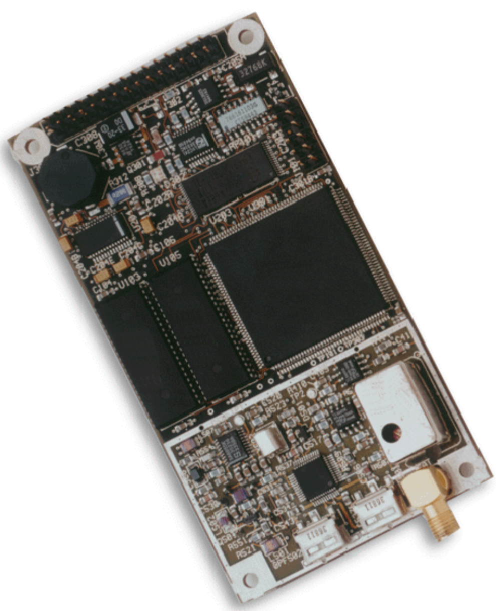
G12 ™
GPS OEM Board & Sensor Reference Manual



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General Information

Overview

The G12 GPS receiver processes signals from the Global Positioning System (GPS) satellite constellation to provide real-time position, velocity, and time measurements. The G12 uses twelve discrete parallel channels for Coarse/Acquisition (C/A) code-phase (pseudo-range) measurements and carrier phase measurements on the L1 (1575.42 Mhz) band. The G12 receives satellite signals through an L-band antenna and an external low-noise amplifier (LNA). The G12 is designed for stand-alone and differential GPS (DGPS) operation; it can operate as a base (reference) station or a remote (rover) station, providing or using real-time differential GPS corrections in RTCM SC-104 format (Version 2.2).

This chapter describes G12 hardware and functionality, describes the RF interface connector and the power/input/output connector, and lists specifications and power requirements.

Table 1.1. G12 Specifications

POSITION ACCURACY (DGPS)	
Horizontal CEP	40.0 cm
Horizontal (95%)	90.0 cm
Vertical (95%)	160.0 cm
TIME TO FIRST FIX (TTFF)	
Re-acquisition	2 seconds
Hot Start	11 seconds
Warm Start	35 seconds
Cold Start	45 seconds

Table 1.1. G12 Specifications (Continued)

PHYSICAL SPECIFICATIONS	
Size	Board: 2.300” x 4.250” (± 0.005); 107.95 mm x 57 mm (± 0.13) Sensor: 178 mm x 105 mm x 52 mm
Weight	Board: 2.8 oz Sensor: 1 lb 4 oz
Humidity	95% non-condensing
Shock	RTCA DO-160C - op/crash safety: • Operational — ± 6 G in X, Y, or Z axis • Non-operational — ± 15 G in X, Y, or Z axis

Vibration	• MIL-STD-810E/Category 10, Minimum Integrity Test - General (HDMA version only)
	• DO 160C - NMB
	• Performance:
	  • 5G sine sweep
	  • 20 - 400 Hz
	  • 20 hours/axis

Acceleration	20 G
Maximum speed	1,000 knots
Maximum altitude	60,000 ft

Higher altitudes and velocities may be available under validated export license.

Functional Description

Upon application of power, the G12 runs a built-in self test of its internal memory, and thereafter periodically self-tests various functions during normal operation. Test results are stored for output on command. After self test, the G12 initializes its battery-backed RAM. If the battery-backed RAM fails self-test (due, for example, to a low battery backup condition), the G12 clears and reports the loss of stored data, then initializes its 12 channels and begins searching for all satellites within the field of view of its antenna.

The G12 can track all GPS satellites (also called space vehicles or SVs) as specified in the Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS-200, Revision B. All 32 satellite PRN (pseudo-random noise) code numbers are programmed into the G12’s firmware. There are 24 satellites in the GPS constellation. As it acquires (locks on to) each satellite, the G12 notes the time and collects almanac and ephemeris data for each orbiting satellite and stores this information in battery-backed memory.

- When tracking one satellite, the G12 gets a time reference from that satellite's clock.
- When tracking three satellites, the G12 computes and time-tags the horizontal position (2D) and velocity of its antenna. Input of an initial position estimate is not required. When it receives an appropriate command message from controller equipment through one of its serial communication ports, the G12 sends the results of its computations to the designated port.
- With four locked satellites, the G12 determines three-dimensional position and velocity. Stand-alone position accuracy is 3 meters Circular Error Probable (CEP) when Position Dilution of Precision (PDOP) is less than 4; velocity accuracy is 0.1 meter per second. Accuracy levels for position and velocity are subject to the US Government policy of Selective Availability (SA). When the G12 is operating in differential mode, position accuracy improves to better than 1.0 m CEP.

The G12 can compute up to 20 independent measurements per cycle (20 Hz), with no interpolation or extrapolation from previous solutions. Position and velocity computations are performed simultaneously using all the satellites in view. The G12 uses instantaneous doppler values from four satellites to compute dynamic speed, allowing velocity computations to be made independent of the last position fix. All measurements are referenced to the WGS-84 (World Geodetic System-1984) ellipsoid model.

The G12 features 12-channel/12-Satellite All-In-View operation; each of up to 12 visible satellites can be assigned to a discrete channel for continuous tracking. Each satellite broadcasts almanac and ephemeris information every 30 seconds; this information is recorded in G12 memory automatically.

Hardware Description

The G12 is available in two versions. The G12 Sensor contains the G12 receiver board, a wide range power supply, and a back-up battery for internal memory in a rugged aluminum enclosure. It can accept input voltage levels from 9 to 36 VDC, and typical power consumption is approximately 2.2 watts. Power drain on the back-up battery is typically less than 0.3 μA when external power is applied to the board, and 1 μA otherwise.

The G12 OEM Board is the G12 GPS receiver board assembly without the enclosure, back-up battery, or wide range power supply. It requires a regulated input voltage of 5 VDC (±5%); typical power consumption is approximately 1.8 watts. User-entered parameters can be maintained in the G12 internal memory by connecting a 3 to 3½-volt external battery to the appropriate pins on J301. The physical dimensions of the G12 GPS board are shown in Figure 1.1.

From a functional point of view, the G12 receiver consists of two major sections: The radio frequency (RF) section, and the digital section, where the signals from the GPS satellites are processed.

Both versions of the G12 have two RS-232 input/output (I/O) ports capable of two-way communication with external equipment, and a coaxial RF port for the antenna.

The RF section receives satellite signals from the GPS antenna and LNA through a coaxial cable, and also supplies power to the antenna/LNA through the cable, eliminating the necessity of a separate power cable for the antenna. Total power consumption (including the LNA) is approximately 2.1 watts for the board and 2.5 watts for the sensor.

The twelve-pin connector (J101) on the side of the board is intended for factory use only.

The G12 uses a standard SMA connector for RF input (Figure 1.1). A straight-up OSX RF connector is also available as an option.

A two-color LED is mounted on the G12: Red indicates the power status, and green indicates the number of satellites locked (e.g., 4 green flashes indicate 4 satellites locked).

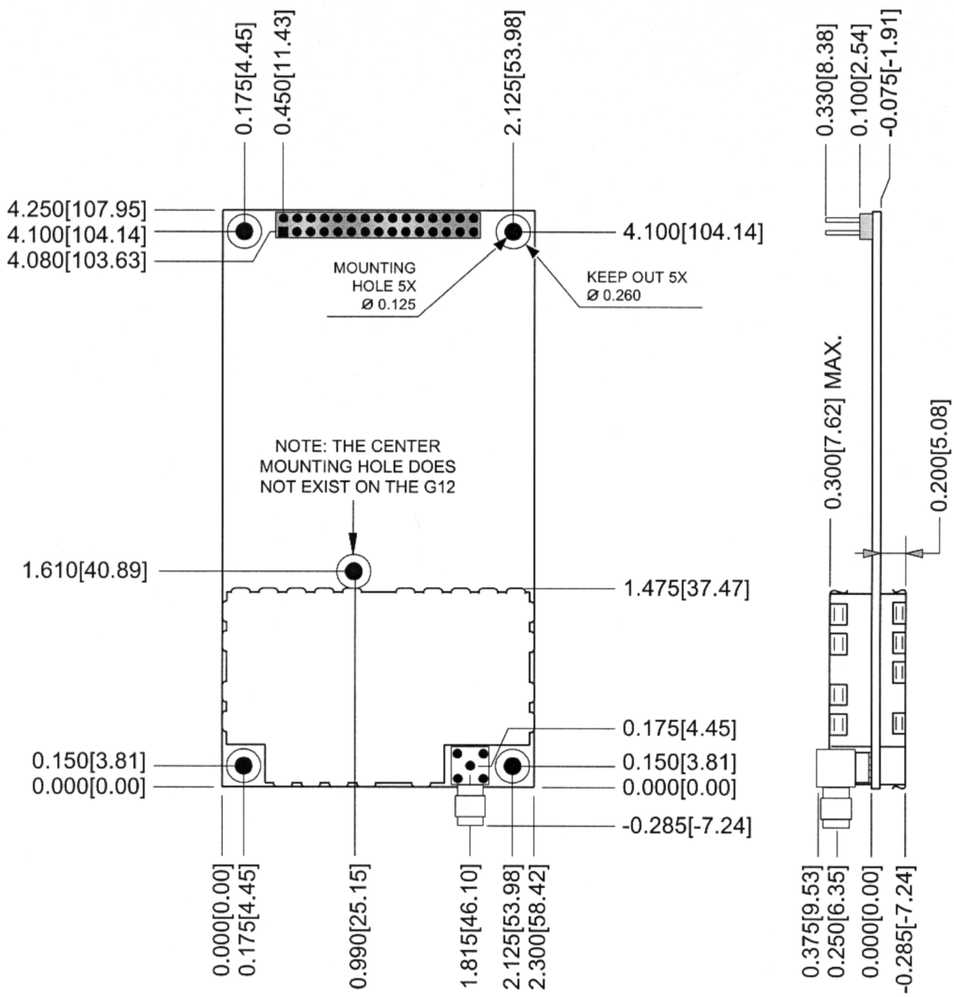


Figure 1.1. G12 GPS Board Dimensions

Power Connections

All power and input/output connections are made at the J301 connector. J301is a 30-pin male dual inline (15 x 2) header connector. It provides a host of useful connections in addition to power and I/O, including a connection for an external

LED, a connection for battery-backup for RAM maintenance, an input for manual hardware reset, an output for a TTL-level timing pulse, a photogrammetry time-tag input, and a measurement strobe output. Figure 1.2 lists the pin assignments for J301.

CAUTION
To avoid damage to the G12 OEM board, ensure that pin 1 of the connecting cable is attached to pin 1 on J301 as indicated in the drawing. In addition, the power source should be turned off while connecting or disconnecting cables to or from the J301 connector.

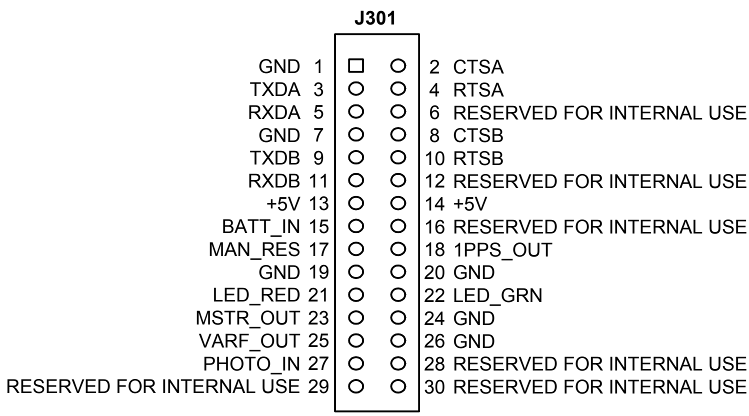


Figure 1.2. J301 Pin Assignments

Table 1.2. J301 Pin Assignments

Pin	Code	Description
01	GND	Ground for serial Port A
02	CTSA	RS-232 Port A clear to send
03	TXDA	RS-232 Port A transmit data
04	RTSA	RS-232 Port A request to send
05	RXDA	RS-232 Port A receive data
06	DX	Ashtech internal use only (leave floating)
07	GND	Ground for serial Port B
08	CTSB	RS-232 Port B clear to send
09	TXDB	RS-232 Port B transmit data

Table 1.2. J301 Pin Assignments (Continued)

Pin	Code	Description
10	RTSB	RS-232 Port B request to send
11	RXDB	RS-232 Port B receive data
12	FSX	Ashtech internal use only (leave floating)
13	+5V	+5 VDC input
14	+5V	+5 VDC input
15	BATT_IN	2.5-3.5 volt battery backup for memory and real-time clock
16	CLKRX	Ashtech internal use only (leave floating)
17	MAN_RES*	Connect to ground for manual hardware reset
18	1PPS_OUT	1 pps TTL output synchronized to GPS time
19	GND	G12 chassis common ground
20	GND	G12 chassis common ground
21	LED_RED	External LED control output (3.3 Volts through 100 Ω)
22	LED_GRN	External LED control output (3.3 Volts through 100 Ω)
23	MSTR_OUT	Measurement strobe output
24	GND	G12 chassis common ground
25	VARF_OUT	Variable frequency output
26	GND	G12 chassis common ground
27	PHOTO_IN	Photogrammetry pulse input
28	FSR	Ashtech internal use only (leave floating)
29	SERBLEN*	Ashtech internal use only (leave floating)
30	DR	Ashtech internal use only (leave floating)

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 open**
- **If pin 17 (MAN_RES*) is used, it can be pulled to ground (GND) using a switch, or driven to ground with an open-collector gate.**

WARNING!

To save user-entered parameters between power cycles, connect the external battery to the corresponding input pins on the J301 connector and set the SAV parameter to Y.

Interfaces to External Equipment

Figure 1.3 shows G12 interfacing connections.

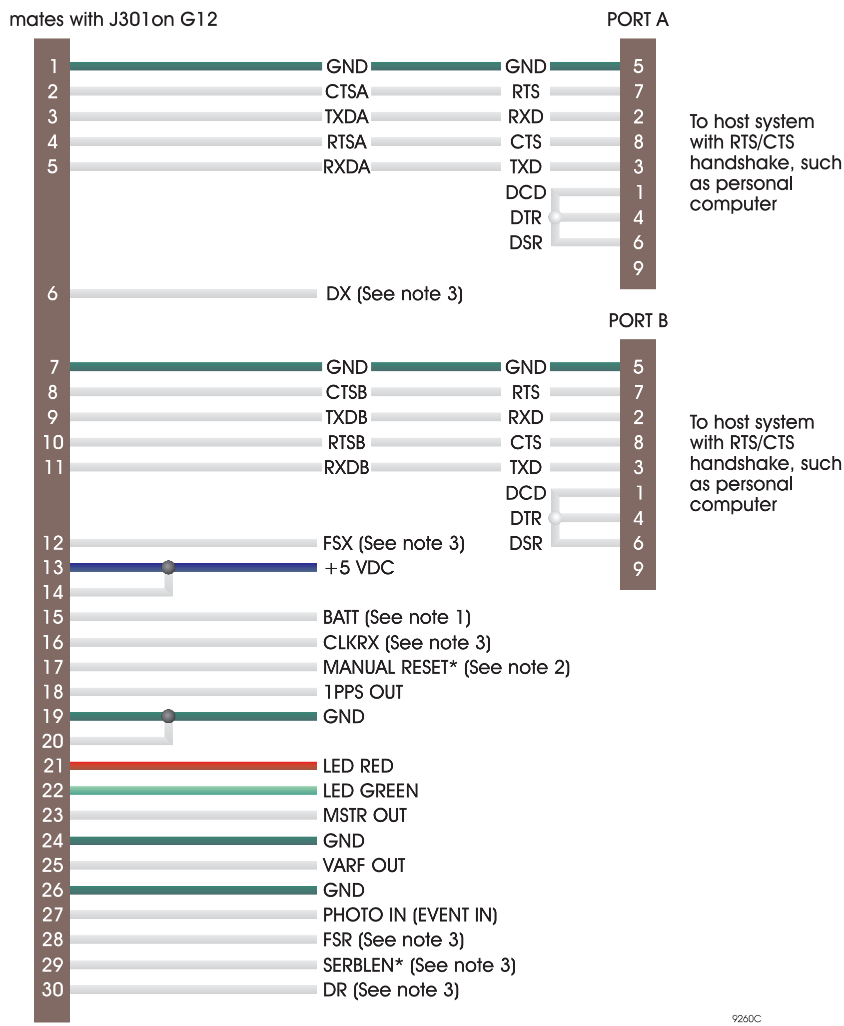


Figure 1.3. External Equipment Interfacing Diagram

Figure 1.3 Notes

1. BATT is a control line normally connected to 3 VDC, or ground if not used.

2. Manual reset (MAN_RES*) should be left unconnected if unused. Manual reset should be activated by a switch or open collector gate.
3. Magellan internal use only (leave floating).

Power Requirements

Table 1.3. Power Requirements

Requirement	Board	Sensor
DC voltage	5 volts DC, regulated ± 5%	9 - 36 VDC
Power Consumption (typical)	1.8 watts (2.1 watts with antenna/LNA) Current draw: 360 mA @ 5 VDC	2.2 watts (2.5 watts with antenna/LNA) Current draw: 245 mA @ 9 VDC 61 mA @ 36 VDC
External wiring	30 gauge (minimum)	30 gauge (minimum)
Internal battery drain	1µA (without 5 VDC applied) 0.3 µA (with 5 VDC applied)	1µA (without 9-36 VDC applied) 0.3 µA (with 9-36 VDC applied)

Environmental Specifications

The operating temperature range of the G12 is -30°C to +70°C; storage temperature range is -30°C to +85°C.

RF Connections

A 50-ohm coaxial cable and an LNA are required for impedance matching between the G12 RF connector and the GPS antenna. The G12 board's RF connector is a standard SMA female connector (TNC on the G12 Sensor, see Figure 1.4). The SMA connector shell is connected to common ground on the G12 board. The SMA center pin provides +4.8 VDC (to power the LNA) and accepts 1575 MHz RF input from the antenna; the RF and DC signals share the same path. The gain of the antenna LNA minus the loss of the cable is in between 20 and 30 dB.

CAUTION

The G12 may be damaged if the SMA center pin is not isolated from DC ground. Provide a DC block between the center pin and ground. The block should have the following characteristics:

- **VSWR 1.15 maximum at 1575 MHz**
- **Insertion loss 0.2 dB maximum**
- **Maximum voltage 5 VDC**

Radio Interference

Some radio transmitters and receivers, such as FM radios, can interfere with the operation of GPS receivers. Magellan recommends that you verify that nearby hand-held or mobile communications devices do not interfere with your GPS receivers before setting up your project.

Receiver Options

The G12 has a number of available options. The options that are set in the receiver will determine which commands and features you can use. For example, if the photogrammetry option is not installed, you will not be able to use the **$PASHS,TTT** command to output event time tags from the serial port.

The command **$PASHQ,RIO** queries for the receiver's configuration. The response message includes version numbers for the processor and channel firmware, a list of installed options, and the receiver's serial identification number. The response is output in the format shown below:

```
$PASHR,RIO,f1,f2,f3,f4,f5*cc
```

Table 1.4. $PASHR,RIO Message Format

Field	Description
f1	Receiver name (maximum 10 characters)
f2	Main processor firmware version (maximum 10 characters)
f3	Channel Firmware version (maximum 10 characters). If not applicable, this field is empty
f4	Option setting (maximum 42 characters). ASCII characters represent installed options. For option definitions, see Table 1.5

Table 1.4. $PASHR,RIO Message Format (Continued)

Field	Description
f5	Receiver serial number (maximum 20 characters). Underscores represent blank fields
cc	Checksum. XOR (exclusive or) of all characters between, but not including, the dollar sign ($) and asterisk (*) characters

Fourteen options are available. Each option is represented by a letter or number presented in a certain order. The presence of given option is indicated by the associated letter or number. If the letter or number is displayed, the option is installed. An dash (“-”) indicates that the option is available, but not installed. An underscore (“_”) indicates a reserved option slot.

Table 1.5 lists the options in the order in which they appear in the RIO response:

Table 1.5. G12 Option Descriptions

Option	Description
[W = 20 Hz] [T = 10 Hz] [5 = 5 Hz] [2 = 2 Hz] [1 = 1 Hz]	Position update rate
[W = 20 Hz] [T = 10 Hz] [5 = 5 Hz] [2 = 2 Hz] [1 = 1 Hz]	Raw measurement update rate
[O]	Raw Data Output
[P]	Carrier Phase Tracking
[U]	Differential - Remote Station
[B]	Differential - Base Station
[I]	RAIM Availability
[L]	Timing Pulse Output (1PPS)
[E]	Photogrammetry Event Marker
[G]	Geoid Model
[M]	Magnetic Variation Model
[-]	Reserved

Table 1.5. G12 Option Descriptions (Continued)

Option	Description
[C]	Code Correlator
[-]	Reserved

Typical RIO message:

```
$PASHR,RIO,G12,GM00,,1TOPUB_LEGM-C-, 710029150420*4D:
```

Table 1.6. Typical RIO Response

Field	Description
$PASHR,RIO	Message header
G12	Receiver type: G12
GM00	Receiver firmware version
[empty field]	Channel firmware not available
1TOPUB_LEGM-C-	Options available: [1] 1 Hz position update rate [T] 10 Hz raw measurement update rate [O] Raw data output [P] Carrier phase [U] Differential remote station [B] Differential base station [_] Option not installed [L] 1 Pulse Per Second [E] Photogrammetry [G] Geoidal height [M] Magnetic Variation [-] Option not available [C] Code Correlator [-] Option not available
710029150420	Receiver serial number
*4D	Checksum in hexadecimal

See Chapter 4, Command/Response Formats, for more information on the G12 commands.

WARNING!
Take the following precautions to avoid damaging your G12 OEM Board: **1. Turn off power before connecting or disconnecting I/O-power cable and J301.** **2. Ensure that when connecting the I/O-power cable to connector J301, pin 1 is correctly oriented per Figure 1.1.** **3. Connect pin 15 (BATT_IN) to ground if it is not being used. Leave pin 17 (MAN_RES) open if it is not being used.** **4. Isolate the center pin on the antenna connector from DC ground. The DC block used between the center pin and DC ground should have the following characteristics:** • **1.15 maximum VSWR @ 1575 Mhz** • **0.2 db maximum insertion loss** • **5 VDC maximum applied voltage** **5. Connect the RAM back-up battery to the appropriate pins on J301 and set the SAV parameter to Y.**

G12-L

A lower-cost version of the G12, called G12-L, is also available. The G12-L supports lower maximum update rates for position (5 Hz) and raw data (2 Hz), and uses Ashtech's edge correlator for multipath mitigation instead of the strobe correlation technology in the standard G12. If higher update rates are required, or if a high-multipath environment requires better multipath mitigation, the G12-L can be upgraded with any of the features available for the standard G12.

G12 Evaluation Kits

There are two G12 evaluation kits available for purchase:

- G12 Sensor Evaluation Kit
- G12 OEM Board Evaluation Kit.

Figure 1.4, Figure 1.5, and Figure 1.6 on the pages that follow illustrate the contents of the two evaluation kits.

The G12 Sensor Evaluation Kit contains a G12 receiver housed in an extruded aluminum enclosure, an antenna, hardware accessories for power and interfacing, and software to allow you to communicate with the receiver and monitor its performance.

The G12 OEM board Evaluation Kit includes the same antenna and accessories, but contains a G12 receiver board and an interface board without the aluminum housing.

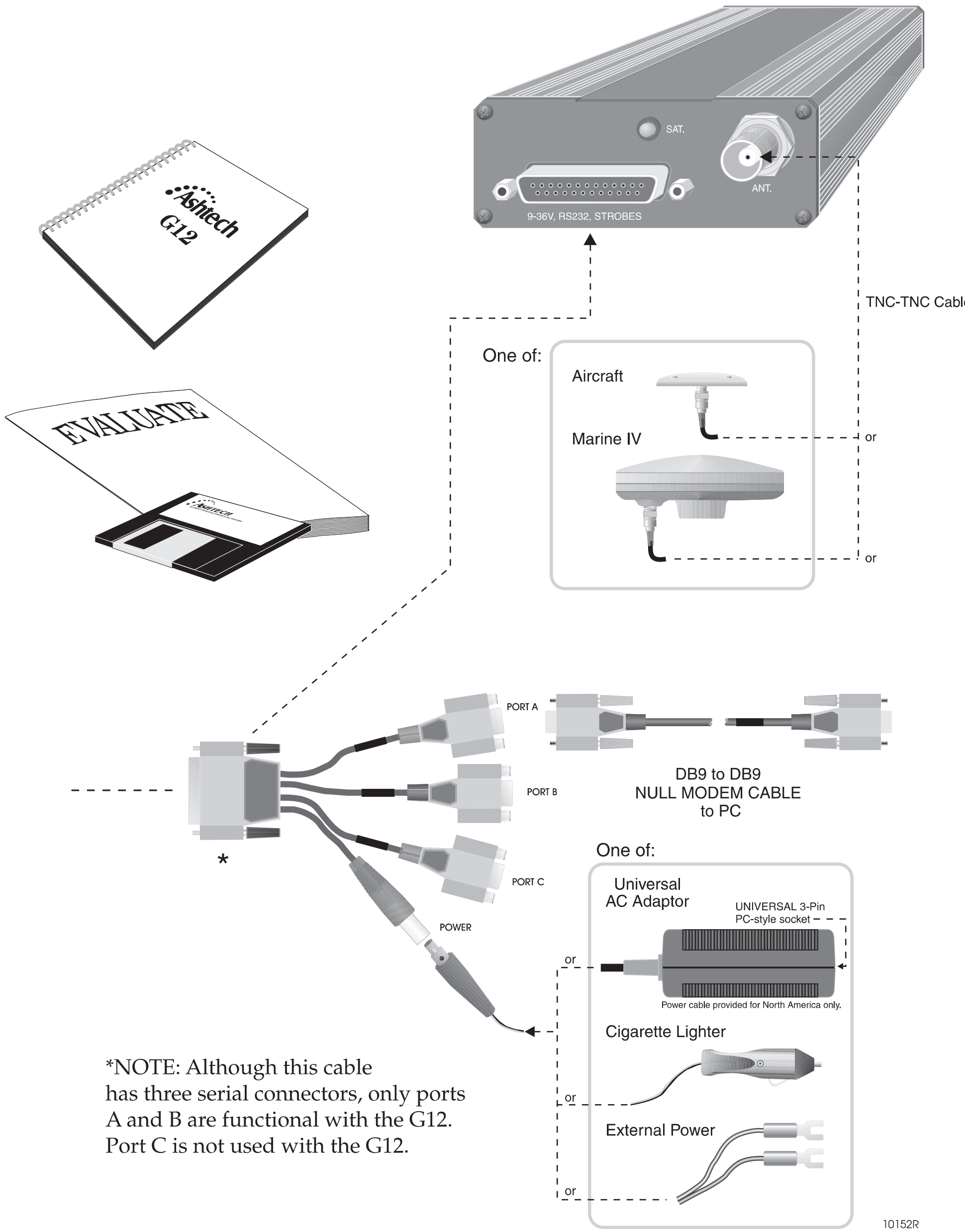
An important difference between the G12 OEM board and the G12 Sensor is the presence of a back-up battery for internal memory. The G12 Sensor has a back-up battery installed. You must obtain and install a back-up battery for the G12 OEM board.

The power and interface cable supplied with the Sensor Evaluation Kit is used with other Magellan products. Although it has three serial connectors, only ports A and B are used with the G12.

Firmware Upgrades

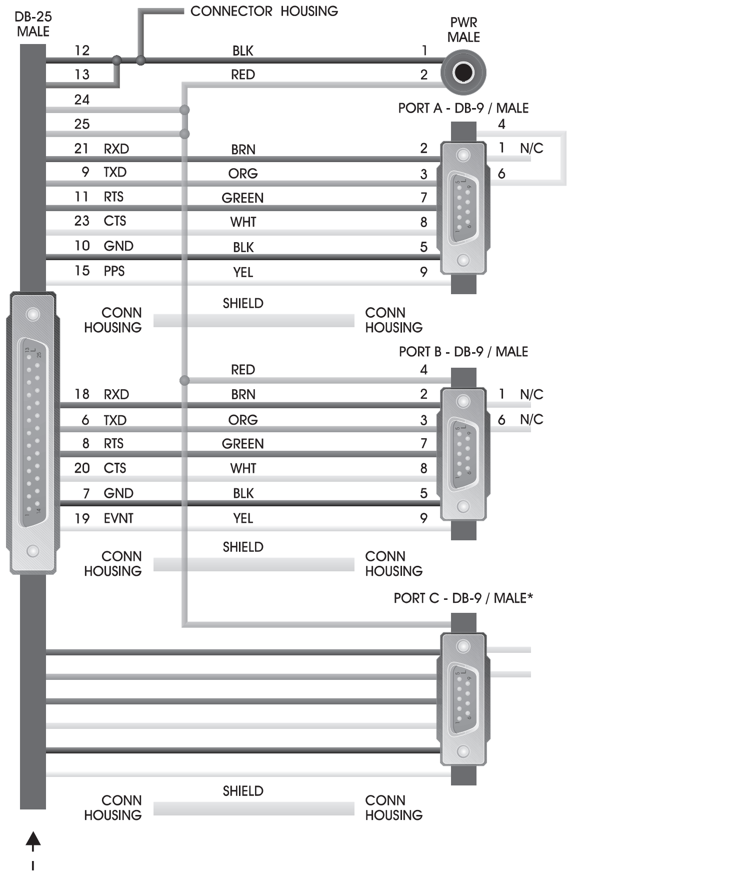
G12 firmware is stored in flash memory. New firmware may be loaded into the receiver through either serial port using a PC. Maintenance releases of firmware are available on a regular basis to fix known bugs and to implement new features.

When embedding the G12 within another system, Magellan recommends that external access to one of the receiver's serial ports be designed into the system for direct monitoring. For example, many system integrators use an internal data cable to connect one of the G12 serial ports to an external DB9 connector.



*NOTE: Although this cable has three serial connectors, only ports A and B are functional with the G12. Port C is not used with the G12.

Figure 1.4. G12 Sensor Evaluation Kit



*NOTE: Although this cable has three serial connectors, only ports A and B are functional with the G12. Port C is not used with the G12.

Figure 1.5. G12 Sensor Power-I/O Connections

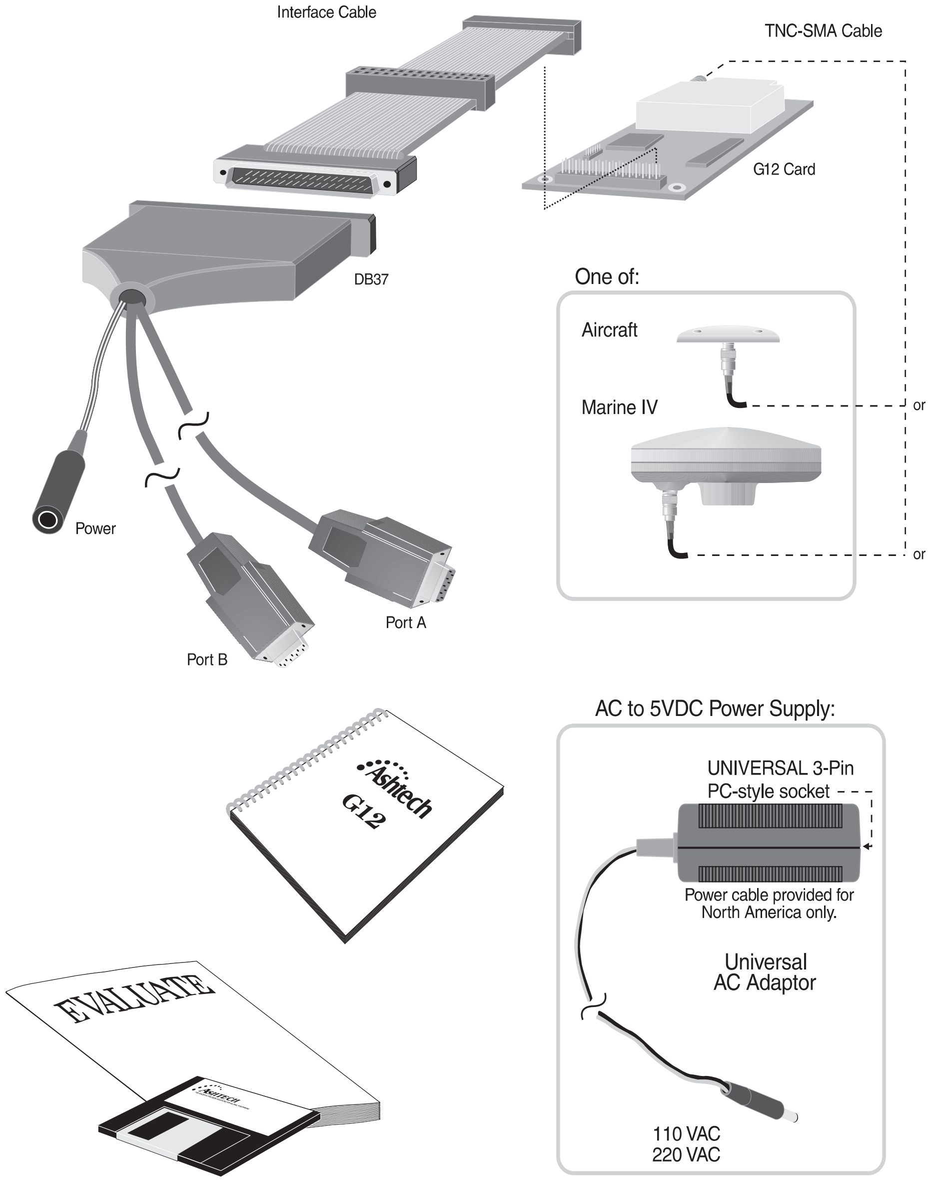


Figure 1.6. G12 OEM Board Evaluation Kit

2

Getting Started

This section is intended to get you started using the G12 receiver. Please refer to the chapters on General Information, Operation, and Command/Response Formats for specific details regarding performance, power requirements, and commands.

This chapter discusses the following topics:

- Connecting the G12 to power, connecting the antenna, and equipment used for receiver control and data logging.
- Default parameters.
- Communicating with the G12 using standard communications software and an IBM-compatible PC.
- Sending common commands to the G12.

Connecting to the G12

Figure 2.1 shows how to connect the components in the G12 Board system.

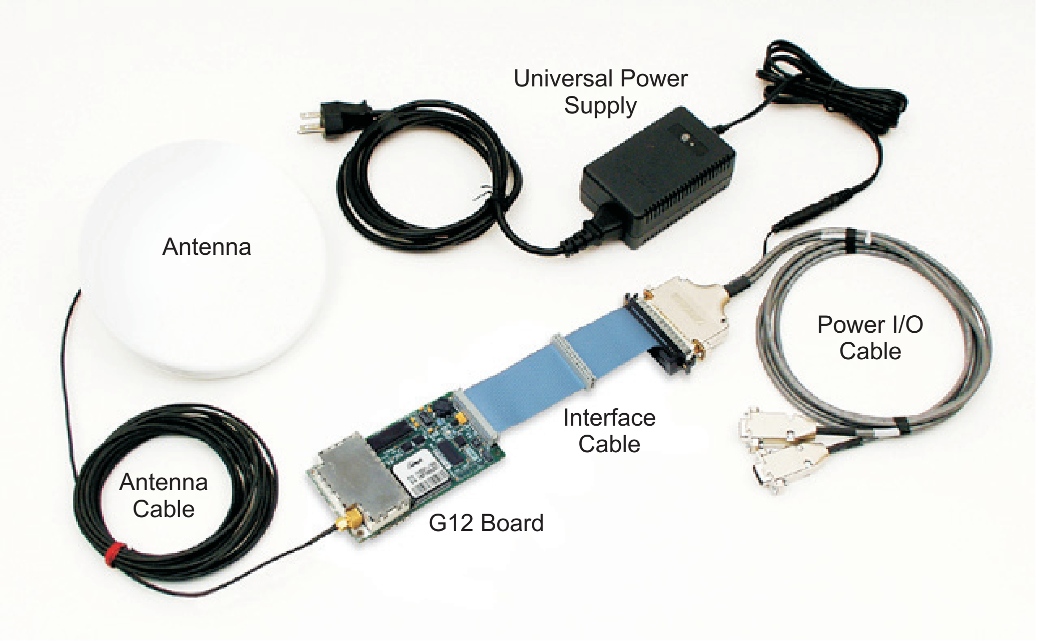


Figure 2.1. G12 Board Connections

Power

Before applying power, connect any controller devices or data logging equipment to the input/output ports of the G12 by way of connector J301. Applying power to the power input pins on connector J301 starts G12 operation.

