message output prompted by a query command occurs independently of any related message output settings.

To enable the output of the POS message on port A at five second intervals, enter the following command:

$PASHS,NME,POS,A,ON,5<CR><LF>

To disable the output of the GGA message on port B, enter the following command:

$PASHS,NME,GGA,B,OFF<CR><LF>

To query the POS message and designate port B for the output of the response message, enter the following command:

$PASHQ,POS,B<CR><LF>

To enable or disable the output of the CHS message, use the following command:

$PASHS,NME,CHS,c1,s2[,f3]<CR><LF>

The setting parameters are described in Table 4.55.

Commands

Table 4.55. $PASHS,NME,CHS Command Format

Setting parameter	Description	Range
c1	Receiver serial port to send data out	‘A’ , ‘ B’

Table 4.55. $PASHS,NME,CHS Command Format (continued)

s2	Turns on or off data output	"ON", "OFF"
f3	Optional period for message	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1-second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1-second increment from 1... 999 seconds

NOTE: If the output is set without a period, the period set by the $PASHS,NME,PER command is used. If a $PASHS,NME,PER command is sent after individual NMEA message output periods were set, the previous individual message period is superseded by the most recent NME,PER value. See also $PASHQ,CHS, $PASHR,CHS, $PASHQ,INF and $PASHR,SBA,INF.

As with the other query commands, the port designator (B) is optional. If a port is not specified, the receiver sends the response to the current port. If a port is not specified, the receiver sends the response to the current port.

Message Structure

Standard NMEA messages output as a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards (version 3). Magellan NMEA-style messages also output in a comma-delimited string of ASCII characters, but may deviate slightly from NMEA standards. For example, the maximum length of a standard NMEA message is eighty characters, but the length of some Magellan messages are variable (i.e., SAT) and may go beyond eighty characters. One message which deviates significantly from NMEA standards is the XYZ message, which outputs in binary format. Both NMEA messages and Magellan NMEA-style messages begin with a dollar sign ($) and end with a Carriage Return/Line Feed <CR><LF> delimiter. Any combination of these messages can be output through different ports at the same time. The output rate can be set to any value between 0.2 and 999 seconds. The default output interval is one second.

Standard NMEA messages have the following structure:

HEADER,DATA*CHECKSUM<CR><LF>

The comma after the header is followed by the ASCII data string and the message checksum. An asterisk separates the checksum from the data string. Both standard and non-standard NMEA messages use a dollar sign ($) to indicate the beginning of a message, and both types are terminated with a <CR><LF> delimiter.

Data items in NMEA messages and Magellan NMEA-style messages are separated by commas Successive commas indicate that data is not available or the data field is reserved. Two successive commas indicate one missing data item; three successive commas indicate two missing items.

GGA, which is a standard NMEA message, outputs as shown follows:

$GPGGA,DATA*CHECKSUM<CR><LF>

The structure of non-standard NMEA messages:

HEADER,MESSAGE ID,DATA*CHECKSUM<CR><LF>

Standard NMEA messages include the message identifier in the header. Non-standard messages, which have an Magellan proprietary format, have the message identifier in a separate field. SAT, a non-standard message, outputs as follows:

$PASHR,SAT,DATA*CHECKSUM<CR><LF>

The data types that appear in NMEA messages can be integers, real numbers (decimal), hexadecimal numbers, alphabetic characters, and alphanumeric character strings.

Table 4.56 lists the NMEA commands.

Table 4.56. NMEA Data Message Commands

Function	Command	Description	Page
General command for controlling NMEA message output	$PASHS,NME $PASHS,NME,ALL	Used to enable or disable output of NMEA messages and Magellan NMEA-style messages, set interval for message output. Disables the output of all NMEA and Magellan NMEA-style messages on an individual serial port	page 121 page 123
Channel Status	$PASHQ,CHS	Query for channel status message	page 110
Latency information	$PASHQ,LTN	Query position output latency	page 120
NMEA output parameters	$PASHQ,NMO	Query for current NMEA output parameter settings	page 124
Position data	$PASHQ,GGA $PASHQ,POS $PASHQ,RMC	Query GPS position information Query for comprehensive position message Query for minimum position, course/speed message	page 111 page 47 page 126
Residual data	$PASHQ,RRE	Query satellite residual and position error information	page 128
Satellite data	$PASHQ,GSA $PASHQ,GST $PASHQ,GSV $PASHQ,SAT	Query for DOPs/satellite used Query for pseudorange error statistics Query for all satellites in view Query for satellite status information	page 113 page 115 page 117 page 130

Table 4.56. NMEA Data Message Commands (continued)

Function	Command	Description	Page
Time and date	$PASHQ,ZDA	Query for time and date information	page 133
Course and speed	$PASHQ,VTG	Query for velocity/course information	page 132

Refer to the *NMEA 0183 Standard for Interfacing Marine Electronic Navigational Devices* for more details on protocols and message formats.

CHS: Query for Channel Status Message

$PASHQ,CHS[,c1]

This command allows you to enable or disable the Channel Status message where c1 is the optional output port (“A” or “B”). If no port is specified, the receiver sends the response to the current port.

$PASHR,CHS

The CHS message is output in the format below (ASCII):

```
$PASHR,CHS,d1{,d2,d3,d4} n*hh<CR><LF>
```

Table 4.57 outlines this message.

Table 4.57. $PASHR,CHS Message Format

Parameters	Description	Range
d1	Number of channels assigned	0-12
d2	SV PRN number	1-32, 120 - 138
d3	Non-smoothed SV Signal-to-Noise Ratio (Note that this SNR may be different from SNR reported in SAT)	0 – 99
d4	SV tracking state. Bits are: Bit 0 – Signal is Detected; Bit 1 – Signal is Locked; Bit 2 – Symbol synchronization established; Bit 3 – Frame synchronization established; Bit 4 – Preamble is confirmed; Bit 5 – Parity is confirmed (for SBAS satellites only); Bit 6 – Satellite used in position solution;	0 – 127
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Typical message:

```
$PASHR,CHS,12,1,47,95,15,45,95,30,47,95,14,46,95,5,46,95,6,45,9
5,130,46,63,22,48,95,9,47,95,18,47,95,21,46,95,124,46,63*0B<CR>
<LF>
```

GGA: 3-D GPS Position

$PASHQ,GGA[,c1]

This command allows you to query the GGA position message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPGGA

This message does not output unless positions are being computed. In addition to a 3-D position (latitude/longitude/altitude), the GGA message contains information on the type of position fix (i.e., autonomous or differentially corrected), HDOP, and current time. The GG12W can be set to output the GGA message at regular intervals by using the command **$PASHS,NME**.

The GGA message output is in the format:

```
$GPGGA,d1d2f3,d4f5,c6,d7f8,c9,d10,d11,f12,±d13,M,±f14,M,d15,d16
*hh<CR><LF>
```

Table 4.58 outlines the message format.

Table 4.58. $GPGGA Message Format

Parameter	Description	Range
 d1 d2 f3	UTC of position fix: Hours Minutes Seconds	 0-23 0-59 0-59.99
 d4 f5	Latitude: Degrees Minutes, with 5 decimal places	 0° - 90° 0-59.99999
c6	Direction of latitude	“N” or “S”
 d7 f8	Longitude: Degrees Minutes, with 5 decimal places	 0° - 180° 0-59.99999
c9	Direction of longitude	“E” or “W”

Commands

Table 4.58. $GPGGA Message Format (continued)

Parameter	Description	Range
d10	GPS quality indicator of Raw/Differential Position: d5= 0 - GPS fix is not available or invalid (position is not computed) d5 = 1 - GPS available (Raw; not differentially corrected) d5 = 2 - DGPS available (position is differentially corrected). Position is marked as differential if all satellites used in position solution have full SBAS corrections. Otherwise position is marked as autonomous.	0-2
d11	Number of satellites used in position computation	1 - total Channels
f12	HDOP (horizontal dilution of precision)	0 - 99.9
d13	Antenna height, in meters (M for meters)	-1000.0 - 18000.0
f14	Geoidal undulation, in meters (M for meters)	-999.99 to 999.99
d15	Age of differential corrections (seconds)	0 - 999
d16	Differential reference station ID	0 - 1023
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Note: Field f5 (geoidal undulation) is available only if the corresponding option ('G') is active (see command $PASHQ,RID).

