GG12-Pro OEM Board Reference Manual

Table of Contents

List of Tables

List of Figures

GG12-Pro OEM Board Reference Manual

Acronyms Used in This Manual [i]

ARINC	Aeronautical Radio Inc.
ARINC 429	Industry-standard avionics data bus (also known as MARK 33 Digital Information Transfer System - DITS)
ASCII	American Standard Code for Information Interchange
BBU	Battery Backed-up
BCD	Binary-coded Decimal
BIT	Built-in Test
BNR	Binary
C/A	Coarse/Acquisition
CDMA	Code Division Multiple Access
CEP	Circular Error of Probability
DGPS	Differential GPS
DIN	Deutsche Industrie Normen
DISC	Discrete
DOP	Dilution of Precision
ECEF	Earth-Centered, Earth-Fixed
ERT	En Route
ETA	Estimated Time of Arrival
ETI	Elapsed Time Indicator
FDE	Fault Detection and Exclusion
FMS	Flight Management System
FOM	Figure of Merit
GNSS	Global Navigation Satellite System
HIL	Horizontal Integrity Limit
IODA	Issue of Data Almanac
IODE	Issue of Data Ephemeris
INS	Inertial Navigation System
LED	Light-emitting Diode
LNA	Low-noise Amplifier
NM	Nautical Miles
NMEA	National Marine Electronics Association
NPA	Non-precision Approach
NVRAM	Non-volatile Random Access Memory

OEM	Original Equipment Manufacturer
PC	Personal Computer (IBM compatible)
RAIM	Receiver Autonomous Integrity Monitor
RAM	Random Access Memory
ROM	Read-only Memory
RTCA	Radio Technical Commission for Aeronautics
SA	Selective Availability
SCAT I	Special Category I
SDI	Source/Destination Identifier
SMA	Type of connector
SNR	Signal-to-noise Ratio
SSM	Sign/Status Matrix
SV	Space Vehicle (GPS satellite)
TER	Terminal
TNC	Type of connector
TSO	Technical Standard Order
TTFF	Time to First Fix
UTC	Universal Time Coordinated
VIL	Vertical Integrity Limit
WP	Waypoint

1

Introduction

This manual describes the operation, capabilities, and programming of the Ashtech® GG12-Pro™ OEM GPS receiver.

The GG12-Pro is a single-board navigation sensor intended for installation in business or commercial aircraft operating anywhere in the world.

The GG12-Pro receives L1 carrier and C/A code signals on twelve independent channels from a selectable mix of GPS and GLONASS satellites, computes position, and outputs three-dimensional position, velocity, and integrity navigational data to the aircraft systems. Output can be used for en-route, terminal, and non-precision approach operations in accordance with TSO-C129 (Class C1), using WGS-84 as the reference frame. The receiver can operate in autonomous and differential modes, making it suitable for all phases of flight, including precision approach.

Incorporating RAIM (Receiver Autonomous Integrity Monitoring), Predictive RAIM, Fault Detection and Exclusion (FDE), and ARINC 429 functions, the GG12-Pro can be integrated with flight management systems that require TSO-C129 C1 certification, ground-based reference stations for GPS aircraft landing systems (SCAT I and LAAS), and other avionic systems.

The GG12-Pro meets RTCA DO-178B Level B, RTCA DO-208, and DO-217 (SCAT I) requirements for FAA qualification by OEM integrators.

In order to receive GPS or GLONASS signals, your antenna must have a direct line of sight to the satellites. One of the primary advantages of the GG12-Pro GPS+GLONASS receiver is the increased satellite coverage. As of September 2001, the GPS constellation contained 28 usable satellites; the GLONASS constellation had 9 usable satellites of the planned constellation of 24 satellites. With a total of 37 healthy satellites, there are more satellites available for position computation than with GPS alone, thus GPS+GLONASS technology can maintain

high performance with limited sky visibility. In addition, powerful anti-jamming capabilities allow the GG12-Pro to perform well in noisy RF environments.

To take advantage of the increased satellite availability, the GG12 Pro has twelve configurable channels for L1 GPS and L1 GLONASS. Each channel can be programmed to track either GPS or GLONASS satellites. For example, you can program channels 1 through 8 to track GPS satellites, and channels 9 through 12 to track GLONASS satellites. The GPS+GLONASS technology in the GG12-Pro typically can deliver autonomous position accuracies ranging from 10 to 30 meters, compared to the 20- to 60-meter accuracy using only the GPS satellites with SA (Selective Availability) in effect.

The GG12-Pro can receive both GPS and GLONASS satellites, but differential corrections only from GPS. Using differential corrections, a properly equipped and optioned GG12-Pro can compute positions with sub-meter accuracy in real-time. Table 1.1 summarizes technical specifications.