Removing power from the power input pins on connector J301 stops G12 operation.

CAUTION
To avoid damage to the G12, always turn off the power supply before connecting or disconnecting connector J301.

1. Connect the female plug on the power cable to the J301 male connector on the G12 before applying power.
2. Connect the power cable to the power supply.

   Applying power to the G12 starts the unit. Once power is connected, the two-color LED on the G12 GPS board flashes red.

Antenna

The G12 is designed to work with an antenna Low Noise Amplifier (LNA) that requires five volts and is isolated from DC ground. The gain of the antenna LNA minus the loss of the cable is between 20 and 30 dB. Table 1 defines the antenna requirements.

Table 2.1. Antenna Requirements

Requirement	Parameter
GPS operational band	1575 ±10 MHz
Polarization type	Right hand circular
Axial ratio	Less than 3 dB in zenith of up area
Antenna gain for elevation angle of 10°	No less than -2.5 dB
Antenna gain for elevation angle greater than 15°	-1 to -2 dB
Antenna gain for elevation angle of 90°	~ +4 dB

Table 2 defines the antenna LNA requirements

Table 2.2. Antenna LNA Requirements

Requirement	Parameter
Impedance of antenna output	50Ω VSWR <1.8
LNA gain	Antenna/LNA gain minus cable loss: between 20 and 30 dB
Noise figure	< 4.0 dB
LNA selectivity	-3 dB bandwidth: 35 MHz -20 dB bandwidth: 60-70 MHz

CAUTION

The G12 may be damaged if the center pin of the RF connector (Type SMA) 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 at 1575 MHz**
- **Insertion loss 0.2 dB maximum**
- **Maximum voltage 5 VDC**

Connect the antenna cable directly to the antenna SMA connector on the G12.

Once power is on and the antenna is connected, the G12 acquires satellites (SVs or Space Vehicles) within the field of view of the antenna. As a channel in the G12 locks on to a satellite, the two-color LED flashes green between the red power flashes for every channel in use (i.e., locked satellites).

Important Default Parameters

Communication Port Setup

Table 3 lists the default communication parameters of the G12:

Table 2.3. G12 Communication Parameters

Baud	Data Bits	Parity	Stop Bits
9600	8	None	One

When first establishing communications with the G12, the communications interface must use this protocol.

Data Output Options

All the default data output commands are set to OFF. The G12 does not output any data until you command it to do so.

Initial Operating Instructions

After the G12 is powered and running, you must send it command messages in order to receive data (such as antenna position). The following procedure describes how to send commands to and receive information from the G12 using an IBM-compatible PC. You can interface with the G12 using Evaluate Software™, RCS (Receiver Communication Software™), or standard communication programs such a ProComm or Hyperterminal. To begin, simply connect the standard 9-pin serial cable supplied in the G12 evaluation kits between port A on the G12 and COM1 on the computer.

After setting up the interface for establishing communications with the G12, you are now ready to send commands. The letters in your command can be typed in UPPER or LOWER case and completed by pressing **<Enter>**. If you sent the command correctly, you should get a response.

The commands used with the G12 are divided into two groups: Set commands allow you to change the G12's operating parameters and begin with the command string $PASHS. Query commands allow you request information from the G12, such as the current operating parameters, current position, or DGPS status. Query commands begin with the command string $PASHQ. The G12 responds to query and set commands by issuing an acknowledgement of a change in operating parameters or with the specific information requested through a query.

To become familiar with the G12 messages, send a few common commands to the G12 and observe the responses. In the following steps, command messages appear as COMMAND, and response messages appear as RESPONSE.

1. Type: **$PASHQ,PRT** and press **<Enter>**. This command queries the communication setup of the port. If interfacing through serial port A, the response message is:

   ```
   $PASHR,PRT,A,5
   ```

   This message indicates Port A of the G12 is using its default communications setup 5: 9600 baud, eight data bits, no parity, and one stop bit.

2. Type **$PASHQ,STA** and press **<Enter>**. This command queries which satellites are locked and their signal strength at the time the command is sent.The response message typically might display:

   ```
   TIME: 18:38:31 UTC
   LOCKED:03 23 16
   COUNT :54 26 17
   ```

3. If interfacing through port A, type **$PASHS,NME,POS,A,ON,1** and press **<Enter>**. This commands the G12 to return comprehensive position information through port A at a set rate. The default rate for NME commands is once per second. The response message output rate is 1 HZ:

   ```
   $PASHR,POS,0,08,164152.90,3721.06962,N,12156.12176,W,+00003.16,
   ,008.64,000.55,+000.03,01.7,01.0,01.4,00.9,GH00*20
   ```

   The data string contains the position information, assuming the receiver is tracking a sufficient number of SVs to compute a position.

4. If interfacing through port A, type **$PASHS,NME,SAT,A,ON,1** and press **<Enter>**. This command tells the G12 to return locked satellite information through port A at a set rate. The response message output rate is 1 Hz (default):

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

The data string contains the number of SVs locked plus the elevation, azimuth, and signal strength for each locked SV, and also indicates whether a given satellite is used (U) or not used (-). Chapter 4 contains details on these commands and responses, as well as the rest of the commands and responses supported by the G12.

3

Operation

This section covers a variety of G12 operating parameters and options, including system setup, power-up, command format, serial port configuration, receiver settings and status, the satellite search algorithm, position modes, altitude hold definition, the ionospheric model, NMEA outputs, raw data outputs, differential operation, the photogrammetry option, the pulse-per-second option, and other options.

System Setup

If you use equipment other than Magellan-supplied with the G12, it must comply with hardware specifications as described in the “Hardware Description” section on page 3.

Before applying power, connect any controller devices or data logging equipment to the input/output pins on the J301 connector. Applying power to the power input pins on the J301 connector starts G12 operation. Cutting the flow of power to the power input pins on connector J301 stops G12 operation.

CAUTION
To avoid damaging the G12, always connect or disconnect the power wiring to 30-pin connector J301 before turning on the power supply.

Power-Up

Upon power-up, the status LED (D302 on the G12 OEM board) lights red and green and then continues to flash red, indicating the unit is on, but position has not yet been computed. When the G12 locks on to a satellite, the status LED flashes green to indicate satellite lock and then red to indicate power status. Each additional satellite to which the receiver locks on produces an additional green flash; that is, if the receiver is locked onto seven satellites, the LED flashes green seven times and red once. A short green flash (.25 sec) indicates the satellite is locked but not used in position computations; a long green flash (.75 sec) indicates that ephemeris for that satellite is available. Once the unit is locked to enough satellites to compute a position (three or more), the duration of the red flash becomes longer to indicate that positions are being computed.

Message Formats

The G12's 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), output data to a separate data logging device, and send or receive differential corrections from a reference or remote station.

G12 Input Messages

Input messages are comprised of set command messages, query command messages, and general command messages. These messages comply with the format defined in the NMEA 0183 standard to the following extent:

- NMEA 0183 ASCII byte strings following a dollar sign ($) character
- Data fields are separated by commas
- Checksum character delimiter and NMEA checksum bytes are recognized by the G12 but are optional. The hexadecimal checksum is computed by exclusive OR-ing all of the bytes in the message between, but not including, the dollar sign ($) and the asterisk (*).
- Messages end with the standard NMEA message terminator characters, [CRLF] (carriage return/line feed).

Input messages deviate from the NMEA standard as follows:

- Headers are Ashtech proprietary
- Message IDs are Ashtech proprietary
- Message length may exceed 80 characters

All command messages—set or query—can be composed in uppercase or lowercase characters. All command messages are sent by pressing **<Enter>**. A valid set command causes the G12 to return the **$PASHR,ACK*3D** (acknowledge) response message. A set command containing a valid $PASHS header followed by character combinations unrecognized by the G12 causes the receiver to respond with **$PASHR,NAK*30**, a “not acknowledge” response message indicating that the command is invalid. Valid query and messages are acknowledged by return of the requested information. All invalid query and general commands cause the G12 to return the **$PASHR,NAK*30** “not acknowledged” response message.

G12 Message Output

The G12 can be programmed to send data to another device. Output messages include general receiver status messages, ACK/NAK messages, and GPS data messages. The general receiver status messages have free-form Ashtech proprietary formats. The acknowledged/not acknowledged messages and GPS data messages comply with NMEA 0183 standards as follows:

- NMEA ASCII byte strings following a dollar sign ($) character
- Headers are standard NMEA or Ashtech proprietary NMEA
- Message IDs are standard NMEA or Ashtech proprietary NMEA
- Standard NMEA format messages contain hexadecimal checksum bytes
- Data items are separated by commas; successive commas indicate invalid or missing data (null fields)
- Messages end with [CRLF] (carriage return/line feed), the standard NMEA message terminator characters

Serial Port Configuration

The G12 receiver has two RS-232 serial ports that support two-way, full-duplex communication. The default protocol for transmitting or receiving data is 9600 baud, eight data bits, no parity, and one stop bit (8N1). The baud rate of the G12 ports is adjustable using the **$PASHS,SPD** speed set command; the data bit, stop bit and parity protocol is always 8N1.

DEFAULT SETTINGS
The default parameters for the G12 serial ports: **•Baud Rate— 9600** **•Data Bits— 8** **•Stop Bits— 1** **•Parity— None**

On initial power-up, or after issuing the **$PASHS,INI** (receiver initialization) command or the **$PASHS,RST** (restore defaults) command, the default data rate is 9600 baud for both G12 serial ports.

The baud rates must be the same between the G12 serial port and the serial port on the device with which it is interfaced.

To maintain communication with the G12 while changing the baud rate, issue the **$PASHS,SPD** (set port speed) to change the baud rate of the G12 port, then change the baud rate of the command device to match the new baud rate setting on the G12 port.

Satellite Tracking

When the G12 is powered on for the first time, or when the power and back-up battery have been disconnected, there is no almanac or ephemeris data in memory. In these cases, the G12 assigns the first 12 elements of a 32-element table of SV PRN numbers to its 12 channels as it begins searching for satellites. If no ephemeris data are in memory, or if the data are older than ten hours, 30 to 60 seconds are needed to collect data. The G12 synchronizes its clock to GPS time within six seconds of locking an satellite. After three or four satellites are locked and the almanac and ephemeris data are collected, the G12 computes its first position. The G12 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 ten hours old, the G12 restricts its satellite search to those satellites that should be visible based on this information. Under these conditions, the G12 on average recomputes position in 10 to 15 seconds (hot start). If the almanac and ephemeris data are available in battery-backed memory, but the ephemeris data are more than ten hours old, the G12 needs 30 to 40 seconds on average to compute a position (warm start). If almanac and ephemeris data and a valid position are not available at power-up, the G12 computes position in less than one minute on average (cold start).

Parameter Settings and Status

On initial power-up or after issuing the **$PASHS,RST** (restore defaults) command, the G12 reverts to its default parameter settings. Enter the following three commands to query the G12 for the current parameter status:

1. **$PASHQ,PAR** (general parameters)

The response message for the query command **$PASHQ,PAR** (general parameters) is shown below:

```
SPDA:5 SPDB:5
GPS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
PMD:1 FIX:0 ALT:+00000.00 PDP:40 HDP:04 VDP:04
PEM:05 UNH:N ION:N SAV:N DTM:W84
RTC: OFF   PRT:A
NMEA: LTN AIM POS GLL GXP GGA VTG GSN MSG GSA SAT GRS RRE TTT ZDA TCM
PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PER:001.0
```

2. **$PASHQ,RAW** (raw data parameters)

   The command **$PASHQ,RAW** is functional only if the Binary Data Outputs option (Option O) is installed in the receiver. An example of the response message for the default values of **$PASHQ,RAW** (raw data parameters) is shown below:

```
RCI:020.00 MSV:3 ELM:05 SIT:????
RAW: MBN PBN SNV SAL MCA
PRTA: OFF OFF OFF OFF OFF
PRTB: OFF OFF OFF OFF OFF
```

3. **$PASHQ,RTC** (differential parameters)

   The **$PASHQ,RTC** query is available only if one of the differential options (B or U) is installed in the receiver. The response message for the **$PASHQ,RTC** (differential parameters and status) query command is shown below:

```
STATUS:
SYNC:   TYPE:00 STID:0000 STHE:0
AGE:+000 QA:100.00% OFFSET:00
SETUP:
MODE:OFF PORT: A AUT:N
SPD:0300 STI:0000 STH:0
MAX:0060 QAF:100 SEQ:N
TYP:1 2 3 6   9 16
FRQ:99 00 00 OFF 00 00
BASE: LAT:0000.00000,N LON:00000.00000,E ALT:+00000.00
MSG:
```

Operation

Saving Parameter Settings

New parameter settings can be saved by issuing the set command, **$PASHS,SAV,Y**. You can verify that new settings are in effect by issuing query commands to prompt the G12 for its current status. After the next power-up, the query response messages display the new settings instead of the default parameters. Issue the command **$PASHS,RST** to restore the default settings. If the SAV command is not entered, the new settings will be lost, and the default settings restored at the next power cycle.

Watchdog Timer

The G12 has a watchdog timer. If the processor hangs up for any reason, the watchdog timer resets the receiver. On reset, the receiver uses the parameters most recently saved during startup. If parameter settings were not saved, the receiver uses the default settings at startup.

CAUTION
User-entered parameters are lost and default settings are restored if the command $PASHS,SAV,Y is not entered before the next power cycle.

Position Modes

The G12 can perform position computations in four modes. The **$PASHS,PMD** command allows you to set the position mode (page 82).

- **Position Mode 0**

  At least four satellites at elevations equal to or above the position elevation mask are needed to compute a position. The receiver stops computing positions if the number of satellites tracked falls below three. All three polar coordinates (latitude, longitude, altitude) are computed in this mode.

- **Position Mode 1**

  At least three satellites with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and the longitude are computed if three satellites are locked and the altitude is held fixed. For more information on fixed altitude modes, see"Fixed Altitude Modes" on page 31. The receiver stops computing positions if the number of satellites tracked falls below three. All three polar coordinates are computed if more than three satellites are locked.

- **Position Mode 2**

  At least three satellites with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and the longitude are computed and altitude is always held fixed even if the receiver is tracking more than three satellites. The receiver stops computing positions if the number of satellites tracked falls below three.

- **Position Mode 3**

  At least three satellites with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and longitude are computed, and the altitude is held if only three satellites are locked. If more than three satellites are used and the HDOP is less than the specified HDOP mask, all three polar components are computed. If HDOP is higher than the specified HDOP mask, the G12 automatically goes into the altitude hold mode. The receiver stops computing positions if the number of satellites tracked falls below three.

DEFAULT SETTINGS
$PASHS,PMD— Position Mode 1

- **Point Positioning Mode**

  The Point Positioning option improves the accuracy of a stand-alone absolute position of a stationary receiver from about 50 meters to less than five meters over a period of four hours, and can typically get down to a couple meters level after ten hours. Point positioning uses an averaging technique to reduce the effects of Selective Availability (SA) and other fluctuating errors. Point positioning mode can be set using the $PASHS,PPO command. Refer to Chapter 3 for details of this command. The Point Positioning receiver option [T] must be set in the receiver for this command to work.

Fixed Altitude Modes

Two modes define the altitude setting when the G12 is in altitude hold mode. The **$PASHS,FIX** set command (page 67) can be used to select between 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 one computed 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**

  Only the last altitude entered through the command $PASHS,ALT is used in the position fix solution.

On initial power-up, or after issuing the **$PASHS,INI** command (initialize memory) or **$PASHS,RST** command (restore defaults), the antenna altitude is set to zero.

DEFAULT SETTINGS
$PASHS,FIX— Fixed Altitude Mode (0)

Geoid Model

The G12 uses the Ohio State University 91A geoid model (OSU91A). For more information on OSU91A, refer to the Ohio State University:

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
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2070 Neil Avenue
Columbus, OH 43210   USA

Tel: 614-292-2771

Fax: 614-292-3780

Web: http://www-ceg.eng.ohio-state.edu

Ionospheric Model

The G12 can use ionospheric and tropospheric models in its position computations to compensate for errors caused by ionospheric and tropospheric delay. This mode of operation is typically used to improve autonomous accuracy by minimizing the influence of the ionosphere and troposphere on the code phase of the GPS signal. When the G12 is in differential mode (base or rover), ionospheric and tropospheric modeling is disabled because differential GPS already compensates for delays associated with the ionosphere and troposphere. When the receiver is in autonomous mode, ionospheric and tropospheric modeling is enabled.

The ionospheric model used by the G12 is based on the model defined in ICD-GPS-200, Revision B. The tropospheric model is based on the Bean and Dutton model. For more information on ICD-GPS-200, refer to ARINC Research Corporation:

ARINC Research Corporation
2250 E. Imperial Highway, Suite 450
El Segundo, CA 90245-3509 USA

Tel: 310-524-1557

Web: http://www.arinc.com/products_services/gpshome.html

Magnetic Variation Model

The G12 uses the Joint US/UK 1995 Epoch World Magnetic Model (WMM-95). For more information on WMM-95, refer to the USGS National Geomagnetic Information Center:

USGS National Geomagnetic Information Center
Box 25046, Mailstop 968
Denver Federal Center
Denver, CO 80225-0046 USA

Tel: 303-273-8475

Fax: 303-273-8450

Web: http://geomag.usgs.gov

Setting Antenna Position

When in Differential Base Mode, the G12 uses an accurate antenna position (reference position) entered by the user to calculate range corrections by subtracting the measured range from the true range. Two commands can be used to enter the reference position:

$PASHS,POS (position setting including latitude, longitude, altitude).

$PASHS,ALT (antenna height setting).

NMEA Outputs

The G12 can output a variety of NMEA messages and Ashtech's NMEA-style messages. Standard NMEA messages are output as a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards (version 2.2). Ashtech's NMEA-style messages are 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 goes beyond eighty characters.

Both NMEA messages and Magellan's 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 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 rate is determined by the **$PASHS,NME,PER** command, and can be set to any value between 0.05 and 999 seconds depending upon the update rate option installed (20, 10, 5, 2 or 1 Hz). For more information refer to the "NMEA Commands" section on page 139.

The output rate can be set to any value between 0.05 and 999 seconds. The default setting for the output interval is one second. See Chapter 4, Command/Response Formats, for more information on NMEA messages and Ashtech's NMEA-style messages.

DEFAULT SETTINGS
Output interval setting for NMEA messages and Ashtech NMEA-style messages is one second.

Raw Data Output (Optional)

The G12 has an optional feature that allows you to output raw data (also called real-time data) through serial ports A and B. Five different messages can be output:

- MBN: Contains measurement data for each locked satellite using the Ashtech type 2 data structure.
- PBN: Contains position and velocity data.
- SNV: Contains satellite ephemeris data.
- SAL: Contains satellite almanac data in a proprietary format.
- MCA: Contains measurement data (same as MBN) for each locked satellite using the Ashtech type 3 data structure

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 determined by the **$PASHS,RCI** command, and can be set to any rate between 0.05 and 999 seconds depending upon which option has been selected for the raw measurement update rate (20, 10, 5, 2, or 1 Hz). For more information on the structure and content for all the above messages, refer to “Raw Data Commands” section on page 113.

DEFAULT SETTINGS
Output interval setting for raw data messages is 20 seconds.

Differential Operation (Optional)

This section contains a general discussion of real-time differential operation, including basic concepts, sources of error, G12 commands related to differential GPS, plus format and content for the RTCM-SC104 (Sub-committee 104) correction messages supported by the G12. Differential remote [U] and base [B] operation are available as receiver options. Both options must be installed in order for the G12 to be able to support both differential modes (base and rover).

When the G12 is set as a differential base or rover, the port which is designated to output or receive differential corrections can no longer be used to communicate with the receiver. If you have set the receiver to output RTCM corrections through port A, you can communicate with the receiver through port B only. You must disable differential mode in order to resume communication with the receiver through port A.

General

Real-time differential positioning involves a reference (base) station calculating range corrections for each satellite it is tracking and transmitting them to the remote (rover) stations through a real-time data communications link. Remote receivers apply the corrections to their own range measurements and use the corrected ranges to compute positions.

The base receiver determines range correction by subtracting the measured range from the true range. A precise reference position must be entered in the base receiver before true range can be calculated. The reference position must have been previously surveyed using GPS or some other comparable technique.

RTCM type 1 corrections with a UDRE (User Differential Range Error) field set to 3 (one-sigma differential error > 8 meters) are not used.

As a stand-alone receiver, the G12 can compute a position with ± 3 meter CEP (Circular Error Probable) of accuracy (on average) with Selective Availability (SA) off. Autonomous accuracy worsens to an average of ±100 meters with SA on. In differential mode, a G12 in rover mode can achieve sub-meter accuracy.

Real-time differential operation requires a communication link between the base and rover receivers. A wireless link, such as a radio-modem link or cellular/ modem link is typically used, although any other medium that can transfer digital data can be used.

Figure 3.1 and Figure 3.2 display a typical DGPS base station and remote system configuration.

CAUTION
Errors in the base station reference position will be duplicated in positions computed by the remote system.

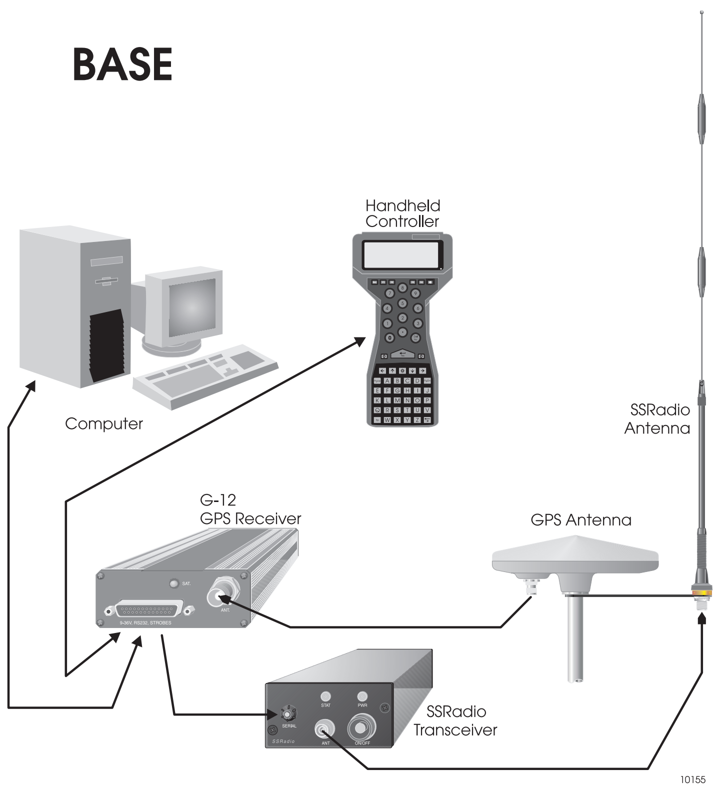

Figure 3.1. RTCM Base Station System

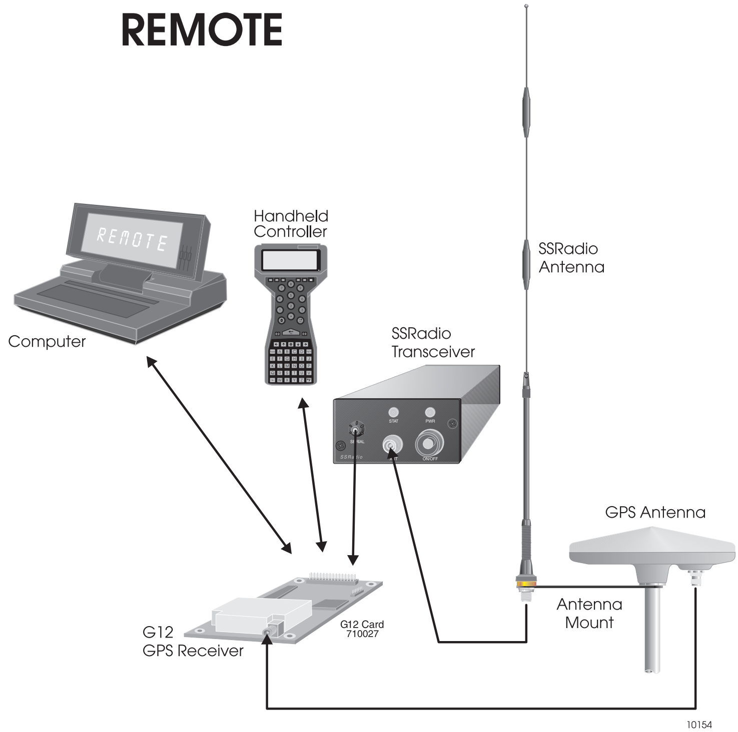

Figure 3.2. RTCM Remote System

Sources of Error

The major sources of error affecting the accuracy of GPS range measurements are satellite orbit estimation, satellite clock estimation, ionosphere, troposphere, multipath, and receiver noise in measuring range. The first four sources of error are almost totally removed by differential corrections. The residual error is in the order of one millimeter for every kilometer of separation between base and remote receivers.

Receiver noise is not correlated between the base and the remote receiver and is not canceled by differential GPS. However, in the G12, integrated doppler measurements are used to smooth the range measurements and reduce the errors resulting from receiver noise.

At the instant an satellite is locked, there is also RMS noise affecting the range measurement. RMS noise is reduced over time by the square root of the number of measurements computed by the receiver. For example, after 100 seconds of locking to a satellite, the rms noise in range measurement is reduced by a factor of 10 (one meter of noise is reduced to 0.1 meter). The noise is further reduced with each additional measurement.

If the lock to a satellite is lost, the noise goes back to one meter and smoothing starts from the one-meter level. The loss of lock to a satellite is rare, and typically happens only when the G12 antenna's line of sight to the satellite is blocked by an object, or when the satellite goes below the horizon.

Total position error (or error-in-position) is a function of the range errors (or errors-in-range) multiplied by the PDOP (three-coordinate position dilution of precision). PDOP is a function of satellite geometry; that is, the positions of the satellites in relation to one another.

RTCM Messages

The G12 accepts differential correction messages in the RTCM format (refer to *RTCM Recommended Standards for Differential GNSS*, version 2.2). The G12 can be set to output or receive RTCM messages using either of its two ports by issuing the set command **$PASHS,RTC,s1,c2** where s1 is either BAS (base station mode) or REM (remote mode) and c2 is the port designator for the input or output of differential corrections. The G12 supports six out of the 64 different types of RTCM messages. Message type 3 contains base station status information. Message type 16 contains a special ASCII message of up to 90 characters. Type 16 messages are used to communicate special information. For example, a base station operator may wish to construct a message informing users that the base station will go offline temporarily in order to perform routine maintenance or repairs. Message types 1, 2, and 9 contain data used for position correction. The type 6 message is a null frame message which is used to establish and maintain RTCM message frame synchronization for remote differential stations. RTCM messages are processed automatically by the G12. Although RTCM messages are output in binary format, it is possible to convert them to ASCII format through the **$PASHS,NME,MSG** set command and the **$PASHQ,MSG** query command.

All RTCM messages except type 1 are generated by the base station only if they are enabled using the **$PASHS,RTC,TYP** set command. In addition, if type 1 or type 9 messages are enabled and a change of ephemeris occurs in one or more satellites, the base station automatically generates a type 2 message with the delta IODE (Issue of Data, Ephemeris) information. The type 2 message is generated regardless of whether the type 2 message has been enabled for output. When a G12 set in differential remote mode receives a type 2 message, and the IODE information in type 1 or 9 messages does not match, the remote receiver uses the delta ephemeris information in the received type 2 message until the IODE information in the incoming type 1 or 9 messages matches the IODE information in the received type 2 message.

On initial power-up, or after issuing the **$PASHS,RST** command (restore defaults), the G12's setting for differential mode is OFF, and the setting for the maximum age of an RTCM differential correction is 60 seconds, meaning that an incoming correction whose age is greater than 60 seconds is not used. If automatic differential GPS mode is not enabled **($PASHS,DIF,AUT)**, and if the differential correction data is unavailable or is older than the maximum age specified by the **$PASHS,RTC,MAX** set command, a G12 set as a remote differential station will not output position data. If automatic differential mode is enabled, a G12 set as a remote differential station will output uncorrected positions if differential correction data is unavailable or if the age of correction exceeds the maximum age setting.

RTCM 104 Format, Version 2.2

When the RTCM base option is enabled and the G12 is configured as a reference station, it computes differential corrections for up to 12 satellites, converts those corrections to RTCM format and outputs the converted messages through its serial ports. The G12 generates message types 1, 2, 3, 6, 9, and 16, listed in Table 3.1:

Table 3.1. RTCM Format

Message Type	Contents of message
1	Differential GPS corrections
2	Delta differential corrections
3	Reference station coordinates
6	Null frame
9	High-rate differential GPS corrections
16	Special Message

The G12 uses the six-of-eight format (data bits a1 through a6 of an eight-bit byte) for differential corrections.

When the RTCM remote option [U] is installed and the G12 is set in differential remote mode, it can decode RTCM message types 1, 2, 3, 6, 9, and 16, but uses only types 1, 2, and 9 to correct its position calculations. When using radio-modems for the communication link, the G12 in remote mode is able to recover bit slippage.

Photogrammetry / Event Marking (Optional)

With the photogrammetry [E] option installed, the G12 can measure and record events with high accuracy. This is an input signal that is received into a 10K ohm impedance; the signal must be at TTL levels for proper functioning. In order to measure an event time, a trigger signal must be sent to pin 27 on connector J301. This input can be driven with either TTL or a switch that grounds the pin. The photogrammetry feature allows the event time to be output by using the **$PASHS,NME,TTT** command.

After enabling the TTT message, the time is measured at the rising or falling edge (selectable) of the trigger signal, causing and the TTT NMEA message is output. The trigger signal can be set to the rising or falling edge using the **$PASHS,PHE** command.

DEFAULT SETTINGS
TTT synchronization message output— synchronize with the rising edge of the trigger signal

The precision of the measured time is 135 nanoseconds (ns) in differential mode and 280 ns in stand-alone mode with SA on. This is based on GPS time, which is output as day number, hours, minutes, seconds, and fractional seconds to 6 digits past the decimal mark.

The photogrammetry time measures the event time relative to the receiver's GPS time. It measures only the first event during the period between 2 GPS epochs (Figure 3.3).

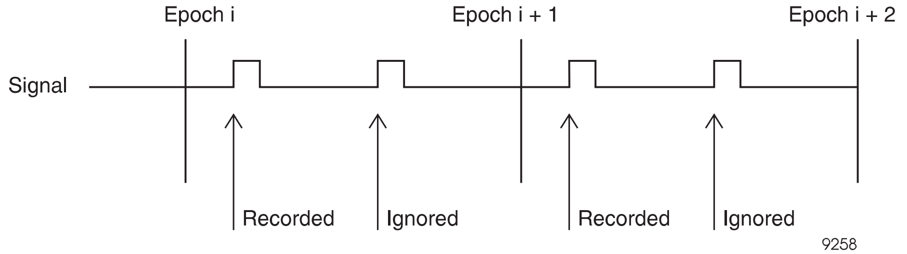

Figure 3.3. GPS Epochs

CAUTION

The G12 measures only one event time per data collection period. If more than one event time is measured within a data collection period, the receiver measures only the first one. The event time record rate is dependent upon the setting of the RCI parameter.

Because the 1 PPS signal is used to measure the photogrammetry events, the period of the 1 PPS signal must be set to a value equal to or less than the period of the event pulse.

The trigger pulse may be TTL-compatible or open collector. Minimum pulse duration is 100 nanoseconds when the signal is not terminated at the receiver input. The impedance is approximately 5 KΩ.

Use a coaxial cable with BNC connectors to connect the camera trigger output to the photogrammetry input connector of the G12.

Time Tagging the Shutter Signal

In this technique, the signal generated by the camera shutter is fed to a GPS receiver for accurate time-tagging which can then be post-processed with the GPS observations. Since the time of the picture is not synchronized with the time that the GPS measurement is taken, the two position computations before and after the shutter time are interpolated to compute the position of the camera at the time the picture was taken.

If GPS measurements are recorded at the rate of one per second, the average distance an aircraft travels in ½ second is about 100 meters. Therefore, the distance between the position of the camera at the time the picture was taken and the GPS position fixes can be as much as 50 meters. The motion of the aircraft during this time may be in the meter range.

To minimize the errors discussed above, the closed loop technique is recommended.

Closed-Loop Technique (Advanced Trigger)

The closed-loop technique combines PPS synchronization and shutter timing (Figure 3.4).

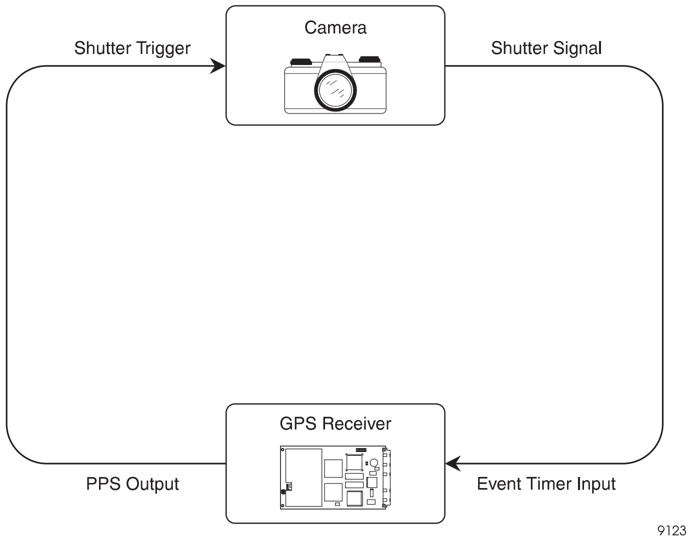

Figure 3.4. PPS Synchronization

In this technique, the 1PPS output of the G12 triggers a camera shutter. The camera shutter generates a signal that is fed to the G12 for accurate time tagging, better than one microsecond.

The delay between the camera receiving the pulse and triggering the photogrammetry port should be calculated. This may then be applied so as to advance the 1PPS from the G12 so that the shutter time exactly matches the GPS time for the epoch. No interpolation between the shutter time and the GPS position time will be needed.

Timing Pulse & Measurement Strobe (Optional)

When the timing pulse option [L] is installed, the G12 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 J301 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. Using the **$PASHS,PPS** command, the period of the pulse can be changed from 0.10 of a second up to 99.90 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 3.5 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 ±190 nanoseconds in stand-alone mode with SA active and ±45 nanoseconds when the G12 is receiving differential corrections. The G12 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.

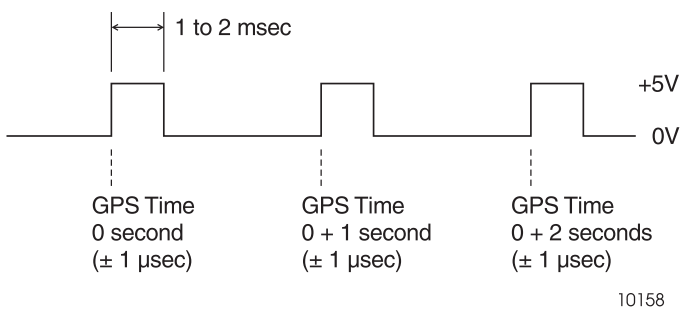

Figure 3.5. Timing Pulse Characteristics

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 3.6). 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.