Note: If there is no valid position, GGA still provides: time, invalid position flag, number of satellites, HDOP, age of corrections, base station ID:

$GPGGA,hhmmss.ss,,,,,0,qq,hh.h,,,,,sss,aaaa

If there are not enough satellites to compute HDOP, then the HDOP field is null. Regardless of whether the receiver is in Differential or Stand-Alone mode, the age of corrections and base station ID fields are both null.

Output format: ASCII

Description: NMEA Global Positioning System Position. This message is always output when enabled, whether or not position is computed. If position is not available, an empty, blank, comma-delineated field is output.

See also:

$PASHS,NME,GGA,c,ON[,f]<CR><LF>

$GPGGA,...<CR><LF>

Examples:

$PASHQ,GGA<CR><LF>

Requests GGA message to be send out of current port.

$PASHQ,GGA,B<CR><LF>

Requests GGA message to be send out of port B.

RETURN MESSAGE:

Stand-Alone:

$GPGGA,000643.50,3400.03029,N,11800.01785,W,1,9,01.2,-00095.13,M,-0033.02,M,,*70<CR><LF>

SBAS differential:

$GPGGA,000859.00,3400.09498,N,11759.96010,W,2,6,02.2,-00221.01,M,-0033.02,M,,*73<CR><LF>

No Position available:

$GPGGA,000011.50,,,,,0,0,,,M,,M,,*7D<CR><LF>

GSA: DOP and Active Satellites

$PASHQ,GSA[,c1]

This command allows you to query the GSA message, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$GPGSA

This version of the GSA message lists the indicators for current position mode ($PASHS,PMD,d1 on page 46), the GPS satellites used for the position computation, and the values for PDOP, HDOP, and VDOP. This message does not output until positions are computed.

The response is output in the format:

```
$GPGSA,c1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,d14,d15,d16,d17*hh<CR><LF>
```

Commands

Table 4.59 outlines the message format.

Table 4.59. $GPGSA Message Format

Parameter	Description	Range
c1	Position mode indicator: • A - Automatic mode • M - Manual mode	A, M
d2	Position mode indicator: • 2 - 2D mode • 3 - 3D mode	2, 3
d3-d14	These twelve fields represent the receiver's twelve channels listed in ascending order. The number 17 appearing in field d5 indicates that GG12W channel 3 is locked on GPS satellite 17. If a given channel is not locked on a satellite, the corresponding field is empty	1 - 32, 120-138
d15	Current PDOP value	0 - 99.9
d16	Current HDOP value	0 - 99.9
d17	Current VDOP value	0 - 99.9
*hh	Checksum	2-character hex

Typical $GPGSA message:

```
$GPGSA,A,3,18,01,14,19,22,04,16,27,03,24,,,01.4,00.9,01.1
*08<CR><LF>
```

Table 4.60 outlines the message format.

Table 4.60. Typical $GPGSA Message

Field	Description
$GPGSA	Header
A	Indicates automatic 2-D/3-D switching mode
3	Indicates 3D position mode
18	GG12W channel 1 locked on GPS satellite 18; satellite 18 used in position computations
01	GG12W channel 2 locked on GPS satellite 1; satellite 1 used in position computations
14	GG12W channel 3 locked on GPS satellite 14; satellite 14 used in position computations
19	GG12W channel 4 locked on GPS satellite 19; satellite 19 used in position computations

Table 4.60. Typical $GPGSA Message (continued)

Field	Description
22	GG12W channel 5 locked on GPS satellite 22; satellite 22 used in position computations
04	GG12W channel 6 locked on GPS satellite 4; satellite 4 used in position computations
16	GG12W channel 7 locked on GPS satellite 16; satellite 16 used in position computations
27	GG12W channel 8 locked on GPS satellite 27; satellite 27 used in position computations
03	GG12W channel 9 locked on GPS satellite 3; satellite 3 used in position computations
24	GG12W channel 10 locked on GPS satellite 24; satellite 24 used in position computations
,,	Indicates that this channel (11) is not locked on a GPS satellite or that the locked satellite is not being used in position computations
,,	Indicates that this channel (12) is not locked on a GPS satellite or that the locked satellite is not being used in position computations
01.4	Current PDOP value
00.9	Current HDOP value
01.1	Current VDOP value
*08	Checksum

GST: Pseudorange Error Statistics

$PASHQ,GST[,c1]

This command allows you to query the GST message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPGST

The GST message contains UTC time, the RMS value of the standard deviation for satellite range measurements, and the corresponding standard deviation values for latitude, longitude, and altitude.

The message format is output in the format:

```
$GPGST,m1,f2,f3,f4,f5,f6,f7,f8*hh<CR><LF>
```

Table 4.61 outlines the message format.

Table 4.61. $GPGST Message Format

Parameter	Description	Range
m1	UTC time (hhmmss.ss) of the position fix	000000.00 to 235959.95
f2	RMS value of the standard deviation of the satellite range inputs to the navigation processor. This field is related to remaining fields as follows: • (RMS value of standard deviation range inputs)^2* (HDOP)^2 = (Standard deviation of latitude error)^2 + (Standard deviation of longitude error)^2 • (RMS value of standard deviation of range inputs)^2* (VDOP)^2 = (Standard deviation of altitude error)^2	0.00 - 99.99
f3	Standard deviation of semi-major axis of error ellipse (meters).	N/A
f4	Standard deviation of semi-minor axis of error ellipse (meters).	N/A
f5	Orientation of semi-major axis of error ellipse (degrees from true north).	N/A
f6	Standard deviation of latitude error (meters)	0000.00 to 9999.99
f7	Standard deviation of longitude error (meters)	0000.00 to 9999.99
f8	Standard deviation of altitude error (meters)	0000.00 to 9999.99
*hh	Checksum	2-character hex

Typical GST message:

```
$GPGST,142958.00,0003.34,,,,0002.64,0002.05,0004.50*78<CR><LF>
```

Table 4.62 outlines the message format.

Table 4.62. Typical GST Message

Field	Description
$GPGST	Header
142958.00	UTC time of the position fix
0003.34	RMS value of the standard deviation of satellite range inputs (1sigma position error)
Blank	Not computed
Blank	Not computed
Blank	Not computed
0002.64	Standard deviation of the latitude error (meters)
0002.05	Standard deviation of the longitude error (meters)
0004.50	Standard deviation of the altitude error (meters)
*78	Checksum

Standard deviation values in the GST message have a precision of one centimeter (two digits past the decimal mark). A zero value (0000.00) in any of the standard deviation fields indicates that the estimate of the standard deviation is less than five millimeters.

GSV: Satellites in View

$PASHQ,GSV[,c1]

This command allows you to query the GSV message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPGSV

The GSV message contains the PRN number, elevation, azimuth, and signal to noise ration for each visible satellite. This message contains data for a maximum of four satellites. If seven satellites are visible, two GSV messages are output; if ten satellites are visible, three GSV messages are output.

The message is output in the format:

```
$GPGSV,d1,d2,d3,d4,d5,d6,f7,d8,d9,d10,f11,d12,d13,d14,f15,d16,
d17,d18,f19*hh<CR><LF>
```

Table 4.63 outlines the message format.

Table 4.63. $GPGSV Message Format

Parameter	Description	Range
d1	Total number of GSV messages to be output	1 - 3
d2	Message number	1 - 3
d3	Total number of satellites in view	1 - 12
d4	Satellite PRN number	1 -32, 120 - 138
d5	Elevation (degrees)	0° - 90°
d6	Azimuth (degrees)	0° - 359°
f7	Signal to noise ration (dbHz)	00.0 - 99.9
d8	Satellite PRN number	1 -32, 120 - 138
d9	Elevation (degrees)	0° - 90°
d10	Azimuth (degrees)	0° - 359°
f11	Signal to noise ration (dbHz)	00.0 - 99.9
d12	Satellite PRN number	1 -32, 120 - 138
d13	Elevation (degrees)	0° - 90°
d14	Azimuth (degrees)	0° - 359°
f15	Signal to noise ration (dbHz)	00.0 - 99.9
d16	Satellite PRN number	1 -32, 120 - 138
d17	Elevation (degrees)	0° - 90°
d18	Azimuth (degrees)	0° - 359°
f19	Signal to noise ration (dbHz)	00.0 - 99.9
*hh	Checksum	2-character hex

Typical GSV message:

```
$GPGSV,3,1,10,18,59,322,51.4,1,39,98,47.4,14,33,169,45.6,19,46,
267,50.4*75<CR><LF>
```

Table 4.64 outlines the message format.