Table 1.1. GG12-Pro Technical Specifications

Dimensions & Weight	
Size	4.6" x 7.75" x 0.5"
Weight	6.0 ounces
Power Requirements	
Power Consumption	GG12-Pro receiver: <4.0 watts GG12-Pro antenna: <0.3 watts ARINC output bus 14 watts max, total power consumption (typical): 5.5 W
Voltage	5 volts regulated ($\pm$ 5%) DC input; 50 mV peak-to-peak ripple +15 VDC ± 10% ARINC output bus -15 VDC ± 10% ARINC output bus +3.5 VDC NVRAM and RTC backup
External Wiring	30 gauge or larger)
Back-up Battery Drain	Consult manufacturer
Environmental Tolerances	
Operating Temperature Range	-30° C to +70° C
Storage Temperature Range	-40° C to +85° C
Dynamics	
Acceleration	10g
Speed	1,000 knots
Altitude	60,000 ft
Vibration	MIL-STD-810E; RTCA DO-160D, Category S (Curve B)

(1) With full GLONASS constellation in place.
(2)The time delay from the instant a message is time-tagged to when the receiver finishes its transmission at 115,200 baud. Latency specification is for certain messages. Latency of other messages under different conditions may yield different results

Hardware Description and Specifications

Dimensions and Mounting

Figure 1.1 shows the physical dimensions and mounting arrangement.
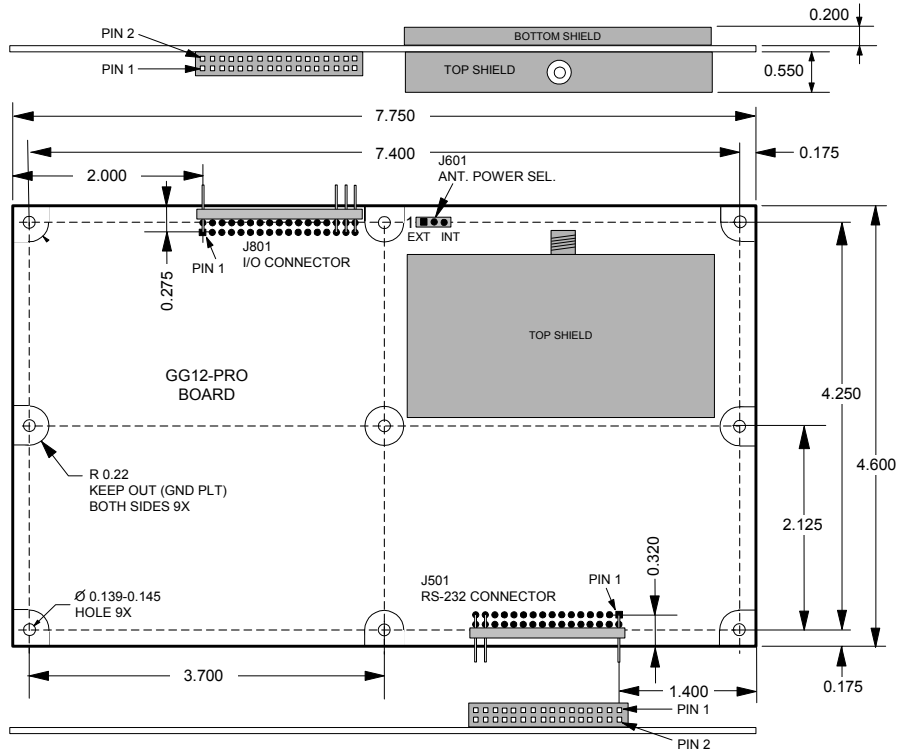
Figure 1.1. Physical Dimensions and Mounting Arrangement

Figure 1.2 shows the physical layout and electrical interfaces. Functionally, the GG12-Pro has two major sections: the radio frequency (RF) section, which receives incoming GPS signals, and the digital section, which processes the information in the RF signal. The digital section also incorporates ARINC 429 I/O

functions.

LED

J 501 RS-232 Connector

J601 LNA Voltage Select

SMA RF Connector

J801 ARINC Connector
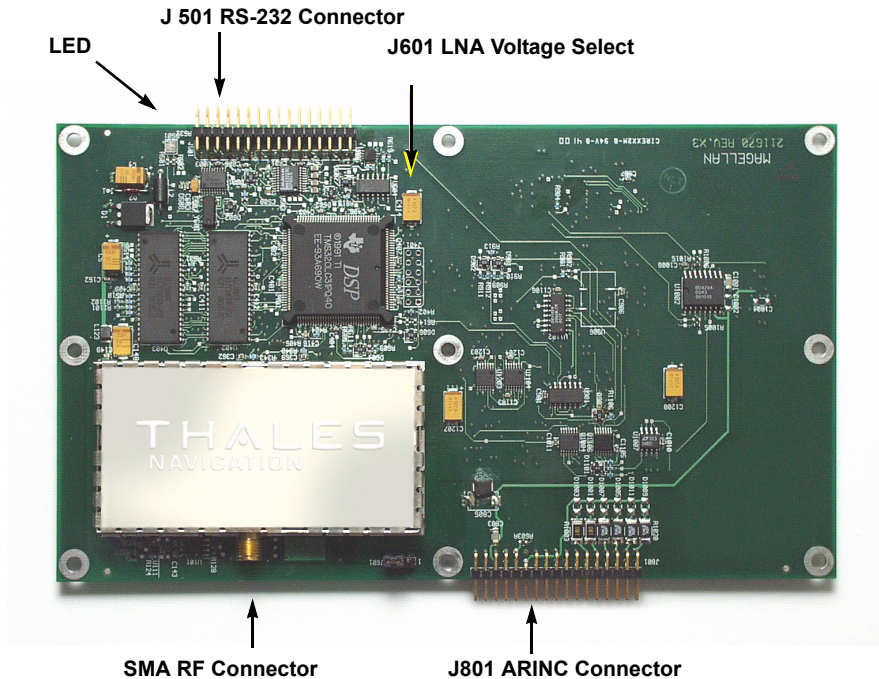
Figure 1.2. GG12-Pro OEM Receiver Board

The GG12-Pro has two bi-directional RS-232 serial ports embedded in the J501 connector, a 32-pin dual inline 2 x 16 header connector.