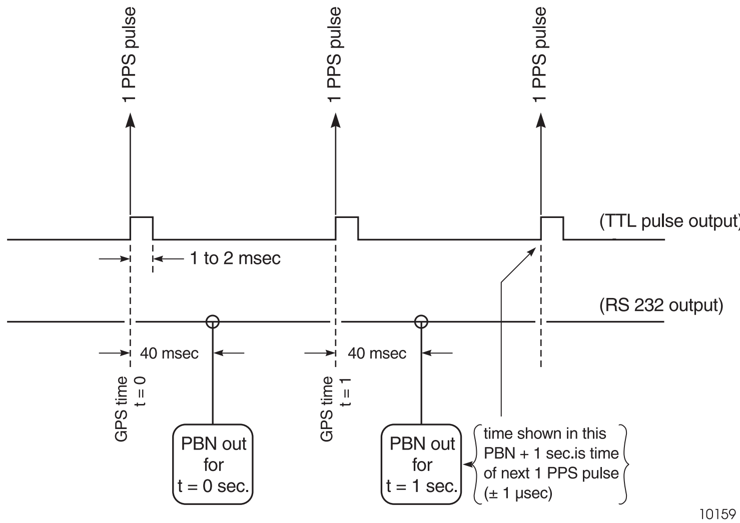

Figure 3.6. Relationship of GPS Time in PRN Record to 1PPS Pulse

The timing pulse option [L] includes a secondary measurement strobe output on pin 23 of 30-pin connector J301. The measurement strobe is also a TTL-level square-wave signal fed into a 75-ohm impedance, and is also synchronized with GPS time to an accuracy of ±1 microsecond. Output of the measurement strobe is controlled by the **$PASHS,STB** command and is synchronized with GPS time. The period depends upon the xxxx value and the setting of the RCI parameter. The ±yyy.yyyy field allows you to set an offset value from GPS time with a resolution of 100 nanoseconds, and also allows you to synchronize the rising or falling edge of the output with GPS time. The accuracy of the measurement strobe output is 0.5 milliseconds. For more information, see Chapter 4, Command/Response Formats.

10 HZ and 20 HZ Outputs

The G12 provides the optional capabilities of 10 Hz or 20 Hz internal update rates for position and raw data computations. When these options are installed, the G12 can output NMEA messages and raw data messages at intervals of 0.1 or 0.05 seconds (see Table 1.4 for a list of the available options). Because of power limitations in the G12's CPU, when the receiver is set to update position and raw data at 20 Hz (**$PASHS,POP,20**), it uses no more than 10 satellites in the navigation solution, although it continues tracking up to 12 satellites. During periods in which a 20 Hz update rate is not required, you can revert to a 10 Hz update rate and resume using up to 12 satellites in the position solution by issuing the command **$PASHS,POP,10**.

CAUTION
When collecting data at 10 or 20 Hz, a 486-33 MHz or Pentium computer with a fast serial and parallel port card (i.e., 16550 serial and parallel card) is required because of large amounts of data being output through the serial ports. The serial port baud rate should be set to 115200.

RAIM Algorithm

RAIM (Receiver Autonomous Integrity Monitoring) provides the detection of anomalous satellite pseudorange error with miss detection probability 0.999 and false alarm probability 0.002 per hour (requirements from RTCA/DO-208) under given horizontal alarm limit in range 200 m to 2 nautical miles. In addition, RAIM isolates wrong satellite and correct position and velocity errors.

RAIM includes three procedures which are called every epoch. The first one is Availability Check which checks current satellites constellation available to determine the possibility of anomalous error detection with given alarm threshold, false alarm and miss detection probabilities. Availability percentage depends on alarm threshold value, satellites number and their position. The less alarm threshold is, the less availability percentage will be. For example, if 7 satellites with good PDOP are in view and alarm threshold is the one nautical mile (terminal mode), detection is always available. If only 4 satellites are visible, detection is impossible.

If detection is available then Detection procedure is called. Detection algorithm compares the residuals with threshold depending upon the number of redundant satellites in view. If the threshold is exceeded then anomalous error is detected. RAIM is a snapshot type algorithm, so detection usually takes place at the first epoch after the alarm limit being exceeded.

If error is detected and at least 6 satellites with good PDOP are in view, then the Exclusion And Correction algorithm is called. The Exclusion And Correction algorithm determines the number of "wrong" satellites by maximal normalized residual, after that the position and velocity are corrected by exclusion of that "wrong" satellite. To avoid possible incorrect isolation, the rest of the satellites' set is tested by Availability Check and Detection algorithm. If the rest of the satellites' set is available and no error is detected, it means the successful correction of position and velocity. The procedures above can be executed recursively. It provides the possibility of more than one simultaneously wrong satellite exclusion. However, in some cases where not enough satellites are available or too many errors are detected, the probability requirement can not be met because of statistical limitations.

4

Command/Response Formats

This chapter covers the formats and content of the serial port commands through which the G12 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 generally change receiver parameters and initiate data output. Query commands generally 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 an **<Enter>** or **<CR><LF>** (Carriage Return/Line Feed) keystroke in order to send the command to the receiver. If desired, an optional checksum may precede the **<Enter>** characters. All response messages also end with **<Enter>** or **<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 G12 responds by outputting a message indicating the acceptance or rejection of the command. In the case of query commands, the G12 either outputs a response message containing data relevant to the query or sends a “NAK” response, indicating that the query command was invalid. All G12 response messages begin with the string **$PASHR**, including status messages that are set for output at regular intervals from either of the G12’s serial ports.

G12 serial port commands fall into four groups:

- Receiver commands
- Raw data commands
- NMEA message commands
- RTCM differential commands

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 the symbols and the types of data represented by them used 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 the G12's operating parameters. Query commands prompt the G12 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:

$PASHR,NAK*30

Set command messages can be accepted by either serial port. When the G12 receives a valid set command message, it returns an "acknowledged" (ACK) message:

$PASHR,ACK*3D

The G12 returns a NAK message if the command is invalid. The set command **$PASHS,SAV,Y<Enter>** instructs the G12 to save user-entered operation parameters; the G12 returns **$PASHR,ACK*3D** to acknowledge that the command was valid and the instruction was carried out. The set command **$PASHS,SAV<Enter>** is incomplete, and would cause the G12 to flag it as an invalid command by responding with a "not acknowledged" response:

$PASHR,NAK*30.

The set command message structure is as follows:

"Header,Command ID,<Command Parameters>*Checksum<Enter>"

The header field always contains **$PASHS**. The command identifier field contains a three character string and is followed by the command parameters. The checksum is strictly optional. All set commands are terminated with an **<Enter>** or **<CR><LF>** keystroke. All command string elements between the dollar sign ($) 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. Enter the following set command to set the HDOP mask value:

$PASHS,HDP,6<Enter>

Query commands are used to request current GPS information and receiver status information such as baud rate settings, position information, and tracking information. Query command messages can be sent to either of the G12's serial ports. Most query commands allow you to designate the port from which the response message is sent. The G12 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 as follows:

$PASHQ,xxx,<optional query parameter>*hh<Enter>

Table 4.2 contains descriptions of the query command elements.

Table 4.2. Query Command Structure

Field	Description
$	NMEA message start character
PASHQ	Proprietary Ashtech 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,CRR** instructs the G12 to output a response message indicating the currently selected code correlation mode:

$PASHR,CRR,E,E,E,E,E,E,E,E,E,E,E,E*37

The query command **$PASHQ,CR<Enter>** is incomplete, and causes the G12 to flag it as an invalid message by outputting the NAK response.

Table 4.3 contains a list of the set and query commands falling into the category of 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

Command	Description	Page
ANTENNA POSITION		
$PASHS,ALT	Set ellipsoidal height of antenna	54
$PASHS,POS	Set base station reference position	86
$PASHQ,POS	Query current position	86
$PASHS,POS,CUR	Set current position as base station reference position	86
DILUTION OF PRECISION (DOP)		
$PASHS,HDP	Set HDOP mask for position computation	71
$PASHS,PDP	Set PDOP mask for position computation	81
$PASHS,VDP	Set VDOP mask for position computation	111

Table 4.3. Receiver Commands (Continued)

Command	Description	Page
IONOSPHERIC AND TROPOSPHERIC MODELLING		
$PASHQ,ION	Query ionospheric measurements	73
MEMORY		
$PASHS,INI	Clear internal and BBU memory	72
$PASHQ,MEM	Query memory status	77
$PASHQ,RSO	Query receiver serial number and options	95
$PASHS,RST	Restore default parameter settings	95
$PASHS,SAV	Save parameters to memory	95
MISCELLANEOUS PARAMETERS		
$PASHS,CRR	Set type of code correlator	56
$PASHQ,CRR	Query code correlator setting	56
$PASHQ,DUG	Query UTC-GPS time difference	65
$PASHS,LTZ	Set local zone time	77
$PASHS,SUI	Enable satellite usage indicator	101
PHOTOGRAMMETRY/1PPS/STROBE		
$PASHS,PHE	Set photogrammetry edge	81
$PASHQ,PHE	Query photogrammetry parameters	82
$PASHS,PPS	Set period and offset of 1PPS signal	87
$PASHQ,PPS	Query timing pulse parameters	88
$PASHS,STB	Set measurement strobe parameters	100
$PASHQ,STB	Query measurement strobe parameters	101
POSITION COMPUTATION		
$PASHS,FIX	Set fixed altitude mode	67
$PASHS,FUM	Select UTM zone to be held fixed	68
$PASHS,FZN	Enable/disable fixed UTM zone mode	68
$PASHS,ERM	Set error masks for position computations	66
$PASHQ,GDC	Query position as rendered in user-defined grid coordinates	69
$PASHS,PEM	Set elevation mask for position computation	81
$PASHS,PMD	Set position computation mode	82
$PASHS,SEM	Set secondary elevation mask	96

Table 4.3. Receiver Commands (Continued)

Command	Description	Page
VELOCITY COMPUTATION		
$PASHS,DAP	Set Doppler averaging interval	
$PASHQ,DAP	Query Doppler averaging interval	
EXTENDED MEMORY G12 ONLY		
$PASHS,AIM	Set RAIM mode	53
$PASHQ,AIM	Query the RAIM configuration	54
$PASHS,GRD	Set datum-to-grid transformation	71
$PASHS,PRR	Upload current ephemeris	88
$PASHS,UDG	Set user-defined datum-to-grid transformation	106
$PASHQ,UDG	Query user-defined datum-to-grid transformation	109
RECEIVER CONFIGURATION		
$PASHQ,CLK	Query clock status	55
$PASHS,CTS	Enable/disable RTS/CTS handshaking protocol	57
$PASHQ,CTS	Query current RTS/CTS setting	57
$PASHS,DSY	Set serial ports for daisy chain communication	60
$PASHS,DTM	Select reference datum	61
$PASHQ,DTM	Query current datum	65
$PASHQ,DUG	Query GPS/UTC time difference	65
$PASHR,DUG	GPS/UTC time difference response message	65
$PASHS,LPS	Set loop tracking parameters	74
$PASHQ,LPS	Query loop tracking parameter setting	75
$PASHQ,PAR	Query current receiver parameter settings	78
$PASHS,POP	Set receiver internal update rate for position and raw data	84
$PASHQ,POP	Query current internal update rate for position and raw data	84
$PASHS,PPO	Set point positioning	85
$PASHQ,PPO	Query point positioning	85
$PASHR,PPO	Point positioning response message	85
$PASHS,PRR	Enable/disable ephemeris/almanac upload mode	88
$PASHQ,PRT	Query port baud rate	89
$PASHS,PSM	Enable/disable position/velocity filters	90

Table 4.3. Receiver Commands (Continued)

Command	Description	Page
$PASHQ,RID	Query receiver identification (Format 1)	90
$PASHQ,RIO	Query receiver identification (Format 2)	93
$PASHS,SMI	Set code measurement smoothing	97
$PASHQ,SMI	Query code measurement smoothing	98
$PASHR,SMI	Code measurement smoothing response message	98
$PASHS,SPD	Set baud rate of serial port	99
$PASHS,UDD	Set user defined datum parameters	102
$PASHQ,UDD	Query user defined datum parameters	102
$PASHS,UTS	Synchronize measurements and coordinates with GPS system time	111
$PASHQ,UTS	Query time synchronization	111
RTCM REMOTE STATION STATUS		
$PASHQ,DFO	Query for current status of RTCM remote station	59
SATELLITE TRACKING PARAMETERS		
$PASHS,USE	Designate individual satellites for tracking	110
$PASHS,USE,ALL	Include/exclude all satellites for tracking	110
$PASHS,USP	Designate individual satellites to be used in position computation	110
$PASHQ,STA	Query currently locked satellites	100

Since they are required for all commands and responses, the <Enter> and <CR><LF> keystrokes are omitted from the examples that follow.

AIM: RAIM Availability—Extended Memory G12 Only

$PASHS,AIM,s

Select the RAIM (Receiver Autonomous Integrity Monitor) mode, where s is one of the following 3-character strings representing a pre-defined alarm limit or a user-defined alarm limit.

- OFF - Disables RAIM
- NPA - Non-precision approach, alarm limit is 0.030 nmi (default)
- TER - Terminal, alarm limit is 1.00 nmi
- ERT - En route, alarm limit is 2.00 nmi

The alarm limit is in the format n.nn and is a value between 0.015 and 4.00 kilometers.

This command is available for G12 extended memory only.

Example

Enter the following command to set RAIM mode to terminal mode.

$PASHS,AIM,TER<Enter>

DEFAULT SETTING
AIM—OFF

$PASHQ,AIM,[c1]

The associated query command displays the RAIM configuration, 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.

The response message is output in the format:

$PASHR,AIM,a,s,[s1,s2,...,si]

Table 4.4 defines the response format.

Table 4.4. AIM Response Message

Parameter	Description
s	Current RAIM mode (3 characters) • OFF— RAIM is off. • NPA— RAIM is set to non-precision approach. The alarm limit is 0.30 nmi. • TER— RAIM is set to terminal. The alarm limit is 1.00 nmi. • ERT— RAIM is set to en route. The alarm limit is 2.00 nmi. • s can also be defined as an alarm limit in the format n.nn from 0.015 to 4.00 nmi.
d	The number RAIM returns • 0— No errors detected. • 1— Error is detected and successfully corrected. • 2— Error is detected and correction is impossible. • 3— Detection is not available for either a lack of satellites or poor geometry. • 4— Error is detected and the rest of the satellite set is not available.
s1, s2, ..., si	Represents a pair of excluded/detected channel and corresponding satellites as **n-m** string where **n** is channel number excluded/detected and **m** is corresponding satellite number.

ALT: 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 G12 uses the altitude value set through this command when it is computing 2D positions.

Example

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

$PASHS,ALT,-30.1

DEFAULT SETTING
ALT—00000.00 meters

CLK: Clock Status

$PASHQ,CLK,c1

This command allows you to query real-time clock status. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CLK

The response message is output in the format:

$PASHR,CLK,d1,d2,d3,d4,d5,d6,d7,d8

Table 4.5 defines the integers values for d1-8:

Table 4.5. $PASHQ,CLK Format

Parameter	Description	Range
d1	Year	0-99
d2	Month	0-12
d3	Date	0-31
d4	Day	0-7
d5	Hour	0-23
d6	Minute	0-60
d7	Second	0-60
d8	Time Difference	0-2^32
*hh	The hexadecimal checksum is computed by exclusive O-Ring 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 CLK response:

$PASHR,CLK,96,12,04,13,25,20,14*1D

This translates to 4 December 1996, Wednesday 13.25, 20 sec; last write time to clock operation was at 14sec before this command.

CRR: Code Correlator Mode

$PASHS,CRR,c1

This command selects the type of code correlator used for multipath mitigation; c1 specifies the code correlator type:

E = Edge correlator

S = Strobe correlator.

The G12 includes the strobe correlator and edge correlator as standard features. The G12-L includes the edge correlator as standard, with the strobe correlator as an option

$PASHQ,CRR,[c1]

This command allows you to query the current code correlation mode, 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.

$PASHR,CRR

The response message is output in the format:

$PASHR,CRR,c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12*hh

Table 4.6 defines the CRR parameters

Table 4.6. $PASHR,CRR Format

Parameter	Description	Range
c1 -c12	Correlator setting for channels 1-12	E(dge correlator) S(trobe correlator)
hh	Checksum	2-character hex

Typical CRR response:

$PASHR,CRR,E,E,E,E,E,E,E,E,E,E,E,E*37

Table 4.7 describes a typical CRR response message.

Table 4.7. Typical CRR Message

Item	Description
$PASHR	Header
CRR	Message identifier
E	Indicates that channels 1-12 are set in edge correlator mode
*37	Checksum

DEFAULT SETTING
CRR—E

CTS: Handshaking Protocol

$PASHS,CTS,[c1,]s1

This command allows you to enable or disable the CTS/RTS (Clear To Send/ Request To Send) handshaking protocol on one or both of the serial ports. The c1 parameter is the optional port designator (A or B); s1 is ON or OFF. If a port is not designated, the command applies the change to the port from which the command was sent. Handshaking is enabled on both ports by default. Handshaking requires five connections for each serial port (CTS, TXD, GND, RTS, RXD). When handshaking is disabled, only three connections are required (TXD, GND, RXD). See Figure 1.2 on page 6 for the J301 pin configuration.

Example: Disable handshaking on port A:

$PASHS,CTS,A,OFF

$PASHQ,CTS,[c1]

This command allows you to query the current CTS setting, 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.

$PASHR,CTS

The response message is output in the format:

$PASHR,CTS,c1,s1*hh

Table 4.8 defines the CTS parameters.

Table 4.8. $PASHR,CTS Format

Parameter	Description	Range
c1	Port identifier	A, B
c2	Current CTS setting	ON, OFF
hh	Checksum	2-character hex

Typical CTS response:

$PASHR,CTS,A,ON*70

Table 4.9 defines a typical CTS response message.

Table 4.9. Typical CTS Response Message

Item	Description
$PASHR	Header
CTS	Message identifier
A	Port identifier
ON	Current CTS setting for the related serial port
*70	Checksum

DEFAULT SETTING
CTS—ON

DAP: Doppler Averaging Interval

$PASHS,DAP,f1

This command sets the time interval for the average Doppler computation, where f1 is the value for the output interval between 0.0 and 5.0. To use the raw Doppler value, set f1 to 0.

The Doppler averaging period affects the noise in the computed velocity, and at approximately 0.5, the velocity reaches its nominal value. The maximum value is 5.0*(maximum position period).

Example

Set doppler averaging time interval to 5 seconds:

$PASHS,DAP,5

$PASHQ,DAP,[c1]

This command queries the doppler averaging interval range, 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.

$PASHR,DAP

The response message is output in the format:

$PASHR,DAP,f1*hh

where the DAP parameters are as defined in Table 4.10.

Table 4.10. $PASHR,DAP Format

Parameter	Description	Range
f1	Doppler averaging interval	0.0 to 5.0
hh	Checksum	2-character hex

DFO: Remote Station Status

$PASHQ,DFO,[c1]

This command queries the remote station status, 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.

$PASHR,DFO

The response is in the format:

$PASHR,DFO,d1,d2,d3,d4,d5,d6,d7,{di,+/-fi1,+/-fi2}1-n

Table 4.11 defines the response format:

Table 4.11. $PASHR,DFO Structure

Parameter	Description	Range
d1	RTCM differential mode status	• 0—Not in remote mode, do not sent remaining messages • 2—Receiver in Remote Mode
d2	Message Status	• 0—No message has been received, do not send remaining messages • 1—Message is not synchronized (message is older than maximum age) • 2—Message is synchronized with the last received message
d3	Reference Station ID	0 to 1023
d4	Reference Station Health	0 to 7
d5	Age of received message in seconds	0 to maximum age
d6	Quality factor	0 to 999
d7	Number of satellites for which the PRC and RRC are transmitted	
di	PRN number (loops d7 times)	
fi1	Pseudo-range correction in meters (loops d7 times)	3 bytes, including +/-
fi2	Range rate correction in centimeters per second (loops d7 times)	3 bytes, including +/-
hh	Checksum	2 character, hexidecimal

DSY: Daisy Chain Communications Mode

$PASHS,DSY,c1,c2;

This command redirects all characters from one serial port to the other without interpreting them, where c1 is the source port and c2 is the destination port. Any combination may be chosen. When daisy chain mode is in effect, the source port can only interpret the OFF command; all other characters are redirected.

$PASHS,DSY,OFF

The OFF command disables daisy chain mode. A bi-directional daisy chain mode (i.e. A to B and B to A at the same time) can also be enabled.

Table 4.12 lists commands and their effects.

Table 4.12. Daisy Chain Commands

Command	Effect
$PASHS,DSY,A,B	Redirects data going into port A over to port B. Can be issued to either port
$PASHS,DSY,B,A	Redirects data going into port B over to port A. Can be issued to either port
$PASHS,DSY,A,OFF	Turns off redirection from A. Can be issued to either port
$PASHS,DSY,B,OFF	Turns off redirection from B. Can be issued to either port
$PASHS,DSY,A,B $PASHS,DSY,B,A	Both commands must be entered to enable bi-directional daisy chain mode. If you are connecting to the G12 through port A, enter $PASHS,DSY,B,A first. If you are interfacing to the G12 through port B, enter $PASHS,DSY,A,B first
$PASHS,DSY,OFF	Disables daisy chain on all ports. Can be issued from any port

DEFAULT SETTING
DSY—OFF

DTM: Set Reference Datum

$PASHS,DTM,UDD

This commands allow you to select a user defined datum type to use as a reference for position computations and measurements. Parameters for the user defined datum are entered with the **$PASHS,UDD** command described on page 102.

$PASHS,DTM,s1 (Extended Memory G12 only)

This command allows you to select one of two datum types to be used as a reference for position computations and measurements; s1 specifies the datum type:

A 3 character string that defines a particular datum

USR (User Defined Datum— Parameters for user defined datum are entered with the **$PASHS,UDD** command described on page 102.

Commands

Table 4.13 lists the available predefined datums and associated reference ellipsoids.

Table 4.13. Predefined Datums and Associated Reference Ellipsoids

Datum ID	Reference Ellipsoid	Offset in meters (dX,dY,dZ)	Datum Description
ARF	Clarke 1880	-143, -90, -294	ARC 1950 (Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe
ARS	Clarke 1880	-160, -8, -300	ARC 1960 (Kenya, Tanzania)
AUA	Australian National	-133, -48, 148	ANS66 Australian Geodetic Datum 1966 (Australia, Tasmania Island)
AUG	Australian National	-134, -48, 149	ANS84 Australian Geodetic Datum 1984 (Australia, Tasmania Island)
BOO	International 1924	307, 304, -318	Bogota, Bogota Observatory (Columbia)
CAI	International 1924	-148, 136, 90	Campo, S. American Campo Inchauspe (Argentina)
CAP	Clarke 1880	-136, -108, -292	Cape (South Africa)
CGE	Clarke 1880	-263, 6, 431	Carthage (Tunisia)
CHI	International 1924	175, -38, 113	Chatham 1971 (Chatham, New Zealand)
CHU	International 1924	-134, 229, -29	S. American Chua Astro (Paraguay)
COA	International 1924	-206, 172, -6	S. American Corrego Alegre (Brazil)
EUA	International 1924	-87, -96, -120	European 1950 (Western Europe: Netherlands, Austria, France, F.R. of Germany, Switzerland, Denmark)
EUE	International 1924	-104, -101, -140	European 1950 (Cyprus)
EUF	International 1924	-130, -117, -151	European 1950 (Egypt)
EUH	International 1924	-117, -132, -164	European 1950 (Iran)
EUJ	International 1924	-97, -88, -135	European 1950 (Sicily)
EUS	International 1924	-86, -98, -119	European 1979 (Austria, Netherlands, Finland, Norway, Spain, Sweden, Switzerland)
FAH	Clarke 1880	-346, -1, 224	Oman
GAA	International 1924	-133, -321, 50	Gandajika Base (Rep. of Maldives)
GEO	International 1924	84, -22, 209	Geodetic Datum 1949 (New Zealand)
HJO	International 1924	-73, 46, -86	Hjorsey 195 (Iceland)
INA	Everest	214, 836, 303	Indian 1 (Thailand, Vietnam)
INM	Everest	289, 734, 257	Indian 2 (India, Nepal, Bangladesh)

Table 4.13. Predefined Datums and Associated Reference Ellipsoids (Continued)

Datum ID	Reference Ellipsoid	Offset in meters (dX,dY,dZ)	Datum Description
IRL	Modified Airy	506, -122, 611	Ireland 1965
KEA	Modified Everest	-11, 851, 5	Kertau 1948 (West Malaysia, Singapore)
LIB	Clarke 1880	-90, 40, 88	Liberia 1964
LUZ	Clarke 1866	-133, -77, -51	Luzon (Philippines excluding MindanoaIs.)
MAS	Bessel 1841	639, 405, 60	Massawa (Eritrea, Ethiopia)
MER	Clarke 1880	31, 146, 47	Merchich (Morocco)
MIN	Clarke 1880	-92, -93, 122	Minna (Nigeria)
NAC	Clarke 1866	-8, 160, 176	NAD27 N. American CONUS 1927 (North America)
NAD	Clarke 1866	-5, 135, 172	AK27 N. American Alaska 1927 (Alaska)
NAE	Clarke 1866	-10, 158, 187	CAN27 N. American Canada 1927 (Canada including Newfoundland Island)
NAH	Clarke 1880	-231, -196, 482	Nahrwan (Saudi Arabia)
NAN	Clarke 1866	-6, 127, 192	Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico)
NAR	GRS1980	0, 0, 0	GRS80 North American 1983
OEG	Helmert 1906	-130, 110, -13	Old Egyptian
OGB	Airy 1830	375, -111, 431	OSG Ordnance Survey of Great Britain 1936 (England, Isle of Main Scotland, Shetland Islands, Wales)
OHA	Clarke 1866	61, -285, -181	OLDHW Old Hawaiian
PIT	International 1924	185, 165, 42	Pitcairn Astro 1967 (Pitcairn Island)
QAT	International 1924	-128, -283, 22	Qatar National (Qatar)
QUO	International 1924	164, 138, -189	Qornoq (South Greenland)
SAN	S. American 1969	-57, 1, -41	SAMER69 S. American 1969 (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyan, Peru, Paraguay, Venezuela, Trinidad, Tobago)
SCK	Bessel 1841 Namibia	616, 97, -251	Schwarzeck (Namibia)
TIL	Everest	-689, 691, -46	Timbalai 1948 (Brunei, East Malaysia, Sarawak, Sabah)
TOY	Bessel 1841	-128, 481, 664	Tokyo (Japan, Korea, Okinawa)
USR	User Defined	user defined	User defined

Table 4.13. Predefined Datums and Associated Reference Ellipsoids (Continued)

Datum ID	Reference Ellipsoid	Offset in meters (dX,dY,dZ)	Datum Description
W72	WGS72	0, 0, +4.5	WGS72 World Geodetic System - 72
W84	WGS84	0, 0, 0	WGS84 World Geodetic System - 84
ZAN	International 1924	-265, 120, -358	Zanderij (Surinam)

Table 4.14 lists the predefined ellipsoids.

Table 4.14. Predefined Ellipsoids

Ellipsoid	a (meters)	1/f	f
Airy 1830	6377563.396	299.3249647	0.00334085064038
Modified Airy	6377340.189	299.3249647	0.00334085064038
Australian National	6378160.0	298.25	0.00335289186924
Bessel 1841	6377397.155	299.1528128	0.00334277318217
Clarke 1866	6378206.4	294.9786982	0.00339007530409
Clarke 1880	6378249.145	293.465	0.00340756137870
Everest (India 1830)	6377276.345	300.8017	0.00332444929666
Everest (W. Malaysia and Singapore)	6377304.063	300.8017	0.00332444929666
Geodetic Reference System 1980	6378137.0	298.257222101	0.00335281068118
Helmert 1906	6378200.0	298.30	0.00335232986926
International 1924	6378388.0	297.00	0.00336700336700
South American 1969	6378160.0	298.25	0.00335289186924
World Geodetic System 1972 (WGS-72)	6378135.0	298.26	0.00335277945417
World Geodetic System 1984 (WGS-84)	6378137.0	298.257223563	0.00335281066475

Example

Select New Zealand Geodetic Datum 1949 for position computation:

$PASHS,DTM,GEO

You can view the current reference datum selection with the **$PASHQ,PAR** command and checking the DTM field.

DEFAULT SETTING
DTM—WGS-84

$PASHQ,DTM,[c]

The associated query command queries the current datum, where c 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.

$PASHR,DTM

The response is in the format:

$PASHR,DTM,s*cc

s is the 3-character string, listed in Table 4.13, which denotes the current datum setting.

DUG: GPS/UTC Time Difference

$PASHQ,DUG,[c1]

This command allows you to query the time difference between UTC time and GPS time, 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.

$PASHR,DUG

The response message is output in the format:

$PASHR,DUG,<Binary Data String + Checksum>

Table 4.15 defines the DUG binary data string parameters.

Table 4.15. $PASHR,DUG Binary Data String 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
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	Checksum (word)
Total bytes	14	

A time step, or leap second, was added to UTC on 12-31-98. GPS time was not physically adjusted, and is now thirteen seconds ahead of UTC. The time change is reflected in the navigation messages generated by the individual satellites as of January 1, 1999.

ERM: Set Position Error Mask Values

$PASHS,ERM,s1,d1,d2

This command allows you to set mask values for horizontal and vertical error in relation to one of three different positioning modes:

- Autonomous (AUT)— Sets the error masks to autonomous mode
- Code-phase differential (DIF)— Sets the error mask to code-differential mode
- Both Autonomous and Differential (ALL)— Sets equal error masks for AUT and DIF

The s1 parameter represents the positioning mode, d1 is the horizontal error mask value, and d2 is the vertical error mask value. The range for d1 and d2 is 1 to 6000 meters. If the calculated 99% (3 sigma) error estimate of the computed position exceeds the set ERM value, no position will be output. The 99% position error estimate is three times the standard deviation values reported in the GST message. Current ERM settings appear in the **$PASHQ,PAR** message.

The various ERM mask parameters are utilized based on the positioning mode the receiver is operating in. For example, in auto-differential mode (AUT,ON), based on the epoch-to-epoch conditions, the receiver will use the respective mask parameters based on the corresponding positioning mode of each epoch. If the receiver is generating autonomous positions (e.g. due to the lack of current RTCM correction) the AUT mask parameters will be used until differential position fixes are computed, which will be masked by the DIF parameters.

The horizontal position standard deviation is derived from the individual latitude and longitude standard deviations (GST) every epoch.

Example

Enter the following command to set the error masks for autonomous mode to five meters for horizontal measurements and ten meters for vertical measurements:

$PASHS,ERM,AUT,5,10

$PASHS,ERM,ALL,d1,d2

This command allows you to set error mask values that are applied to all positioning modes (AUT, DIF). Error mask values set through this command are in effect regardless of the receiver's current positioning mode. The various ERM mask parameters are utilized based on the positioning mode the receiver is operating in. For example, in auto-differential mode (AUT,ON), based on the epoch-to-epoch conditions, the receiver will use the respective mask parameters based on the corresponding positioning mode of each epoch. If the receiver is generating autonomous positions (e.g. due to the lack of current RTCM correction) the AUT mask parameters will be used until differential position fixes are computed, which will be masked by the DIF parameters.

Example

Enter the following command to set the horizontal error mask to 2 meters and the vertical error mask to 4 meters for all positioning modes:

$PASHS,ERM,ALL,2,4

DEFAULT SETTING			
ERM	**Positioning Mode**	**Horizontal Mask**	**Vertical Mask**
	Autonomous	**6000**	**6000**
	Code Differential	**6000**	**6000**

Users who currently use the RMS and standard deviation information reported in the GST message, and who also use the PDOP mask to screen out position fixes in less than favorable conditions, may choose to disable the additional ERM masking feature. To disable the ERM, use the default ERM settings or issue the command: $PASHS,ERM,ALL,6000,6000.

FIX: Fixed Altitude Mode

$PASHS,FIX,d1

This command allows you to set the fixed altitude mode. It is typically used when the receiver is in 2-D position mode or when there are not enough visible satellites to compute a 3-D position; d1 can be 0 or 1. You can view the current setting for fixed altitude mode with the **$PASHQ,PAR** command and checking the FIX field.

- Fixed Altitude Mode 0

  The most recently recorded antenna altitude is used. The altitude value is taken either from the altitude entered through the **$PASHS,ALT** command or from the last altitude computed in which the VDOP value is lower than the value entered for the VDOP mask

- Fixed Altitude Mode 1

  Only the most recent altitude value entered through the **$PASHS,ALT** command is used.

Example

Enter the following command to set the G12 in fixed altitude mode 1:

$PASHS,FIX,1

DEFAULT SETTING
FIX—Mode 0

FUM: Fix UTM Zone

$PASHS,FUM,c1

This command enables/disables the fixing of the UTM zone, where c1 is Y (enable) or N (disable). The default is N. This command is typically enabled when the user is near a UTM boundary and wants to avoid the coordinate shift that occurs when crossing from one UTM zone into another. This command is used in conjunction with the **$PASHS,FZN** command which is used to select the zone to be fixed by the FUM command.

Example

Enter the following command to enable the fixed zone setting:

$PASHS,FUM,Y

DEFAULT SETTING
FUM—N

FZN: Select Fixed UTM Zone

$PASHS,FZN,d1

This command allows you to select the UTM zone that will be held fixed, where d1 is the UTM zone number ranging from 1 to 60. This command is typically used when the user is near a UTM boundary and wants to avoid the coordinate shift that occurs when crossing from one UTM zone into another. This command is used in conjunction with the command **$PASHS,FUM**, which holds fixed the zone selected by the FZN command.

Example

Enter the following command to select UTM zone 10 as the zone to be held fixed:

$PASHS,FZN,10

GDC: 3-D Position in User-defined Grid Coordinates

$PASHQ,GDC,[c1]

This command allows you to query for current position according to the user-defined grid coordinate system selected through the UDG command, 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. The response message does not output unless the following three conditions are met:

1. The receiver is computing positions.
2. A grid coordinate system has been selected through the UDG command.
3. The conversion from geodetic coordinates to the selected grid coordinate system has been enabled through the GRD command.

$PASHR,GDC

The response message is output in the format:

$PASHR,GDC,m1,s2,f3,f4,d5,d6,f7,f8,f9,d10,s11,s12*hh

Table 4.16 defines the parameters.

Table 4.16. GDC Message Structure

Parameter	Description	Range
m1	UTC of position in hours, minutes, and decimal seconds (hhmmss.ss)	000000.00 to 235959.90
s2	Map projection type	EMER, TM83, OM83, LC83, STER, LC27, Tm27, TA22
f3	Easting (x) of the user grid coordinate (meters)	-9999999.999 to +9999999.999
f4	Northing (y) of the user grid coordinate (meters)	-9999999.999 to +9999999.999
d5	Positioning mode Indicator • 1: Autonomous position • 2: RTCM differential, or CPD float position • 3: Carrier Phase differential (CPD) fixed	1, 2, 3
d6	Number of GPS satellites being used	3 - 12
f7	Horizontal Dilution of Position (HDOP)	00.0 - 99.9
f8	Altitude (meters)	-9999999.999 to +9999999.999

Table 4.16. GDC Message Structure (Continued)

Parameter	Description	Range
M	Altitude units	M(eters)
f9	Geoidal separation in meters w.r.t. selected datum and Geoid Model	-999.999 to +999.999
d10	Age of differential corrections	0 - 999
s11	Differential reference station ID	0000 - 1023
s12	Datum type	W84, USR
*hh	Checksum	2-character hex

Typical GDC response message:

$PASHR,GDC,015151.00,EMER,588757.623,+4136720.056,2,04,03.8,00012.123,M,-031.711,M,14,1010,W84*2A

Table 4.17 describes the response message.