Table 4.64. Typical GSV Message

Field	Description
$GPGSV	Header
3	Indicates that three GSV messages will be output
1	Indicates that this is the first GSV message
10	Indicates that ten satellites are visible
18	Indicates GPS satellite 18 is visible
59	Elevation of satellite 18
322	Azimuth of satellite 18
51.4	Signal to noise ratio of PRN 18
1	Indicates GPS satellite 1 is visible
39	Elevation of satellite 1
98	Azimuth of satellite 1
47.4	Signal to noise ratio of satellite 1
14	Indicates GPS satellite14 is visible
33	Elevation of satellite 14
169	Azimuth of satellite 14
45.6	Signal to noise ratio of satellite 14
19	Indicates GPS satellite 19 is visible
46	Elevation of satellite 19
267	Azimuth of satellite 19
50.4	Signal to noise ration of satellite 19
*75	Checksum

LTN: Position Output Latency

$PASHQ,LTN[,c1]

This command allows you to query the LTN message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,LTN

This single-field message is output even if a position is not computed. Latency is defined as the number of milliseconds it takes the receiver to compute a position (from the position fix tag time) and prepare data to be output through the serial port. The latency range is typically between 65 and 95 milliseconds, depending on the number of satellites tracked and the number of satellites used in the position solution.

The message response is output in the format below:

```
$PASHR,LTN,d*hh<CR><LF>
```

Output format: ASCII

Table 4.65 outlines the message format.

Table 4.65. $PASHR,LTN Message Format

Parameter	Description	Range
d	d is an integer number of milliseconds being required before position is available, i.e. a latency in getting current position within a one-second interval. The response is a one-field message containing information on the number of milliseconds it takes the receiver to compute a position (from the measurement tag time) and prepare data to be transmitted through the serial port. This number is dependent upon the number of locked satellites.	50 - 100 (Fast CPD modes) 1500 (time-tagged CPD mode)
*hh	Checksum	2-character hex

Note: This message conveys the time elapsed between the time the latest position was computed, and the moment when the first character of LTN message ($) was sent to the port. The elapsed time is computed by counting the number of ASIC interruptions. The period of ASIC interruptions being known, the time elapsed between any two events can be determined. "The time the latest position was computed" is the time for which the latest position is computed (this is the time tag displayed in GGA, POS,..). Usually this is a UTC second (with 1-Hz position update) or half-second (with 2-Hz position update). The measurements are hardware-sampled not exactly on UTC second or half-second, but according to receiver clock. Then the measurements are extrapolated to the UTC second/half-second and the position is computed. So the LTN message is delayed compared to the moment when the latest position is computed (this moment corresponds to the time tag displayed in GGA, POS,..). LTN being always the first message to be output, the delay for this message does not depend on other messages being output (all of them are output *after* LTN).

Typical LTN message:

```
$PASHR,LTN,69*01<CR><LF>
```

Table 4.65 outlines the message format.

Table 4.66. $PASHQ,LTN Query Response

Field	Significance
$PASHR,LTN	Header
69	Latency value (milliseconds)
01	Checksum

NME: Enable/Disable NMEA Message Output and Interval

$PASHS,NME,s1,c2,s3,f4

This command allows you to control the output of NMEA messages and Magellan NMEA-style messages. Use the **$PASHQ,NMO** query command (page 124) to view the messages available to output. All messages are disabled for output by default. Each message is enabled for output individually.

The s1 parameter is the three-letter message identifier (GGA, LTN, POS, etc.), c2 is the port designator for message output, s3 is ON or OFF, and f4 is the value for the message output interval. The range of the value for the output interval depends on the output option selected. The f4 parameter allows you to set the output interval for each individual message. You can set the GGA and VTG messages to be output every two seconds, but have the SAT message output at ten second intervals. Table 4.67 below outlines the options and ranges for the output interval:

Table 4.67. Output Interval Settings for NMEA Messages

Installed Option	Output Range (seconds)	Increments
1 Hz	1-999	1 second
2 Hz	0.5-999	0.5 second from 0.5 to 1 1 second from 1 to 999
5 Hz	0.2-999	0.2 second from 0.2 to 1 1 second from 1 to 999

The GG12W is designed to synchronize NMEA message output with the hour rollover, so that message output from multiple receivers can be synchronized regardless of when they were turned on. An output interval of 0.7 is not allowed because it overlaps the hour rollover, which corrupts the synchronization of message output between multiple receivers.

Example

Enter the following command to output the POS message from port B at five second intervals:

$PASHS,NME,POS,B,ON,5<CR><LF>

Enter the following command to disable the output of the POS message on port B:

$PASHS,NME,POS,B,OFF<CR><LF>

$PASHS,NME,PER,f1

This command allows you to set a global output interval for all NMEA messages and Magellan NMEA-style messages currently enabled for output, where f1 is the value for the output interval. This command overrides individual settings for output interval. That is, if the GGA message is enabled for output at intervals of two seconds and the SAT message is enabled for output at intervals of ten seconds, using the PER command to set an output interval of five seconds resets the output interval of both messages to five seconds.

Example

Enter the following command to set the global NMEA output interval to five seconds:

$PASHS,PER,5<CR><LF>

$PASHS,NME,ALL,c1,s2

This command allows you to globally disable the output of all NMEA messages and Magellan NMEA-style messages on a single port, where c1 is the port designator (A or B) and s2 is OFF.

Example

Enter the command below to disable the output of all NMEA messages on port A:

$PASHS,NME,ALL,A,OFF<CR><LF>

Enter the command below to disable the output of all NMEA messages on port B:

$PASHS,NME,ALL,B,OFF<CR><LF>

The $PASHS, NME commands in this example must be entered in order to disable the output of all NMEA messages and Magellan NMEA-style messages on both ports.

NMO: Query for NMEA Output Parameters

$PASHQ,NMO,c1[,c2]

This command allows you to read the current output status for the NMEA message where c1 identifies the port requested to output the NMEA message (A or B) and c2 is an optional parameter identifying the port through which the response to this command will be output (also A or B). If c2 is not defined, then the response will be output on the port defined as “c1”.

$PASHR,NMO

The response contains the parameter settings for NMEA message output, including the serial port being used and its baud rate, a default output interval, the number of pairs of output strings. Each pair of output string includes a three-letter identifier and the corresponding output interval.

The message is output in the format (ASCII format):

```
$PASHR,NMO,c1,d2,f3,d4[,s5,f6]*hh<CR><LF>
```

Table 4.68 outlines the message format.

Table 4.68. $PASHR,NMO Message Format

Parameters	Description	Range
c1	RTCM output port	‘A’, ‘B’
d2	Port baud rate index	0 => 300 bps; 1 => 600; 2 => 1200; 3 => 2400; 4 => 4800; 5 => 9600; 6 => 19200; 7 => 38400; 8 > 57600; 9 => 115,200;
f3	Default output interval in seconds	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second; 1-second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec; 1-second increment from 1... 999 seconds Note: A period of 0.7 sec is not available, because message output is always synchronized with the hour rollover, and 3600 is not evenly divisible by 0.7
d4	Number of pairs of output strings and period for update to follow	14
s5	3-letter string identifier	"POS", "GGA", …

Table 4.68. $PASHR,NMO Message Format

f6	Update period for message type	0 => message not output 0.05...999 (see parameter f3)
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Typical NMO response message:

```
$PASHR,NMO,A,9,001.0,14,LTN,000.0,ZDA,000.0,POS,000.0,GGA,000.0
,VTG,000.0,GSA,000.0,GSV,000.0,SAT,000.0,RRE,000.0,RMC,000.0,GS
T,000.0,CHS,000.0,DAT,000.0,INF,000.0*6B<CR><LF>
```

Table 4.69 outlines the message format.

Table 4.69. Typical NMO Response Message

Parameter	Description
$PASHR,NMO	Header
A	Indicates that serial port A is referenced in the response
9	This code number indicates that the data rate for port A is 115,200 baud
0001.0	Global output interval setting for NMEA messages and Magellan NMEA-style messages
14	Indicates that fourteen NMEA and Magellan NMEA-style messages are available for output
LTN,000.0... ...INF,000.0	Message identifiers and corresponding output periods
*6B	Checksum

RMC: Recommended Minimum Position & Course

$PASHQ,RMC[,c1]

This command allows you to query the RMC message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPRMC

This message contains UTC time, date, position status, latitude, longitude, course and speed over the ground, and magnetic variation. The RMC message does not output unless positions are being computed.