The RF input port is a coaxial SMA connector. Satellite data from a GPS+GLONASS antenna and LNA is sent to the RF port through a coaxial antenna cable. The GG12-Pro supplies power to the antenna and LNA through the same coaxial cable, eliminating the need of separate power for the antenna. Power consumption for the antenna and LNA is approximately 150 milliwatts, depending upon model and manufacturer. A jumper can be configured on J601 to select internal or external voltage for the LNA.

Connector J801 is a 34-pin dual inline 2 x 17 header connector that provides the electrical interface for the ARINC I/O functions.

A two-color LED indicates status for power and satellite tracking. The LED flashes red to indicate power status and green to indicate satellite tracking status. A green flash occurs for each satellite being tracked. A yellow flash (red and green

flashing simultaneously) separates the GPS satellite count from the GLONASS satellite count.

An external LED can be connected to the board by wiring the common cathode to ground and wiring the anodes to LED-GRN (pin 19) and LED-RED (pin 20) on the J801 connector.

Pins 19 and 20 are routed to the processor through 100-ohm resistors.

J501 Connector - RS-232 I/O

All RS-232 input/output (I/O) connections are made at connector J501. J501 is a 32-pin male dual inline header connector, SAMTEC TSW-116-08-G-D-RA-15. In addition to connections for serial communication, J501 provides connections for manual reset, and input for photogrammetric events. Figure 1.3 shows the pin configuration, and Table 1.2 describes the RS-232 interface.
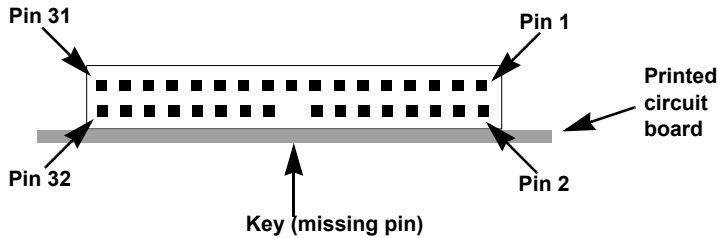
Figure 1.3. J501 Pinout

CAUTION
To avoid damaging the GG12-Pro board, turn off your power supply before connecting or disconnecting cables to the J501 connector. When connecting to J501, ensure that terminal 1 of the cable is mated to pin 1 of the connector.

Table 1.2. J501 RS-232 Interface Connector

Pin	Signal	Description
1	GND	Ground connection for serial port A
2	CTSA	RS-232 port A clear to send
3	TXDA	RS-232 port A transmit data
4	RTSA	RS-232 port A request to send
5	RXDA	RS-232 port A receive data
6	DX	Factory use only (leave floating)
7	GND	Ground
8	CTSB	RS-232 port B clear to send
9	TXDB	RS-232 port B transmit data
10	RTSB	RS-232 port B request to send
11	RXDB	RS-232 port B receive data
12	FSX	Factory use only (leave floating)
13	NC	No connection
14	NC	No connection
15	NC	No connection
16	CLKRX	Sync serial - receive/transmit clock
17	MAN_RES	Manual reset (active low)
18	KEY	Missing pin
19	GND	Ground
20	GND	Ground
21	NC	No connection
22	NC	No connection
23	NC	No connection
24	GND	Ground
25	NC	No connection
26	GND	Ground
27	PHOTO_IN	Photogrammetry pulse input
28	FSR	Factory use only (leave floating)
29	SERBLEN	Factory use only (leave floating)
30	DR	Factory use only (leave floating)

Introduction 7

Table 1.2. J501 RS-232 Interface Connector (continued)

Pin	Signal	Description
31	GND	GG12-Pro chassis common ground
32	NC	No connection

CAUTION

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

J801 Power and ARINC 429 Connector

Connector J801, a 34-pin dual inline header connector, Figure 1.4, provides the ARINC 429 electrical interface. This connector, a SAMTEC TSW-117-08-G-D-RA-012, carries all the signals required by the ARINC functions, plus time mark signals, LNA power from an external source, power inputs, and backup input for non-volatile RAM and RTC. Table 1.3 defines the pinout.
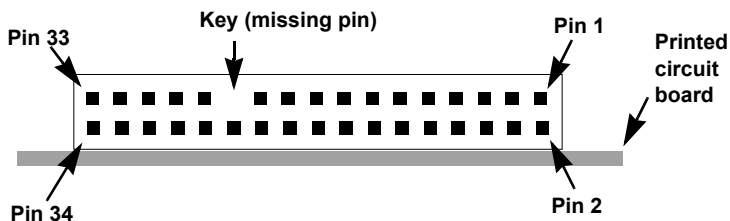
Figure 1.4. J801 ARINC Connector