Table 4.17. Typical GDC Response Message

Item	Significance
015454.00	UTM time
EMER	Equatorial Mercator map projection
588757.623	User grid easting coordinate (x)
4136720.056	User grid northing coordinate (y)
2	RTCM differential position
04	Number of satellites used to compute position
03.8	HDOP
00012.123	Altitude of position
M	Altitude units (M=meters)
-031.711	Geoidal separation with respect to selected datum
M	Geoidal separation units (M = meters)
014	age of corrections
1010	Differential station ID
W84	Datum is WGS-84
2A	Checksum

GRD: Datum-to-Grid (Map Projection)— Extended Memory G12 Only

$PASHS,GRD,s1

This command allows you to enable or disable the usage of the user defined datum to grid transformation to position outputs, where s1 is either NON (transformation disabled) or UDG (enable user defined datum to grid transformation). The GRD command is used in conjunction with the **$PASHS,UDG** command, which is used to select the desired datum to grid transformation parameters.

Example

Enter the following command to enable the user defined to grid transformation:

$PASHS,GRD,UDG

$PASHQ,GRD,[c1]

This command allows you to query for current GRD status, 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.

$PASHR,GRD

The response message is output in the format:

$PASHR,GRD,s1*hh

The s1 parameter is the 3-character string indicating the current datum-to-grid setting (NON or UDG).

HDP: HDOP Mask Value

$PASHS,HDP,d1

This command allows you to set the value of the HDOP mask, where d1 is a number between 0 and 99.9. If the HDOP value computed by the G12 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,PAR and checking the HDP field.

Example

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

$PASHS,HDP,6

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 4.18 and Table 4.19 list the code numbers and the settings associated with them.

Table 4.18. 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 4.19. Memory Reset Codes

Reset Memory Code	Action
0	No memory reset
1	Reset internal memory (battery-backed RAM)
2	Reset external memory (data storage)— Not functional
3	Reset internal and external memory— Not functional

Example

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

$PASHS,INI,4,6,1

The INI command is not fully functional with the G12. Since the G12 does not contain a memory area for data storage, the reset memory code for external memory (2) has no effect on the receiver. Resetting internal memory (1), or resetting internal and external memory (3) have the same effect. The parameter settings for this command were maintained for the G12 in order to preserve consistency with other Ashtech receivers.

ION: Ionospheric and Tropospheric Modeling

$PASHQ,ION,[c1]

This command allows you to query for current ionospheric data generated by the GPS satellites, 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.

Ionospheric and tropospheric modeling are enabled when the receiver is functioning in stand-alone mode (autonomous mode), but are disabled if the receiver is set as an RTCM base or rover, since differential corrections already compensate for ionospheric and tropospheric delays.

$PASHR,ION

The response message is output in binary format:

$PASHR,ION,<Binary Data String + Checksum>

Table 4.20 describes the elements in the binary data string:

Table 4.20. $PASHR,ION Format

Type	Size	Contents
float	4	α_0 ionospheric parameter (seconds)
float	4	α_1 ionospheric parameter (sec. per semicircle)
float	4	α_2 ionospheric parameter (sec. per semicircle)
float	4	α_3 ionospheric parameter (sec. per semicircle)
float	4	β_0 ionospheric parameter (seconds)
float	4	β_1 ionospheric parameter (sec. per semicircle)
float	4	β_2 ionospheric parameter (sec. per semicircle)

Table 4.20. $PASHR,ION Format (Continued)

Type	Size	Contents
float	4	β_3 ionospheric parameter (sec. per semicircle)
double	8	A_0 Constant term of GPS/UTC polynomial
double	8	A_1 Constant term of GPS/UTC polynomial
unsigned long	4	t_{ot} Reference time
short	2	W_{nt} reference week
short	2	Δt_{LS} Delta UTC-GPS time at reference time
short	2	WN_{LSF} Week of leap second correction
short	2	DN day of leap second correction
short	2	Δt_{LSF} Delta time between GPS and UTC
short	2	WN Current GPS week number
unsigned long	4	tow Current time of week
short	2	bulwn Current GPS week number when message was read
unsigned long	4	bultow Time of week when message was read
short	2	Checksum (word)
Total characters = 76 bytes		

The G12 does not calculate ionospheric parameters on its own. The ionospheric data, listed in Table 4.20, are obtained from subframe 4 of the GPS navigation message.

LPS: Third-order Loop Tracking Parameters

$PASHS,LPS,d1,d2,d3

This command allows you to set third-order loop tracking parameters to optimize loop tracking performance for a specific application, where d1 is the ratio of the carrier loop, d2 is the carrier loop parameter, and d3 is the code loop parameter. The carrier and code loop parameters are set independently. The G12 uses default loop tracking values until new parameters are set through this command. Loop tracking parameters set through this command are saved in battery-backed memory and used until new settings are selected, battery-backed memory is cleared, or the RST command is issued to the receiver.

Example

Enter the following command to set loop tracking parameters for a low-dynamic application:

$PASHS,LPS,1,2,2

$PASHQ,LPS,[c1]

This command allows you to query for the current loop tracking parameter settings, 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.

$PASHR,LPS

The response message is output in the format:

$PASHR,LPS,d1,d2,d3*hh

Table 4.21 defines the LPS parameters.

Table 4.21. $PASHR,LPS Format

Parameter	Description	Range
d1	Third-order ratio setting for the carrier loop: • 0: Indicates a ratio of zero; i.e., the third-order ratio is disabled • 1: Indicates a ratio of 0.1; suitable for low acceleration rates • 10: Indicates a ratio of 1.0; suitable for high acceleration rates	0, 1, 10

Table 4.21. $PASHR,LPS Format

Parameter	Description	Range
d2	Carrier loop parameter: • 1: This setting indicates a noise bandwidth of 0=10; suitable for static, very low phase noise conditions • 2: This setting indicates a noise bandwidth of 0=25; suitable for low dynamic, low phase noise conditions (< 2g when d1=1; < 20g when d1=10) • 3: This setting indicates a noise bandwidth of 0=50; suitable for high dynamic, medium phase noise conditions (< 6g when d1=1; < 100g when d1=10)	1, 2, 3
d3	Code loop parameter: • 1: Indicates noise bandwidth of 0=1.0; suitable for fast range availability (5 sec.), medium range noise conditions • 2: Indicates noise bandwidth of 0=0.5; suitable for medium range availability (10 sec.), low range noise conditions • 3: Indicates noise bandwidth of 0=0.1; suitable for slow range availability (50 sec.), very low range noise conditions	1, 2, 3

Typical LPS response message:

$PASHS,LPS,10,3,1,*14

Table 4.22 describes the typical LPS response message.

Table 4.22. Typical LPS Response Message

Item	Description
$PASHR	Header
LPS	Message identifier
10	Third-order ratio setting for carrier loop (high acceleration rate)
3	Carrier loop parameter setting (high dynamics, medium phase noise)
1	Code loop parameter setting (fast range availability, medium range noise)
14	Checksum

DEFAULT SETTING
LPS—10, 3, 1

LTZ: Local Time Zone

$PASHS,LTZ,d1,d2

This command allows you to enter an offset value from Greenwich Mean Time (GMT) in order to derive local time, where d1 is the number of hours and d2 is the number of minutes that should be added to or subtracted from GMT to get local time. The range for d1 is -13 to +13; the range for d2 is 0 to 59. Issue the command **$PASHQ,ZDA** to get current local time offset values, which are displayed in the last two fields before the checksum. See the section in this chapter entitled "NMEA Commands/Responses" for more information on the ZDA message.

Examples

Enter the following command to add an offset of +7 hours to GMT:

$PASHS,LTZ,+7,0

Enter the following command to add an offset of -4 hours, 25 minutes:

$PASHS,LTZ,-4,25

DEFAULT SETTING
LTZ—00 hours, 00 minutes

MEM: Results of Last Memory Test

$PASHQ,MEM,[c1]

This command allows you to query for the results of the last memory self-test performed by the G12, 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. The G12 performs a memory test each time it is powered up.

This message outputs without a header or message identifier. The response message is output in the format:

h1,h2,h3,h4,h5

Table 4.23 defines the parameters.

Table 4.23. Format of Response for $PASHQ,MEM

Parameter	Description	Range
h1	Volatile memory test result. The returned value should always be FFF0	
h2	Non-volatile memory checksum result. A non-zero result indicates a checksum failure, and the receiver will re-test this memory sector. In this case, the third field will show the result of the non-volatile memory re-test. A non-zero value is registered in this field the first time the receiver is used	Zero / Non-zero
h3	If the second field contains a non-zero value, indicating a failure in the checksum reading of the non-volatile memory, this field will show the results of the re-test of that memory sector. If non-volatile memory passes the re-test, the value in this field must be 8000. If the second field contains a zero value, indicating a good checksum, this field is ignored	FFFF / 8000
h4	This field must always be zero	0000
h5	ROM checksum result. A zero value indicates the checksum is good	0000

PAR: Query General Receiver Parameters

$PASHQ,PAR,[c1]

This command allows you to query for the current settings of general receiver parameters, 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.

The response message has a free-form Ashtech proprietary format. This message does not have a header or message identifier as shown in the following example:

```
SPDA:5 SPDB:5
GPS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
PMD:1 FIX:0 ALT:+00000.00 PDP:40 HDP:04 VDP:04 ERM:6000,6000,6000,6000
PEM:05 SEM:OFF UNH:N ION:Y SAV:N DTM:W84
RTC: OFF   PRT:A
NMEA: LTN POS GLL GGA VTG GSN MSG GSA GSV SAT GRS RRE TTT ZDA TCM RMC
GST GNS CRT
PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
OFF OFF OFF
PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
OFF OFF OFF
PER:001.0
```

Table 4.23 describes the items in the PAR response message:

Table 4.24. PAR Response Format

Item	Description	Range
SPDA:5	Serial port A baud rate. Default is 5 (9600)	0 - 9
SPDB:5	Serial port B baud rate. Default is 5 (9600)	0 - 9
GPS:Y...Y	Indicates which satellites (1-32) will be used (Y) or ignored (N) in position computations. Default is Y for all satellites	Y, N
PMD:1	Current position mode setting for the minimum number of satellites required to compute a position. With default value 1, a minimum of 3 satellites are needed to compute a position. With 3 satellites, the altitude is fixed (2-D); with 4 or more, the altitude is computed (3-D)	0 - 3
FIX	Current fixed altitude mode setting used when computing a 2-D position or when there are not enough visible satellites to compute a 3-D position. Mode 0 (default) Indicates that the altitude value is either the most recently entered antenna altitude ($PASHS,ALT) or the most recently computed altitude in which the VDOP value is lower than the VDOP mask	0, 1
ALT	Current altitude of the antenna position (meters). Default is 00000.00 meters	-99999.99 to +99999.99
PDP	Current PDOP (Position Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated PDOP value exceeds the PDOP mask value. The default setting is 40	00.0 - 99.9
HDP	Current HDOP (Horizontal Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated HDOP value exceeds the HDOP mask value. Default is 04	00.0 - 99.9
VDP	Current VDOP (Vertical Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated VDOP value exceeds the VDOP mask value. Default is 04	00.0 - 99.9
ERM	This setting indicates the mask values for horizontal and vertical error in relation to the different positioning modes. The default is OFF for both autonomous and differential modes which is represented by 6000,6000,6000,6000.	1 to 6000
PEM	Current position elevation mask setting (degrees). The receiver excludes any satellite from the position computation when its elevation falls below the elevation mask setting. Default is 05	0° - 90°
SEM	This field indicates the secondary elevation mask angle value for a sector of the sky defined by two azimuth angles. The default is OFF.	ON, OFF

Table 4.24. PAR Response Format (Continued)

Item	Description	Range
UNH	This setting indicates whether the receiver uses (Y) or ignores (N) unhealthy satellites. This setting is always N. The G12 never uses unhealthy satellites in position computation	N
ION	Indicates whether ionospheric and tropospheric modelling are enabled (Y) or disabled (N) in position computation. Default is always N when the receiver is in differential mode and always Y in autonomous mode.	Y, N
SAV	Indicates whether user-entered parameters are saved (Y) or not saved (N) in battery-backed memory. If user-entered parameters are not saved, the default parameter settings are restored at the next power cycle. Default is N	Y, N
DTM	Indicates whether the current geodetic reference datum is WGS-84 (W84) or a user-defined datum (USR). Default is W84	W84, USR
RTC	Current RTCM differential mode setting. OFF indicates RTCM is disabled; BAS indicates base station mode; REM indicates remote mode. Default is OFF	OFF, BAS, REM
PRT	Port assignment for sending or receiving differential corrections	A, B
NMEA	Lists the NMEA and Ashtech NMEA-style messages supported by the G12	CRT, GGA, GLL, GRS, GSA, GSN, GST, GSV, LTN, MSG, POS, RMC, RRC, SAT, TCM, TTT, VTG, ZDA
PRTA	Indicates whether a given NMEA or Ashtech NMEA-style message is enabled (ON) or disabled (OFF) for output from Port A. Default is OFF	ON, OFF
PRTB	Indicates whether a given NMEA or Ashtech NMEA-style message is enabled (ON) or disabled (OFF) for output from Port B. Default is OFF	ON, OFF
PER	Output interval setting for NMEA and Ashtech NMEA-style messages, excluding the TTT message. Default is 1 second	0.05 - 999

PDP: PDOP Mask Value

$PASHS,PDP,d1

This command allows you to set the value of the PDOP (Position Dilution of Precision) mask, 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 **$PASHQ,PAR** command and checking the PDP field.

Example

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

$PASHS,PDP,30

DEFAULT SETTING
PDP—40

PEM: 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 an elevation less than the elevation mask setting is excluded from position computations. You can view the current elevation mask value by entering the query command $PASHQ,PAR and checking the PEM field.

Example

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

$PASHS,PEM,15

DEFAULT SETTING
PEM—5°

PHE: Photogrammetry Edge Mode

$PASHS,PHE,c1

This command allows you to synchronize the photogrammetry trigger to the rising edge or the falling edge of the timing pulse, where c1 is either R (rising edge) or F (falling edge). Default is R.

$PASHQ,PHE,[c1]

This command allows you to query for the current photogrammetry edge setting, 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.

$PASHR,PHE

The response message is output in the format:

$PASHR,PHE,c1*hh

Table 4.25 defines the parameters.

Table 4.25. $PASHR,PHE Format

Parameter	Description	Range
c1	Photogrammetry edge setting	R, F
hh	Checksum	2-character hex

Typical PHE response message:

$PASHR,PHE,R*57

Table 4.26 describes the typical PHE response message.

Table 4.26. Typical PHE Response Message

Item	Description
$PASHR	Header
PHE	Message identifier
R	Indicates that photogrammetry events are synchronized to the rising edge of the timing pulse
*57	Checksum

DEFAULT SETTING
PHE—R

PMD: 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,PAR and checking the PMD field. See the section in chapter 3 entitled “Position Modes” for more information on the position mode settings.

- Position Mode 0: Manual 3-D Mode

  Sets the receiver for 3-D position computation. The receiver must be tracking a minimum of four satellites in order to compute a position.

- Position Mode 1: Automatic 3-D Mode

  The receiver must track a minimum of three satellites to compute a position. With three satellites, latitude and longitude are computed and altitude is held to a fixed value (2-D positioning). With four satellites or more, altitude is computed (3-D positioning).

- Position Mode 2: Manual 2-D Mode

  The receiver must track a minimum of three satellites to compute a position. This mode locks the receiver to 2-D positioning, meaning latitude and longitude are computed and altitude is always held fixed regardless of the number of satellites tracked.

- Position Mode 3: Automatic 3-D Mode

  The receiver must track a minimum of three satellites to compute a position. With 3 satellites, longitude and latitude are computed and altitude is held fixed (2-D positioning). With 4 satellites, altitude is computed (3-D positioning) unless the calculated HDOP value is greater than HDOP mask setting.

Example

Enter the following command to select Position Mode 3:

$PASHS,PMD,3

DEFAULT SETTING
PMD—1

POP: Position and Raw Data Update Rate

$PASHS,POP,d1

This command allows you to set the G12's internal update rate for position and raw data, where d1 is 10 (Hz) or 20 (Hz). Ten indicates that position and raw data will be computed internally 10 per second; twenty indicates that position and raw data will be computed internally 20 times per second. The default is 10. Changes made to POP are saved with the **$PASHS,SAV,Y** command.

$PASHQ,POP

This command allows you to query for the internal update rate setting.

$PASHR,POP

The response message is output in the format:

$PASHR,POP,d1*hh

Table 4.27 defines the parameters.

Table 4.27. $PASHR,PHE Format

Parameter	Description	Range
d1	Current setting for internal update rate (seconds)	5, 10, 20
hh	Checksum	2-character hex

Typical POP response message:

$PASHR,POP,10*16

Table 4.28 describes the typical POP response message.

Table 4.28. Typical POP Response Message

Item	Description
$PASHR	Header
POP	Message identifier
10	Indicates that position and raw data are being updated internally at 10 Hz
*16	Checksum

DEFAULT SETTING
POP—10

When positions are output at 20 Hz, the G12 can use a maximum of eight satellites to compute positions, although the receiver can still track and generate raw data for twelve satellites. When positions are output at 10 Hz or lower, the G12 can use up to twelve satellites to compute positions.

The G12-L supports a maximum internal update rate of 5 Hz for position and 2 hz for raw data. The standard G12 supports a maximum internal update rate of 10 Hz for position and raw data. Both the G12 and the G12-L can be upgraded to support an internal update rate of 20 Hz for position and raw data, and the G12-L can be upgraded to the 10 Hz rate as well. The [W] option corresponds to the 20 Hz update rate for position and raw data; the [T] option corresponds to the 10 Hz update rate for position and raw data.

PPO: Point Positioning

$PASHS,PPO,c

Enable/disable point positioning mode, where c is Y (enable) or N (disable). Point positioning is an averaging algorithm that improves the stand-alone accuracy of a static point after about 4 hours (Table 4.29).

Table 4.29. PPO Parameter Table

Item	Description	Range
c	Enable/disable point position mode	Y = enable N = disable

Example: Enable point positioning:

$PASHS,PPO,Y

$PASHQ,PPO

Query point position.

$PASHR,PPO

The point position response message is in the format:

$PASHR,PPO,c

where c is Y or N

POS: 3-D Antenna Position

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

This command allows you to set a 3-D antenna reference position for a differential base station receiver. m1 is the latitude, c2 is the latitude sector, m3 is the longitude, c4 is the longitude sector, and f5 is the altitude. Use the **$PASHQ,RTC** command to verify that the desired coordinates are in effect.

$PASHS,POS,CUR

This command allows you to set the current computed position as the reference position for a differential base station receiver. This setting is useful in some applications which do not require absolute accuracy. Remote receivers getting differential corrections from a base station whose reference position was entered using this command can still compute very accurate positions relative to the base station.

This command is not accepted when a position is not computed.

$PASHQ,POS,[c1]

This command allows you to query for 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:

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

Table 4.30 defines the parameters.

Table 4.30. $PASHR,POS Message Format

Parameter	Description	Range
d1	Indicates whether the position solution has been computed autonomously or with the aid of RTCM differential corrections: • 0: Autonomous position • 1: Corrected position	0, 1
d2	Indicates the number of satellites used in computing positions	0-12
m1	Current time (UTC)	00-235959.50
m2	Current latitude measured in degrees, minutes, and decimal minutes (ddmm.mmmmm)	0°-90°

Table 4.30. $PASHR,POS Message Format (Continued)

Parameter	Description	Range
c1	Latitude sector	N / S
m3	Current longitude measured in degrees, minutes, and decimal minutes (dddmm.mmmmm)	0°-180°
c2	Longitude sector	E / W
f1	Current altitude (±aaaaa.aa) ellipsoid height in meters. In 2-D positioning mode, this field contains the fixed altitude value	-3000.00 to +3000.00
,,	Reserved data field	
f2	Course over the ground (ttt.tt); referenced to true north	0.00°-359.99°
f3	Speed over the ground (knots)	000.00 to 999.99
f4	Vertical velocity (meters per second)	-999.9 to +999.9
f5	Current computed PDOP value	0.00-99.9
f6	Current computed HDOP value	00.0-99.9
f7	Current computed VDOP value	0.00-99.9
f8	Current computed TDOP value (seconds)	0.00-99.9
s1	Firmware version code	4-character ASCII
hh	Checksum	2-character hex

PPS: Pulse Per Second

$PASHS,PPS,f1,f2,c1

The G12 can generate a timing pulse with programmable period and offset. The timing pulse is a square-wave signal which is generated by default once every second (1PPS) with its rising edge synchronized to the GPS time and no offset from GPS time. The PPS command allows you to change the period, offset (from GPS time), and synchronization edge of the pulse. The f1 parameter sets the period of the pulse in seconds with a range between 0.10 and 99.90. The minimum setting and increment depend 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 100 ns resolution (range between -999.9999 and +999.9999). The c1 parameter determines whether the GPS time is synchronized with the rising edge of the pulse (R) or the falling edge of the pulse (F).

$PASHQ,PPS,[c1]

This command allows you to query for timing pulse parameters, 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.

$PASHR,PPS

The response message is output in the format:

$PASHR,PPS,f1,f2,c3*hh

Table 4.31 defines the parameters.

Table 4.31. $PASHR,PPS Message Format

Parameter	Description	Range
f1	Timing pulse output interval (seconds). Timing pulse output is disabled when this parameter is set to zero	0 - 99.90
f2	Timing pulse offset value (milliseconds)	-999.9999 to +999.9999
c1	Synchronization parameter setting for GPS time	R(ising edge) F(alling edge)
*hh	Checksum	

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

See Timing Pulse & Measurement Strobe (Optional) on page 42 for more information on the conditions surrounding timing pulse generation, accuracy, and precision.

PRR: Extended-Memory— Extended Memory G12 Only

$PASHS,PRR,c1

This command allows you to upload the current ephemeris and almanac data in Ashtech format (SNV and SAL) to a receiver so when it is powered on it is hot (up to date) and TTFF (time to first fix) is minimum.

To enable ephemeris and almanac uploading mode issue the **$PASHS,PRR,Y** command. After uploading the data, turn PRR off by issuing the command **$PASHS,PRR,N**. The default is N.

To upload ephemeris and almanac data, perform the following steps:

1. Use the **$PASHQ,SNV** and **$PASHQ,SAL** commands to obtain ephemeris “SNV” and almanac “SAL” data from another running Ashtech receiver. Save the generated SNV and SAL messages in a file.
2. Issue the **$PASHS,PRR,Y** command to the receiver to be uploaded.
3. Use a file upload utility such as gterm.exe or term90.exe in Norton Commander to upload the previously logged SNV and SAL files.
4. The **$PASHR,ACK** response generated by the receiver after each successfully decoded ephemeris or almanac record.

PRT: Serial Port Baud Rate

$PASHQ,PRT,[c1]

This command allows you to query the baud rate code of the G12 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

Table 4.32 defines the parameters.

Table 4.32. $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 4.33)	0 - 9
hh	Checksum	2-character hex

Table 4.33 lists baud rate codes and the corresponding baud rates:

Table 4.33. G12 Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
0	300	5	9600
1	600	6	19200

Commands

Table 4.33. G12 Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
2	1200	7	38400
3	2400	8	56800
4	4800	9	115200

DEFAULT SETTING
PRT—5 (9600 baud)

PSM: Navigation Mode Filtering

$PASHS,PSM,x

This command allows you to enable or disable the position/velocity filter that smooths the position and velocity output by reducing the short term noise effects. Table 4.34 lists the filtering models available to suit the navigation mode.

Table 4.34. $PASHS,PSM Fields

X	Description
0	No filtering
1	Filtering without kinematic model
2	Filtering with static model
3	Filtering with walking kinematic model

RID: Receiver Identification Parameters (Format 1)

$PASHQ,RID,[c1]

This command allows you to query various receiver identification parameters, 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.

When you contact customer support, the customer support agent will request the response to the $PASHQ,RID command for your receiver.

$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

Table 4.35 defines the parameters.

Table 4.35. $PASHR,RID Fields

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

Fourteen options are available for the G12. 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 4.36 lists the letters and numbers in conjunction with the options they represent.

Table 4.36. Available G12 Options

Option	Description
[W = 20 Hz] [T = 10 Hz] [5 = 5 Hz] [2 = 2 Hz] [1 = 1 Hz]	Position update rate
[W = 20 Hz] [T = 10 Hz] [5 = 5 Hz] [2 = 2 Hz] [1 = 1 Hz]	Raw measurement update rate
[O]	Raw data output
[P]	Carrier phase tracking
[U]	Differential - remote station
[B]	Differential - base station
[L]	Timing pulse output (1PPS)
[E]	Photogrammetry event marker

Table 4.36. Available G12 Options (Continued)

Option	Description
[G]	Geoid model
[M]	Magnetic variation model
[_]	Reserved
[C]	Code correlator
[_]	Reserved

Typical RID response message:

$PASHR,RID,G1,GH00,T5OP--_LEGM_C_*1A

Table 4.37 defines the typical RID response message.

Table 4.37. $PASHR,RID Fields

Field	Description
$PASHR	Header
RID	Message identifier
G1	Receiver model identifier
GH00	Firmware version number
T	10 Hz update rate (0.1 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
-	Differential remote option not installed
-	Differential base option not installed
_	Reserved option slot
L	Timing pulse output option installed
E	Photogrammetry event marker option installed
G	Geoid model option installed
M	Magnetic variation model option installed
_	Reserved option slot

Table 4.37. $PASHR,RID Fields

Field	Description
C	Code correlator option installed
_	Reserved option slot
*1A	Checksum

RIO: Receiver Identification Parameters (Format 2)

$PASHQ,RIO,[c1]

This command allows you to query for receiver identification parameters, 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.

When you contact customer support, the customer support agent will request the response to the $PASHQ,RIO command for your receiver.

$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,f5*hh

Table 4.38 defines the RIO message structure.

Table 4.38. RIO Structure

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 G12
s4	Option list (maximum 42 characters). ASCII characters represent options not available. For option definitions, see Table 4.36
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

As with the RID query, 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.

Typical RIO response message:

$PASHR,RIO,G12,GH00,,WWOPUB_LEGM_C_,7100291S0422*5E

Table 4.39 describes the typical RIO response message.

Table 4.39. $PASHR,RIO Fields

Field	Description
$PASHR	Header
RIO	Message identifier
G12	Receiver model identifier
GH00	Firmware version number
W	20 Hz update rate (0.05 seconds) installed for raw data update option
W	20 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
B	Differential base option installed
_	Reserved option slot
L	Timing pulse output option installed
E	Photogrammetry event marker option installed
G	Geoid model option installed
M	Magnetic variation model option installed
_	Reserved option slot
C	Code correlator option installed
_	Reserved option slot
710...422	Receiver serial number
*5E	Checksum

See Table 4.36 for more information on available options for the G12.

RSO: Receiver Serial Options

$PASHQ,RSO,[c]

This command allows you to query the receiver serial number and installed options, where c 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.

The response message is in the format:

$PASHR,RSO,s1,s2

Table 4.40 defines the response format.

Table 4.40. RSO Format

Code	Description
s1	is the receiver serial number
s2	list of installed options

RST: Restore Default Parameters

$PASHS,RST

This command allows you to restore G12 parameters to their default values. After issuing the RST command, you can query PAR (general receiver parameters), RAW (raw data output parameters), and RTC (RTCM and differential GPS parameters) to obtain G12 default settings.

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 external memory is cleared through the INI command or default settings are restored through the RST command. If c1 is set to N, default parameter settings will be restored at the next power cycle. You can see whether user-entered parameters have been saved by issuing the **$PASHQ,PAR** command and checking the SAV field.

User-enter parameters cannot be saved unless a back-up battery is wired to appropriate pins on the J301 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.

The G12 has a "watchdog" timer. If the processor hangs up for any reason, the watchdog timer will reset the receiver. On reset, the receiver parameters most recently saved using the set command $PASHS,SAV will be used at startup following the reset. If parameter settings were not saved, the default settings will be used at startup.

SEM: Secondary Elevation Mask

$PASHS,SEM,d1,d2,d3

This command allows you to set a secondary elevation mask angle value for a sector of the sky defined by two azimuth angles. The second sector is the region between the first and second azimuths measured clockwise from North. d1 is the secondary elevation mask angle. d2 is the first azimuth defining the second sector. d3 is the second azimuth defining the secondary sector.

When you send the SEM command, it overrides any previously existing values. PEM commands issued after the SEM command change the elevation mask for only the primary PEM zone. The previously issued SEM setting continues in effect. To apply PEM to the whole sky, you must disable the SEM.

DEFAULT SETTING
SEM— OFF

Example

Enter the following commands to set the mask zone in Figure 4.1.

$PASHS,PEM 10

$PASHS,SEM,20,300,60

—OR—

$PASHS,PEM 20

$PASHS,SEM,10,60,300

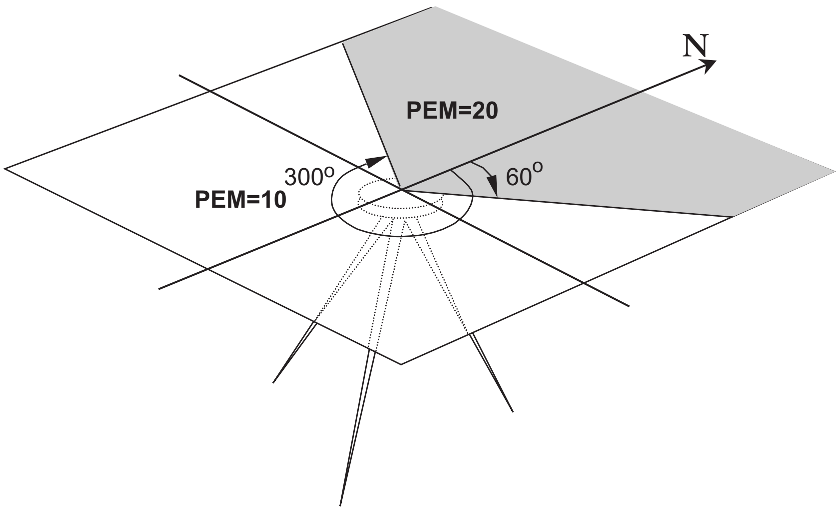

Figure 4.1. SEM Mask Zone

$PASHS,SEM,OFF

This command allows you to disable the SEM command.

SEM only applies to PEM or the elevation mask angle used in position computation. ELM functionality remains unchanged without zoning.

SMI: Code Measurement Smoothing

$PASHS,SMI,d

Set interval in seconds of code measurements smoothing, which reduces the effect of noise, where d is the smoothing interval in seconds, from 0 to 1000seconds. This setting is independent of the internal receiver update interval.

The smoothing correction is provided in the MCA/MBN message, along with the smoothing count. If the internal smoothing count is greater than 255, the smoothing count in the MCA/MBN message is set to 255.

Commands

Notes on smoothing:

- Code smoothing by the carrier is performed by a first-order complimentary filter which band goes narrower with time.
- Code smoothing works with update interval corresponding to the POP setting
- Maximum smoothing interval is controlled by the SMI setting; smoothing constant is changed from 1 to 1/SMI from locking a satellite.
- After SMI sec passes, smoothing constant is kept as 1/SMI (steady state); the corresponding value in MCA changes from 0 to SMI.
- After reacquisition, smoothing is reset.
- Smoothing may also be reset in case of a large jump in code-carrier value, and if current smoothing correction exceeds a preset value.

Example: Set code measurement smoothing to 100 seconds:

$PASHS,SMI,100

DEFAULT SETTING
SMI smoothing interval: 100 seconds

$PASHQ,SMI,[c1]

The associated query command is $PASHQ,SMI,[c1], where c1 is the optional output port.

$PASHR,SMI

The response message is in the form:

$PASHR,SMI,d*cc

where d is the smoothing interval in seconds.

SNR: Set Signal-to-Noise Ratio

$PASHS,SNR,s

Sets the algorithm used for computing signal-to-noise ratio, where s is a 3-character algorithm identifier; algorithm identifiers are DBH and AMP. Default is AMP. When set to DBH, the SNR is calculated in dB-Hz, and with AMP the SNR values are a function of amplitude.

Example: Compute SNR using DBH algorithm:

$PASHS,SNR,DBH

$PASHQ,SNR,[x]

The associated query command is $PASHQ,SNR,x where x is the optional port where the reply will be sent.

$PASHR,SNR

The response message is in the form $PASHR,SNR,str*cc, where str is DBH or AMP, and cc is the checksum.

SPD: Serial Port Baud Rate

$PASHS,SPD,c1,d1

This command allows you to set the baud rate for the G12 serial ports, where c1 is port A or B and d1 is a code number between 0 and 9 corresponding to the baud rate codes listed in Table 4.41. The default baud rate is 9600. You can view the baud rate settings for both ports by entering the **$PASHQ,PAR** command and checking the SPDA and SPDB fields.

Table 4.41. G12 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

Example: Set baud rate of port A to 19200:

$PASHS,SPD,A,6

Example: Set baud rate of port B to 4800:

$PASHS,SPD,B,4

If you change the baud rate of the G12 serial port, be sure that the serial port of the device to which the G12 port is connected is set to the same baud rate.

STA: Satellite Tracking Status

$PASHQ,STA,[c1]

This command allows you to query for the current satellite tracking status, 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.

The response message has a free-form Ashtech proprietary format. Like the MEM and PAR response messages, the STA response message does not have a header or message identifier as shown in the following example:

```
TIME: 00:48:18 UTC
LOCKED: 31 25 29 23 21 15 08 03 01
COUNT: 42 46 47 37 45 48 40 36 49
```

Table 4.42 defines the parameters.

Table 4.42. STA Response Format

Item	Description
Time	Current UTC time
Locked	The PRN numbers of the satellites being tracked
Count	The signal count for each tracked satellite

STB: Measurement Strobe Output

$PASHS,STB,d1,f2,c3

This command allows you to set the output interval, offset and synchronization edge of the measurement strobe signal. The value of the output interval (d1) is equal to the number of measurements occurring between outputs of the strobe signal. If d1is zero, the strobe is disabled. The period is measured in seconds. depends upon the rate of raw measurement output, which is defined by the set command $PASHS,RCI. and is defined as (xxxxx*RCI). For example, if RCI is set to 2 and xxxx is set to 3, then the period is 6 seconds. The a parameter represents either the rising (R) or falling (F) edge of the strobe. The strobe is synchronized with GPS time. Default parameters are 1,0.0,R. Accuracy is ±0.5 ms.

period = xxxx (0-9999)

offset = ±yyy.yyyy (-999.9999 to +999.9999) milliseconds

sync edge =

$PASHQ,STB,c1

The associated query command is **$PASHQ,STB,x**, where x is port A or B. If a port is not specified, the receiver sends the response to the current port.

$PASHR,STB

The receiver response message is in the format:

$PASHR,STB,xxxx,±yyy.yyyy,a*cc

Table 4.43 defines the STB response structure:

Table 4.43. $PASHR,STB Response Structure

Field	Description
xxxx	Period. Range from 0.05 to 99.95
±yyy.yyyy	Offset, Range from -999.9999 to +999.9999
a	Edge, R = rising edge or F = falling edge
cc	Checksum

SUI: Satellite Usage Indicator

$PASHS,SUI, x

This command allows you to enable or disable the satellite usage indicator, where x is ON or OFF.

If **$PASHS,SUI, OFF** is sent the usagge indicator in the SAT message will be U for used or - for not used. If **$PASHS,SUI,ON** is sent the usagge indicator in the SAT message will be U for used or one of the letters listed in Table 4.44 in the SAT column.