The message is output in the format:

```
$GPRMC,m1,c2,m3,c4,m5,c6,f7,f8,d9,f10,c11,c12*hh<CR><LF>
```

Table 4.70 outlines the message format.

Table 4.70. $GPRMC Message Format

Parameter	Description	Range
m1	UTC time of the position fix (hhmmss.ss)	000000.00 to 235959.90
c2	Status of the position fix (always A) • A - Position data is valid • V - Position data is invalid	A, V
m3	Latitude (ddmm.mmmmmm)	0000.000000° to 8959.999999°
c4	Latitude sector	N(orth) S(outh)
m5	Longitude (dddmm.mmmmmm)	00000.000000° to 17959.999999°
c6	Longitude sector	E(ast W(est)
f7	Speed over the ground (knots)	000.00 - 999.99
f8	Course over the ground (degrees); referenced to true north	000.00° - 359.99°
d9	Date (ddmmyy)	010100 - 123199
f10	Magnetic variation (degrees)	00.00° -179.99°
c11	Direction of magnetic variation: • Easterly variation - subtract this value from true north course. • Westerly variation - add this value to true north course	E (ast) W (est)

Table 4.70. $GPRMC Message Format (continued)

Parameter	Description	Range
c12	Positioning System Mode Indicator. Position is marked as differential if all satellites used in position solution have full SBAS corrections. Otherwise position is marked as Autonomous.	A = Autonomous mode D = Differential mode E = Estimated mode M = Manual input mode S = Simulator mode N = Data not valid
*hh	Checksum	2-character hex

Typical RMC message:

```
$GPRMC,174820.20,A,3759.2459,N,12159.8404,W,518.36,123.12,06169
7,13.50,W,A<CR><LF>
```

Table 4.71 outlines the message format.

Table 4.71. Typical RMC Message

Parameter	Description
174820.20	UTC time of the position fix (hhmmss.ss)
A	Valid position
3759.2459	Latitude
N	Latitude sector
12159.8404	Longitude
W	Longitude Sector
518.36	Speed over ground (knots)
123.12	Course Over Ground (degrees True)
061697	21 October 1999
13.50	Magnetic Variation, degrees
W	Easterly variation (subtract from the True course)
A	Autonomous mode

RRE: Satellite Range Residuals and Position Error

$PASHQ,RRE[,c1]

This command allows you to query the RRE message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port. The GG12W outputs one RRE message. This message (**$GPRRE**) contains information for the GPS and SBAS satellites.

$GPRRE

This message contains residual error values for the each pseudorange measurement and RMS values for horizontal and vertical position error for the GPS and SBAS satellites. The satellites are listed in the order in which they were acquired. The RRE message does not output unless positions are being computed. Residual errors and position errors are computed only if a minimum of 5 locked satellites are used to compute position; otherwise zero values are registered in the data fields.

The message is output in the format below:

```
$GPRRE,d1,((d2,f3)*d1),f4,f5*hh<CR><LF>
```

The data fields for satellite number (d2) and residual range error (f1) are repeated for each locked satellite, with the d1 value acting as a multiplier. Table 4.72 outlines the message format.

Table 4.72. $GPRRE Message Format

Parameter	Description	Range
d1	Number of satellites used to compute position	0 - 12
d2	PRN number for each of the satellites used in the position computation	1 - 32, 120-138
f3	Magnitude of the residual range error (meters) for each satellite used in the position computation	-999.9 to +999.9
f4	RMS value for the horizontal position error (meters)	-9999.9 to +9999.9
f5	RMS value for the vertical position error (meters)	

Typical $GPRRE message:

```
$GPRRE,10,18,-038.9,01,+018.4,14,-006.5,19,001.7,22,+015.3,04,+
032.5,16,+005.1,27,-014.5,03,+000.1,24,-010.6,0018.8,0022.7
*74<CR><LF>
```

Table 4.73 outlines the message format.

Table 4.73. Typical $GPRRE Message

Field	Description
$GPRRE	Header for GPS-based RRE message
10	Number of GPS satellites used to compute positions
18	PRN number of the first GPS satellite acquired
-038.9	Range residual of first GPS satellite (meters)
01	PRN number of the second GPS satellite acquired
+018.4	Range residual for second satellite (meters)
14	PRN number of the third GPS satellite acquired
-006.5	Range residual of the third satellite (meters)
19	PRN number of the fourth GPS satellite acquired
+001.7	Range residual of the fourth satellite (meters)
22	PRN number of the fifth GPS satellite acquired
+015.3	Range residual of the fifth satellite (meters)
04	PRN number of the sixth GPS satellite acquired
+032.5	Range residual of the sixth satellite (meters)
16	PRN number of the seventh GPS satellite acquired
+005.1	Range residual of the fifth satellite (meters)
27	PRN number of the eighth GPS satellite acquired
-014.5	Range residual of the eighth satellite (meters)
03	PRN number of the ninth GPS satellite acquired
+000.1	Range residual of the ninth satellite (meters)
24	PRN number of the tenth GPS satellite acquired
-010.6	Range residual of the tenth satellite (meters)
0018.8	Horizontal position error (meters)
0022.7	Vertical position error (meters)
*76	Checksum

SAT: Comprehensive Satellite Tracking Data

$PASHQ,SAT[,c1]

This command allows you to query the SAT message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAT

The SAT message contains information on the number of visible satellites, whether the satellite is being used in position computations, plus elevation, azimuth, and signal to noise measurements for each satellite.

The message is output in the format:

```
$PASHR,SAT,d1,((d2,d3,d4,d5,c6)*d1)*hh<CR><LF>
```

The data fields for PRN number (d2), azimuth (d3), elevation (d4), signal to noise ration (d5), and the used/not used flag (c6) are repeated for each satellite, using the value in the d1 field as a multiplier.

Table 4.74 outlines the message format.

Table 4.74. $PASHR,SAT Message Format

Field	Description	Range
d1	The number of satellites locked by the receiver	1 - 12
d2	Satellite PRN number	1 - 32,120 - 138
d3	Satellite azimuth angle	0° - 359°
d4	Satellite elevation angle	0° - 90°
d5	Satellite signal-to-noise ratio (dbHz)	20 - 56
c6	Indicates whether the locked satellite is used in position computations: • A “U” indicates that the satellite is being used in position computations • A dash (-) indicates that the satellite is not being used in position computations	U, -
*hh	Checksum	2-character hex

Typical SAT message:

```
$PASHR,SAT,03,03,103,56,60,U,23,225,61,39,U,16,045,02,21,U
*6E<CR><LF>
```

Table 4.75 outlines the message format.

Table 4.75. Typical SAT Message

Field	Description
$PASHR,SAT	Header
03	Number of satellite locked
03	PRN number of the first satellite
103	Azimuth of the first satellite in degrees
56	Elevation of the first satellite in degrees
60	Signal strength of the first satellite
U	Satellite used in position computation
23	PRN number of the second satellite
225	Azimuth of the second satellite in degrees
61	Elevation of the second satellite in degrees
39	Signal strength of the second satellite
U	satellite used in position computation
16	PRN number of the third satellite
045	Azimuth of the third satellite in degrees
02	Elevation of the third satellite in degrees
21	Signal strength of the third satellite
U	Satellite used in position computation
6E	Checksum

VTG: Course and Speed Over Ground

$PASHQ,VTG[,c1]

This command allows you to query the VTG message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPVTG

This message does not output unless positions are computed. The VTG contains course over the ground (COG) referenced to both true and magnetic north and speed over the ground (SOG) in kilometers per hour and nautical miles per hour (knots).

The message is output in the format:

```
$GPVTG,f1,c2,f3,c4,f5,c6,f7,c8,c9*hh<CR><LF>
```

Table 4.76 outlines the message format.