Table 1.3. J801 ARINC Connector Pinout

Pin	Signal	Description
1	TM1A	Time Mark 1 (A)
2	TM1B	Time Mark 1 (B)
3	TM2A	Time Mark 2 (A)
4	TM2B	Time Mark 2 (A)
5	ARO1A	ARINC Output 1 A
6	ARO1B	ARINC Output 1 B
7	ARO2A	ARINC Output 2 A
8	ARO2B	ARINC Output 2 B
9	ARI1A	ARINC Input 1 A
10	ARI1B	ARINC Input 1 B
11	ARI2A	ARINC Input 2 A
12	ARI2B	ARINC Input 2 B
13	SDI-1	SDI Discrete Input 1
14	SDI-2	SDI Discrete Input 2
15	SPD	429 HS/LS output speed select
16	GND	Ground
17	FAULT	Fault discrete output: GND = fault Open = normal operation
18	GND	Ground
19	LED-GRN	Green LED
20	LED-RED	Red LED
21	LNA-PWR	LNA power input from external source
22	N VRAM DC	DC backup input for non-volatile RAM and RTC
23	KEY	Missing pin
24	GND	Ground
25	GND	Ground
26	GND	Ground
27	+5 VDC	+5 VDC ± 5% power input
28	+5 VDC	+5 VDC ± 5% power input
29	+15 VDC	+15 VDC ± 10% ARINC I/O power input
30	-15 VDC	-15 VDC ± 10% ARINC I/O power input

RF Connector

The RF connector is a standard 50-ohm SMA female coaxial connector wired for connection via coaxial cabling to a GPS or GPS+GLONASS antenna with integral LNA. The SMA connector shell is connected to the GG12-Pro common ground. The SMA center pin provides +5 VDC to power the LNA (maximum 100 mA draw) and accepts 1575-1616 MHz RF input from the antenna; the RF and DC signals share the same path.

CAUTION
The GG12-Pro may be damaged if the center pin of the RF connector is not isolated from DC ground. Provide a DC block between the center pin and ground. The DC block should have the following characteristics: • **VSWR 1.15 maximum** • **Insertion loss 0.2 db maximum** • **5 VDC maximum**

Antenna

The GG12-Pro is designed to work with an active antenna and low-noise amplifier (LNA). An external LNA higher power source can be used (pin 32 on connector J501) by moving the jumper J601 from position 2-3 to position 1-2 (nearest to J501); the external power must not exceed 15 VDC . The gain of the antenna/ preamplifier minus the loss of the cable and connectors should be between 20 and 30 dB. Connect the antenna cable directly to the antenna connector on the GG12-Pro. A line amplifier (Line Amp) should be used with antenna cables longer than 30 meters. Line Amps with Type N coaxial connectors are available from Ashtech for applications requiring longer cables or for cables with higher signal loss.

ARINC 429 Interface

The GG12-Pro incorporates two input and two output ARINC 429 buses. Bus speed is automatically adjusted to match the speed of the incoming data.

The two output buses can be physically programmed (chip installation at time of manufacture) to be high or low speed. The buses can have two independent data streams, or the same information on both buses.

The 429 interface is described in detail in Chapter 4, beginning on page 192.

Digital Thermometer

A digital thermometer keeps the system reset at low temperatures in accordance with DO-160D section 4 *Ground Survival Low Temperature and Operating Low Temperature Test*. The limit has a hysterisis of -25 to -22 degrees.

Antenna Short/Open Detect

Built-in Test (BIT) detects antenna open and short conditions and reports the condition to the flight management system.

Watchdog Timer Memory

Watchdog timer resets are recorded in memory so that the processor, on subsequent bootup, can determine that the watchdog was the cause of the last reset. The processor then reports the appropriate error status on the ARINC link.

Tri-State LED

A tri-state LED displays a blinking pattern to indicate tracking and navigation status as listed below.

- Red,green for each GPS SV
- Yellow, green for each GLONASS SV
- Short red for invalid position or no position
- Long red for valid position
- Short green for SV not used in position
- Long green for SV used in position

Memory

Program code is stored in flash ROM which can be updated via serial port.

Power Requirements

Table 1.4 lists input power requirements.

Table 1.4. Power Requirements

Input Voltage	Tolerance	Ripple	Power
+ 5 VDC	± 5%	50 mV p-p	4 watts
+ 15 VDC	±10%		1.2 watts
- 15 VDC	±10%		1.2 watts
+ 3.5 VDC*			3.5 mW
* Backup for NVRAM and RTC.			

Environmental Conditions

The GG12-Pro meets the environmental conditions specified in RTCA/DO-217, paragraph 2.2.4, DO-160D, and ARINC 743a Supplement 4, as listed in Table 1.5.

Table 1.5. DO-160 Environmental Specifications

Requirement	DO-160D Section	Category
Temperature and altitude	4.0	A1
Temperature variation	5.0	B
Humidity	6.0	A
Shock and crash safety	7.0	B
Vibration	8.0	S, Curve B
Magnetic effect	15.0	A
Power input	16.0*	A (DC power)
Voltage spike	17.0*	A
Audio frequency conducted susceptibility	18.0	Z (DC power)
Induced signal susceptibility	19.0	Z
Radio frequency susceptibility	20.0	Y
Emission of radio frequency energy	21.0	L

Table 1.5. DO-160 Environmental Specifications (continued)

Requirement	DO-160D Section	Category
Lightning-induced transient susceptibility	22.0	XXE2
Lightning direct	23.0	X
Icing	24.0	X
Electrostatic discharge	25.0	a
*Applies to power supply		

Functional Description

Upon application of power, the GG12-Pro runs a self-test of internal memory, and thereafter periodically self-tests various functions during normal operation. Test results are stored in memory and can be examined by issuing the query command $PASHQ,BIT. In addition, you can issue the $PASHQ,HST command to display a history of BIT failures.