Table 4.44. MCA Good/Bad Flags and SAT Messages When SUI is ON

MCA good/ bad Flag	SAT	Description
24	U	Used and position computed
23	U	Used and position not computed
22	-	RESERVED
21	M	Satellite NOT used because of low elevation
20	S	Satellite NOT used because the pseudorange is not settled (transient is not over)
19	H	Satellite NOT used because marked 'unhealthy' in ephemeris

Table 4.44. MCA Good/Bad Flags and SAT Messages When SUI is ON

MCA good/ bad Flag	SAT	Description
18	B	Satellite NOT used because of bad URA (or some accuracy problem indicated in navigational data)
17	Z	Satellite NOT used because marked 'unhealthy' in almanac
16	D	Satellite NOT used because differential corrections are old or invalid
15	J	Satellite NOT used because big code outlier was detected
14	R	Satellite NOT used because RAIM or some other algorithm detected a pseudorange bias
13	I	Satellite NOT used because satellite disabled by external command SVP,USP)
12	L	Satellite NOT used because Signal To Noise Ratio is less than Mask
11	G	Satellite NOT used because it's possibly a ghost satellite
10	V	Satellite NOT used because computed satellite coordinates are suspicious
09	N	Satellite NOT used because satellite true number unknown (for modes, where we need the true satellite number
08	K	Satellite NOT used because it was disabled by RTK engine (N/A in G12)
02	O	Satellite NOT used because of some other case
01	E	Satellite NOT used because no navigational data (ephemeris) is available
7	P	Satellite NOT used because no full range is available.

UDD: User-defined Datum

$PASHS,UDD,d1,f2,f3,Δx,Δy,Δz,ε_x,ε_y,ε_z,f4

This command allows you to set parameters for the user defined datum and store them in battery-backed memory. Use this command with the **$PASHS,DTM,UDD** command, described on page 61. Table 4.45 lists the parameters.

$PASHQ,UDD,[c]

This is the associated query command, where c is the optional output port. If a port is not specified, the receiver sends the response to the current port.

The response message is in the format:

$PASHR,UDD,d1,f2,f3,Δx,Δy,Δz,εx,εy,εz,f4

Table 4.45 lists the parameters.

Table 4.45. User-defined Datum Parameters

Field	Description	Range	Units	Default
d1	Identifier for the geodetic reference datum; always zero	0	N/A	0
f2	Semi-major axis	6300000.000 to 6400000.000	meters	6378137.000
f3	Inverse flattening. 1/f3 = f2/(f2-b), where b is semi-minor axis	290.00000000 to 301.00000000	meters	298.257223563
$\Delta x, \Delta y, \Delta z$	Translation from the local datum to WGS84	-1000.000 to +1000.000	meters	0.00
$\varepsilon_x, \varepsilon_y, \varepsilon_z$	Rotations from the local datum to WGS84. Viewed from the positive end of the axis about which the rotation takes place, the positive rotation is counterclockwise; the negative rotation is clockwise	-10.0000 to +10.0000	seconds of arc	0.00
f4	Delta scale factor (scale factor = 1 + delta scale factor)	-25.000 to +25.000	ppm	0.00

Example

To activate the user-defined datum for position computations and measurements, enter the following command after defining datum parameters with the UDD command:

$PASHS,DTM,USR

After the user-defined datum is activated, the receiver internally transforms positions *from* the reference datum (WGS84) *to* the user-defined datum. In standard text books, however, the datum transformations are given *from* local datums *to* WGS84. To simplify the entering of the transformation parameters, the translation, rotation, and scale parameters are defined *from* the local datum *to* WGS84.

The generic formula used to translate and rotate from coordinate system 1 to coordinate system 2:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix}_2 = \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \end{bmatrix} + (1 + m \times 10^{-6}) \begin{bmatrix} 1 & \varepsilon_{rz} & -\varepsilon_{ry} \\ -\varepsilon_{rz} & 1 & \varepsilon_{rx} \\ \varepsilon_{ry} & -\varepsilon_{rx} & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}_1$$

$\varepsilon_{rx} = \varepsilon_x$ expressed in radians (this also applies to ε_{ry} and ε_{rz}).

To clarify the datum transformation process, create a user-defined datum using parameters from the WGS72 datum. Table 4.46 contains ellipsoid parameters for the WGS84 datum and the WGS72 datum:

Table 4.46. Ellipsoid Parameters for WGS72 and WGS84

Datum	Reference Ellipsoid	f2[f4]	1/f3
WGS72	WGS72	6378135.0	298.26
WGS84	WGS84	6378137.0	298.257223563

1. Enter the following UDD command which lists parameters from the WGS72 datum:

   $PASHS,UDD, 0,6378135.0, 298.26,0,0,4.5,0,0,-0.554,0.23

2. After entering the datum parameters, enter the following command to activate the new datum:

   $PASHS,DTM,USR

The following ellipsoid values are now in effect:

$\Delta x = \Delta y = 0$ $\Delta z = 4.5$ meters $m = 0.23 \times 10^{-6}$

$\varepsilon_x = \varepsilon_y = 0$ $\varepsilon_z = -2.686 \times 10^{-6} = -0''.554$

Taking these values, the following equation is used in calculating the transformation from WGS84 coordinates to WGS72 coordinates:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix}_{WGS84} = \begin{bmatrix} 0 \\ 0 \\ 4.5 \end{bmatrix} + (1 + 0.23 \times 10^{-6}) \begin{bmatrix} 1 & (-2.686) \times 10^{-6} & 0 \\ 2.686 \times 10^{-6} & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}_{WGS72}$$

The G12 performs an internal coordinate transformation *from* WGS84 *to* WGS72 so that geodetic position messages can be output in the desired coordinates as dictated by the parameters specified in the UDD command. Figure 4.2 illustrates the translation and rotation that occur in the WGS84 to WGS72 transformation.

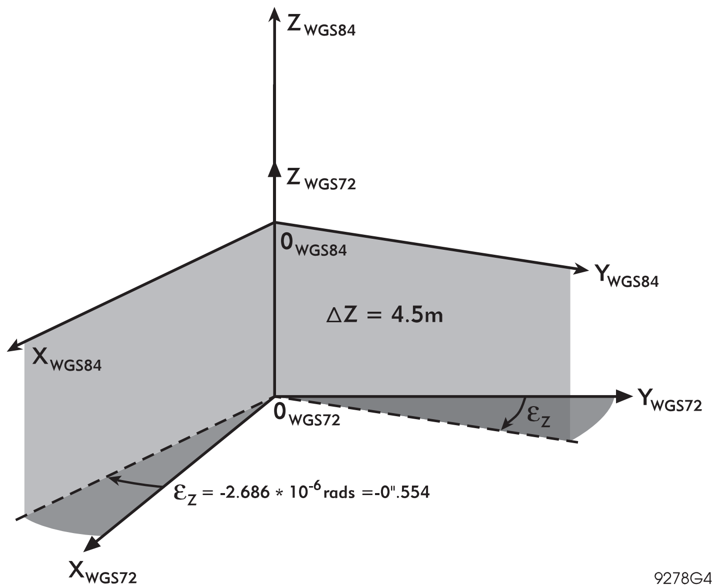

Figure 4.2. Rotation and Translation Between WGS72 and WGS84

$PASHQ,UDD,[c1]

This command allows you to query for the current user-defined datum parameters, 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.

$PASHR,UDD

The response message is output in the format:

$PASHSR,UDD,d1,f1,f2,Δx,Δy,Δz,ε_x,ε_y,ε_z,f3

The fields in the response message are defined in Table 4.45.

Commands

UDG: User-Defined Datum-to-Grid, Extended Memory G12 Only

$PASHS,UDG,s1,d2,f3,f4,f5,f6,f7,f8,f9,f10,f11,f12,f13

This command allows you to set parameters to transform geodetic coordinates specified by the UDD command to grid coordinates. The G12 performs the transformation internally. The number of UDG parameters required for the transformation depends on the type of map projection selected, and must be indicated by the user in the d2 parameter.

Table 4.47 through Table 4.54 lists the parameters for each map projection:

Table 4.47. UDG Structure for Equatorial Mercator

Field	Description	Range / Name	Units
s1	Map projection type	EMER	n/a
d2	Number of parameters for the selected projection	3	n/a
f3	Longitude for the Central Meridian	±1800000.000 0	dddmmss.sss
f4	False Northing	±10,000,000	meters
f5	False Easting	±10,000,000	meters

Table 4.48. UDG Structure for Transverse Mercator

Field	Description	Range / Name	Units
s1	Map projection type	TM83	n/a
d2	Number of parameters for the selected projection	5 or 7 (last 2 optional)	n/a
f3	Longitude for Central meridian	±1800000.0000	dddmmss.ssss
f4	Scale factor at Central Meridian	0.5 to 1.5	n/a
f5	Latitude of the grid origin of the projection	±1000000.0000	ddmmss.ssss
f6	False Easting	±10000000	meters
f7	False Northing	±10000000	meters
f8	Zone width (Default is 6°)	3 or 6	degrees
f9	Zone number at 0° longitude (Default is 31°)	1 to 60	N/A

Table 4.49. UDG Structure for Oblique Mercator

Field	Description	Range / Name	Units
s1	Map projection type	OM83	n/a
d2	Number of parameters for the selected projection	6	n/a
f3	Azimuth of the skew axis	±1800000.0000	ddmmss.ssss
f4	Scale factor at center of projection	0.5 to 1.5	n/a
f5	Longitude of the grid origin of the projection	±1800000.0000	ddmmss.sss
f6	Latitude of the grid origin of the projection	±900000.0000	ddmmss.sss
f7	False easting	±10,000,000	meters
f8	False northing	±10,000,000	meters

Table 4.50. UDG Structure for Stereographic (Polar and Oblique)

Field	Description	Range / Name	Units
s1	Map projection type	STER	n/a
d2	Number of parameters for the selected projection	5	n/a
f3	Latitude of the grid origin of the projection	±900000.0000	ddmmss.sss
f4	Longitude of the grid origin of the projection	±1800000.0000	ddmmss.sss
f5	Scale factor at center of projection	0.5 to 1.5	n/a
f6	False easting	±10,000,000	meters
f7	False northing	±10,000,000	meters

Table 4.51. UDG Structure for Lambert Conformal SPC83 (2 Std.Parallels)

Field	Description	Range / Name	Units
s1	Map projection type	LC83	n/a
d2	Number of parameters for the selected projection	6	n/a
f3	Latitude of Southern Standard parallel	±900000.0000	ddmmss.ssss
f4	Latitude of Northern Standard parallel	±900000.0000	ddmmss.ssss
f5	Longitude of the grid origin of the projection	±1800000.0000	ddmmss.ssss
f6	Latitude of the grid origin of the projection	±900000.0000	ddmmss.ssss
f7	False Easting	±10,000,000	meters
f8	False Northing	±10,000,000	meters

The SPC27 map projections presented in Table 4.52 must be used in conjunction with the Clark 1866 ellipsoid: (a = 6378206.4 m and 1/f= 294.978698200) and the following datum (Tx = -8.0, Ty = 160.0, Tz = 176.0, rotation and scale = 0) which is included in the preset datum list as NAC.

Values are derived from tables which can be obtained from various sources, including NGS Publication 62-4 (1986 Reprint) which also includes discussion and definitions of applied formulas and parameters.

Table 4.52. UDG Structure for Lambert Conformal Conic for SPC27

Field	Description	Range / Name
s1	Map projection type.	LC27
d2	Number of parameters for the selected projection	11
f3	False Easting or x coordinate of central meridian	L1
f4	Longitude of central meridian	L2
f5	Map radius of central parallel (Φo)	L3
f6	Map radius of lowest parallel of the projection table plus y value on central meridian at this parallel (y = 0 in most cases)	L4
f7	Scale (m) of the projection along the central parallel (Φo)	L5
f8	Sine of latitude of central parallel (Φo) computed from basic equations for Lambert projection with 2 standard parallel	L6
f9	Degree, minute portion of the rectifying latitude ωo for Φo, latitude of origin	L7
f10	Remainder of ωo	L8
f11	1/6 * Ro * No * 10^6	L9
f12	tanΦo / 24 * (Ro * No)^3/2] * 10^24	L10
f13	[(5 + 3 * tan^2 Φo)/120 * Ro * N0^3] * 10^32	L11
	Number of parameters for the selected projection	11

f9: ω = Φ - [1052.893882 - (4.483344 - 0.002352 * cos^2Φ) * cos^2 Φ] * sin Φ * cos Φ

f11/f12/f13: Ro = a * (1 - e^2) / (1 - e^2 *sin^2 Φo)^3/2: radius of curvature in meridian plane at Φo

No = a / (1-e^2 * sin^2 Φo)^1/2: radius of curvature in prime vertical at Φo

Table 4.53. UDG Structure for Transverse Mercator for SPC27

Field	Description	Range/Name
s1	Map projection type	TM27
d2	Number of parameters for the selected projection	6
f3	False easting or x coordinate of central meridian	T1
f4	Longitude of Central meridian	T2
f5	Degree, minute portion of the rectifying latitude ωo for Φo, latitude of origin	T3
f6	Remainder of ωo	T4
f7	Scale along central meridian	T5
f8	$(1/6 * Rm * Nm * T5^2) * 10^{15}$ Rm = radius of curvature in meridian plane Nm = radius of curvature in prime vertical Both are calculated for the mean latitude of the area in the zone.	T6

Table 4.54. UDG Structure for Transverse Mercator SPC27 Alaska Zones 2-9

Parameters	Description	Range / Name
s1	Map projection type	TMA7
d2	Number of parameters for the selected projection	2
f3	False easting or x coordinate of central meridian	C
f4	Longitude of central meridian	CM

Examples:

Set datum to grid transformation parameters for Lambert Conformal CA-zone 4:

$PASHS,UDG,LC83,6,360000.0,371500.0,-1190000.0,352000.0,
2000000,500000

Set datum to grid transformation parameters:

$PASHS,UDG,LC83,637 8240,297.323,121.4,18.9,0,0,0,1.5

$PASHQ,UDG,[c1]

This command allows you to query current UDG parameters, 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.

$PASHR,UDG

The response is output in the format:

$PASHR,UDG,s1,d2,f3,f4,f5,f6,f7,f8,f9,f10,f11,f12,f13*hh

where the fields (and the number of them) are defined in the above tables and depend on the type of map projection selected.

USE: Satellites for Acquisition

$PASHS,USE,d1,c2

This command allows you to exclude specific satellites from being tracked, where d1 is the satellite PRN number (01 - 32), or ALL to enable or disable all satellites. c2 is N (exclude) or Y (include). All satellites are included for tracking by default.

Example:

Exclude satellites 13 and 21 from being tracked by the receiver (2 commands):

$PASHS,USE,13,N

$PASHS,USE,21,N

DEFAULT SETTING
USE—ALL

$PASHS,USE,ALL,c1

This command allows you to include or exclude all satellites simultaneously, where c1 is Y (include) or N (exclude). In a case where several satellites were excluded from being tracked, this shortcut command allows you to once again include all satellites for tracking instead of constructing a lengthy command to re-enable those specific satellites for tracking.

USP: Satellites Used in Position Computation

$PASHS,USP,d1,c2

This command allows you to select specific satellites to be used in computing positions, where d1 is the satellite PRN number (01 - 32) or ALL (all satellites simultaneously) and c2 is Y (include) or N (exclude).

Example

Enter the following command to exclude PRN 4 from being used in position computation:

$PASHS,USP,4,N

DEFAULT SETTING
USP—All satellites included for position computation

UTS: Synchronize with GPS Time

$PASHS,UTS,s

This command enables (s=ON) or disables (s=OFF) a mechanism that synchronizes measurements and coordinates with GPS system time rather than with local (receiver) clock. The calculated pseudo-ranges do not depend upon the receiver clock stability. This mode simulates a configuration where the receiver has a quartz oscillator with very high stability and is synchronized with GPS. Default is OFF.

If processing raw data from the receiver with your own processing algorithms, enable UTS.

DEFAULT SETTING
UTS—OFF

$PASHQ,UTS,x

The associated query command is **$PASHQ,UTS,x**, where x is the port where the reply will be sent. Note that x is not required to direct the response message to the current communication port.

The receiver response message is in the format:

$PASHR,UTS,x*cc

where x is ON or OFF and *cc is the checksum.

VDP: VDOP Mask

$PASHS,VDP,d1

This command allows you to set the value of the VDOP mask, where d1 is a number between 0 and 99. If the VDOP value computed by the G12 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,PAR and checking the VDP field.

Examples

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

$PASHS,HDP,6

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

$PASHS,VDP,6

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 an output interval for raw data messages. All raw data messages are disabled for output by default. Table 4.55 lists the raw data commands.

Table 4.55. Raw Data Commands

Command	Description	Page
	ALMANAC DATA	
$PASHS,RAW,SAL	Enable/disable raw almanac data.	135
$PASHQ,SAL	Query GPS raw almanac data.	135
$PASHR,SAL	Raw almanac data response message	135
	RAW DATA OUTPUT	
$PASHS,RAW,ALL	Enable/disable raw date message	109
	EPHEMERIS DATA	
$PASHS,RAW,SNV	Enable/disable GPS raw satellite ephemeris data message	137
$PASHQ,SNV	Query raw ephemeris data	137
$PASHR,SNV	Raw ephemeris data response message	137
	MEASUREMENT DATA	
$PASHS,RAW,MBN	Enable/disable the raw measurement data (MBN) messages	123
$PASHQ,MBN	Query Ashtech type 2 raw measurement data messages	123
$PASHR,MBN	MBN response message	123
$PASHS,RAW,MCA	Enable/disable the raw measurement data (MCA) messages	125
$PASHQ,MCA	Query raw measurements data (MCA)	125
$PASHR,MCA	MCA response message	126
	POSITION DATA	
$PASHS,RAW,PBN	Enable/disable position data (PBN) messages	132
$PASHQ,PBN	Query raw position data (PBEN)	132
$PASHR,PBN	PBN response message	132
	RAW DATA PARAMETERS	
$PASHS,ELM	Set raw data output elevation mask	122
$PASHS,MSV	Set minimum number of satellites	131

Table 4.55. Raw Data Commands (Continued)

Command	Description	Page
$PASHS,RCI	Set recording interval	134
$PASHS,RAW	Set raw data parameters	109
$PASHS,SIT	Set site name	136
COMBINED RAW DATA		
$PASHS,RAW,CT1	Enable/disable combined measurement/position data message format 1	117
$PASHQ,CT1	Query combined raw data in CT1 format data structure	117
$PASHR,CT1	CT1 response message	117
$PASHS,RAW,CT2	Enable/disables combined measurement/position data message format 2	118
$PASHQ,CT2	Query combined raw data in CT2 format data structure	118
$PASHR,CT2	CT2 response message	119
$PASHS,RAW,CT3	Enable/disables combined measurement/position data message format 3	120
$PASHQ,CT3	Query combined raw data in CT3 format data structure	120
$PASHR,CT3	CT3 response message	120
$PASHS,RAW,MCM	Set Missile Applications Condensed Measurements data structure	128
$PASHQ,MCM	Query Missile Applications Condensed Measurements data structure	129
Response msg	MACM response message structure	129

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

$PASHS,RAW,s1,c1,s2,[f1]

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, CT1, etc.), c1 is the port designator for message output, s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending on the measurement update rate option installed.

If the output is set without a period, f, and the period set by the $PASHS,RCI command is issued after individual RAW message output periods have been set, all individual message periods will be reset to the RCI output period setting.

Before using 10 Hz or 20 Hz update rate, you must issue the $PASHS,POP command.

Query commands direct 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.

Examples:

Enable the output of the MBN message on port A at five-second intervals

$PASHS,RAW,MBN,A,ON,5

Disable the output of the MBN message on port B

$PASHS,RAW,MBN,B,OFF

Query MBN message and designate port B for output of response message

$PASHQ,MBN,B

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.

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 is output:

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

The general format for the set command to enable or disable output of raw data messages is **$PASHS,RAW,s1,c1,s2** where s1 is the three-character message identifier, c1 is the port designator, and s2 is ON or OFF. The port designator is a required parameter in enabling or disabling the output of raw data messages.

Checksum

There are three different algorithms used in the checksum calculation, one for text messages and two for binary messages:

- Text Messages:
  - 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 hh is a hex character.
- Binary Messages:
  - The checksum for all binary messages except MCA is computed by breaking the structure into 20 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
  - The checksum for the MCA message is computed by a bytewise exclusive OR (XOR) of all bytes from sequence tag (just after header) to the byte before the checksum.

All bytes are in MC6800 order: most significant byte first (IBM PC uses Intel order: least significant byte first).

CT1: Combined Measurement/Position Data (Format 1)

$PASHS,RAW,CT1,[c1],s2,[f1]

This command enables or disables the combined measurement and position data message format 1, where c1 is port A, B or C (optional port), s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending on the measurement update rate option installed.

$PASHQ,CT1,[c1]

This command allows you to query a combined raw data message in the CT1 data structure, which contains elements derived from the MCA and PBN messages.

c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CT1

This message is not output unless the receiver is tracking at least one satellite. The CT1 message contains an adjusted receive time (the time at which the data was received) with satellite PRN numbers and channel assignments in association with smoothed pseudoranges. This message contains data for a maximum of six satellites. If the receiver is tracking more than six satellites, two CT1 messages are output. The message is output in the format:

$PASHR,CT1,<Format 1 Data String + Checksum>

Table 4.56 defines the data string format.

Table 4.56. $PASHR,CT1 Data String

Binary Type	Bytes	Content
Long [adj_rcvtime]	4	The time at which the data was received, based on the following formula using the rcvtime and navt values from the PBN message: adj_rcvtime = rcvtime - navt/speed of light
char [sv_no]	1	The number of satellites in the message (1...6).
char [remainder]	1	The number of satellites remaining for the current epoch; i.e., since the CT1 message can contain data for a maximum of six satellites, if the receiver is tracking eight satellites, two are remaining
char [chn1]	1	Channel (1...12)
char [prn1]	1	Satellite PRN number
double [smooth_rng1]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn2]	1	Channel (1...12)
char [prn2]	1	Satellite PRN number

Table 4.56. $PASHR,CT1 Data String (Continued)

Binary Type	Bytes	Content
double [smooth_rng2]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn3]	1	Channel (1...12)
char [prn3]	1	Satellite PRN number
double [smooth_rng3]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn4]	1	Channel (1...12)
char [prn4]	1	Satellite PRN number
double [smooth_rng4]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn5]	1	Channel (1...12)
char [prn5	1	Satellite PRN number
double [smooth_rng5]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn6]	1	Channel (1...12)
char [prn6]	1	Satellite PRN number
double [smooth_rng6]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
short [checksum]	2	The checksum is calculated by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 10*number of satellites in the message + 8 (68 for 6 satellites)		

CT2: Combined Measurement/Position Data (Format 2)

$PASHS,RAW,CT2,[c1],s2,[f1]

This command enables or disables the combined measurement and position data message format 2, where c1 is port A, B or C (optional port), s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending on the measurement update rate option installed.

$PASHQ,CT2,[c1]

This command allows you to query for a combined raw data message in the CT2 data structure. This message contains elements derived from the MCA and PBN messages; c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CT2

This message is not output unless the receiver is tracking at least one satellite. The CT2 message contains an adjusted receive time (the time at which the data was received) with satellite PRN numbers and channel assignments in association with full carrier phase measurements and smoothed pseudoranges. This message contains data for a maximum of four satellites. If the receiver is tracking eight satellites, two CT2 messages are output. If the receiver is tracking more than eight satellites, three CT2 messages are output. The message is output in the format:

$PASHR,CT2,<Format 2 Data String + Checksum>

Table 4.57 defines the data string format.

Table 4.57. $PASHR,CT2 Data String

Binary Type	Bytes	Content
Long [adj_rcvtime]	4	The time at which the data was received, based on the following formula using the rcvtime and navt values from the PBN message: adj_rcvtime = rcvtime - navt/speed of light
char [sv_no]	1	The number of satellites in the message (1...4)
char [remainder]	1	The number of satellites remaining for the current epoch; i.e., since the CT2 message can contain data for a maximum of four satellites, if the receiver is tracking eight satellites, four are remaining
char [chn1]	1	Channel (1...12)
char [prn1]	1	Satellite PRN number
double [full_phase1]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng1]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn2]	1	Channel (1...12)
char [prn2]	1	Satellite PRN number
double [full_phase2]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng2]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn3]	1	Channel (1...12)
char [prn3]	1	Satellite PRN number
double [full_phase3]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng3]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn4]	1	Channel (1...12)
char [prn4]	1	Satellite PRN number

Table 4.57. $PASHR,CT2 Data String (Continued)

Binary Type	Bytes	Content
double [full_phase4]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng4]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
short [checksum]	2	Checksum is calculated by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 18*number of satellites in the message + 8 (80 for 4 satellites)		

CT3: Combined Measurement/Position Data (Format 3)

$PASHS,RAW,CT3,[c1],s2,[f1]

This command enables or disables the combined measurement and position data message format 3, where c1 is port A, B or C (optional port), s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending on the measurement update rate option installed.

$PASHQ,CT3,[c1]

This command allows you to query for a combined raw data message in the CT3 data structure. This message contains elements derived from the MCA and PBN messages; c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CT3

This message is not output unless the receiver is tracking at least one satellite. The CT3 message contains an adjusted receive time (the time at which the data was received) with satellite PRN numbers and channel assignments in association with full carrier phase measurements, smoothed pseudoranges, and doppler measurements. This message contains data for a maximum of three satellites. If the receiver is tracking nine satellites, three CT3 messages are output. If the receiver is tracking more than nine satellites, four CT3 messages are output. The message is output in the format:

$PASHR,CT3,<Format 3 Data String + Checksum>

Table 4.58 defines the data string format.

Table 4.58. $PASHR,CT3 Data String

Binary Type	Bytes	Content
Long [adj_rcvtime]	4	The time at which the data was received, based on the following formula using the rcvtime and navt values from the PBN message: adj_rcvtime = rcvtime - navt/speed of light
char [sv_no]	1	The number of satellites in the message (1...4).
char [remainder]	1	The number of satellites remaining for the current epoch; i.e., since the CT3 message can contain data for a maximum of three satellites, if the receiver is tracking six satellites, three are remaining
char [chn1]	1	Channel (1...12)
char [prn1]	1	Satellite PRN number
double [full_phase1]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng1]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
long [doppler1]	4	Doppler measurement as defined in the MCA message
char [chn2]	1	Channel (1...12)
char [prn2]	1	Satellite PRN number
double [full_phase2]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng2]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
long [doppler2]	4	Doppler measurement as defined in the MCA message
char [chn3]	1	Channel (1...12)
char [prn3]	1	Satellite PRN number
double [full_phase3]	8	Full carrier measurements in cycles (as defined in the MCA message)
double [smooth_rng3]	8	Smoothed pseudorange measurement, derived from raw range data and smoothing as defined in the MCA message
long [doppler3]	4	Satellite doppler measurement (10^{-4} Hz) as defined in the MCA message
short [checksum]	2	The checksum is calculated by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 22*number of satellites in the message + 8 (74 for 3 satellites)		

Commands

ELM: Elevation Mask for Raw Measurements Outputs

$PASHS,ELM,d1

This command allows you to set the minimum elevation for the output of raw measurement data (CT1, 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 outputs raw measurement data for all tracked satellites with an elevation of 11° or higher, but 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,RAW and checking the ELM field.

Examples

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

$PASHS,ELM,10

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

$PASHS,ELM,15

DEFAULT SETTING	
ELM	0°

MBN: Raw Measurements (Ashtech Type 2 Data Structure)

$PASHS,RAW,MBN

Enables/disables raw measurement data (MBN) messages. The structure is

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

where the parameters are as defined in Table 4.59

Table 4.59. $PASHS,RAW,MBN Output Rate Range and Increments

Parameter	Description	Range
c1	Select output port	A or B
s2	Enable port	ON or OFF
f3	Optional update rate	See Table 4.66 on page 134.

$PASHQ,MBN,[c1]

This command queries raw satellite measurement data contained in the Ashtech Type 2 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 format of the message is:

$PASHR,MBN,<Ashtech Type 2 data string + checksum>

where Type 2 data string is defined in Table 4.60.

Table 4.60. $PASHR,MBN Data String, Ashtech Type 2

Field	Bytes	Content
char	1	Always 1
unsigned char	1	Number of remaining structures to be sent for current epoch
unsigned char	1	Satellite PRN number (1 - 56)
unsigned char	1	Channel ID (1 - 12)
long	4	Lost lock counter: continuous counts since satellite was locked
char	1	Polarity known: 0 or 5 0 = SV just locked 5 = beginning of the (1st-5th) subframe was found (i.e., phase measurements can be used for ambiguity fixing.
unsigned char	1	Goodbad indicates quality of the position measurement 0 = measurements not available and no additional data will be sent 21 = Satellite was NOT used because of low elevation 22 = Satellite was NOT used because of any reason except low elevation (e.g. satellite is unhealthy, no differential corrections, satellite is manually disabled, etc.) 23 = code and/or carrier phase measured and navigation measurement was obtained, but measurement was not used to compute position 24 = code and/or carrier phase measured and navigation measurement was obtained, and measurement was used to compute position
unsigned char	1	Warning flag (see Table 4.61 below)
unsigned char	1	Signal-to-noise ratio of satellite observation
double	8	Raw_range The fractional part of the satellite transmit time
long	4	Satellite Doppler measurement (10^{-4} Hz)
double	8	Full phase
unsigned short	2	Carphase1 not available
unsigned short	2	Carphase2 not available
unsigned short	2	Satellite elevation in units of 0.01 degrees
unsigned short	2	Satellite azimuth in degrees
unsigned short	2	Checksum. Computed by adding all two-byte words in a message structure, and taking the least significant 16 bits of the result. Message structure starts just after header and goes to the byte before checksum.
Total bytes	42	

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 4.61 defines the format of the MBN warning flag.

Table 4.61. MBN Warning Flag Format

Bits Index		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 to compute position
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		Pseudorange measurement is not smoothed
5		
6		Cycle slip indicator
7		
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.

MCA: Raw Measurements (Ashtech Type 3 Data Structure)

$PASHS,RAW,MCA,[c1],s2,[f1]

This command enables or disables the measurement data (MCAA) messages with Ashtech Type 3 data structure, where c1 is port A, B or C (optional port), s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending on the measurement update rate option installed.

This message is output in binary format on every recording interval (RCI) for locked satellites with an elevation equal to or greater than the elevation mask (ELM), and only if the number of locked satellites is equal to or greater than the minimum satellite mask (MSV).

$PASHQ,MCA,[c1]

This command queries for raw satellite measurement data contained in the Ashtech Type 3 data structure; c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

If the command is set without a period, the DG12 uses the period set by the **$PASHS,RCI** command If the **$PASHS,RCI** command is issued after this message period has been set, the period resets to the RCI setting.

$PASHR,MCA

This message is 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 pseudo-range, full carrier phase, satellite PRN number, elevation, and azimuth. A separate MCA message is output for each satellite being tracked. The structure of the message is in the format:

$PASHR,MCA,<Ashtech type 3 data string + checksum>

Table 4.62 defines the data string format.

Table 4.62. $PASHR,MCA Data String

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
unsigned char [svprn]	1	Satellite PRN number (1 to 32 for GPS and 33 to 64 for SBAS)
unsigned char [elev]	1	Satellite elevation angle in degrees
unsigned char [azim]	1	Satellite azimuth angle in increments of 2 degrees
unsigned char [chnind]	1	Channel (1 to 14) assigned to the satellite
unsigned char [warning]	1	Warning flag: • Bit 1 set - See note below • Bit 2 set - See note below • Bit 3 set - Carrier phase questionable • Bit 4 set - Code phase questionable • Bit 5 set - Code phase integration questionable • Bit 6 set - Not used • Bit 7 set - Possible loss of lock • Bit 8 set - Loss of lock; counter reset The interpretation of bits 1 and 2 is as follows: [Bit 1, Bit 2] • [0, 0] Same as 22 in good/bad flag (see next field) • [1, 0] Same as 23 in good/bad flag • [0, 1] Same as 24 in good/bad flag Note that more than one bit may be set at the same time, e.g., if bits 1, 3, and 6 are set at the same time, the warning flag is 37 (1 + 4 + 32)

Table 4.62. $PASHR,MCA Data String (Continued)

Field	Bytes	Content
unsigned char [goodbad]	1	Indicates the quality of the position measurement: • 24—Used and position computed. • 23—Used, position not computed • 22—RESERVED • 21—Satellite NOT used because of low elevation • 20—Satellite NOT used because the pseudo-range is not settled (transient is not over) • 19—Satellite NOT used because marked 'unhealthy' in ephemeris • 18—Satellite NOT used because of bad URA (or some accuracy problem indicated in navigational data) • 17—Satellite NOT used because marked 'unhealthy' in almanac • 16—Satellite NOT used because differential corrections are old or invalid • 15—Satellite NOT used because big code outlier was detected • 14—Satellite NOT used because RAIM or some other algorithm detected a pseudo-range bias. • 13—Satellite NOT used because SV disabled by external command SVP,USP) • 12—Satellite NOT used because Signal To Noise Ratio is less than Mask • 11—Satellite NOT used because it's possibly a ghost satellite • 10—Satellite NOT used because computed satellite coordinates are suspicious • 09—Satellite NOT used because satellite true number unknown (for modes, where we need the true SV number • 08—Satellite NOT used because it was disabled by RTK engine (N/A in DG12) • 02—Satellite NOT used because of some other case • 01—Satellite NOT used because no navigational data (ephemeris) is available • 07—Satellite NOT used because no full range available
unsigned char [polarity_known]	1	This number is either 0 or 5, 0 meaning satellite is just locked, and 5 meaning the beginning of the first frame has been found
unsigned char [ireg]	1	Signal-to-noise measurement for the satellite observation
unsigned char [qa_phase]	1	Not used; always zero
double [full phase]	8	Full carrier phase measurements in cycles. Not available unless carrier phase option is installed
double [raw_range]	8	Raw range to satellite in seconds, i.e., receive time - raw range = transmit time
long [doppler]	4	Doppler (10^{-4} Hz)

Table 4.62. $PASHR,MCA Data String (Continued)

Field	Bytes	Content
long [smoothing]	4	32 bits where 31-24 are the smooth_count, unsigned, and normalized, representing the amount of smoothing specified in the **$PASHS,SMI** command: • 0 - Unsmoothed • 1 - Least smoothed • 255 - Most smoothed Bits 23-0 are smooth_corr, where bit 23 (MSB) is the sign and the LSBs (22-0) are the magnitude of correction in centimeters
checksum	1	Checksum, a bytewise exclusive OR (XOR) of all bytes from sequence_tag (just after header) to the byte before checksum
Total Bytes: 37		

For a given channel expecting more than one block of data, when one of them is not yet available, the warning flag is set to 7 and the rest of the block is zeroed out.

This message is output for those satellites with elevation equal to or greater than the elevation mask, and only if the number of locked satellites is equal to or greater than the minimum satellite mask.

MCM: Missile Application Condensed Measurement Record (MACM) - G12 HDMA Users Only

This message optimizes the data output and data transmission in missile applications requiring high speed data output with communications bandwidth limitations. Although this message is intended for HDMA users, it is available on all G12 products.

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

This command enables or disables the missile application condensed measurement record, where c1 is the output port (A or B) for the response message. s2 is ON (enable) or OFF (disable), and f3 is the optional message interval in seconds ranging from 0.05 to 999 seconds. If the command is set without an interval, the G12 uses the period set by the **$PASHS,RCI** command If the **$PASHS,RCI** command is issued after this message period has been set, the period resets to the RCI setting.

Examples

Enter the following command to enable the missile application condensed measurement record through port A at the current RCI setting:

$PASHS,RAW,MCM,A,ON

Enter the following command to enable the missile application condensed measurement record through port A every 5 seconds:

$PASHS,RAW,MCM,A,ON,5

$PASHQ,MCM,[c1]

This command allows you to query for raw satellite and position measurement data in the Missile Application Condensed Measurement (MACM) format.

c1 is the optional port designator (port A or B) for the response. If a port is not specified, the receiver sends the response to the current port.