Table 4.76. $GPVTG Message Format

Field	Description	Range
f1	Course over ground; referenced to true north	000.0° - 359.99°
c2	North reference indicator (always T; true north)	T
f3	Course over the ground; referenced to magnetic north	000.0° - 359.99°
c4	North reference indicator (always M; magnetic north)	M
f5	Speed over ground (knots)	000.00 - 999.99
c6	Speed unit of measure (always N; nautical miles per hour)	N
f7	Speed over ground (kilometers per hour)	000.00 - 999.99
c8	Speed unit of measure (always K; KPH)	K
c9	Positioning System Mode Indicator. Position is marked as differential if all satellites used in position solution have full SBAS corrections. Otherwise position is marked as Autonomous.	A = Autonomous mode D = Differential mode E = Estimated mode M = Manual input mode S = Simulator mode N = Data not valid
*hh	Checksum	2-character hex

Typical VTG message:

```
$GPVTG,179.00,T,193.00,M,000.11,N,000.20,K,A*3E<CR><LF>
```

Table 4.77 outlines the message format.

Table 4.77. Typical VTG Message

Field	Description
$GPVTG	Header
179.00	Course over ground (degrees)
T	True course over ground marker
193.00	Magnetic course over ground
M	Magnetic course over ground marker
000.11	Speed over ground (knots)
N	Nautical miles per hour
000.20	Speed over ground in kilometers/hour
K	Kilometers per hour
A	Autonomous mode
*3E	Checksum

ZDA: Time and Date

$PASHQ,ZDA[,c1]

This command allows you to query the ZDA message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPZDA

This message does not output until the receiver has locked on at least one satellite. The ZDA message contains UTC time, the current date, and offset values for converting UTC time to local time.

The message is output in the format:

```
$GPZDA,m1,d2,d3,d4,d5,d6*hh<CR><LF>
```

Commands

Table 4.78 outlines the message format.

Table 4.78. $GPZDA Message Format

Field	Description	Range
m1	UTC time	000000.00 to 235959.90
d2	Current day	01 - 31
d3	Current month	01 - 12
d4	Current year	0000 - 9999
d5	Local time zone offset from UTC time (hours)	Not implemented
d6	Local time zone offset from UTC time (minutes). This value has the same sign [+/-] as d5, but the sign is not displayed for this field.	Not implemented
*hh	Checksum	2-character hex

Typical ZDA message:

```
$GPZDA,060729.00,14,07,2007,-07,00*41<CR><LF>
```

Table 4.79 outlines the message format.

Table 4.79. Typical ZDA Message

Field	Description
$GPZDA	Message header
060729.00	Current UTC time
14	Current day
07	Current month
2007	Current year
-07	Local time zone offset from UTC (hours)
00	Local time zone offset from UTC (minutes)
41	Checksum

SBAS Commands

SBAS commands allow you to set the output parameters for SBAS messages. These commands can be sent to the GG12W through either serial port. The general format for the set commands used to control the SBAS message output is as follows:

$PASHS,SBA,c,...

Where c is one of the possible commands (CEM, DAT, ELM, FMM, INF, NSA, PAM, PEM, PRO, SCA) followed by their specific setting parameters.

INF: Query for SBAS Information Message

$PASHQ,INF[,c1]

This command allows you to ask the receiver to output the SBAS Information message, where c1 is the optional output port (“A” or “B”). If no port is specified, the receiver sends the response to the current port

SBA: SBAS-Related Parameters

$PASHQ,SBA[,c1]

This command asks the receiver to return the current settings of SBAS-related parameters, where c1 is the optional output port (“A” or “B”). If no port is specified, the receiver sends the response to the current port.

Examples: $PASHQ,SBA<CR><LF>

Requests SBA message to be sent out on current port.

$PASHQ,SBA,B<CR><LF>

Requests SBA message to be sent out of port B.

$PASHR,SBA

This is the response to $PASHQ,SBA.

The SBA message is output in the format below (ASCII):

```
$PASHR,SBA,s1,d2,s3,d4,s5,d6,d7,d8,s9*hh<CR><LF>
```

Commands

Table 4.80 outlines the response message

Table 4.80. $PASHR,SBA Message Format

Parameters	Description	Range
s1	Precision Approach Mode setting	‘ON’, ‘OFF’
d2	Preferred Provider (SBA,PRO,0 – 15, 15 means that a preferred provider is not specified.)	0 – 15
s3	GEO PRN Signal Scanning Mode setting	‘ON’, ‘OFF’
d4	GEO PRN Signal Scanning Mode (SBA,SCA parameter (if s3 is ON – d4 is the number of minutes between scan intervals, if s1 is OFF – d4 is 0).	0 – …
s5	Non-Safety-of Life Application Mode setting	‘ON’, ‘OFF’
d6	SBAS satellite track elevation mask (SBA,ELM)	0 – 90
d7	SBAS position elevation mask (SBA,PEM)	0 – 90
d8	SBAS correction use mask (SBA,CEM)	0 – 90
s9	Fully Monitored Mode setting (ON/OFF)	‘ON’, ‘OFF’
*hh	The hexadecimal ckecksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Example: $PASHQ,SBA,B<CR><LF>

Response: $PASHR,SBA,ON,15,ON,15,OFF,2,5,5,OFF*3A<CR><LF>

$PASHS,SBA,CEM,d1

This command is used to set the elevation mask of SBAS satellites above which SBAS correction and integrity data from these satellites can be used. “d1” is the elevation mask in degrees (0-90 degrees). The default value is 5 degrees.

Return message: $PASHR,ACK*3D (Received command OK)

$PASHR,NAK*30 (Received command INVALID)

Example:

$PASHS,SBA,CEM,20<CR><LF>

(Sets the elevation mask for use of SBAS correction and integrity data to 20 degrees)

$PASHS,SBA,DAT,c1,s2[,f3]

This command allows you enable or disable the output of SBA,DAT data on a given port. If no port is specified, the receiver sends the response to the current port.

Return message: $PASHR,ACK*3D (Received command OK)

$PASHR,NAK*30 (Received command INVALID)

Table 4.81. $PASHS,SBA,DAT Command Format

Setting parameter	Description	Range
c1	Receiver comm. port to send data out	'A' , ' B'
s2	Turns on or off data output	"ON", "OFF"
[f3]	optional period for message	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec 1 second increment from 1... 999 seconds

Note: The output period of SBA,DAT messages does not depend on the NME,PER setting and on the interval specified in the command. The output of SBA,DAT messages is event-driven. SBA,DAT messages are output upon reception of another SBAS message from any of the SBAS satellites. The syntax of the SBA,DAT message is described below.

$PASHR,SBA,DAT

The SBA,DAT message is output in the format below:

```
$PASHR,SBA,DAT,d1,d2,d3,d4,s5*hh<CR><LF>
```

Table 4.82 outlines this message.

Table 4.82. $PASHR,SBA,DAT Message Format

Parameters	Description	Range
d1	SV PRN number	120 - 138
d2	UTC Time tag of the beginning of this message transmission.	000000 – 235959
d3	RTCA message ID	0 - 63
d4	Error flags (in HEX). Bits are: bit0: preamble error bit1: parity error	0 – 3
s5	RTCA message: 250 bit in 63 HEX numbers, data lies from left to right and from high-order to low-order bits. The two low-order bits in the 63rd number are not used.	
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Example:

$PASHR,SBA,DAT,138,161214.00,2,0,
9A09C001FFDFFDFFC001FFDFFDFFDFFDFFFFEC00DFFD7BB97BBBB95BA
C9AEB0*2F<CR><LF>

$PASHS,SBA,ELM,d

This command is used to set the elevation mask of SBAS satellites above which SBAS measurements from these satellites can be output. “d” is the elevation mask in degrees (0-90 degrees). The default value is 2 degrees.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Example:

$PASHS,SBA,ELM,20<CR><LF>

(Sets the elevation mask for output of SBAS measurements to 20 degrees)

$PASHS,SBA,FMM,s

This command allows you to enable or disable the Fully Monitored Mode. The mode is enabled if “s” is set to “ON” or disabled if it’s set to “OFF”. The default setting is “OFF”.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Example: $PASHS,SBA,FMM,ON<CR><LF>

Fully Monitor Mode is included to enhance the DO-229D satellite selection algorithm described in DO-229D section 2.1.1.6.

Fully Monitored Mode is enabled (ON) when there are sufficient SBAS monitored GPS satellites for a position solution with sufficient integrity for the phase of flight.