Commands are issued to the GG12-Pro from an office computer, using a data cable connected to RS232 port J501.

After self-test, the GG12-Pro initializes its battery-backed RAM. If the battery-backed RAM fails self-test (for example, due to a low power condition), the GG12-Pro resets itself and reports the loss of stored data, then initializes the 12 channels and begins searching for all satellites within its antenna's field of view. The GG12 can track up to 12 GPS or 12 GLONASS satellites simultaneously, or it can be programmed to track any combination of 12 satellites from the GPS and GLONASS constellations. The GG12 locks onto the satellites and begins downloading information on the orbital positions (ephemeris data) and the orbit schedules (almanac data) for each GPS and GLONASS satellite. This data is automatically stored in battery-backed memory. Once the ephemeris data are collected for at least five satellites from both systems, or four satellites from a single system, the GG12-Pro can compute its own position.

The GG12-Pro calculates three-dimensional position and velocity when tracking any combination of five satellites, as, for example, when tracking three GPS and two GLONASS satellites. When set to hold the GPS-GLONASS clock offset fixed, the GG12-Pro can calculate a 3D position with any combination of four satellites (e.g., 2 GPS and 2 GLONASS). By also holding the altitude fixed, the GG12-Pro can calculate a 2D position with any combination of three satellites.

The GG12-Pro can compute up to five independent measurements every second, with no interpolation or extrapolation from previous solutions. The position and velocity computations are performed using all twelve channels simultaneously. The GG12-Pro uses an instantaneous Doppler measurement technique to compute velocity, independent of the previous position computation. All computations for position, velocity, and direction of travel are referenced to the World Geodetic System WGS-84 ellipsoid.

Performance Specifications

Table 1.6 lists the major performance specifications.

Table 1.6. Performance Specifications

Parameter	Specification
Horizontal accuracy (95%)* (stand-alone mode)	100 m with SA 10 m without SA
Vertical accuracy (95%)** (stand-alone mode)	Vertical accuracy defined as: vertical accuracy/horizontal accuracy = VDOP/HDOP
Horizontal velocity accuracy	1 knot or less (95%) with SA on 0.2 knot (95%) with SA off
Vertical velocity accuracy	1.5-2 times horizontal accuracy depending upon HDOP/VDOP ratio
Dynamic tracking	Meets all performance requirements when aircraft is subjected to ± 0.58 g, also within 10 seconds after aircraft returns to stable flight from normal maneuvers for speeds up to 800 knots. Normal maneuvers include 180-degree heading change with horizontal acceleration up to and including 0.58 g, turn rate up to and including 1.3 x standard rate (but not more than 0.58 g), and vertical acceleration up to and including ± 0.5 g.
Time to First Fix (50%/95%)	
Hot Start	17 seconds / 21 seconds
Warm Start	37 seconds / 45 seconds
Cold Start	67 seconds / 90 seconds
Position Accuracy (DGPS)	
Horizontal (95%)	90 cm (GPS only) 75 cm (GPS+GLONASS)
Vertical (95%)	1.6 m (GPS only) 1.4 m (GPS+GLONASS)
Position Latency	70 ms
Velocity Accuracy	
Horizontal (95%)	0.1 knots
Vertical (95%)	0.1 knots

Receiver Options

The GG12-Pro supports a variety of internal options. The commands and features available to you depend upon the options installed in the receiver. For example, if the Timing Pulse Output option is not installed, you cannot use the set command **$PASHS,PPS** to configure and enable the output of a timing pulse.

Table 1.7 lists the available options. Each option is represented by a letter or number presented in a specific order. You can verify the installed options by issuing the **$PASHQ,RID** query command to the receiver through an external handheld controller or PC, as described in Table 1.7 . The RID response message lists the installed options in a 14-character alphanumeric string.

Example: $PASHR,RID,GG,#I96,55OPU__L_GM__S*62

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

Table 1.7. GG12-Pro Receiver Options

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

Summary of Features

The following paragraphs describe the major features of the GG12-Pro.

Fault Annunciator

The GG12-Pro receiver provides an output discrete that annunciates a fault if the BIT function detects a critical sensor hardware fault which adversely affects the navigation and time outputs. This output is preserved in cases where the GG12-Pro receiver is reset because of the fault. This means that when a fault is detected and the system is reset, this reset does not deactivate the FAULT output. A power down of the receiver, manual reset, or reset due to low temperature does reset the FAULT output.

If a fatal failure is detected, the GG12-Pro does not compute or output a position solution. The affected ARINC 429 binary data SSMs is set to 0,0, failure warning; the affected discrete words and BCD data SSMs ARE set to 0,1, no computed data.

 Labels 273, 352, 354, 355, and 356 are output despite failures including a fatal failure, with the SSM = 00 so that the sensor status is available to using equipment. If it is not possible to format word 273 correctly, SSM is set to 01.

Navigation System Modes

The GG12-Pro supports four navigational modes which can be set by $PASHS,SYS command (details in Chapter 4). All navigation solutions are synchronized to UTC.

The GG12-Pro provides a method to independently set the navigation mode for both differential and non-differential modes. For example, the GG12-Pro can be commanded such that the navigation mode is GPS when differential corrections are applied, and the mode is GPG when differential corrections are not applied. This configuration is achieved by software commands.