If the command is set without a period, the G12 uses the period set by the **$PASHS,RCI** command If the **$PASHS,RCI** command is issued after this message period has been set, the period resets to the RCI setting.

MACM Message Structure

This message is not output unless positions are being computed. MCM is a combined message containing elements from the MBN, MCA, and PBN messages. The MCM message was designed for high speed data output under the limited bandwidth conditions common to high dynamic telemetry. Satellite PRN number, receive time (the time at which the data was received), doppler measurements, pseudo-range measurements, and full carrier phase measurements are contained in this message. The MCM message is variable in length, defined by the count field in the header. The message begins with a 4-byte sync word [4D 41 43 4D] (ASCII “MACM”) and ends with a checksum byte. The **<CR><LF>** characters that terminate the majority of G12 response messages are not used in this case. In addition, the usual response header, $PASHR, is not used here. If the receiver is set to output the MCM message at regular intervals, the MACM sync word appears only the first time the message is output and is excluded from the messages that follow; however, the sync word is output each time MCM is queried. The following is the output for one epoch. The syntax for each parameter is listed in brackets ads [parameter name:number of bytes for parameter]. At the right of each line is an identifier and byte count.

```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
[MACM:4] [COUNT:2] [RCVTIME:4] [NAVT: 4]                        Header: 14

[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1] PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
[PRN:1][WRN:1][POL:1][CN0:1][PHASE:8][RANGE:4][DPL:4][LCK_TIME:4]    Prn Data: 24
```

[CHECKSUM:1] **Checksum: 1**

~~~~~~

The total message length for 8 satellite measurements is 207 bytes. Table 4.63 defines the MACM data string format.

Table 4.63. MACM Data String

Byte #	Name	Type	Size	Content	Origin
1	MACM	char	4	Name of Message (“MACM”)	sync_word (ASCII"MACM")
5	COUNT	char	2	Number of remaining structures to be sent for the current epoch.	MBN record, count
7	RCVTIME	long	4	Signal received in milliseconds of week GPS system time. This is the time tag for all measurements and position data.	PBN record, rcvtime
11	NAVT	float	4	Receiver clock offset in meters.	PBN record, navt
24*j-9	PRN	unsigned char	1	Satellite PRN number	MCA record, svprn
24*j-8	WRN	unsigned char	1	Warning flag, where: • Bit 1 set = see note below • Bit 2 set = see note below • Bit 3 set = carrier phase questionable • Bit 4 set = code phase questionable • Bit 5 set = code phase integration questionable • Bit 6 set = not used • Bit 7 set = possible loss of lock • Bit 8 set = loss of lock counter reset The interpretation of bits 1 and 2 is as follows: Bit 1 Bit 2 • 0 0 Same as 22 in goodbad flag (see next field) • 1 0 Same as 23 in goodbad flag • 0 1 Same as 24 in goodbad flag More than one bit may be set at the same time, e.g., if bits 1, 3, and 6 are set at the same time, the warning flag is 37 (1 + 4 + 32)	MCA record, warning
~~~~~~

Table 4.63. MACM Data String (Continued)

Byte #	Name	Type	Size	Content	Origin
24*j-7	POL	unsigned char	1	This number is either 0 or 5, 0 meaning satellite is just locked, and 5 meaning the beginning of the first frame has been found.	MCA record, polarity_known
24*j-6	CN0	unsigned char	1	Signal-to-noise of satellite observation	MCA record, ireg
24*j-5	PHASE	double	8	Full carrier phase measurements in cycles. Not available unless carrier phase option is installed.	MCA record, full_phase
24*j+3	RANGE	unsigned long	4	Pseudo-range in seconds, sf=3.0e10	G-8 ITA record, raw_range
24*j+7	DPL	long	4	Doppler (10^{-4} Hz)	MCA record, doppler
24*j+11	LCK_TIME	unsigned long	4	Continuous counts since satellite is locked. This number increments about 500 timesper second	MBN record, lost_lock_ctr
24*N+15	checksum	unsigned char	1		MCA record

j = 1,2...N; N = the order number of the PRN record in the message.

MSV: 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 stops 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 **$PASHQ,RAW** command and checking the MSV field.

Examples

Set minimum number of satellites to 4:

$PASHS,MSV,4

Set minimum number of satellites to 1:

$PASHS,MSV,1

DEFAULT SETTING	
MSV	3

PBN: Raw Position Data

$PASHS,RAW,PBN,[c1],s2,[f1]

This command enables or disables the position data (PBN) messages, where c1 is port A, B or C (optional port), s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending upon the measurement update rate option installed.

$PASHQ,PBN,[c1]