Fully Monitored Mode is disabled (OFF) when there are sufficient SBAS monitored GPS satellites for a position solution, but poor geometry of the SBAS monitored GPS satellites results in insufficient integrity for the phase of flight. In this case, inclusion of SBAS UNMONITORED (and GPS HEALTHY) GPS satellites in the position solution provides sufficient integrity for the phase of flight.

If the Receiver is unable to compute a fully monitored position solution using corrections and integrity data from the available SBAS GEO PRN signals, then the Receiver shall continue to compute an unmonitored position solution. The Receiver shall indicate whether or not the position solution is not fully monitored in the Status of Position Computation field in the UN1 message. When computing a position solution that is not fully monitored, SBAS corrections are not applied to GPS ranges, and GEO ranges are corrected for the difference between GPS time and SBAS Network time.

$PASHS,SBA,INF,c,s[,f]

This command allows you to enable or disable the SBA,INF message on the specified port, and optionally at a given period.

Table 4.83. $PASHS,SBA,INF Command Format

Parameters	Description	Range
c	Identification of port routing the message	“A”, “B”
s	Enables (ON) / disables (OFF) message	“ON”, “OFF”
[f]	Message rate (optional)	1 Hz: 1.. 999 seconds. Increment: 1 second 2 Hz: 0.5 second from 0.5 to 1.0 second; 1-second increment from 1 to 999 seconds 5 Hz: 0.2 seconds from 0.2 to 1.0 seconds. 1-second increment from 1 to 999 seconds.

NOTE: If the output is set without a period, the period set by the $PASHS,NME,PER command is used. If a $PASHS,NME,PER command is sent after individual NMEA message output periods were set, the previous individual message period is superseded by the more recent NME,PER value.

Examples:

$PASHS,SBA,INF,B,ON<CR><LF>

Sets SBA,INF message to be output on port B at the PER period.

$PASHS,SBA,INF,A,ON,2<CR><LF>

Sets SBA,INF message to be output on port A at a 2-second period.

$PASHR,SBA,INF

The SBAS,INF message is output in the format below (ASCII):

```
$PASHR,SBA,INF,d1((,d2,d3,d4)*n)*hh<CR><LF>
```

Commands

Table 4.84 outlines the response message

Table 4.84. $PASHR,SBA,INF Message Format

Parameters	Description	Range
d1	Number of SBAS SVs assigned	0-2
d2	SBAS SV PRN number	120 - 138
d3	Non-smoothed SBAS SV Signal-to-Noise Ratio (Note that this SNR may be different from SNR reported in SAT)	0 – 99
d4	SBAS SV tracking state. Bits are: Bit 0 – Signal is Detected; Bit 1 – Signal is Locked; Bit 2 – Symbol synchronization established; Bit 3 – Viterby synchronization established; Bit 4 – Frame synchronization established; Bit 5 – Parity confirmed; Bit 6 – Satellite is used in position solution; Bit 7 – Almanac information (including provider definition) and integrity data are available. Note 1. Almanac information is considered available when the receiver decoded almanac information for this satellite from any SBAS satellite. Note 2. Integrity data is considered available when receiver decoded at least one of fast corrections messages (Message Types 2-5, 24) and Message Type 6.	0 – 255
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Example:

$PASHR,SBA,INF,2,135,45,191,138,49,255*5D<CR><LF>

S$PASHS,SBA,NSA,s

This command allows you to enable or disable the non-safety-of-life mode. The mode is enabled if “s” is set to “ON” or disabled if it’s set to “OFF”. The default setting is “OFF”.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Example: $PASHS,SBA,NSA,ON<CR><LF>

During development, it may be necessary to use GEO PRN signals from SBAS providers before the provider is certified for use in safety-of-life applications. For example EGNOS GEO PRN signals are currently available, but are not enabled for safety-of-life applications.

While non-safety-of-life application mode is enabled (ON), the receiver will accept correction, integrity, and ranging data from GEO PRN signals that are transmitting valid (containing correction and integrity data) Message Type 0. An invalid Message Type 0 may either be empty (all data fields zero-filled) or it may contain alternating 1's and 0's. SBAS GEO PRN signals may broadcast empty Message Type 0. EGNOS GEO PRN signals may broadcast Message Type 0 with alternating 1's and 0's.

While non-safety-of-life application mode is disabled (OFF), the receiver will not accept correction or integrity data from GEO PRN signals that are transmitting Message Type 0.

$PASHS,SBA,PAM,s

This command allows you to enable or disable the Precision Approach Mode. The mode is enabled if "s" is set to "ON" or disabled if it's set to "OFF". The default setting is "OFF".

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Example: $PASHS,SBA,PAM,ON<CR><LF>

Precision Approach Mode is included to support precision approach operation as described in RTCA/DO-229D, Section 1.8.2.

When Precision Approach Mode is enabled (ON), the Receiver shall compute a PA-qualified position solution using correction and integrity data from the best GEO PRN signal from the preferred SBAS provider. If the preferred SBAS provider is not specified, then the Receiver selects the best SBAS provider.

If the Receiver is unable to compute a PA-qualified position solution using correction and integrity data from either a primary or backup GEO PRN signal, then the Receiver shall continue to compute a position solution based on the state of Fully Monitored Mode (refer to $PASHS,SBA,FMM). The Receiver shall indicate whether or not the position solution is PA-qualified in the Status of Position Computation field in the UN1 message.

$PASHS,SBA,PEM,d

This command allows you to set the elevation mask required of the SBAS satellites. Only those seen above the specified elevation angle will be used in the position solution. “d” is the elevation mask in degrees (0-90 degrees). The default value is 5 degrees.

Return message: $PASHR,ACK*3D (Received command OK)

$PASHR,NAK*30 (Received command INVALID)

Example:

$PASHS,SBA,PEM,20<CR><LF>

(Sets the elevation mask of SBAS satellites for use in position solution to 20 degrees)

$PASHS,SBA,PRO,d

This command allows you to define your preferred SBAS provider where “d” is the ID of this provider (range 0-15). The default SBAS provider ID is 15 (Any), i.e. the Preferred SBAS Provider Mode is disabled by default.

Return message: $PASHR,ACK*3D (Received command OK)

$PASHR,NAK*30 (Received command INVALID)

Table 4.85 provided the list of possible SBAS provider IDs..

Table 4.85. $PASHS,SBA,PRO Command Format

d field	SBAS Provider
0	WAAS
1	EGNOS
2	MSAS
3 – 13	Not Yet Assigned
14	Reserved
15	Any

Example:

$PASHS,SBA,PRO,0<CR><LF>

(Sets WAAS as preferred SBAS provider)

The Preferred SBAS Provider Mode is included to support precision approach operation as described in RTCA/DO-229D, Section 1.8.2.

The command used to disable the Preferred SBAS Provider Mode is:

$PASHS,SBA,PRO,15<CR><LF>

$PASHS,SBA,SCA,s[,d]

This command allows you to enable or disable the SBAS scanning mode and scanning interval. The mode is enabled if “s” is set to “ON” or disabled if it’s set to “OFF”. The default setting is “OFF”. For “d” see below.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.86. $PASHS,SBAS,SCA Command Format

Setting parameter	Description	Range
s	Enable or Disable SBAS scanning mode	‘ON’, ‘OFF’
d	Optional SBAS scanning interval in minutes	0 - …

Example: $PASHS,SBA,SCA,ON<CR><LF>

The GEO PRN Signal Scanning Mode is included to allow the receiver to update its list of available GEO PRN signals from all SBAS providers.

$PASHS,SBA,SCA,ON[,d]

Where d is the number of minutes between scan intervals. This is a periodic GEO PRN signal scanning mode.

If the scan interval is omitted, the receiver will assume an interval of 0 minutes. If the scan interval is 0 minutes, then the receiver will immediately perform a single scan cycle.

The command sequence for disabling the GEO PRN Signal Scanning Mode is:

$PASHS,SBA,SCA,OFF

When the Precision Approach Mode is enabled (ON), the GEO PRN Signal Scanning Mode is disabled.

SPR: Provider of SBAS Corrections

$PASHS,SPR,s1

This command allows you to define the SBAS providers from which the receiver will receive ranging, corrections and integrity information.