This allows you to configure the GG12-Pro to use GLONASS satellites during oceanic through non-precision approach phases of flight, and not to use GLONASS satellites during SCAT 1 approaches. Currently, the FAA allows use of GLONASS in nav mode but opposes its use in differential mode due to additional pseudorange errors caused by the group delay across different GLONASS channels.

In GPG or GLG mode, if all available primary system satellites above the

elevation mask angle are not being tracked, the GG12-Pro keeps at least one channel for searching for these primary system satellites instead of using the channel to track secondary system satellites.

If also in differential mode, there is one further condition: the GG12-Pro uses this channel to search for the available primary system satellites for which differential corrections are available.

In differential mode, if every channel is tracking a satellite for which differential corrections are available, and corrections are then lost for one of those tracked satellites for at least X seconds, and corrections are available for another satellite that is not currently being tracked, the GG12-Pro drops the satellite with no corrections and uses the free channel to acquire another satellite with the highest elevation for which corrections are available. Here X is the maximum age of corrections controlled by software command.

Display Rate & Latency

As specified in RTCA/DO-217 Paragraph 2.2.1.9, the ARINC 429 data output is at 1Hz. The data is valid at the time of the time mark and is transmitted within 200ms of the time mark.

Each position solution is completely independent of the previous solution.

The GG12-Pro provides the position in both WGS-84 ECEF X, Y, Z coordinates and WGS-84 latitude, longitude, and altitude.

Latitude, Longitude, Altitude, and Mode Status (indication of whether differential corrections were applied; externally supplied altitude was held, or internally computed altitude was held; time shift was held fixed) are provided first.

The latency between time tag of the position estimation and the time the receiver finishes transmitting ZDA, MIS and PBN messages at the baud rate of 115200 is less than 70ms.

Velocity, time and status data immediately follow the position output.

Position Accuracy

One of the most important functions of the GG12-Pro is providing real-time position solutions with accuracy ranging from the sub-meter level to 100 meters.

Table 1.8 summarizes the positioning modes and expected accuracy.

Table 1.8. Accuracy as Function of Mode

Positioning Mode	GPS + GLONASS	GPS Only	GLONASS Only
Real-Time Position-Autonomous	10 meters (CEP 50%) 25 meters (95%)	25 meters (CEP 50%) 100 meters (95%)	8 meters (CEP 50%) 20 meters (95%)
Real-Time Position-Code Differential	N/A	40 centimeters (CEP) 90 centimeters (95%)	50 centimeters (CEP) 1 meter (95%)
Velocity Accuracy-Autonomous	0.15 knots (mean) 0.30 knots (95%)	1 knots (mean) 4 knots (95%)	0.03 knots (mean) 0.05 knots (95%)
Velocity Accuracy-Code Differential	0.04 knots (mean) 0.1 knots (95%)	0.05 knots (mean) 0.1 knots (95%)	0.02 knots (mean) 0.05 knots (95%)

Position and velocity accuracy are for based on tests conducted in Moscow with 5° elevation mask angles, with medium to high multipath interference. The 100-meter GPS value is the 2d RMS accuracy promised by the U.S. Department of Defense. A GG24 Reference Station board was used to provide differential corrections over a short baseline. Differential data rate setting was 300 bps; the calculated HDOP < 4. Position accuracy specifications are for horizontal position. Vertical error < 2 x horizontal error.

Precision Approach Accuracy

Display of Warnings

As specified in RTCA/DO-217 Paragraph 2.2.2.2.1(4), the GG12-Pro provides status indicating that the computed solution is differentially corrected or is uncorrected.

The GG12-Pro provides status that indicates if the altitude was fixed (2D position was computed).

If differential corrections are applied, altitude is not fixed.

GPS status is reported in words 273 and 355 of the ARINC 429 bus. Fatal failures cause the setting of the **Failure Warn** output discrete and the setting of the output bus SSMs.

Satellite Selection and Indication

In accordance with RTCA/DO-217 Paragraph 2.2.2.13, if the navigation data collected from a satellite indicates that it is unhealthy, then the GG12-Pro removes the failed satellite from the position solution, and continues to track the failed satellite.

The navigation data of removed satellites is continuously monitored for re-

admission to the position solution when the condition no longer exists.

RAIM

The GG12-Pro provides RAIM (Receiver Autonomous Integrity Monitoring) in accordance with paragraph 1.5.1 of RTCA document DO-208, *Minimum Operational Standards for Airborne Supplemental Navigation Equipment using Global Positioning System (GPS)*.

RAIM can be set to one of five modes:

OFF - Disabled

NPA - Non-precision approach, alarm limit 0.03 nmi

TER - Terminal, alarm limit 1.00 nmi

ERT - En route, alarm limit 2.00 nmi

n.nn - user-defined alarm limit between 0.015 and 4.00 km

Software commands allow the RAIM status to be queried and reported.

Cold Start

A cold start is defined as startup with neither an almanac nor an ephemeris. Under cold-start conditions, the time to first fix is required to be less than 5 minutes in GPS-only, GLONASS-only, or any of the mixed navigation modes as required by RTCA DO-208. Actual performance is less than 90 seconds for 95% confidence level.