This command queries raw position data, where c1 is the optional port designator for the response. 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>
```

Table 7.64 defines the message format.

Table 7.64. PBN Data String

Field	Bytes	Content
long rcvtime	4	Signal received time in milliseconds of week of GPS time. This is the time tag for all measurements and position data
char sitename	4	4 character string (user entered)
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 in meters
float navxdot	4	The antenna x velocity in meters per second
float navydot	4	The antenna y velocity in meters per second

Table 7.64. PBN Data String (Continued)

Field	Bytes	Content
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: Setting Query Command

$PASHQ,RAW,[x]

Show current settings of raw data parameters, where x is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

The response is in the format:

RCI:020.00 MSV:3 ELM:00

ANH:0.0000 SIT:???? EPG:000

RAW: MCA MBN PBN MCM CT1 CT2 CT3 SNV SAL

PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF

PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF

Table 4.65 describes the response parameters:

Table 4.65. $PASHQ,RAW Response Parameters

Field	Description
RCI:020.00	This is the output interval of the data in seconds. Default is once every 20 seconds.
MSV:3	Minimum number of satellites for the data to be output. Default is 3.
ELM:05	Data elevation mask. Elevation below which data from that satellite will not output.
SIT:????	Four-character site name.
RAW:	Raw data types: MCA, MBN, PBN, MCM, CT1, CT2, CT3, SNV, SAL, SNG, SAG.

Commands

Table 4.65. $PASHQ,RAW Response Parameters

Field	Description
PRTA PRTB	Communication Ports A and B
OFF/ON	OFF indicates that the RAW data message is not sent to the port. ON indicates the RAW data message is sent to the communication port.

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. Use Table 4.66 to determine the value for f1. This command overrides individual settings for output interval. That is, if the CT1 message is enabled for output at intervals of two seconds and the MBN message is enabled for output at intervals of ten seconds, you can ese the RCI command to set an output interval of five seconds and reset the output interval of both messages to five seconds. You can view the current raw data output interval setting by entering the **$PASHQ,RAW** command and checking the RCI field.

Example

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

$PASHS,RCI,5

Table 4.66. 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
10 Hz	T	0.1-999	0.1 from 0.1 to 1 1 from 1 to 999
20 Hz	W	0.05-999	0.05 from 0.05 to 0.1 0.1 from 0.1 to 1 1 from 1 to 999

DEFAULT SETTING	
RCI	20

The G12 is designed to synchronize raw 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 synchronization between multiple receivers.

Almanac data for all satellites is output once every hour, with one almanac message output for each satellite in the constellation. The almanac messages are output at interval prescribed by the $PASHS,RCI command.

At the 10 Hz output rate (0.1 seconds), a baud rate of 115,000 bps is required to output all the raw data (MBN, PBN, SNV, and SAL). For greater output rates, the raw data must be split between the two serial ports, or some of the messages should be turned off. To receive data at high baud rates (e.g., 115,000), you must ensure that your computer has a suitable serial I/O capability. Most newer computers with Pentium or 486 processors have good enough serial communication to support high data rates.

SAL: Satellite Almanac Data

$PASHQ,SAL,[c1]

This command allows you to query for satellite almanac data.

c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAL

This message is not output until the G12 has completed downloading the current GPS almanac file. The receiver begins downloading the almanac file automatically almanac file can be obtained directly from the satellites, which happens automatically and takes about twelve minutes, or, with the aid of software, a current almanac file from another receiver can be manually downloaded into the G12. 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,<Satellite almanac data string + checksum>

Table 4.67 defines the data string format.

Table 4.67. $PASHR,SAL Data String

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
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		

SIT: Site Name for Observation Session

$PASHS,SIT,s1

This command allows you to set a site name for your observation session, where s1 is a user-defined string of 4 characters. The site name is captured in the PBN message; if a site name is not defined by the user, this part of the PBN message is occupied by four question marks. You can view the current site name by entering the query command **$PASHQ,RAW** and checking the SIT field.

Examples

Enter the following command to set site name to 0001:

$PASHS,SIT,0001

Enter the following command to set the site name to SQR1:

$PASHS,SIT,SQR1

DEFAULT SETTING	
SIT	**????**

Ephemeris data is output once every 15 minutes or each time the IODE changes, whichever comes first, with one satellite output at each recording interval (RCI).

SNV: Satellite Ephemeris Data

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

This command enables/disables the GPS raw satellite ephemeris data message, where c1 is A or B (port), s2 is ON or OFF, and f3 is the optional update rate as defined in Table 4.66 on page 134.

$PASHQ,SNV,[c1]

This command allows you to query ephemeris data from each satellite currently being tracked by the receiver, where [c1] is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SNV

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

$PASHR,SNV,<Ephemeris data string + checksum>

Table 4.68 defines the SNV data string format.

Table 4.68. $PASHQ,SNV Response Structure

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

Table 4.68. $PASHQ,SNV Response Structure (Continued)

Field	Bytes	Content
long toc	4	Clock data reference time in seconds
float af2	4	Clock correction (sec/sec^2)
float af1	4	Clock correction (sec/sec)
float af0	4	Clock correction (sec)
long aode	4	Orbit data issue
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	Checksum is computed by breaking structure into 65 unsigned shorts, adding them together, and taking least significant 16 bits of result
Total Bytes:	132	

NMEA Commands

NMEA commands allow you to set parameters for outputting NMEA messages and Ashtech's NMEA-style messages. These commands can be sent to the G12 through either serial port. Table 4.69 lists the set and query commands used in controlling NMEA message output. All NMEA messages and Ashtech NMEA-style messages are disabled for output by default.

Table 4.69. NMEA Data Message Commands

	Command	Description	Page
General Command for Controlling NMEA output	$PASHS,NME,ALL	Enable/disable all messages	142
	$PASHS,NME	Enable/disable one or more NMEA message	132
Latency Information	$PASHS,NME,LTN	Enable/disable the latency message	162
	$PASHQ,LTN	Query position output latency	163
Differential Information	$PASHS,NME,MSG	Enable/disable base station message	164
	$PASHQ,MSG	Query base station status messages	164
	$PASHS,NME,TCM	Enable/disable RTCM rover status	181
	$PASHQ,TCM	Query RTCM rover station status	182
Output Rate Parameter	$PASHS,NME,PER	Set send interval of NMEA response message	172
Photogrammetry	$PASHR,TTT	Photogrammetry message	183
Position Information	$PASHS,NME,GGA	Enable/disable 3-D position response message	148
	$PASHQ,GGA	Query 3-D position message	149
	$PASHS,NME,GLL	Enable/disable latitude/longitude message	151
	$PASHQ,GGL	Query latitude/longitude message	151
	$PASHS,NME,POS	Enable/disable NMEA position response message	172
	$PASHS,NME,RMC	Enable/disable minimum position, course/speed message	174
	$PASHQ,RMC	Query for minimum position, course/speed message	175
RAIM Information	$PASHS,NME,AIM	Enable/disable RAIM message	143
	$PASHQ,AIM	Query RAIM information	143

Table 4.69. NMEA Data Message Commands (Continued)

	Command	Description	Page
Receiver Configuration	$PASHS,NME,CRT	Enable/disable Cartesian coordinates message	144
	$PASHQ,CRT	Query Cartesian coordinates message	145
	$PASHS,NME,GDC	Enable/disable Grid coordinates message	146
	$PASHQ,GDC	Query Grid coordinates message	146
	$PASHS,NME,UTM	Enable/disable Universal Transverse Mercator (UTM) coordinates message	184
	$PASHQ,UTM	Query Universal Transverse Mercator (UTM) coordinates message	185
Residual Information	$PASHS,NME,RRE	Enable/disable satellite residual and position error	177
	$PASHQ,RRE	Query satellite residual and position error information	177
	$PASHS,NME,GRS	Enable/disable satellite range residual information message	152
	$PASHQ,GRS	Query satellite range residual information message	153
	$PASHS,NME,GST	Enable/disable pseudorange error message	158
	$PASHQ,GST	Query pseudorange error message	159
Satellite Information	$PASHS,NME,GSA	Enable/disable satellites used message	154
	$PASHQ,GSA	Query satellites used message	154
	$PASHS,NME,GSN	Enable/disable signal strength and satellite number message	156
	$PASHQ,GSN	Query signal strength and satellite number message	157
	$PASHS,NME,GSV	Enable/disable satellites in view message	160
	$PASHQ,GSV	Query satellites in view message	160
	$PASHS,NME,SAT	Enable/disable satellite status message	178
	$PASHQ,SAT	Query satellite status message	179
Time and Date	$PASHS,NME,ZDA	Enable/disable time and date message	188
	$PASHQ,ZDA	Query time and date information	188
Course and Speed	$PASHS,NME,VTG	Enable/disable velocity/course message	187
	$PASHQ,VTG	Query velocity and course information	187

Using the symbols from Table 4.1, 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.). c1 is the port designator (A or B) for message output. s3 is ON or OFF. f4 is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Before using the 10 Hz or 20 Hz update rate, you must issue the $PASHS,POP command.

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

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

$PASHS,NME,GGA,B,OFF

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

$PASHQ,POS,[B]

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.

Message Structure

Standard NMEA messages are output as a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards (version 2.1). Ashtech's NMEA-style messages are 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 Ashtech messages are variable (i.e., SAT) and may go beyond eighty characters. Both NMEA messages and Ashtech 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 0.05 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. The checksum is separated from the data string by an asterisk. 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. GGA, which is a standard NMEA message:

$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 Ashtech proprietary format, have the message identifier in a separate field. SAT, a non-standard message:

$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.

Data items are separated by commas; successive commas indicate data not available. Two successive commas indicate one missing data item; three successive commas indicate two missing items.

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

NME: Enable/Disable All NMEA Messages

$PASHS,NME,ALL,x,OFF

Disable ALL NMEA message types on port x, where x is the output port.

Example

Enter the following command to disable all NMEA messages for Port A.

$PASHS,NME,ALL,A,OFF <Enter>

Enter the following command to disable all NMEA messages for Port B.

$PASHS,NME,ALL,B,OFF <Enter>

You must enter both of the above commands to disable the output of all messages from both ports.

At 10 Hz output rate, a baud rate of 115,000 bps is required to output all the NMEA messages. At greater output rates, the raw data must be split between the two serial ports, or some of the messages should be turned off. To receive data at high baud rates (e.g., 115,000), ensure that the computer has a suitable serial I/O capability. Most newer computers with Pentium or 486 processors have good enough serial communication to support high data rates.

AIM: Receiver Autonomous Integrity Monitor — Ext. Mem. G12 Only

$PASHS,NME,AIM,x,s,[f]

Enable/disable RAIM message on port x, where x is the output port, and s is ON or OFF. This message is not output unless a position is computed. f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable RAIM message on port B.

$PASHS,NME,AIM,B,ON<Enter>

$PASHQ,AIM,[x]

The associated query command is $PASHQ,AIM,x. This command outputs the AIM response message on port x, where x is the optional output port. This message is not output unless a position is computed.

$PASHR,AIM

The response message to the set or query command is in the form:

$PASHR,AIM,s1,d1,n(d2-d3)*cc

Table 4.70 defines the structure of the RAIM response message.

Table 4.70. RAIM Response Message Structure

Field	Description
s1	Current RAIM mode (3-character) OFF - Turns RAIM off NPA - Non-precision approach, alarm limit is 0.030 nmi TER - Terminal, alarm limit is 1.00 nmi ERT - En route, alarm limit is 2.00 nmi n.nn - user-selectable alarm limit between 0.015 and 4.00 km
d1	Value returned by RAIM gives: 0 - no errors detected 1 - error detected and corrected 2 - error detected, correction not possible 3 - detection not available (lack of satellite or poor geometry) 4 - error detected, rest of satellite set not available
n	Number of channel - satellite pairs
d2-d3	Represents a pair of excluded channel and its corresponding satellite, where d2 is the number of the excluded channel and d3 is the number of the corresponding satellite

Example

$PASHR,AIM,NPA,1,10-12,05-20*FF

where:

NPA = non-precision approach mode

1 = error detected and corrected

10-12 = channel 10, satellite 12 excluded

05-20 = channel 5, satellite 20 excluded

CRT: Cartesian Coordinates Message

$PASHS,NME,CRT,x,c,[f]

This command allows you to output the computed Cartesian coordinates and velocities. Enable or disable the NMEA position response message on output port x, and c is ON or OFF. f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the receiver is not computing a position, it outputs an empty message.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,CRT,[x]

This command allows you to query the CRT command, where x is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CRT

The Cartesian coordinates and velocities message contains information on the antenna position, number of satellites, altitude, speed, velocity, and dilution of precision. The message is output in the format:

$PASHR,CRT,d1,d2,m1,m2,m3,m4,f2,f3,f4,f5,f6,f7,f8,f9,s*cc

Table 4.71 defines the message format.

Table 4.71. $PASHR,CRT Message Format

Parameter	Description	Range
d1	position type: 0 = autonomous 1 = position differentially corrected with RTCM code 2 = position differentially corrected with CPD float solution 3 = position is CPD fixed solution	0 to 3
d2	Number of satellites used in position computation	3 to 12
m1	Current UTC time, (hhmmss), of position computation in hours, minutes, and seconds	00 to 235959.50
m2	Antenna position ECEF x coordinate in meters	
m3	Antenna position ECEF y coordinate in meters	
m4	Antenna position ECEF z coordinate in meters	
f2	Receiver clock offset in meters	
f3	X-component of velocity vector in m/s	
f4	Y-component of velocity vector in m/s	
f5	Z-component of velocity vector in m/s	
f6	Receiver clock drift in m/s	
f6	PDOP - position dilution of precision	0 to 99.9
f7	HDOP - horizontal dilution of precision	0 to 99.9
f8	VDOP - vertical dilution of precision	0 to 99.9
f9	TDOP - time dilution of precision	0 to 99.9
s*cc	Firmware version ID	4 character string

The ECEF coordinates reported are in the datum set by the user. ECEF coordinates are reported in meters (with two decimal places) without leading zeros or positive signs.

GDC: Grid Coordinates

$PASHS,NME,GDC,c1,s,[f]

This command enables/disables the $PASHR,GDC message.

c1 is the port designator (A or B) for message output. s3 is ON or OFF. f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,GDC,[c]

The associated query command is **$PASHQ,GDC,c**, where c is the optional output serial port. The message is not output unless position is being computed.

The response is in the format:

$PASHR,GDC,m1,s2,f3,f4,d5,d6,f7,f8,M,f9,M,d10,s11,s12*cc

Table 4.72 defines the GDC message format:

Table 4.72. GDC Response Message Format

Parameter	Description	Range
m1	UTC of position in hours, minutes, and decimal seconds (hhmmss.ss)	0 - 235959.90
s2	Map projection type	EMER, TM83, OM83, LC83, STER, TM27, TMA7, LC27
f3	East (X) User Grid coordinate (meters)	±9999999.99
f4	North (Y) User Grid coordinate (meters)	±9999999.99
d5	Position indicator 1: Raw position 2: RTCM differential, or CPD float solution	1, 2, 3
d6	Number of GPS satellites being used	3 - 12
f7	Horizontal dilution of precision (HDOP)	999.9
f8	Altitude in meters	±99999.999
M	Altitude units (M = meters)	M

Table 4.72. GDC Response Message Format

Parameter	Description	Range
f9	Geoidal separation in meters w.r.t. selected datum	±999.999
M	Geoidal separation units (M = meters)	M
d10	Age of differential corrections	0 - 999
s11	Differential reference station ID	4 char string
s12	Reference Datum for the map projection	3 char string
cc	checksum	

Typical GDD message:

$PASHR,GDC,015454.00,EMER,588757.623,4136720.056,2,04,03.8,00012.123,M, -031.711,M,14,1010,W84*2A

Table 4.72 describes the typical GDD message.

Table 4.73. Typical GDC Message

Item	Description
015454.00	UTC time
EMER	Equatorial Mercator map projection
588757.623	User Grid easting (X) coordinate
4136720.056	User Grid northing (Y) coordinate
2	RTCM differential position
04	Number of satellites used to compute position
03.8	HDOP
00012.123	Altitude
M	Altitude units (M = meters)
-031.711	geoidal separation w.r.t. selected datum
M	geoidal separation units (M = meters)
014	age of corrections
1010	Differential Station ID
W84	Reference datum is WGS 84
2A	checksum

GGA: 3-D GPS Position

$PASHS,NME,GGA,x,s,[f]

Enable/disable NMEA GPS position response message on port x, where x is the output port A, B, or C. s is ON or OFF. f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHS,GGA,x,[f]

This command commands the receiver to output either the entire GGA message (x=FUL) or the standard GGA message (x=STD). NMEA standards restricts the length of any message to a maximum of 82 characters, including the header, checksum and **<CR><LF>** characters. f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

A GGA message output in the FUL format may exceed the maximum length of 82 characters to accommodate the highest level of resolution (recommended in RTK mode). Some software and hardware devices which accept NMEA inputs may reject or ignore NMEA messages that exceed the maximum length; in those cases, the STD format should be selected.

When using the STD format, leading zeroes in numeric fields and plus signs (+) for positive values are eliminated and the geoidal separation value is rounded to the nearest meter. This allows the GGA message to comply with the maximum length restriction.

All fields are variable length.

DEFAULT SETTING
GGA—FULL

Example:

Enable GGA on port A:

$PASHS,NME,GGA,A,ON

Output standard GGA message.

$PASHS,GGA,STD

$PASHQ,GGA,[c1]

This command allows you to query the GGA position 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.

$GPGGA

This message is 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 G12 can be set to output the GGA message at regular intervals by using the command $PASHS,NME. The message is output in the format:

$GPGGA,m1,m2,c3,m4,c5,d6,d7,d8,f9,c10,d11,c12,d13,d14*hh

Table 4.74 defines the message format.

Table 4.74. $GPGGA Message Format

Parameter	Description	Range (FUL)	Range (STD)
m1	UTC time (hhmmss.s) of the position fix	0 to 235959.99	0 to 235959.99
m2	Latitude of the position fix (ddmm.mmmmm)	0 to 9000.000000	0 to 9000.000000
c3	Latitude sector	N/S	N/S
m4	Longitude of the position fix (dddmm.mmmmm)	0 to 18000.000000	0 to 18000.000000
c5	Longitude sector	E/W	E/W
d6	Position fix type: • 0 - Invalid position or position not available • 1 - Autonomous position • 2 - Differentially corrected position	‘0’/’1’/’2’/’3’	‘0’/’1’/’2’/’3’
d7	Number of satellites used in position computation	‘3’ -’24’	‘3’ -’24’
d8	HDOP (horizontal dilution of precision)	‘00.0’ -’ 99.9’	‘00.0’ -’ 99.9’
f9	Altitude above Mean Sea Level (geoidal height)	‘-1000.00’ to ‘18000.00’	‘-1000.00’ to ‘18000.00’
c10	Altitude unit of measure (always M)	‘M’	‘M’
d11	Geoidal separation value	‘-999.999’ - ‘999.999’	‘-99’ - ‘99’
c12	Geoidal separation unit of measure (always M)	‘M’	‘M’
d13	Age of differential corrections (seconds)	‘0’ - ‘999.999’	‘0’ -’99’

Table 4.74. $GPGGA Message Format (Continued)

Parameter	Description	Range (FUL)	Range (STD)
d14	Differential base station ID number	'0' - '1023'	'0' - '1023'
hh	Checksum	2-character hex	

Example full GGA message structure:

$GPGGA,123456.12,1234.123456,N,12345.123456,W,2,12,12.1,12345.12,M,-12.1,M,123,1234*7F

Example standard GGA message structure:

$GPGGA,123456.12,1234.12345,N,12345.12345,W,2,12,12.1,12345.1,M,12,1234*7F

Typical GGA message:

$GPGGA,183805.50,3722.36223,N,12159.82741,W,2,7,2.8, 16.12,M,-31.24,M,005,0001 *6F

Table 4.75 describes the typical GGA response message.

Table 4.75. Typical GGA Message

Item	Description
$GPGGA	Header
183805.50	Time of position fix
3722.36223	Latitude
N	North
12159.82741	Longitude
W	West
2	RTCM differential corrections applied to position fix
7	Number of satellites used in position computation
2.8	HDOP
+00016.12	Altitude
M	Altitude unit of measure (meters)
-31.24	Geoidal separation value
M	Geoidal separation unit of measure (meters)
005	Age of differential corrections
0001	Base station ID number
6F	Checksum

GLL: 2-D Position

$PASHS,NME,GLL,x,s,[f]

Enable/disable NMEA latitude/longitude response message on port x, where x is the output port, s is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending upon the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command. If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable GLL message on port A.

$PASHS,NME,GLL,A,ON

$PASHQ,GLL,[c1]

This command allows you to query for the GLL position 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.

$GPGLL

This message is not output unless position is computed. The GLL message contains a 2-D position (latitude/longitude only) and time of position fix. The G12 can be set to output the GLL message at regular intervals by using the command $PASHS,NME. The message is output in the format:

$GPGLL,m1,c2,m3,c4,m5,c6*hh

Table 4.76 defines the message format.

Table 4.76. $GPGLL Message Format

Parameter	Description	Range
m1	Latitude of the position fix (ddmm.mmmmm)	0° - 90°
c2	Latitude sector	N(orth) S(outh)
m3	Longitude of the position fix (dddmm.mmmmm)	0° - 180°
c4	Longitude sector	E(ast) or W(est)
m5	UTC time (hhmmss.ss) of the position fix	000000.00 to 235959.90

Commands

Table 4.76. $GPGLL Message Format

Parameter	Description	Range
c6	Status of the position fix (always A): • A = Valid • V = Invalid	A, V
hh	Checksum	2-character hex

Typical GLL message:

$GPGLL,3722.36223,N,12159.82741,W,170003.00,A*7F

Table 4.77 describes the typical response message.

Table 4.77. Typical GLL Message

Item	Description
$GPGLL	Header
3722.36223	Latitude
N	North
12159.82741	Longitude
W	West
170003.00	UTC of position fix
A	Indicates valid position fix
7F	Checksum.

GRS: Satellite Range Residuals

$PASHS,NME,GRS,x,s,[f]

Enable/disable NMEA satellite range residual response message to port x, where x is the output port, and s is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The receiver does not output this message if a position is not computed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable GRS message on port B.

$PASHS,NME,GRS,B,ON

$PASHQ,GRS,[c1]

This command allows you to query for the GRS 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.

$GPGRS

The GRS message contains current time, an indicator for the mode used to calculate the residual error in the satellite pseudo-range, and the residual error values for each locked satellite. The order in which the residual error values are listed corresponds to the order in which the satellites are listed in the GSA message. A minus sign (-) in front of the residual error value indicates a Residual pseudorange error is not calculated until at least five satellites are being used to compute positions. The response is output in the format:

$GPGRS,m1,d2,(f3*n)*hh

Table 4.78 defines the message format.

Table 4.78. $GPGRS Message Format

Parameter	Description	Range
m1	Current UTC time (hhmmss.ss) as taken from the GGA message	000000.00 to 235959.90
d2	Mode used to calculate residual errors in the pseudo-range measurement (always 1): • 0 - Residual error values are calculated at the same time the GGA position is computed • 1 -Residual error values are recalculated after the GGA position is computed	0, 1
f3*n	Pseudo-range residual error value. This field is repeated for each satellite used in position computation, where f3 is the calculated error value and n is the number of satellites ($\leq$ 5) used in computing positions. The order in which the error values are listed matches the order in which the satellites are listed in the GSA message	-999.9 to 999.9
*hh	Checksum	2-character hex

Typical GRS message:

$GPGRS,180257.50,1,019.3,004.6,-009.3,-005.6,-004.5,005.4*49

Table 4.79 describes the typical GRS response message.

Table 4.79. Typical GRS Message

Field	Description
$GPGRS	Header
180257.50	UTC time of position fix
1	Pseudo-range residual error calculation mode
019.3	Range residual for first satellite in GSA message
004.6	Range residual for second satellite in GSA message
-009.3	Range residual for third satellite in GSA message
-005.6	Range residual for fourth satellite in GSA message
-004.5	Range residual for fifth satellite in GSA message
005.4	Range residual for sixth satellite in GSA message
*49	Checksum

GSA: DOP and Active Satellites

$PASHS,NME,GSA,x,s,[f]

Enable/disable DOP and active satellite message to be sent out to the serial port, where x is the output port, and s is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The receiver does not output this message if a position is not computed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable GSA message on port B.

$PASHS,NME,GSA,B,ON

$PASHQ,GSA,[c1]

This command allows you to query for 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

The GSA message contains indicators for current position mode (see PMD command on page 82), a list of the satellites being used to compute position, and the values for PDOP, HDOP, and VDOP. This message is not output until positions are being 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

Table 4.80 defines the message format.

Table 4.80. $GPGSA Message Format

Parameter	Significance	
c1	Position mode indicator: • A - Automatic mode • M - Manual mode	A, M
d1	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 G12 channel 3 is locked on satellite 17. If a given channel is not locked on a satellite, the corresponding field will be empty.	1 - 32
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 GSA message:

$GPGSA,A,3,31,29,23,26,,21,17,09,08,,03,,01.7,01.0,01.4*0B

Table 4.81 describes the typical GSA response message.

Table 4.81. Typical $GPGSA Message

Field	Description
$GPGSA	Header
A	Indicates automatic 2-D/3-D switching mode
3	Indicates 3D position mode
31	G12 channel 1 locked on satellite 15; satellite 15 being used in position computations
29	G12 channel 2 locked on satellite 29; satellite 29 being used in position computations

Table 4.81. Typical $GPGSA Message (Continued)

Field	Description
23	G12 channel 3 locked on satellite 23; satellite 23 being used in position computations
26	G12 channel 4 locked on satellite 26; satellite 26 being used in position computations
empty field	Indicates that this channel (5) is not locked on a satellite or that the locked satellite is not being used in position computations
21	G12 channel 6 locked on satellite 21; satellite 21 being used in position computations
17	G12 channel 7 locked on satellite 17; satellite 17 being used in position computations
09	G12 channel 8 locked on satellite 09; satellite 09 being used in position computations
08	G12 channel 9 locked on satellite 08; satellite 08 being used in position computations
empty field	Indicates that this channel (10) is not locked on a satellite or that the locked satellite is not being used in position computations
03	G12 channel 11 locked on satellite 03; satellite 03 being used in position computations
empty field	Indicates that this channel (12) is not locked on a satellite or that the locked satellite is not being used in position computation
01.8	Current PDOP value
01.0	Current HDOP value
01.5	Current VDOP value
*0B	Checksum

GSN: Satellite PRN Number and Signal Strength

$PASHS,NME,GSN,x,s,[f]

Enable/disable the signal strength/satellite number response message on port x, where x is the output port, and s is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The receiver does not output this message if a position is not computed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable GSN message on port B.

$PASHS,NME,GSN,B,ON

$PASHQ,GSN,[c1]

This command allows you to query for the GSN 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.

$GPGSN

This message is not output until the receiver has locked on at least one satellite. The first data field in the GSN message contains the number of satellites currently being used to compute positions, followed by two fields containing a satellite PRN number and the measured (dbHz) signal-to-noise ratio for that satellite. The last field before the checksum contains the age of correction for differential GPS. Generally speaking, the receiver will be able to lock more quickly, and will be better able to maintain lock, on satellites whose signals register higher signal-to-noise values. The response is output in the format:

$GPGSN,d1,((d2,d3)*d1),d4*hh

The fields containing the PRN number (d2) and the signal-to-noise ratio (d3) are repeated for each locked satellite, with the d1 value used as a multiplier.

Table 4.82. $GPGSN Message Format

Parameter	Description	Range
d1	Number of satellites currently locked	0 - 12
d2	Satellite PRN number	01 - 32
d3	Signal to noise ratio for the corresponding satellite	000 - 999
d4	Age of differential correction. The number 999 is registered in this field when the G12 is set in differential rover mode but is not receiving corrections or when differential GPS is disabled.	1 - 999
*hh	Checksum	2-character hex

Typical GSN message:

$GPGSN,07,01,048,29,046,25,048,08,040,31,037,15,048,21,046, 999*4F

Table 4.83 describes the typical GSN response message.

Table 4.83. Typical GSN Message

Field	Description
$GPGSN	Header
07	Number of satellites currently locked
01	PRN number of the first satellite

Table 4.83. Typical GSN Message (Continued)

Field	Description
048	Signal strength of the first satellite
29	PRN number of the second satellite
046	Signal strength of the second satellite
25	PRN number of the third satellite
048	Signal strength of the third satellite
08	PRN number of the fourth satellite
040	Signal strength of the fourth satellite
31	PRN number of the fifth satellite
037	Signal strength of the fifth satellite
15	PRN number of the sixth satellite
048	Signal strength of the sixth satellite
21	PRN number of the seventh satellite
046	Signal strength of the seventh satellite
999	Indicates that the G12 is unable to receive differential corrections or differential GPS is disabled
*4F	Checksum

GST: Pseudo-Range Error Statistics

$PASHS,NME,GST,x,c,[f]

Enables/disables the GST message where x is the serial port, and c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The GST message provides a real time estimate (1 sigma) of the position error. The receiver does not output this message if a position is not computed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable GST message on port B.

$PASHS,NME,GST,B,ON

$PASHQ,GST,[c1]

This command allows you to query for the GST 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.

$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 response is output in the format:

$GPGST,m1,f2,f3,f4,f5,f7,f8,f9*hh

Table 4.84 defines the message format.

Table 4.84. $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). THIS FIELD NOT IMPLEMENTED	N/A
f4	Standard deviation of semi-minor axis of error ellipse (meters). THIS FIELD NOT IMPLEMENTED	N/A
f5	Orientation of semi-major axis of error ellipse (degrees from true north). THIS FIELD NOT IMPLEMENTED	N/A
f6	Standard deviation of latitude error (meters)	0.00 - 99.99
f7	Standard deviation of longitude error (meters)	0.00 - 99.99
f8	Standard deviation of altitude error (meters)	0.00 - 99.99
*hh	Checksum	2-character hex

Typical GST message:

$GPGST,130927.00,18.45,,,,17.78,11.74,28.68*71

Commands

Table 4.85 defines the response message structure.

Table 4.85. Typical GST Message

Field	Description
$GPGST	Header
130927.00	UTC time of the position fix
18.45	RMS value of the standard deviation of satellite range inputs (1sigma position error)
empty field	THIS FIELD NOT IMPLEMENTED
empty field	THIS FIELD NOT IMPLEMENTED
empty field	THIS FIELD NOT IMPLEMENTED
17.78	Standard deviation of the latitude error (meters)
11.74	Standard deviation of the longitude error (meters)
28.68	Standard deviation of the altitude error (meters)
*71	Checksum

GSV: Satellites in View

$PASHS,NME,GSV,x,c,[f]

This command allows you to enable or disable the GSV response message on the output port x, where c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,GSV,[c1]

This command allows you to query for the GSV 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.

$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 total number of messages transmitted and the number of messages transmitted are indicated in the first two fields of the first message.The first three messages contain GPS satellite information and the second three messages contain GLONASS satellite information.

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

Table 4.86 defines the response message.

Table 4.86. $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
d5	Elevation (degrees)	0° - 90°
d6	Azimuth (degrees)	0° - 359°
d7	Signal to noise ration (dbHz)	30 - 60
d8	Satellite PRN number	1 - 32
d9	Elevation (degrees)	0° - 90°
d10	Azimuth (degrees)	0° - 359°
d11	Signal to noise ration (dbHz)	30 - 60
d12	Satellite PRN number	1 - 32
d13	Elevation (degrees)	0° - 90°
d14	Azimuth (degrees)	0° - 359°
d15	Signal to noise ration (dbHz)	30 - 60
d16	Satellite PRN number	1 - 32
d17	Elevation (degrees)	0° - 90°
d18	Azimuth (degrees)	0° - 359°
d19	Signal to noise ration (dbHz)	30 - 60
*hh	Checksum	2-character hex

Typical GSV message:

$GPGSV,2,2,08,43,294,47,07,19,062,42,05,49,314,49,02,03,120,29 *45

Table 4.87 describes the typical GSV response message.

Table 4.87. Typical GSV Message

Field	Description
$GPGSV	Header
2	Indicates that two GSV messages will output
2	Indicates that this is the second message
8	Indicates that eight satellites are visible
08	Indicates PRN 8 is visible
43	Elevation of PRN 8
294	Azimuth of PRN 8
47	Signal to noise ration of PRN 8
07	Indicates PRN 7 is visible
19	Elevation of PRN 7
062	Azimuth of PRN 7
42	Signal to noise ratio of PRN 7
05	Indicates PRN 5 is visible
49	Elevation of PRN 5
314	Azimuth of PRN 5
49	Signal to noise ration of PRN 5
02	Indicates PRN 2 is visible
03	Elevation of PRN 2
120	Azimuth of PRN 2
29	Signal to noise ration of PRN 2
*45	Checksum

LTN: Position Output Latency

$PASHS,NME,LTN,x,s,[f]

Enable/disable message containing latency information on port x, where x is the output port (A or B), s is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

The receiver outputs this message even when a position is not computed.

Example

Enter the following command to enable the LTN output message on port B.

$PASHS,NME,LTN,B,ON

$PASHQ,LTN,[c1]

This command allows you to query for the LTN 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.

$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 20 and 40 milliseconds, depending on the number of satellites tracked and the number of satellites used in the position solution. The response is output in the format:

$PASHR,LTN,d1*hh

Table 4.88 defines the message format.

Table 4.88. $PASHR,LTN Message Format

Parameter	Description	Range
d1	Latency value (milliseconds)	20 - 40
*hh	Checksum	2-character hex

Typical LTN message:

$PASHR,LTN,29*05

Table 4.89 describes the typical LTN response message.

Table 4.89. $PASHQ,LTN Query Response

Field	Significance
$PASHR,LTN	Header
29	Latency value (milliseconds)
05	Checksum

MSG: Differential Base Station Data

$PASHS,NME,MSG,x,s,[f]

Enable/disable message containing RTCM reference (base) station message types 01, 03, 09, 16, 18, 19, 31, 32, 34, and 36 on port x, where x is the output port, and s is ON or OFF, and [f] is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command. If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

The G12 ignores this command unless it is sending or receiving differential corrections.

Example

Enable the MSG message on port A:

$PASHS,NME,MSG,A,ON

$PASHQ,MSG,[c1]

This command allows you to query for the MSG 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. This command is ignored if the G12 is not sending or receiving differential corrections.

$GPMSG

The MSG messages contain base station status data for incoming or outgoing RTCM messages. Fields containing base station ID number, current Z count, current GPS time, and base station health status are common to all MSG messages.

In addition to the foregoing data items, the MSG message generated for RTCM message type 1 also contains pseudorange correction values (PRC), range rate correction values (RRC), ephemeris data (IODE), and user differential range error values (UDRE) referenced to the PRN number for each locked satellite. This message can be set for output in one second increments.

The MSG message generated for RTCM message type 2 includes UDRE and IODE data, but also contains delta pseudorange corrections (delta PRC) and delta range rate corrections (delta RRC) for each locked satellite. This message can be set for output in one minute increments.

The MSG message generated for RTCM message type 3 contains the common data fields (station ID number, Z count, etc.), but also contains the X, Y, and Z components (earth-centered/earth-fixed; ECEF) of the base station GPS coordinates. This message can set for output in one-minute increments.

The MSG message generated for RTCM message type 6 contains the common data fields only. This message is typically used as transmission fill to assist in establishing and maintaining message frame synchronization. This message can be set for output in one-second increments.

The MSG message generated for RTCM message type 9 is an abbreviated version of the MSG message for RTCM message type 1. It contains the common data fields, but contains PRC, RRC, UDRE, and IODE data for a maximum of three satellites per message. This message can be set for output in one-second increments.

The MSG message generated for the RTCM type 16 message contains the common data fields and a text message of up to 90 characters, spaces included. The text in the type 16 message is entered through the command $PASHS,RTC,MSG. See the next section, RTCM Commands, for more information on set commands for differential operation.

MSG Formats

The MSG format for RTCM message type 1 is in the format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n*(d8,d9,f10,f11,d12)*hh

The MSG format for RTCM message type 2 is in the format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n*(d8,d9,f10,f11,d12)*hh

The MSG format for RTCM message type 3 is in the format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,f8,f9,f10*hh

The MSG format for RTCM message type 6 is in the format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7*hh

The MSG format for RTCM message type 9 is in the format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,(3*(d8,d9,f10,f11,d12))*hh

The MSG format for RTCM message type 16 is in the format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,s8*hh

In MSG messages generated for RTCM message types 1 and 2, fields d8 through d12 are repeated “n” times; n = the number of locked satellites. For RTCM message type 9, fields d8 through d12 are repeated 3 times per message.

The data fields common to each MSG message are listed in Table 4.90:

Table 4.90. Common MSG Data Fields

Fields	Description	Range
d1	RTCM message type	1, 2, 3, 6, 9, 16
d2	Station Identifier	0 - 1023
f3	Z count	0 - 9999.9
d4	Sequence number	0 - 9
d5	Station health	0 - 7
d6	Total number of characters following the time tag (including commas and <CR><LF> characters)	0 - 999
m7	Current GPS time of position fix (hhmmss.ss)	00-235959.90

Table 4.91 lists the remainder of the MSG message for RTCM type 1. The remainder for RTCM type 9 is identical.

Table 4.91. Remainder of Type 1

Fields	Description	Range
d8	User differential range error (UDRE)	0-9
d9	Satellite PRN number	1-32
f10	Pseudo range correction (PRC) in meters	±9999.99
f11	Range rate correction (RRC) in meters/sec	±9.999
d12	Issue of data ephemeris (IODE)	0-999
*hh	Checksum	2-character hex

Table 4.92 lists the remainder of the MSG message for RTCM type 2:

Table 4.92. Remainder of Type 2 Message

Fields	Description	Range
d8	User differential range error (UDRE)	0-9
d9	Satellite PRN Number	1-32
f10	Delta pseudo range correction (Delta PRC) in meters	±99.99
f11	Delta range rate correction (Delta RRC) in meters/sec	±9.999

Table 4.92. Remainder of Type 2 Message

Fields	Description	Range
d12	Issue of data ephemeris (IODE)	0-999
*hh	Checksum	2-character hex

Table 4.93 lists the remainder of the MSG message for RTCM type 3:

Table 4.93. Remainder of Type 3 Message

Fields	Description	Range
f8	Base station X component	±9999999.99
f9	Base station Y component	±9999999.99
f10	Base station Z component	±9999999.99
*hh	Checksum	2-character hex

Table 4.94 lists the remainder of message for Type 16. The structure of the remainder for Type 6 is the same, but contains no text.

Table 4.94. Remainder of Type 16 Message

Fields	Description	Range
s8	text message send from base receiver	Up to 80 alpha-numeric characters
*cc	Checksum	

Typical MSG message for RTCM type 1:

$GPMSG,01,0000,2220.0,1,0,127,003702:00,2,12,-0081.30, 0.026,235,2,13,0022.86,0.006,106,2,26,-0053.42,-0.070, 155,2,02,0003.56,0.040,120,2,27,0047.42,-0.005,145*7A

Table 4.95 describes the typical RTCM Type 1 response message.

Table 4.95. Typical MSG message for RTCM Type 01

Field	Description
$GPMSG	Header
01	RTCM message type
0000	Station ID
2220.0	Z count in seconds and tenths

Table 4.95. Typical MSG message for RTCM Type 01 (Continued)

Field	Description
1	Sequence number
0	Station health
127	Total number of characters of the time item
003702.00	Current time in hours, minutes, and seconds
2	UDRE for SV 12
12	Satellite PRN number
-0081.30	PRC for SV 12
+0.026	RRC for SV 12
235	IODE for SV 12
2	UDRE for SV 13
13	Satellite PRN number
0022.86	PRC for SV 13
0.006	RRC for SV 13
106	IODE for SV 13
2	UDRE for SV 26
26	Satellite PRN number
-0053.42	PRC for SV 26
-0.070	RRC for SV 26
155	IODE for SV 26
2	UDRE for SV 02
02	Satellite PRN number
0003.56	PRC for SV 02
0.040	RRC for SV 02
120	IODE for SV 02
2	UDRE for SV 27
27	Satellite PRN number
0047.42	PRC for SV 27
-0.005	RRC for SV 27
145	IODE for SV 27
7A	Checksum

Typical MSG message for RTCM type 2:

$GPMSG,02,0000,0790.8,5,0,205,151258.00,0,30,0000.98,0.000,200,0,04,000.14,0.000,078,0,10,0002.22,0.000,235,0,24,0001.42,0.000,142,0,06,0000.02,0.000,171,0,09,0000.04,0.000,110,0,08,0000.00,0.000,192,0,05,0000.00,0.000,080*66

Table 4.96 describes the typical RTCM Type 2 response message.

Table 4.96. Typical MSG message for RTCM Type 2

Field	Description
$GPMSG	Header
02	RTCM message type
0000	Station ID
0790.8	Z count in seconds and tenths
5	Sequence number
0	Station health
205	Total number of characters following the time tag
003702.00	Current time in hours, minutes, and seconds
0	Current UDRE
30	Satellite PRN number
0000.98	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
200	Current IODE
0	Current UDRE
04	Satellite PRN number
0000.14	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
078	Current IODE
0	Current UDRE
10	Satellite PRN number
-0002.22	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
235	Current IODE
0	Current UDRE
24	Satellite PRN number
0001.42	Current delta pseudorange correction (meters)

Table 4.96. Typical MSG message for RTCM Type 2 (Continued)

Field	Description
0.000	Current delta range rate correction (meters)
142	Current IODE
0	Current UDRE
06	Satellite PRN number
0000.02	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
171	Current IODE
0	Current UDRE
09	Satellite PRN number
0000.04	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
110	Current IODE
0	Current UDRE
08	Satellite PRN number
0000.00	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
192	Current IODE
0	Current UDRE
05	Satellite PRN number
0000.00	Current delta pseudorange correction (meters)
0.000	Current delta range rate correction (meters)
080	Current IODE
*66	Checksum

Typical MSG message for RTCM type 3:

**$GPMSG,03,0000,1200.0,7,0,038,231958.00,-2691561.37,
-4301271.02,3851650.89*6C**

Table 4.97 describes the typical RTCM Type 3 response message.

Table 4.97. Typical MSG Message for RTCM Type 3

Field	Description
03	RTCM type
0000	Station ID
1200.0	Z count in seconds and tenths
7	Sequence number
0	Station health
038	Total number of characters after the time item
231958.00	Current time in hours, minutes and seconds
-2691561.37	Station X component
-4301271.02	Station Y component
3851650.89	Station Z component
*6C	Checksum

RTCM TYPE 3 messages transmit the saved-base position following a power cycle.

Typical MSG message for RTCM Type 16:

$GPMSG,16,0000,0888.0,5,0,033,191436.00,BASE STATION TEXT MESSAGE*71

Table 4.98 describes the typica Type 16 response message.

Table 4.98. Typical MSG Message For RTCM Type 16

Field	Description
$GPMSG	Header
16	RTCM message type
0000	Station ID
1209.6	Z count in seconds and tenths
5	Sequence number
0	Station health
038	Total number of characters following the time tag
232008.00	Current time in hours, minutes and seconds
TEXT	Message content
*71	Checksum

PER: Global Output Interval

$PASHS,NME,PER,f1

This command allows you to set the global output interval for all NMEA messages and Ashtech NMEA-style messages, 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 will cause reset the output interval of both messages to five seconds.

Example

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

$PASHS,NME,PER,5

POS: Position Message

$PASHS,NME,POS,x,c,[f]

Enable/disable NMEA position response message on output port x, c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The receiver displays an empty message if no position is computed.

Example

Enter the following command to enable position message on port B.

$PASHS,NME,POS,B,ON

$PASHQ,POS,[x]

The associated query command is **$PASHQ,POS,x** where x is the optional output port.

$PASHR,POS

The response is a message containing information on the most recently computed position. This response message is in the form:

$PASHR,POS,d1,d2,m1,m2,c1,m3,c2,f1,f2,f3,f4,f5,f6,f7,f8,f9,s*cc

Table 4.99 defines the POS response structure.

Table 4.99. POS Response Structure

Field	Description	Range
d1	position type: 0 = autonomous 1 = position differentially corrected with RTCM code	0 to 1
d2	Number of satellites used in position computation	3 to 12
m1	Current UTC time, (hhmmss), of position computation in hours, minutes and seconds	00 to 235959.50
m2	Latitude component of position in degrees, minutes, and fraction of minutes (ddmm.mmmm)	0 to 90°
c1	Latitude sector: N = North, S = South	‘N’ or ‘S’
m3	Longitude component of position in degrees, minutes, and fraction of minutes	0 to 180°
c2	Longitude sector: E = East, W = West	W or E
f1	Altitude in meters above WGS-84 reference ellipsoid. For 2-D position computation this item contains altitude held fixed.	± 30000.00
f2	Reserved	
f3	True track/true course over ground in degrees (000.00 to 359.99)	0 to 359.9
f4	Speed over ground in knots	0 to 999.9
f5	Vertical velocity in meters per second	± 999.9
f6	PDOP - position dilution of precision	0 to 99.9
f7	HDOP - horizontal dilution of precision	0 to 99.9
f8	VDOP - vertical dilution of precision	0 to 99.9
f9	TDOP - time dilution of precision	0 to 99.9
s1	Firmware version ID	4 character string

If there is no valid position, POS provides: number of satellites, time, DOPs, firmware version ID. All other fields are null.

If there are not enough satellites to compute DOP, then the DOP field is null.

Typical Response:

$PASHR,POS,0,06,183805:00,3722.36221,N, 12159.82742, W, +00016.06,179.22,021.21,+003.96+34,06.1,04.2,03.2,01.4,GA00*cc

Table 4.100 describes a typical POS response message.

Table 4.100. Typical POS Response Message

Item	Description
$PASHR,POS	Header
0	Position is autonomous
06	Number of satellites used in position computation
183805.00	Time of position computation
3722.36221	Latitude
N	North
12159.82742	Longitude
W	West
+00016.06	Altitude in meters
empty field	Reserved
179.22	Course over ground in degrees (True)
021.21	Speed over ground in knots
+003.96	Vertical velocity in meters per second
06.1	PDOP
04.2	HDOP
03.3	VDOP
01.4	TDOP
GA00	Version number
cc	Message checksum in hexadecimal

RMC: Recommended Minimum Course

$PASHS,NME,RMC,x,c,[f]

Enables/disables the output of the NMEA recommended minimum course message which contains time, position, course, and speed data where x is the serial port, and c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable the RMC message on port C.

$PASHS,NME,RMC,C,ON

$PASHQ,RMC,[c],

This command allows you to query the RMC message, where c 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.

$GPRMC

This message contains UTC time, date, position status, latitude, longitude, course and speed over the ground, and magnetic variation. The RMC message is 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*hh

Table 4.101 defines the message format.

Table 4.101. $GPRMC Message Format

Parameter	Description	Range
m1	UTC time of the position fix (hhmmss.ss)	000000.00 to 235959.95
c2	Status of the position fix (always A) • A - Position data is valid • V - Navigation receiver warning	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 ground (knots)	000.0 - 999.9
f8	Course over ground (degrees); referenced to true north	000.0° - 359.9°
d9	Date (ddmmyy)	010100 - 123199
f10	Magnetic variation (degrees)	0.0° - 99.9°

Table 4.101. $GPRMC Message Format (Continued)

Parameter	Description	Range
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)
*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 to 9 and A through F

Typical RMC message:

$GPRMC,213357.20,A,3722.410857,N,12159.773686,W,000.3,102.4,290498,15.4,W *43

Table 4.102 describes the typical RMC response message.

Table 4.102. Typical RMC Message

Parameter	Description
213357.20	UTC time of the position fix (hhmmss.ss)
A	Valid position
3722.410857	Latitude
N	North latitude ddmm.mmmmmm
12159.773686	Longitude ddmm.mmmmmm
W	West longitude
000.3	Speed over ground, knots
102.4	Course over ground, degrees True
290498	29 April 1998
15.4	Magnetic variation, degrees
W	Westerly variation (add to the true course)
*43	Checksum

RRE: Satellite Range Residuals and Position Error

$PASHS,NME,RRE,x,c,[f]

Enable/disable satellite residual and position error message to port x, where x is the output port, and c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The G12 does not output this message unless it computes a position.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable RRE message on port A.

$PASHS,NME,RRE,A,ON

$PASHQ,RRE,[c1]

This command allows you to query for the RRE 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.

$GPRRE

This message contains residual error values for the each pseudorange measurement and RMS values for horizontal and vertical position error. The RRE message is not output unless positions are being computed. Residual errors and position errors are computed only if a minimum of 5 locked satellite's are used to compute position; otherwise zero values are registered in the data fields. The message is output in the format:

$GPRRE,d1,((d2,f1)*d1),f2,f3*hh

Table 4.103 defines the message format.

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

Table 4.103. $GPRRE Message Format

Parameter	Description	Range
d1	The number of satellites used to compute position	0 - 12
d2	PRN number for each of the satellites used in the position computation	1 - 32
f1	Magnitude of the residual range error (meters) for each satellite used in the position computation	-999.9 to +999.9

Commands

Table 4.103. $GPRRE Message Format

Parameter	Description	Range
f2	RMS value for the horizontal position error (meters)	-9999.9 to +9999.9
f3	RMS value for the vertical position error (meters)	

Typical RRE message:

$GPRRE,05,18,000.2,29,000.2,22,-000.1,19,-000.1,28,000.5, 0002.0,0001.3*76

Table 4.104 describes the typical RRE response message.

Table 4.104. Typical RRE Message

Field	Description
$GPRRE	Header
05	Number of satellites used to compute position
18	PRN of first satellite
000.2	Range residual for first satellite (meters)
29	PRN of second satellite
000.2	Range residual for second satellite (meters)
22	PRN of third satellite
-000.1	Range residual for third satellite (meters)
19	PRN of fourth satellite
-000.1	Range residual for fourth satellite (meters)
28	PRN of fifth satellite
000.5	Range residual for fifth satellite (meters)
0002.0	Horizontal position error (meters)
0001.3	Vertical position error (meters)
*76	Checksum

SAT: Comprehensive Satellite Tracking Data

$PASHS,NME,SAT,x,y,[f]

Enable/disable satellite status message on port x, where x is the output port, and y is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The G12 does not output this message unless it computes a position.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enable SAT message on port B.

$PASHS,NME,SAT,B,ON

$PASHQ,SAT,[c1]

This command allows you to query for the SAT 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.

$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

Table 4.105 defines the response message.The data fields for PRN number (d2), azimuth (d3), elevation (d4), signal to noise ratio (d5), and the used/not used flag (c6) are repeated for each satellite, using the value in the d1 field as a multiplier.

Table 4.105. $PASHR,SAT Message Format

Field	Description	Range
d1	The number of satellites locked by the receiver	1 - 12
d2	Satellite PRN number	1 - 32
d3	Satellite azimuth angle	0° - 359°
d4	Satellite elevation angle	0° - 90°
d5	Satellite signal-to-noise ratio (dbHz)	30-55

Table 4.105. $PASHR,SAT Message Format (Continued)

Field	Description	Range
c6	Indicates whether the locked satellite is used in position computations: • U—Used, position not computed • A dash (-) indicates that the satellite is not being used in position computations • M—Satellite NOT used because of low elevation • S—Satellite NOT used because the pseudorange is not settled (transient is not over) • H—Satellite NOT used because marked 'unhealthy' in ephemeris • B—Satellite NOT used because of bad URA (or some accuracy problem indicated in navigational data) • Z—Satellite NOT used because marked 'unhealthy' in almanac • D—Satellite NOT used because differential corrections are old or invalid • J—Satellite NOT used because big code outlier was detected • R—Satellite NOT used because RAIM or some other algorithm detected a pseudorange bias. • I—Satellite NOT used because SV disabled by external command SVP,USP) • L—Satellite NOT used because Signal To Noise Ratio is less than Mask • G—Satellite NOT used because it's possibly a ghost satellite • V—Satellite NOT used because computed satellite coordinates are suspicious • N—Satellite NOT used because satellite true number unknown (for modes, where we need the true SV number • K—Satellite NOT used because it was disabled by RTK engine (N/A in G12) • O—Satellite NOT used because of some other case • E—Satellite NOT used because no navigational data (ephemeris) is available	
*hh	Checksum	2-character hex

The SAT message displays more information on unused satellites. Used satellites are indicated with a U and unused satellites, by default, are indicated with a -. If you enable the satellite usage indicator, SUI, switch, a variety of flags display instead of a - to indicate the reason why the respective satellite is not used in the solution.

Typical SAT message:

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

Table 4.106 describes the typical SAT response message.

Table 4.106. Typical SAT Message

Field	Description
$PASHR,SAT	Header
03	Number of satellites 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

TCM: Differential Remote Station Status

$PASHS,NME,TCM,x,c,[f]

This command enables or disables the RTCM rover data message, where x is the port, A or B, and c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,TCM,[c1]

This command allows you to query the TCM 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.

$PASHR,TCM

The TCM message contains status information for the remote differential station as well as information on the transmitting base station, such as the base station ID number, base station health, remote station synchronization status, the RTCM message type being received, a quality indicator for message reception, and age of correction. the response is output in the format:

$PASHS,NME,TCM,d1,d2,d3,d4,f5,d6,d7*hh

Table 4.107 defines the response message.

Table 4.107. $PASHS,NME,TCM Response Structure

Parameter	Description	Range
d1	Message synchronization indicator: • 0 - synchronization between base and remote not established or lost. • 1 - synchronization established between base and remote	0, 1
d2	RTCM message type received by the remote	1, 2, 3, 6, 9, 16
d3	Base station ID number	0 - 1023
d4	Base station health indicator	
f5	Modified Z count (seconds; variable length number) with range between 0 and 3599.4 seconds	0 - 3599.4D
d6	Message reception quality indicator. Message reception quality is defined as follows: (Number of good measurements / total number of measurements)*100	000 - 100
d7	Age of the received correction messages	0 - 99
*hh	Checksum	2-character hex

Typical TCM message:

$PASHR,TCM,1,31,0000,0,2644.0,100,01*28

Table 4.108 describes the typical TCM response message.

Table 4.108. Typical TCM Message

Field	Description
$PASHR,TCM	Header
1	Indicates that the base and remote station are synchronized
31	Indicates that the remote station is receiving RTCM message types 1 and 3
0000	Base station ID number
0	Base station health code
2644.0	Z count
100	Indicates that message reception quality is 100%
01	Indicates that the age of the correction messages is one second
*28	Checksum

TTT: Photogrammetry Event Marker

$PASHS,NME,TTT,x,c,[f]

Enable/disable event marker message on port x, where x is the output port, c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed. This message is not output unless a photogrammetry pulse is being input, and the photogrammetry option (E) is available in the receiver.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to enable TTT message on port A

$PASHS,NME,TTT,A,ON

There is no query command for TTT.

$PASHR,TTT

The response message is in the form:

$PASHR,TTT,d1,m1*cc

The time displayed in the TTT message depends upon the selected constellation. If SYS=MIX, the time depends upon the setting of the TSC parameter. If SYS=GPS, the time is GPS. IF SYS=GLO, the time is UTC + 3 hours.

Table 4.109 defines the TTT response message structure.

Table 4.109. $PASHR,TTT Message Format

Field	Description	Range
d1	Day of GPS week (Sunday = 1; Monday = 2; Tuesday = 3; etc.)	1 - 7
m2	Time at which the pulse was input (hhmmss.ss)	000000.00 to 235959.90
*hh	Checksum	2-character hex

Example

Enter the following command to enable TTT event marker on port A

Set: **$PASHS,NME,TTT,A,ON**

Typical response: $PASHR,TTT,6,20:41:02.0000000*OD

Table 4.110 describes the example TTT response message.

Table 4.110. Example TTT Response Message

Item	Description
$PASHR,TTT	Header
6	Day of week (Friday)
20:41:02.000000 0	Time
OD	Message checksum in hexadecimal

UTM: Universal Transverse Mercator (UTM) - Ext. Mem. G12 Only

$PASHS,NME,UTM, x,s,[f]

Enable/disable UTM message on port x, where x is the output port, and y is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The G12 does not output this message unless it computes a position.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,UTM,[c]

This command allows you to query the UTM message, where c 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.

$PASHR,UTM

This message is not output unless positions are being computed. The UTM message contains position rendered in UTM coordinates, plus UTC time, the number of satellites used to compute the position, the mode of the position fix (i.e., autonomous or corrected), and more. The message is output in the format:

$PASHR,UTM,m1,m2,f3,f4,d5,d6,f7,f8,c9,f10,c11,d12,s13*hh

Table 4.111 defines the message format.

Table 4.111. $PASHR,UTM Message Format

Parameters	Description	Range
m1	UTC of position in hours, minutes, and decimal seconds (hhmmss.ss)	0 - 235959.50
m2	Zone number for the coordinates	1-60, 99 N(orth) S(outh)
f3	East UTM coordinate (meters)	-9999999.999 to +9999999.999
f4	North UTM coordinate (meters)	-9999999.999 to +9999999.999
d5	Position fix mode indicator. 2 - Autonomous 3 - RTCM differential	2, 3
d6	Number of GPS satellites being used to compute positions	3 - 12
f7	Horizontal dilution of precision (HDOP)	0.00 - 999.9
f8	Antenna height (meters)	-99999.999 to +99999.999
M	Antenna height units	M= meters
f9	Geoidal separation in meters	±999.999
M	Geoidal separation units (meters)	M(eters)
d10	Age of differential corrections	0 - 999
d11	Differential reference station ID	4 character string
*hh	Checksum	

The antenna altitude is either ellipsoidal (default) or geoidal (mean-sea-level) depending on the selection made with $PASHS,HGT (see UCT section). The geoidal altitude can be also derived by subtracting the geoidal separation from the ellipsoidal altitude.

Typical UTM message:

$PASHR,UTM,015454.00,10S,588757.623,4136720.056,2,04,03.8, 00012.123,M,-031.711,M,014,1010*3A

Table 4.112 describes the typical UTM response message.

Table 4.112. Typical UTM Message

Item	Description
015454.00	UTC time
10S	UTM zone 10; southern hemisphere
588757.623	UTM easting coordinate
4136720.056	UTM northing coordinate
2	Autonomous
04	Number of satellites used to compute position
03.8	HDOP
00012.123	altitude
M	Altitude units (meters)
-031.711	geoidal separation
M	geoidal separation units (meters)
014	age of corrections
1010	Differential Station ID
*3A	Checksum

VTG: Course and Speed Over Ground

$PASHS,NME,VTG,x,c,[f]

Enable/disable the velocity/course message on port x, where x is the output port, and c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending upon the measurement update rate option installed.

The G12 does not output this message unless it computes a position.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command. If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enable VTG message or port B.

$PASHS,NME,VTG,B,ON

$PASHQ,VTG,[c1]

This command allows you to query the VTG 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.

$GPVTG

This message is not output unless positions are being computed. The VTG contains course over ground referenced to both true and magnetic north, and speed over ground 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*hh

Table 4.113 defines the message format.

Table 4.113. $GPVTG Response Structure

Field	Description	Range
f1	Course over ground; referenced to true north	000.00° to 359.99°
c2	North reference indicator (always T; true north)	T
f3	Course over ground; referenced to magnetic north	000.00° to 359.99°
c4	North reference indicator (always M; magnetic north)	M
f5	Speed over ground (knots)	000.00 to 999.99
c6	Speed unit of measure (always N; nautical miles per hour)	N
f7	Speed over ground (kilometers per hour)	000.00 to 999.99
c8	Speed unit of measure (always K; KPH)	K
*hh	Checksum	2-character hex

Typical VTG message:

$GPVTG,179.00,T,193.00,M,000.11,N,000.20,K*3E

Table 4.114 describes the typical VTG response message.

Table 4.114. 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
*3E	Checksum

ZDA: Time and Date

$PASHS,NME,ZDA,x,c,[f]

Enable/disable the time and date message or port x, where x is the output port, and c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The G12 does not output this message unless it computes a position.

If the command is set without a period, the G12 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to disable ZDA message on port A.

$PASHS,NME,ZDA,A,OFF

$PASHQ,ZDA,[c1]

This command allows you to query for the ZDA 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.

$GPZDA

This message is 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

Table 4.115 defines the message format.

Table 4.115. $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)	-13 to +13
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	00 - 59
*hh	Checksum	2-character hex

Typical ZDA message:

$GPZDA,222835.10,21,07,1999,-07,00*4D

Table 4.116 describes the typical ZDA response message.

Table 4.116. Typical ZDA Message

Field	Description
$GPZDA	Message header
222835.10	Current UTC time
21	Current day
07	Current month
1999	Current year
-07	Local time zone offset from UTC (hours)
00	Local time zone offset from UTC (minutes)
4D	Checksum

RTCM Commands

RTCM commands allow you control and monitor operation in differential mode. RTCM commands are available if the differential options are installed. If only the base station option [B] is installed, only commands controlling base station parameters are available when setting the receiver for differential operation. If only the remote differential option [U] is installed, only commands controlling remote station parameters are available when setting the receiver for differential operation. Both options must be installed in order for base station commands and remote station commands to be available to the receiver. **Please note that when the G12 is set as an RTCM base or rover, the port which is designated to output or receive differential corrections can no longer be used to communicate with the receiver.** If the receiver has been set to output RTCM corrections through port A, you will only be able to communicate with the receiver through port B. You must disable differential mode in order to resume communication with the receiver through port A. The RTCM mode is off by default.

All but one of the RTCM commands are set commands. The set commands allow you to enable and modify a variety of parameters affecting differential operation. There is only one query command: **$PASHQ,RTC**. This command is used to monitor differential parameters and status. Table 4.117 lists the RTCM commands.

Table 4.117. RTCM Response Message Commands

Function	Command	Description	Page
Base station parameters	$PASHS,RTC,BAS	Sets receiver to operate as differential base station	191
	$PASHS,RTC,IOD	Set ephemeris data update for RTCM base	192
	$PASHS,RTC,MSG	Defines RTCM type 16 message (base to remote)	193
	$PASHS,RTC,SPD	Sets baud rate of base station	197
	$PASHS,RTC,STH	Sets health of reference station	198
	$PASHS,RTC,TYP	Enable/disable RTCM message types	199
Remote station parameters	$PASHS,RTC,AUT	Turns auto differential mode on or off	191
	$PASHS,RTC,MAX	Sets maximum age of RTCM differential corrections	192
	$PASHS,RTC,REM	Sets receiver to operate as differential remote station	193
	$PASHS,RTC,SEQ	Checks sequence number of received messages	196

Table 4.117. RTCM Response Message Commands (Continued)

Function	Command	Description	Page
General parameters	$PASHS,RTC,OFF	Disables differential mode	193
	$PASHS,RTC,STI	Sets station identification of base or remote	198
	$PASHQ,RTC	Requests base or remote differential mode parameters and status	194

AUT: Automatic Differential Mode

$PASHS,RTC,AUT,s1

This command allows you to enable or disable automatic differential mode, where s1 is Y (enabled) or N (disabled). When auto differential mode is enabled, the receiver outputs raw positions automatically if differential corrections are older than the maximum age setting, or when differential corrections are not available. When auto differential mode is disabled, the receiver stops outputting positions when the age of the differential correction exceeds the maximum age setting or when differential corrections are not available, and does not resume position output until it receives RTCM corrections with age values lower than the maximum or differential mode is disabled. The automatic differential setting applies to remote differential stations only. You can view the current automatic differential setting by entering the **$PASHQ,RTC** command and checking the AUT field.

Example

Enter the following command to turn auto differential mode on:

$PASHS,RTC,AUT,Y

DEFAULT SETTING
RTC,AUT— Y

BAS: Set Receiver in Differential Base Station Mode

$PASHS,RTC,BAS,c1

This command allows you to set the G12 to operate as an RTCM differential base station, where c1 designates the output port (A or B) for differential corrections. You can view the current RTCM mode setting by entering the **$PASHQ,RTC** command and checking the MODE field.

Example

Enter the following command to set the receiver as an RTCM base station outputting differential corrections from port B:

$PASHS,RTC,BAS,B

IOD: Ephemeris Data Update Rate for RTCM Base Station

$PASHS,RTC,IOD,d

This command allows you to set the time period before the RTCM base station switches to a new issue of the ephemeris data (IODE) where d is the time between 0 and 90 seconds. The default is 30 seconds.

This message is applicable to receivers in RTCM BASE mode only. A base receiver continues to transmit corrections on the old ephemeris in the navigation solution until it receives RTCM corrections on the new IODE.

$PASHQ,RTC,IOD,[x]

This command allows you to query for the time period for when the RTCM base station switches to a new issue of the ephemeris data, where x 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.

The response is in the format:

$PASHR,RTC,IOD,d*cc

where d is the set IOD switch period in seconds.

MAX: Maximum Age Threshold for Differential Corrections

$PASHS,RTC,MAX,d1

This command allows you to set the maximum age for incoming RTCM differential corrections, where d1 is any number between 1 and 1199. The receiver ignores incoming corrections whose age exceeds the maximum age setting. The default value is 60. The maximum age setting applies to remote differential stations only. You can view the current maximum age setting by entering the query command **$PASHQ,RTC** and checking the MAX field.

Enter the following command to set the maximum age to 30 seconds:

$PASHS,RTC,MAX,30

DEFAULT SETTING
RTC,MAX— 60

MSG: Define RTCM Type 16 Message

$PASHS,RTC,MSG,s1

This command allows you to define an ASCII message of up to 90 characters which can be enabled for broadcast by the RTCM base station. The contents of this message can be obtained in different ways depending on whether the receiver is configured as a base station or a remote station. In the case of the base station, you can issue the commands $PASHQ,RTC or $PASHQ,MSG. The type 16 message must be enabled for output in order to use the MSG query to get the contents of the type 16 message when the receiver is configured as a base station. In the case of the remote station, only the MSG query can be used to obtain the contents of a type 16 message broadcasted from a base station.

Example

Enter the following command to create a type 16 message stating, “This is a test message”:

$PASHS,RTC,MSG,THIS IS A TEST MESSAGE

OFF: Disable Differential Operation

$PASHS,RTC,OFF

This command allows you to disable differential operation, whether the receiver is set as a base station or a remote station. You can view the current RTCM mode setting by entering the **$PASHQ,RTC** command and checking the MODE field.

REM: Set Receiver in Differential Remote Station Mode

$PASHS,RTC,REM,c1

This command allows you to set the G12 to operate as an RTCM differential remote station. The c1 parameter designates the input port (A or B) for differential corrections. You can view the current RTCM mode setting by entering the **$PASHQ,RTC** command and checking the MODE field.

Example

Enter the following command to set receiver as a differential remote station with port B designated as the input port for RTCM differential corrections:

$PASHS,RTC,REM,B

Once a port is set to receive RTCM corrections, it will longer accept other incoming communications.

RTC: Query RTCM Operating Parameters and Status

$PASHQ,RTC,[c1]

This command allows you to query for differential parameter settings and status, 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.

The response message has a free-form Ashtech proprietary format. Like the PAR response message, the RTC response message does not have a header or message identifier as shown in the following example:

```
STATUS:
SYNC:   TYPE:00 STID:0000 STHE:0
AGE:+000 QA:100.0% OFFSET:00
SETUP:
MODE:OFF PORT:A AUT:N
SPD: 0300 STI:0000 STH:0
MAX: 0060 QAF:100 SEQ:N
TYP:01 02 03 06 09 16
FRQ:99 00 00 ON 00 00
BASE: LAT:0000.0000,N LON:00000.00000,W ALT:+00000.00
MSG:
THIS IS A TEST MESSAGE
```

Table 4.118 describes the items in the RTC response message:

Table 4.118. RTC Response Format

Parameter	Description	Range
STATUS	This subsection of the RTC response contains status information related to the performance of the remote differential station, such as message synchronization status, the type of message being received, the ID number of base station broadcasting the corrections, etc. SYNC, TYPE, STID, STHE, AGE, QA, and OFFSET fall into this subsection	
SYNC:	An asterisk (*) appearing in this field indicates that synchronization between base and remote has been established. Synchronization has not been established if this field is blank. This field applies to remote differential mode only	*
TYPE:	Indicates type of message being received by the remote station	1, 2, 3, 6, 9, 16
STID:	The ID number of the differential base station. This ID number is received from the base station	0000 - 1023
STHE:	This code number indicates the health of the base station	0 - 7

Table 4.118. RTC Response Format (Continued)

Parameter	Description	Range
AGE:	In base station mode, this field indicates the elapsed time in seconds between the transmission of Type 1 or 9 messages. In remote station mode, this field indicates the age of the received messages in seconds	1 - 999
QA:	The communication quality factor between base and remote. Defined as (number of good messages received/total number of messages) x 100 total number of messages. This field applies to remote differential mode only	000.0% to 100.0%
OFFSET	The number of bits from the beginning of the RTCM byte (in case of a bit slippage)	
SETUP	This subsection of the RTC response message contains status information related to RTCM parameter settings, such as the operating mode, the RTCM messages enabled for output, the port assigned to receive or transmit differential corrections, etc. MODE, PORT, AUT, SPD, STI, STH, MAX, QAF, SEQ, TYP, FRQ, BASE, and MSG fall into this subsection	
MODE	Indicates the current differential mode. The default setting is OFF	BAS, REM, OFF
PORT	Indicates which port (A or B) is being used for receiving or transmitting RTCM corrections	A, B
AUT	Indicates whether automatic differential mode is enabled (Y) or disabled (N). The default setting is N. This field applies to remote station mode only	Y, N
SPD	Indicates the current rate of output for RTCM corrections in bits per second (bps). The default output rate is 300 bps. This field applies to base station mode only	25 - 1500
STI	The differential station ID number. The ID number is a user-entered parameter. A remote station with an ID number of 0000 can receive corrections from any RTCM base station. Otherwise, the remote station must be programmed with the same ID number as the base station the in order to receive corrections from that base station. The default ID number is 0000	0000 - 1023
STH	Code number indicating the health of the base station. This code number is a user-entered parameter. This field applies to base station mode only	0 - 7
MAX	The maximum age (seconds) of a received differential correction, above which the remote station will not use the correction. The maximum age setting is a user-entered parameter. The default setting is 60 seconds. This field applies to remote station mode only	1 - 1199
QAF	The multiplier value used to calculate the QA value. Always 100. This field applies to remote station mode only	100

Table 4.118. RTC Response Format (Continued)

Parameter	Description	Range
SEQ	Indicates whether the remote station is checking (Y) or not checking (N) the sequence numbers of the received RTCM correction messages. When SEQ is enabled, the remote station will not output corrected positions until is receives two sequential corrections. The default setting is N. This field applies to remote station mode only	Y, N
TYP	The RTCM message types supported by the G12	1, 2, 3, 6, 9, 16
FRQ	Indicates the output interval setting for each RTCM message except for the type 6 message, which is either ON or OFF. Zero (0) indicates the message is disabled; 99 indicates continuous output. The output interval unit of measure for message types 1 and 9 is seconds; the output interval for unit of measure for message types 2, 3, and 16 is minutes. The default output interval setting is 99 for the type 1 message, OFF for the type 6 message, and 00 for all other RTCM messages	0 - 99; ON, OFF
BASE	The base station reference position, used to calculate corrections. The reference position is entered the POS command set commands. If no position has been entered, this field displays all zeroes. This field applies to base station mode only	Latitude: 0° - 90° Longitude: 0° - 180°
MSG	This field contains the text entered for the type 16 message. The text in the type 16 message is entered by the user through the $PASHS,RTC,MSG command. This field applies to base station mode only	Up to 90 characters

SEQ: Verify RTCM Message Sequence

$PASHS,RTC,SEQ,c1

This command allows you to enable or disable a check on the sequence number of received RTCM correction messages, where c1 is Y (on) or N (off). When SEQ is enabled, the remote station must receive two sequential RTCM correction messages before it starts applying the corrections. This condition is in effect only at beginning of differential operation, and applies to remote station mode only. You can see whether message sequence monitoring is enabled or disabled by entering the **$PASHQ,RTC** command and checking the SEQ field.

Example

Enter the following command to enable a check of RTCM message sequence:

$PASHS,RTC,SEQ,Y

DEFAULT SETTING
RTC,SEQ— N

SPD: Baud Rate for RTCM Message Output

$PASHS,RTC,SPD,d1

This command allows you to set the base station's output rate for RTCM messages in bits per second (bps), where d1 is a code number between 0 and 8. Table 4.119 lists the available bit rates and corresponding codes. The default output bit rate is 300 bps. This command applies to base station mode only. You can view the current output bit rate setting by entering the **$PASHQ,RTC** command and checking the SPD field.

Table 4.119. Available Output Bit Rates for RTCM Messages

Code	Rate
0	25
1	50
2	100
3	110
4	150
5	200
6	250
7	300
8	1500

DEFAULT SETTING
RTC,SPD— 300

Example

Enter the following command to set the output bit rate for RTCM messages to 1500 bits per second:

$PASHS,RTC,SPD,8

STH: Differential Base Station Health

$PASHS,RTC,STH,d1

This command allows you to set the health of the base station, where d1 is a code number between 0 and 7. The health states and the corresponding codes are listed in Table 4.120. This command applies to base station mode only. You can view the current base station health setting by entering the **$PASHQ,RTC** command and checking the STH field.

Table 4.120. $PASHS,RTC Health of Reference

Code	Base Station Health Status
7	Reference station not working
6	Reference station transmission not monitored
5	Specified by service provider
4	Specified by service provider
3	Specified by service provider
2	Specified by service provider
1	Specified by service provider
0	Specified by service provider

Example

Enter the following command to set the base station health code to indicate that the base station is not working:

$PASHS,RTC,STH,7

DEFAULT SETTING
RTC,STH— 0

STI: Differential Base/Remote Station ID

$PASHS,RTC,STI,d1

This command allows you to set differential station identification numbers, where d1 is any number between 0000 and 1023. A remote station with the ID number 0000 can receive corrections from any RTCM base station; otherwise, the remote station must be programmed with the same ID number as the base station in order to receive corrections from that base station.

Example

Enter the following command to set the differential station ID number to 0001:

$PASHS,RTC,STI,0001

DEFAULT SETTING
RTC,STI— 0000

TYP: Enable/Disable Output of RTCM Message Types

$PASHS,RTC,TYP,d1,d2

This command allows you to enable or disable the output of specific RTCM message types as well as the message output interval, where d1 is the type number and d2 is value of the output interval. This command applies to base station mode only. Table 4.121 lists the available message types range of the output interval setting.

Table 4.121. $PASHS,RTC,TYP Message Types

Type	Range
01	0-99 seconds, where 0 is disabled and 99 is generated continuously
02	0-99 minutes, where 0 is disabled and 99 is generated continuously
03	0-99 minutes, where 0 is disabled and 99 is generated continuously
06	1 = ON, 0 = OFF Default = OFF
09	same as type 1
16	same as type 3

All messages, except for 01 and 09, can be enabled simultaneously with any output period setting. Default is type 6 OFF, type 1 set to 99, and all others set to 00 (disabled).

RTCM type 1 correction with a UDRE (User Differential Range Error) field set to 3 (one-sigma differential error > 8 meters) are no longer used.

Example

Enter the following command to enable the type 1 message once per second:

$PASHS,RTC,TYP,1,1

DEFAULT SETTING		
RTC,TYP	**Type 1**	**99**
	Type 2	**00**
	Type 3	**00**
	Type 6	**OFF**
	Type 9	**00**
	Type 16	**00**

A

G12 and Sensor II: Differences and Compatibility

The G12 command structure has been kept as close as possible to that of Sensor II, while allowing for the increased capabilities of the G12.

Most $PASHS commands are the same for both receivers, but there are differences. For example, the Sensor II can support RTCM and Ashtech differential modes, while the G12 supports RTCM only. Further, because G12 has many new features, there are a significant number of new $PASHS commands.

$PASHR response messages are different in most cases. This is due to the presence of additional features and operational parameter settings in the G12. For example, the Sensor II can only be set as a remote station, while the G12 can be set as a base or remote station, so the response to the query command **$PASHQ,RTC** (query RTCM operating parameters and status) is different. Responses for the **$PASHQ,PAR, $PASHQ,RAW**, and **$PASHQ,RID** query commands are also different for the G12.

Raw data output formats are the same for the Sensor II and the G12, but the G12 can output additional raw messages not available for Sensor II: CT1, CT2, CT3, MCA, and MCM. NMEA message output formats for both receivers are in compliance with NMEA 2.0 standards, but the resolution in certain fields of some messages is different.

Table A.1. shows the connector pin configuration differences between the G12 and Sensor II.

Table A.1. G12 and Sensor II Connector Pin Configurations

Pin	Sensor II	G12
1	GND Ground for serial port A	GND Ground for serial port A
2	CTSA RS-232 port A clear to send	CTSA RS-232 port A clear to send
3	TXDA RS-232 port A transmit data	TXDA RS-232 port A transmit data
4	RTSA RS-232 port A request to send	RXSA RS-232 port A request to send
5	RXDA RS-232 port A receive data	RXDA RS-232 port A receive data
6	Ashtech internal use only (leave floating)	Ashtech internal use only (leave floating)
7	GND Ground for serial port B	Ground for serial port B
8	CTSB RS-232 port B clear to send	CTSB RS-232 serial port B clear to send
9	TXDB RS-232 port B transmit data	TXDB RS-232 port B transmit data
10	RTSB RS-232 port B request to send	RTSB RS-232 port B request to send
11	RXDB RS-232 port B receive data	RXDB RS-232 port B receive data
12	Ashtech internal use only (leave floating)	Ashtech internal use only (leave floating)
13	+5VDC input	+5 VDC input
14	+5VDC input	+5 VDC input
15	BATT_IN 3-3½-volt battery backup for memory	BATT_IN 2.5-3.5 volt battery backup for memory and real-time clock
16	Ashtech internal use only (leave floating)	Ashtech internal use only (leave floating)
17	MAN_RES* Connect to ground for manual hardware reset	MAN_RES* Connect to ground for manual hardware reset
18	1PPS_OUT 1 pps TTL output synchronized to GPS time	1PPS_OUT 1 pps TTL output synchronized to GPS time
19	GND Sensor II-S chassis common ground	GND G12 chassis common ground
20	GND Sensor II-S chassis common ground	GND G12 chassis common ground
21		LED_RED External LED control
22		LED_GRN External LED control
23		MSTR_OUT Measurement strobe output
24		G12 chassis common ground
25		VARF_OUT Variable frequency output

Table A.1. G12 and Sensor II Connector Pin Configurations (Continued)

Pin	Sensor II	G12
26		GND G12 chassis common ground
27		PHOTO-IN Photogrammetry pulse input
28		Ashtech internal use only (leave floating)
29		Ashtech internal use only (leave floating)
30		Ashtech internal use only (leave floating)

B

Floating Point Data Representation

The G12 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), 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 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 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), 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 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 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).

C

Global Product Support

If you have any problems or require further assistance, the Customer Support team can be reached through the following:

- telephone
- email
- Internet

Please refer to the documentation before contacting Customer Support. Many common problems are identified within the documentation and suggestions are offered for solving them.

Magellan customer support:

471 El Camino Real

Santa Clara, California

USA, 95050-4300

Toll-free Voice Line: 1-800-229-2400

Local and International Voice Line: +1 408-615-3980

Fax Line: +1 408-615-5200

Email: support@ashtech.com or support@magellangps.com

Magellan Europe Ltd. Reading, UK

Voice: +44-118-931-9600

Fax: +44-118-931-9601

Magellan South America

Voice: +56 2 234 56 43

Fax: +56 2 234 56 47

Solutions for Common Problems

- Check cables and power supplies. Many hardware problems are related to these components.
- If the problem seems to be with your computer, re-boot it to clear the system's RAM memory.
- If you are experiencing receiver problems, reset the receiver as documented in the set commands section of this manual. Note that the reset command clears receiver memory and resets operating parameters to factory default values.
- Verify that batteries, including the backup battery for RAM memory, have adequate charge.
- Verify that the antenna is oriented skyward and is unobstructed by trees, buildings, or other objects overhead.

If these suggestions don’t solve the problem, contact the Customer Support team. To assist the Customer Support team, please have the following information in hand:

Table C.1. GPS Product Information

Information Category	Your actual numbers
Receiver model	
Receiver serial #	
Software version #	
Firmware version #	
Options*	

Table C.1. GPS Product Information

Information Category	Your actual numbers
A brief description of the problem	
* The firmware version # and options can be obtained using the $PASHQ,RID (receiver identification) command.	

Corporate Web Page

You can obtain data sheets, GPS information, application notes, and a variety of useful information from Ashtech's Internet web page. In addition, you can locate additional support areas such as frequently asked questions (FAQs). Use the internet addresses below:

http://www.ashtech.com

http://www.magellangps.com

Repair Centers

In addition to repair centers in California and England, authorized distributors in 27 countries can assist you with your service needs.

Magellan Corp.
471 El Camino Real
Santa Clara, California   95050-4300   USA
Voice: (408) 615-3980
or (800) 229-2400
Fax: (408) 615-5200
E-mail: support@ashtech.com
or support@magellangps.com

Ashtech Europe Ltd.
First Base, Beacontree Plaza
Gillette Way
Reading RG2 OBP
United Kingdom
TEL: 44 118 931 9600
FAX: 44 118 931 9601

Glossary

A

Aerotriangulation (phototriangulation)
A complex process vital to aerial **Photogrammetry** that involves extending vertical and/or horizontal control so that the measurements of angles and/or distances on overlapping photographs are related to a spatial solution using the perspective principles of the photographs. Aerotriangulation consists of mathematically extending the vectors/ angles of the triangular pattern of known reference points on or near the designated photo-block terrain upward through a rectangle representing the area of the photo-block (as seen by the camera's optical center) in such a way that the tree-point terrain triangle and the camera's eye three-point triangle (within the photographic frame) are analogous.

AFT
After

AGE
Age of Data

ALM
See **Almanac**

Almanac
A set of parameters used by a GPS receiver to predict the approximate locations of all GPS satellites and the expected satellite clock offsets. Each GPS satellite contains and transmits the almanac data for all GPS satellites (See **Ellipsoid**).

ALT
Altitude

Ambiguity
The initial bias in a carrier-phase observation of an arbitrary number of carrier cycles; the uncertainty of the number of carrier cycles a receiver is attempting to count. If wavelength is known, the distance to a satellite can be computed once the number of cycles is established via carrier-phase processing.

AMI
ATM Management Interface

ANT
Antenna

Antenna

A variety of GPS antennas ranging from simpler microstrip devices to complex choke ring antennas that mitigate the effects of multipath scattering.

Anti-Spoofing (AS)

The process of encrypting the P-Code modulation sequence so the code cannot be replicated by hostile forces. When encrypted, the P-Code is referred to as the Y-Code.

ASCII

American Standard Code for Information Interchange. A set of characters (letters, numbers, symbols) used to display and transfer digital data in human-readable format.

Atomic clock

A clock whose frequency is maintained using electromagnetic waves that are emitted or absorbed in the transition of atomic particles between energy states. The frequency of an atomic transition is very precise, resulting in very stable clocks. A cesium clock has an error of about one second in one million years. For redundancy purposes, GPS satellites carry multiple atomic clocks. GPS satellites have used rubidium clocks as well as cesium clocks. The GPS Master Control Station uses cesium clocks and a hydrogen master clock.

Argument of latitude

The sum of the true anomaly and the argument of perigee.

Argument of perigee

The angle or arc from the ascending node to the closest approach of the orbiting body to the focus or perigee, as measured at the focus of an elliptical orbit, in the orbital plane in the direction of motion of the orbiting body.

Ascending node

The point at which an object's orbit crosses the reference plane (e.g., equatorial plane) from south to north.

Azimuth

A horizontal direction expressed as the angular distance between a fixed direction and the direction of the object.

AZM

See Azimuth

B

Bandwidth

A measure of the information-carrying capacity of a signal expressed as the width of the spectrum of that signal (frequency domain representation) in Hertz.

Baseline

The measured distance between two receivers or two antennas

Bias

See **Integer bias terms**

BIN

Binary Index (file)

C

C/A

Coarse Acquisition

C/A code

A sequence of 1023 bits (0 or 1) that repeats every millisecond. Each satellite broadcasts a unique 1023-bit sequence that allows a receiver to distinguish between various satellites. The C/A-Code modulates only the L1 carrier frequency on GPS satellites. The C/A-Code allows a receiver to Carrier frequency

The basic frequency of an unmodulated radio signal. GPS satellite navigation signals are broadcast on two L-band frequencies, L1 and L2 is at 1575.42 Mhz, and L2 is at 1227.6 Mhz.

Carrier phase

The phase of either the L1 or L2 carrier of a GPS signal, measured by a receiver while locked-on to the signal (also known as integrated Doppler).

CEP

See Circular error probable.

Channel

Refers to the hardware in a receiver that allows the receiver to detect, lock-on and continuously track the signal from a single satellite. The more receiver channels available, the greater number of satellite signals a receiver can simultaneously lock-on and track.

Chip

The length of time to transmit either a zero or a one in a binary pulse code.

Chip rate

Number of chips per second (e.g., C/A code = 1.023 MHz).

Circular Error Probable

A circle's radius, centered at the true antenna position, containing 50% of the points in the horizontal scatter plot.

Clock offset

The difference in time between GPS time and a satellite clock or a sensor clock (less accurate).

COG

Course Over Ground

Constellation

Refers to the collection of orbiting GPS satellites. The GPS constellation consists of 24 satellites in 12-hour circular orbits at an altitude of 20,200 kilometers. In the nominal constellation, four satellites are spaced in each of six orbital planes. The constellation was selected to provoke a very high probability of satellite coverage even in the event of satellite outages.

CTD

Course To Destination

Cycle slip

A loss of count of carrier cycles as they are being measured by a GPS receiver. Loss of signal, ionospheric interference and other forms of interference cause cycle slips to occur.

D

DGPS

See Differential GPS

Differential GPS (DGPS)

A technique whereby data from a receiver at a known location is used to correct the data from a receiver at an unknown location. Differential corrections can be applied in real-time or by post-processing. Since most of the errors in GPS are common to users in a wide area, the DGPS-corrected solution is significantly more accurate than a normal SPS solution.

Differential processing
GPS measurements can be differenced between receivers, satellites, and epochs. Although many combinations are possible, the present convention for differential processing of GPS measurements is to take differences between receivers (single difference), then between satellites (double difference), then between measurement epochs (triple difference). A single-difference measurement between receivers is the instantaneous difference in phase of the signal from the same satellite, measured by two receivers simultaneously. A double-difference measurement is the difference for a chosen reference satellite. A triple-difference measurement is the difference between a double difference at one epoch and the same double difference at the previous epoch.

Differential (relative) positioning
Determination of relative coordinates of two or more receivers which are simultaneously tracking the same satellites. Dynamic differential positioning is a real-time calibration technique achieved by sending corrections to the roving user from one or more reference stations. Static differential GPS involves determining baseline vectors between pairs of receivers.

Dilution of Precision (DOP)
A measure of the receiver-satellite(s) geometry. DOP relates the statistical accuracy of the GPS measurements to the statistical accuracy of the solution. Geometric Dilution of Precision (GDOP) is composed of Time Dilution of Precision (TDOP); and Position Dilution of Precision (PDOP), which are composed of Horizontal Dilution of Precision (HDOP); and Vertical Dilution of Precision (VDOP).

DOP
Dilution of Precision

Doppler aiding
The use of Doppler carrier-phase measurements to smooth code-phase position measurements.

Doppler shift
An apparent change in signal frequency which occurs as the transmitter and receiver move toward or away from one another.

Double difference
The arithmetic differencing of carrier phases measured simultaneously by a pair of receivers tracking the same pair of satellites. Single differences are obtained by each receiver from each satellite; these differences are then differenced in turn, which essentially deletes all satellite and receiver clock errors.

DTD
Distance to Destination

Dynamic positioning
Determination of a timed series of sets of coordinates for a moving receiver, each set of coordinates being determined from a single data sample, and usually computed in real-time.

E

Earth Centered, Earth Fixed (ECEF)
A cartesian coordinate system centered at the earth's center of mass. The Z-axis is aligned with the earth's mean spin axis. The X-axis is aligned with the zero meridian. The Y-axis is 90 degrees west of the X-axis, forming a right-handed coordinate system.

EDOP
Elevation Dilution of Precision

ELEV
Elevation

Elevation
Height above mean sea level. Vertical distance above the geoid.

Elevation mask
An adjustable feature of GPS receivers that specifies that a satellite must be at least a specified number of degrees above the horizon before the signals from the satellite are to be used. Satellites at low elevation angles (five degrees or less) have lower signal strengths and are more prone to loss of lock thus causing noisy solutions.

Elevation mask angle
That angle below which it is not advisable to track satellites. Normally set to 15 degrees to avoid interference problems caused by buildings and trees and multipath reflections.

Ellipsoid
In geodesy, unless otherwise specified, a mathematical figure formed by revolving an ellipse about its minor axis. It is often used interchangeably with spheroid. Two quantities define an ellipsoid; the length of the semimajor axis, a, and the flattening, f =- (a - b)/a, where b is the length of the semiminor axis. Prolate and triaxial ellipsoids are invariably described as such.

Ellipsoid height
The measure of vertical distance above the ellipsoid. Not the same as elevation above sea level. GPS receiver output position fix height in the WGS-84 datum.

Ephemeris
A set of parameters used by a GPS receiver to predict the location of a single GPS satellite and its clock behavior. Each GPS satellite contains and transmits ephemeris data for its own orbit and clock. Ephemeris data is more accurate than the almanac data but is applicable over a short time frame (four to six hours). Ephemeris data is transmitted by the satellite every 30 seconds.

Epoch
Measurement interval or data frequency, as in making observations every 15 seconds. Loading data using 30-second epochs means loading every other measurement.

F

FCC
Federal Communications Commission

Firmware
The coded instructions relating to receiver function, and (sometimes) data processing algorithms, embedded as integral portions of the internal circuitry.

Flattening

$f = (a- b)/a = 1 - (1 - e^2)^{1/2}$ where
a = semimajor axis
b = semiminor axis
e = Eccentricity

G

GDOP

Geometric Dilution of Precision. The relationship between errors in user position and time and in satellite range. $GDOP^2 = PDOP^2 + TDOP^2$. See Position Dilution of Precision.

.

Geodetic datum (horizontal datum)

A specifically oriented ellipsoid typically defined by eight parameters which establish its dimensions, define its center with respect to Earth's center of mass and specify its orientation in relation to the Earth's average spin axis and Greenwich reference meridian.

Geodetic height (ellipsoidal height)

The height of a point above an ellipsoidal surface. The difference between a point's geodetic height and its orthometric height equals the geoidal height.

Geoid

The equipotential surface of the Earth's gravity field which best fits mean sea level. Geoids currently in use are GEOID84 and GEOID90.

Geoidal height (geoidal separation; undulation)

The height of a point on the geoid above the ellipsoid measured along a perpendicular to the ellipsoid.

GLL

Position Latitude/Longitude

GMST

Greenwich Mean Sidereal Time

GPS DIFF

Differential

GPS ICD-200

The GPS Interface Control Document is a government document that contains the full technical description of the interface between the satellites and the user. GPS receiver must comply with this specification if it is to receive and process GPS signals properly.

GPS week

GPS time started at Saturday/Sunday midnight, January 6, 1980. The GPS week is the number of whole weeks since GPS time zero.

Greenwich mean time (GMT)

See universal time. In this text, they are often used interchangeably.

H

HDOP

Horizontal Dilution of Precision. See Dilution of Precision.

HI

Height of Instrument

HTDOP

Horizontal/Time Dilution of Precision. See Dilution of Precision.

I

ID

Identification or Integrated Doppler

Integer bias terms

The receiver counts the carrier waves from the satellite, as they pass the antenna, to a high degree of accuracy. However, it has no information number of waves to the satellite at the time it started counting. This unknown number of wavelengths between the satellite and the antenna is the integer bias term.

Integrated Doppler
A measurement of Doppler shift frequency or phase over time.

Ionosphere
Refers to the layers of ionized air in the atmosphere extending from 70 kilometers to 700 kilometers and higher. Depending on frequency, the ionosphere can either block radio signals completely or change the propagation speed. GPS signals penetrate the ionosphere but are delayed. The ionospheric delays can be predicted using models, though with relatively poor accuracy, or measured using two receivers.

Ionospheric delay
A wave propagating through the ionosphere [which is a nonhomogeneous (in space and time) and dispersive medium] experiences delay. Phase delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.

J

Julian date
The number of days that have elapsed since 1 January 4713 B.C. in the Julian calendar. GPS time zero is defined to be midnight UTC, Saturday/Sunday, 6 January 1980 at Greenwich. The Julian date for GPS time zero is 2,444,244.5.

K

Kinematic surveying
A method which initially solves wavelength ambiguities and retains the resulting measurements by maintaining a lock on a specific number of satellites throughout the entire surveying period.

L

L1
The primary L-band signal radiated by each NAVSTAR satellite at 1575.42 MHz. The LI beacon is modulated with the C/A and P codes, and with the NAV message. L2 is centered at 1227.60 MHz and is modulated with the P code and the NAV message.

L-band
A nominal portion of the microwave electro-magnetic spectrum ranging from 390 MHz to 1.55 GHz.

LNA
Low-Noise Amplifier

M

MSG
RTCM Message

MSL
Mean Sea Level

Multichannel receiver
A receiver containing many independent channels. Such a receiver offers highest

SNR because each channel tracks one satellite continuously.

Multipath

The reception of a signal both along a direct path and along one or more reflected paths. The resulting signal results in an incorrect pseudorange measurement. The classical example of multipath is the "ghosting" that appears on television when an airplane passes overhead.

Multipath error

A positioning error resulting from interference between radio waves which have traveled between the transmitter and the receiver by two paths of different electrical lengths.

Multiplexing

A technique used in some GPS receivers to sequence the signals of two or more satellites through a single hardware channel. Multiplexing allows a receiver to track more satellites than the number of hardware channels at the cost of lower effective signal strength.

Multiplexing channel

A receiver channel which is sequenced through several satellite signals (each from a specific satellite at a specific frequency) at a rate which is synchronous with the satellite message bit-rate (50 bits per second, or 20 milliseconds per bit). Thus, one complete sequence is completed in a multiple of 20 milliseconds.

N

NMEA

National Marine Electronics Association

NV

Non-Volatile. Usually refers to a memory device that retains data after power is removed.

O

Outage

The occurrence in time and space of a GPS dilution of precision value exceeding a specified maximum.

P

Position Dilution of Precision (PDOP)

A unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Geometrically, POP is proportional to 1 divided by the volume of the pyramid formed by lines running from the receiver to four satellites observed. Values considered 'good' for positioning are small, say 3. Values greater than 7 are considered poor. Thus, small PDOP is associated with widely separated satellites. PDOP is related to horizontal and vertical DOP by $PDOP^2 = HDOP^2 + VDOP^2$. Small PDOP is important in positioning, but much less so in surveying.

Photogrammetry

An aerial remote sensing technique whose latest innovations employ a high-resolution aerial camera with forward motion compensation and uses GPS technology for pilot guidance over the designated photo block(s). Photogrammetry forms the baseline of many Geographic Information Systems (GIS) and Land Information System (LIS) studies.

Point positioning
A geographic position produced from one receiver in a stand-alone mode. At best, position accuracy obtained from a stand-alone receiver is 15-25 meters, depending on the geometry of the satellites.

POS
Position

Post-processing
The reduction and processing of GPS data after the data was collected in the field. Post-processing is usually accomplished on a computer in an office environment where appropriate software is employed to achieve optimum position solutions.

Precise Positioning System (PPS)
The more accurate GPS capability that is restricted to authorized, typically military, users.

Pseudo-kinematic surveying
A variation of the kinematic method where roughly five-minute site occupations are repeated at a minimum of once each hour.

Pseudorandom noise (PRN)
The P(Y) and C/A codes are pseudo-random noise sequences which modulate the navigation signals. The modulation appears to be random noise but is, in fact, predictable hence the term "pseudo" random. Use of this technique allows the use of a single frequency by all GPS satellites and also permits the satellites to broadcast a low power signal.

Pseudorange
The measured distance between the GPS receiver antenna and the GPS satellite. The pseudorange is approximately the geometric range biased by the offset of the receiver clock from the satellite clock. The receiver actually measures a time difference which is related to distance (range) by the speed of propagation.

R

RAM
Random-Access Memory. A memory device whose data can be accessed at random, as approved to sequential access. RAM data is lost when power is removed.

Range rate
The rate of change of range between the satellite and receiver. The range to a satellite changes due to satellite and observer motions. Range rate is determined by measuring the doppler shift of the satellite beacon carrier.

RDOP
Relative Dilution of Precision. See Dilution of Precision.

Reconstructed carrier phase
The difference between the phase of the incoming Doppler-shifted GPS carrier and the phase of a nominally constant reference frequency generated in the receiver. For static positioning, the reconstructed carrier phase is sampled at epochs determined by a clock in the receiver. The reconstructed carrier phase changes according to the continuously integrated Doppler shift of the incoming signal biased by the integral

of the frequency offset between the satellite and receiver reference oscillators.

Real-time
Refers to immediate, GPS data collection, processing and position determination (usually) within a receiver's firmware after the fact with a computer in an office environment.

Reference Network
A series of monuments or reference points with accurately measured vectors/distances that is used as a reference basis for cadastral and other types of survey.

Reference station
A point (site) where crustal stability, or tidal current constants, have been determined through accurate observations, and which is then used as a standard for the comparison of simultaneous observations at one or more subordinate stations. Certain of these are known as Continuous Operating Reference Stations (CORS), and transmit reference data on a 24-hour basis.

Relative positioning
The process of determining the relative difference in position between two points with greater precision than that to which the position of a single point can be determined. Here, a receiver (antenna) is placed over each point and measurements are made by observing the same satellite at the same time. This technique allows cancellation (during computations) of all errors which are common to both observers, such as satellite clock errors, propagation delays, etc. See also Translocation and Differential Navigation.

RF
Radio Frequency

RFI
Radio Frequency Interference

RINEX
The Receiver-INdependent EXchange format for GPS data, which includes provisions for pseudorange, carrier-phase, and Doppler observations.

RMS
Root Mean Square. A statistical measure of the scatter of computed positions about a "best fit" position solution. RMS can be applied to any random variable.

RTCM
Radio Technical Commission for Maritime Services
P.O. Box 19087
Washington, DC. 20036-9087

RTCM SC-104 Format
A standard format used in the transmission of differential corrections.

S

Selective Availability (SA)
The process whereby DOD dithers the satellite clock and/or broadcasts erroneous orbital ephemeris data to create a pseudorange error

SEP
See Spherical Error Probable

Sidereal day
Time between two successive upper transits of the vernal equinox.

Sidereal time
The hour angle of the vernal equinox.

Taking the mean equinox as the reference yields true or apparent Sidereal Time. Neither Solar nor Sidereal Time are constant, since angular velocity varies due to fluctuations caused by the Earth's polar moment of inertia as exerted through tidal deformation and other mass transports.

Single difference
The arithmetic differencing of carrier phases simultaneously measured by a pair of receivers tracking the same satellite (between receivers and satellite), or by a single receiver tracking two satellites (between-satellite and receivers); the former essentially deletes all satellite clock errors, while the latter essentially deletes all receiver errors.

Spherical Error Probable (SEP)
A statistical measure of precision defined as the 50th percentile value of the three-dimensional position error statistics. Thus, half of the results are within a 3D SEP value.

Spoofing
The process of replicating the GPS code in such a way that the user computes incorrect position solutions.

SPS
See Standard Positioning Service

Standard Positioning Service (SPS)
Uses the C/A code to provide a minimum level of dynamic- or static-positioning capability. The accuracy of this service is set at a level consistent with national security.

Static observations
A GPS survey technique requiring roughly one hour of observation, with two or more receivers observing simultaneously, and results in high accuracies and vector measurements.

Static positioning
Positioning applications in which the positions of static or near static points are determined.

SV
Satellite Vehicle, Satellite Visibility or Space Vehicle.

Switching channel
A receiver channel which is sequenced through a number of satellite signals (each from a specific satellite and at a specific frequency) at a rate which is slower than, and asynchronous with, the message data rate.

T

TDOP
Time Dilution of Precision. See Dilution of Precision.

TOW
Time of week, in seconds, from midnight Sunday UTC.

Translocation
A version of relative positioning which makes use of a known position, such as a USGS survey mark, to aid in the accurate positioning of a desired point. Here, the position of the mark, determined using GPS, is compared with the accepted value. The three-dimensional differences are then used in the calculations for the second point.

Tropospheric correction.
The correction applied to the measurement to account for tropospheric delay. This value is obtained from the modified Hopfield model.

True anomaly
The angular distance, measured in the orbital plane from the earth's center (occupied focus) from the perigee to the current location of the satellite (orbital body).

U

Universal Time Coordinated (UTC)
Time as maintained by the U.S. Naval Observatory. Because of variations in the Earth's rotation, UTC is sometimes adjusted by an integer second. The accumulation of these adjustments compared to GPS time, which runs continuously, has resulted in an 11 second offset between GPS time and UTC at the start of 1996. After accounting for leap seconds and using adjustments contained in the navigation message, GPS time can be related to UTC within 20 nanoseconds or better.

User Range Accuracy (URA)
The contribution to the range-measurement error from an individual error source (apparent clock and ephemeris prediction accuracies), converted into range units, assuming that the error source is uncorrelated with all other error sources. Values less than 10 are preferred.

UT
Universal Time

UTM
Universal Transverse Mercator Map Projection. A special case of the Transverse Mercator projection. Abbreviated as the UTM Grid, it consists of 60 north-south zones, each 6 degrees wide in longitude.

V

VDC
Volts Direct Current

VDOP
Vertical Dilution of Precision. See Dilution of Precision and Position Dilution of Precision.

W

WGS
World Geodetic System

World Geodetic System 1984 (WGS-84)
A set of U.S. Defense Mapping Agency parameters for determining global geometric and physical geodetic relationships. Parameters include a geocentric reference ellipsoid; a coordinate system; and a gravity field model. GPS satellite orbital information in the navigation message is referenced to WGS-84.

World Geodetic System (WGS-72)
The mathematical reference ellipsoid previously used by GPS, having a semimajor axis of 6378.135 km and a flattening of 1/298.26.

Y

Y-Code

The designation for the end result of P-Code during Anti-Spoofing (AS) activation by DoD.

Y-code tracking, civilian

Signal squaring (now obsolete) multiplies the signal by itself, thus deleting the carrier's code information and making distance measurement (ranging) impossible. Carrier phase measurements can still be accomplished, although doubling the carrier frequency halves the wavelength.

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