Return message: $PASHR,ACK*3D (Received command OK)

$PASHR,NAK*30 (Received command INVALID)

Table 4.87. $PASHS,SPR Command Format

Setting parameter	Description	Range
s1	14-character string made up of Y's and N's depending on whether you want to enable ('Y') or disable ('N') ranging, correction, and integrity information from SBAS providers.	'Y' or 'N'

Example:

$PASHS,SPR,YNNNNNNNNNNNNN*1F<CR><LF>

Note: Up to 14 SBAS providers may be selected. They are entered in order of SBAS provider number, where numbers 0 to 13 correspond to the SBAS provider IDs from bits 4-7 of the Health and Status field in the Type 17 Almanacs Message. If fewer than 14 are specified, the remaining characters are all set to N. Only the characters 'Y' and 'N' are accepted.

$PASHQ,SPR[,c1]

This command lists the SBAS providers allowed to deliver ranging, corrections and integrity information to the receiver, where c1 is the optional output serial port ('A' or 'B'). If no port is specified, the receiver sends the response to the current port.

$PASHR,SPR

The SPR message is output in the format below:

```
$PASHR,SPR,s1*hh<CR><LF>
```

Table 4.88 outlines the response message.

Table 4.88. $PASHR,SPR Message Format

Returned parameter	Description	Range
s1	14-character string made up of Y's and N's depending on whether you want to enable ('Y') or disable ('N') ranging, correction, and integrity information from SBAS providers.	'Y' or 'N'
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Example:

$PASHR,SPR,YNNNNNNNNNNNNN*1E<CR><LF>

Note: The selection status of all 14 SBAS providers is provided. They are listed in order of SBAS provider number, where numbers 0 to 13 correspond to the SBAS provider IDs from bits 4-7 of the Health and Status field in the Type 17 Almanacs Message.

SVW: SBAS Satellites Used

$PASHS,SVW,s

This command allows you to define the SBAS satellites from which the receiver will receive corrections and integrity information.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.89. $PASHS,SVW Command Format

Setting parameter	Description	Range
s	19-character string made up of 'Y's and Ns' depending on whether you want to enable ('Y') or disable ('N') the use of correction and integrity information from SBAS satellites	'Y' or 'N'

Note: Up to 19 SVs may be selected. They are entered in order of PRN number, where numbers 1 to 19 correspond to the SBAS satellites from 120 to 138. If fewer than 19 are specified, the remaining characters are all set to N. Only the characters 'Y' and 'N' are accepted.

$PASHQ,SVW[,c1]

This command allows you to list the SBAS satellites that the receiver uses to acquire corrections and integrity information. “c1” is the optional output serial port (‘A’ or ‘B’). If no port is specified, the receiver sends the response to the current port.

Example:

$PASHQ,SVW,A - requests $PASHR,SVW reply on port A.

$PASHR,SVW

The SVW message is output in the format below:

```
$PASHR,SVW,sss...*hh<CR><LF>
```

Table 4.90 outlines the response message.

Table 4.90. $PASHR,SVW Message Format

Returned parameter	Description	Range
s	19-character string made up of Y’s and N’s depending on whether you want to enable (‘Y’) or disable (‘N’) correction and integrity information from SBAS satellites.	‘Y’ or ‘N’
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Example:

$PASHR,SVW,YYYYYYYYYYYYYYYYYYY*53<CR><LF>

USW: Correction and Integrity Information

$PASHS,USW,d,c

This command allows you to enable or disable the use of correction and integrity information from or all or part of the SBAS satellites. For “d” see below. The use of correction and integrity information is enabled if “c” is set to “ON” or disabled if it’s set to “OFF”.

Return message: $PASHR,ACK*3D (Received command OK)
$PASHR,NAK*30 (Received command INVALID)

Table 4.91. $PASHS,USW Command Format

Setting parameter	Description	Range
d or ccc	PRN of satellite to be enabled or disabled depending on “c”. All satellites will be enabled or disabled depending on “c”.	120 – 138 ALL
c	Enables (‘Y’) or disables (‘N’) the use of correction & integrity from specified satellite(s)	'Y' / 'N'

Examples:

$PASHS,USW,120,N

Disables use of correction and integrity information from PRN 120

$PASHS,USW,122,Y

Enables use of correction and integrity information from PRN 122

$PASHS,USW,ALL,N

Disables use of correction and integrity information from all SBAS satellites

$PASHS,USW,ALL,Y

Enables use of correction and integrity information from all SBAS satellites.

A

GPS Concepts

When the Global Positioning System (GPS) became operational in 1993, it promised to provide a new utility as pervasive and as useful as the telephone. However, GPS has certain limitations that become apparent in certain applications. These limitations are dramatically reduced by the augmentation of GPS with SBAS (Satellite Based Augmentation System). The GG12W GPS+SBAS receiver uses SBAS satellites in addition to GPS satellites, providing a system even more reliable and more accurate than either system alone.

GG12W is the world's first fully integrated GPS+SBAS receiver for easy integration with electronic displays, vehicle tracking, flight management survey, and mapping systems.

Background

There are three primary benefits of adding SBAS to GPS: availability, integrity and accuracy.

Availability

A navigation system is *available* when it produces valid position fixes. The availability of a valid and accurate GPS position fix depends strongly on the visibility of enough satellites. A GPS receiver needs to “see” at least four satellites to calculate latitude, longitude and altitude. This is easy in a perfect environment. With 26 GPS satellites orbiting the earth, there are usually seven satellites visible 10 degrees or more above the horizon. But if there is a mountain, building, tree, or other obstruction nearby, the number of visible satellites may fall to four, three or fewer, with the possibility that the GPS receiver has too few satellites to compute position.

Accuracy

The accuracy of the GPS system can intentionally be degraded through the implementation of Selective Availability (SA). However, the accuracy of the SBAS system is not degraded. As a result, the accuracy of autonomous (non-differential) GPS+SBAS positions are approximately 5-10 times better than GPS-only.

Differential Position Accuracy

Because there are more satellites in view, the DOP (Dilution Of Precision) values typically decrease by 20%-50%, and differential accuracy improves by a similar amount. In fact, there is no limit to how much the DOPs can change. Periods of poor GPS satellite visibility can cause the GPS DOPs to be tens to hundreds of times worse than the combined GPS+SBAS DOPs.

Basic Concepts

GPS works on the principle of triangulation: If you know your distance from several known points, then you can compute your position. The known points for both systems are the satellites. The distance to a satellite is measured by measuring how long the satellite signal takes to reach you. Multiply this time by the speed of light and you have the range from the antenna to the satellite.

The GPS satellite clocks are all synchronized. The receiver clock must solve for the error with GPS time. This clock error, plus latitude, longitude, and altitude, give 4 unknowns, which are solved by having 4 satellites (or more) in view.

If the altitude is known, the GG12W can be set to hold the altitude to a fixed value. This removes one unknown, and only three satellites are needed to compute positions. You can set the receiver to hold the time-shift to a fixed value, which eliminates another unknown. In this case, only two satellites are needed for a 2D position, or three for a 3D position.

Signal Structure

GPS has the following signal structure.

- Two transmission frequency bands, L1 and L2
- PRN codes in the L1 frequency band, known as Coarse/ Acquisition (C/A) code
- Almanac and ephemerides transmitted at a data rate of 50 bps. The GG12W tracks the L1 C/A and S codes from the GPS
- PRN codes (C/A) repeat every one millisecond

Satellite Orbits

GPS satellites orbit in 6 planes, 4 satellites per plane. The GPS inclination is 55°. The orbits are circular with similar radii.

Geoid Model

The GG12W uses the OSU-91A geoid model. Grid size is 5 x 5 degrees, and the interpolation technique is similar to the GPS ICS algorithm. Expected accuracy when the actual position is on a grid point is 0.5 to 0.6 meters, in accordance with the OSU-91 specification. Expected accuracy when the actual position is halfway between grid points is better than 8 meters. For more information on OSU91A, please refer to:

Rapp, R.H., Y.M. Wang and N.K. Pavlis, 1991: The Ohio State 1991 Geopotential and Sea Surface Topography Harmonic Coefficient Models, Report No. 410. Columbus: Department of Geodetic Science and Surveying, The Ohio State University.