Warm Start

A warm start is defined as startup with a valid almanac, but an old ephemeris. Under warm-start conditions, the time from application of power to the first valid position fix is required to be less than 5 minutes (95% confidence level). In this context, valid position fix means that the determined position meets the 2D accuracy requirements; this requirement is met even if GLONASS is not available. Actual performance is less than 45 seconds for 95% confidence level.

Hot Start

A hot start is defined as startup with a valid almanac and a valid ephemeris. Under warm-start conditions, the time to first fix is less than 21 seconds in GPS-only or GLONASS-only navigation modes, and less than 21 seconds in any of the mixed navigation modes; the 21 seconds includes initialization time for built-in tests.

Reacquisition Time

Once signals have been acquired and the GG12-Pro is tracking satellites, blockage by aircraft surfaces may cause temporary loss of signals from some satellites, resulting in fewer than four satellites being usable. Once a minimum of four satellites becomes visible again, the GG12-Pro reacquires all satellites and determines a valid position fix in accordance with Table 1.9.

Table 1.9. Satellite Re-acquisition Time (95 Percent)

Outage Duration (seconds)	Reacquisition Time (seconds)
Less than 5	5
5 – 60	10

Long-term Non-stop Operation

The GG12-Pro is capable of long-term non-stop operation. None of the following events cause any change in performance:

Week rollover (weekly)

Leap second change.

Uninterrupted operation through leap-second transitions

If working in mixed navigational modes or in GPS-only navigational mode, the GG12-Pro provides uninterrupted valid position through the leap-second transitions.

Satellite Cross-correlation Check

By checking the ephemeris/almanac data, the GG12-Pro verifies that it does not acquire an existing satellite cross-correlation product instead of a rising satellite.

Boundary Conditions

The GG12-Pro continues to operate correctly in the following boundary conditions, and in transitions about these boundaries (e.g. crossing the equator, crossing the prime meridian, etc.).

Latitude 90×N or 90×S.

Latitude 0×

Longitude 0×, longitude 180×.

Standard Software Features

The following paragraphs summarize major features of the GG12-Pro. Details and additional features are described in Chapter 4, *Command/Response Formats*.

Magnetic Variation Table

The GG12-Pro contains a magnetic variation table. This table allows the GG12-Pro to output true and magnetic course.

Geoidal Separation Table

The GG12-Pro contains a geoidal separation table.

Pulse Per Second

Two time marks, as defined in ARINC 743A-3, Attachment 8, are output once per second. The time marks are synchronized with UTC within 2usec

Pseudorange Data

The unsmoothed pseudorange to each satellite being tracked is output with an update rate of 1 per second. An option is provided to update at a 2 Hz rate.

Each set of pseudoranges, to all satellites being tracked, is measured simultaneously, and tagged with one time stamp indicating the time of measurement. If the 1 Hz option is selected, the time tag is the top of the GPS epoch ± 1 us. If the 2 Hz option is selected, the time tag is the top of the GPS epoch and 0.5 seconds after GPS epoch ± 1 us.

The interchannel bias is no more than 0.08 meters RMS.

The resolution of the pseudorange measurement is less than 5 mm.

No atmospheric corrections are applied to pseudorange measurements.

Built-in Test (BIT)

Turn-on and operational tests are described in Appendix D.

GG12-Pro Development Kit

The GG12-Pro Development Kit (Figure 1.5) contains a GG12-Pro receiver and antenna plus the necessary hardware and software accessories you will need to evaluate the receiver.

Figure 1.5. GG12-Pro Development Kit

2

Getting Started

This chapter discusses basic operation of the GG12-Pro, including hardware connections, power-up, serial port configuration, and status monitoring. Figure 2.1 shows the hardware connections to external equipment and devices.

User-supplied PC
(personal computer,
IBM compatible)

GPS/GLONASS
Antenna

Coaxial Cable

J501 RS232
Connector

SMA RF
Connector

GG12-Pro OEM Board

J801 ARINC 429
Connector

ARINC port on
user-supplied avionics
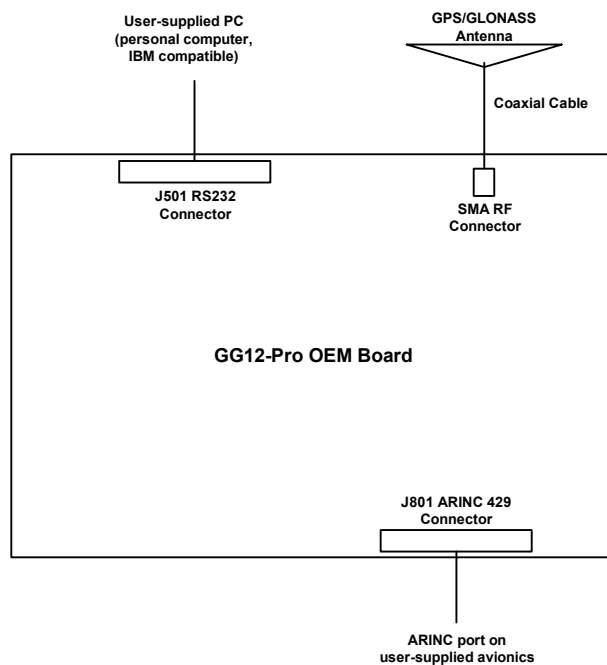
Figure 2.1. GG12-Pro Hardware Connections

Antenna Connection

Attach the SMA connector on the antenna cable to the SMA connector on the GG12-Pro board. Attach the TNC connector on the other end of the antenna cable to the TNC connector on the antenna. In order to receive GPS or GLONASS signals, your antenna must be mounted so that it has a direct line of sight to the satellites.