The Ohio State University
Department of Civil and Environmental Engineering and Geodetic Science
470 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210
Tel: 614-292-2771
Fax: 614-292-3780
Web: http://www-ceg.eng.ohio-state.edu

Magnetic Model

The receiver uses the WMM-95 magnetic model. Grid size is 5 x 5 degrees, and the interpolation technique is similar to the GPS ICD algorithm. Expected accuracy depends upon the geomagnetic latitude. The errors are smallest at the equator, and greatest at the magnetic poles, and equal to 0.5 degrees (RMS) when the actual position is on a grid point. Expected accuracy when the actual position is halfway between grid points is better than 2.5 degrees (RMS). In arctic and antarctic regions, deviations from model values are frequent and persistent.

For more information on WMM-95, please refer to:

USGS National Geomagnetic Information Center
Box 25046, Mailstop 968
Denver Federal Center
Denver, CO 80225-0046
Tel: 1-303-273-8475
Fax: 1-303-273-8450
Web: http://geomag.usgs.gov

GPS Operating Characteristics

Table A.1 lists the operating characteristics of GPS.

Table A.1. GPS Operating Characteristics

Parameter	GPS
SIGNAL STRUCTURE	
C/A Code (L1)	
Code rate	1.023 MHz
Chip length	293 m
Selective availability	Yes
P Code	
Code rate	10.23 MHz
Chip length	29.3 m
Selective availability	Yes
Encryption (anti-spoofing)	Yes
Signal separation	CDMA

Table A.1. GPS Operating Characteristics (continued)

Parameter	GPS
Carrier frequency	• 1575.42 MHz • 1227.60 MHz
SATELLITES	
Number	24
Planes	6
Satellites per plane	4, unevenly spaced
Orbital inclination	55°
Orbital radius	26560 km
Orbital period	11 hours 58 minutes
NAVIGATION MESSAGE	
Duration	12.5 minutes
Capacity	37500 bits
Time reference	UTC (US Naval Observatory)
Geodetic datum	WGS-84

GPS System Time

GPS system time is equal to UTC time + the number of leap seconds added since 1980 (currently 14 seconds). Therefore, when UTC time equals 00:00:00.000000, GPS system time equals 00:00:14.000000.

NMEA 0183 Standards

The National Marine Electronics Association Standard NMEA 0183 defines interfacing standards for marine electronic devices. Although this standard was initally for marine use, it has been adopted worldwide for all applications of GPS.

The following messages are supported by the GG12W.

- GGA—Global positioning system fix data
- GSA—GPS DOP and active satellites
- RRE—GPS range residuals for each satellite
- ZDA—Date and Time
- VTG—Vector track an Speed over the Ground
- GSV—Detailed Satellite data
- RMC—Recommended Minimum Data for GPS
- GST—GPS Pseudorange Noise Statistics

For more information on NMEA messages and decisions, see the NMEA web page, *http://www.coastalnet.com/nmea/*.

B

Floating Point Data Representation

The GG12W stores the floating point data types using the IEEE single and double precision format. The formats contain a **sign bit field**, an **exponent field**, and a **fraction field**. The value is represented in these three fields.

Sign Bit Field

The sign bit field of the number being represented is stored in the sign bit field. If the number is positive, the sign bit field contains the value 0. If the number is negative, the sign bit field contains the value 1. The sign bit field is stored in the most significant bit of a floating point value.

Exponent Field

The exponent of a number is multiplied by the fractional value of the number to get a value. The exponent field of the number contains a biased form of the exponent. The bias is subtracted from the exponent field to get the actual exponent. This allows both positive and negative exponents.

Fraction Field

The IEEE floating point format stores the fractional part of a number in a normalized form. This form assumes that all non-zero numbers are of the form:

1.xxxxxx (binary)

The character ‘x’ represents either a 0 or 1 (binary).

Because all floating point binary numbers begin with 1, the 1 becomes the implicit normalized bit and is omitted. It is the most significant bit of the fraction, and the binary point is located immediately to its right. All bits after the binary point represent values less than 1 (binary). For example, the number 1.625 (decimal) can be represented as:

1.101 (binary) which is equal to:

$2^0 + 2^{-1} + 2^{-3}$ (decimal) which is equal to:

1 + 0.5 + 0.125 (decimal) which is equal to:

1.625 (decimal).

The Represented Value

The value of the number being represented is equal to the exponent multiplied by the fractional value, with the sign specified by the sign bit field.

If both the exponent field and the fraction field are equal to zero, the number being represented will also be zero.

Note that in some systems (Intel-based PCs in particular) the order of the bytes will be reversed.

Single-Precision Float

The single precision format uses four consecutive bytes, with the 32 bits containing a sign bit field, an 8-bit biased exponent field, and a 23-bit fraction field. The exponent has a bias of 7F (hexadecimal). The fraction field is precise to 7 decimal digits. The single-precision format can represent values in the range $1.18*10^{-38}$ to $3.4*10^{38}$ (decimal), Table B-1.

Table B.1. Single-Precision Format

31-28	**27-24**	**23-20**	**19-16**	**15-12**	**11-8**	**7-4**	**3-0**	
S EXPONENT FRACTION								VALUE
0000	0000	0000	0000	0000	0000	0000	0000	0.0
0011	1111	1000	0000	0000	0000	0000	0000	1.0
1111	1111	1111	1111	1111	1111	1111	1111	NAN (not a number)
0011	1111	0100	0000	0000	0000	0000	0000	0.75

In Table B-1, the value 1.0 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.

2. The exponent field is equal to 7F (hexadecimal). The exponent is calculated by subtracting the bias value (7F) from the exponent field value. The result is 0.

   7F - 7F = 0

   The exponent multiplier is equal to 2^0, which is equal to 1 (decimal).
3. The fraction field is equal to .0. After adding the implicit normalized bit, the fraction is equal to 1.0 (binary). The fraction value is equal to 2^0 (decimal), which is equal to 1 (decimal).
4. The value of the number is positive 1*1= 1.0 (decimal).

In Table B-1, the value 0.75 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 7E (hexadecimal). The exponent is calculated by subtracting the bias value (7F) from the exponent field value. The result is -1 (decimal).

   7E - 7F = -1

   The exponent multiplier is equal to 2^{-1}, which is equal to 0.5 (decimal).
3. The fraction field is equal to .1 (binary). After adding the implicit normalized bit, the fraction is equal to 1.1 (binary). The fraction value is equal to $2^0 + 2^{-1}$ (decimal), which is equal to 1 + 0.5 (decimal), which is equal to 1.5 (decimal).
4. The value of the number is positive 0.5*1.5 = 0.75 (decimal).

Double-Precision Float

The double-precision format uses eight consecutive bytes, with the 64 bits containing a sign bit field, an 11-bit biased exponent field, and a 52-bit fraction field. The exponent has a bias of 3FF (hexadecimal). The fraction field is precise to 15 decimal digits. The double-precision format can represent values in the range $9.46*10^{-308}$ to $1.79*10^{308}$ (decimal), Table B-2.

Table B.2 Double-Precision Format

63-60	**59-56**	**55-62**	**51-48**	**47-44**	**43-40**	**...**	**15-12**	**11-8**	**7-4**	**3-0**	
S EXPONENT FRACTION											VALUE
0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0.0
0011	1111	1111	0000	0000	0000	...	0000	0000	0000	0000	1.0
1111	1111	1111	1111	1111	1111	...	1111	1111	1111	1111	NAN (not a number)
0011	1111	1110	1000	0000	0000	...	0000	0000	0000	0000	0.75

In Table B-2, the value 1 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 3FF (hexadecimal). The exponent is calculated by subtracting the bias value (3FF) from the exponent field value. The result is 0 (decimal).

   3FF - 3FF = 0

   The exponent multiplier is equal to 2^0, which is equal to 1 (decimal).
3. The fraction field is equal to .0 (binary). After adding the implicit normalized bit, the fraction is equal to 1.0 (binary). The fraction value is equal to 2^0 (decimal), which is equal to 1 (decimal).
4. The value of the number is positive 1*1 = 1.0 (decimal).

In Table B-2, the value 0.75 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 3FE (hexadecimal). The exponent is calculated by subtracting the bias value (3FF) from the exponent field value. The result is -1 (decimal).

   3FE - 3FF = -1
3. The fraction field is equal to .1 (binary). After adding the implicit normalized bit, the fraction is equal to 1.1 (binary). The fraction value is equal to $2^0 + 2^{-1}$ (decimal), which is equal to 1 + 0.5 (decimal), which is equal to 1.5 (decimal).
4. The value of the number is positive 0.5*1.5 = 0.75 (decimal).

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