Power Connection

If you plan to use the GG12-Pro with equipment not supplied by Ashtech, the equipment must meet the hardware specifications described in Table 1.1.

Applying power to the power input pins on the J801 connector starts GG12-Pro operation. Removing power from the power input pins on J801 stops GG12-Pro Pro operation. Connect any controller devices or data logging equipment to the input/output ports of the GG12-Pro before applying power.

1. Connect the female DIN34 connector on the external cable assembly to the male DIN34 (J801) connector on the GG12-Pro before applying power.

2. Connect the power cable to the power supply. On power-up, the status LED (D501) lights red and continues to flash red to indicate that the unit is on but is not yet computing positions. When the GG12-Pro's automatic search results in a satellite acquisition, the status LED flashes green between the red power status flashes. Every satellite lock-on produces a green flash. A short green flash indicates the satellite is locked but not being used to compute positions; a long green flash indicates the receiver has locked on the satellite and is using it to compute positions. Once the GG12-Pro locks to enough satellites to compute a position, the duration of the red flash also increases to indicate that positions are being computed. To differentiate between locked GPS and GLONASS satellites, the LED blinks green for each locked GPS satellite first, then blinks yellow once, and then blinks green for each locked GLONASS satellite.

CAUTION
To avoid damaging the GG12-Pro, always turn off the power supply before connecting to or disconnecting from the J801 connector.

Receiver Initialization

It is a good idea to initialize the receiver before turning it on for the first time or if a system malfunction occurs. Initialization clears the receiver's internal memory and restores the default parameter settings. Issue the command below to initialize the GG12-Pro:

$PASHS,INI,5,5,1<Enter>

This command sets the baud rate for both of the GG12-Pro's serial ports to 9600, clears the receiver's internal memory, and restores the default parameter settings.

The GG12-Pro accepts ARINC position, date and time labels to help reduce acquisition time, using the scheme shown in Figure 2.2.

First Epoch.
Start of ARINC output

GPS Time is Determined
from either BBU or Input Labels

Position is
Computed

A

B

C

D
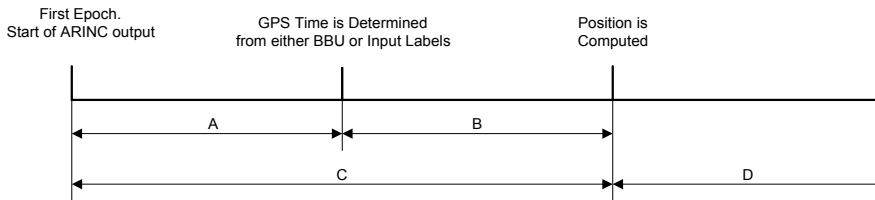
Figure 2.2. Receiver Initialization

The initialization sequence, set by ARINC output label 273 (page 235), is:

1. At turn-on, set to the **Initialization Mode**. Wait for at least one ARINC transmission indicating INIT mode.
2. Check for the position and time/date from the BBU (NVRAM).
3. If position and time/date from the BBU (NVRAM) are available, go to step 5.
4. If position and time/date from the BBU (NVRAM) are not available, go to step 10.
5. Check availability of GPS almanac.
6. If almanac available, go to step 8.
7. If almanac not available, go to step 10.
8. Use the time/date along with the GPS almanac to determine the best satellites to use, then go to step 9.
9. If warm start, go to step 11.
10. If cold start, go to step 11
11. Set to **Acquisition Mode**.
12. When 4 satellites are tracked for position fix, set to **NAV Mode**.
13. If satellites tracked for Position Fix are less than 4, returns to step # 11.

Notes on Acquisition Mode:
Period A begins at the step #1 through step #12 or #13. Position and Time/Date labels are accepted and used during this period.
Period B begins at step #14. Position and Time/Date labels are accepted and used during this period. If a satellite lock has already been accomplished, the date/Time labels will be ignored.
Period C begins with Period A and follows with Period B. Position and Time/Date labels are accepted and used during this period in the same way as described for Period A/B above.
Period D NAV Mode begins when 4 satellites are locked and a position fix is available.

Satellite Tracking

When the GG12-Pro is powered on for the first time, or when the power and back-up battery have been disconnected, the receiver has no almanac or ephemeris data in its memory, and set to the default parameters. In these cases, the GG12-Pro assigns 12 elements from a 56-element table of satellite ID 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 GG12-Pro synchronizes its clock to GPS time within six seconds of locking an SV. After three or four satellites are locked and the ephemeris data collected, the GG12-Pro computes its first position. The GG12-Pro 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 GG12-Pro restricts its satellite search to those satellites that should be visible based on this information. Under these conditions, the GG12-Pro on average recomputes position in 10 to 20 seconds (this is called a hot start). If the almanac and ephemeris data are available in battery-backed memory, but the ephemeris data are more than ten hours old, the GG12-Pro 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 GG12-Pro computes position in less than one minute on average (cold start).

Receiver Communication

After the GG12-Pro has power, you must issue commands to get data from it or to change the GG12-Pro's operating parameters. The two RS-232 ports (A and B) can receive command messages from an external control device such as a desktop computer, send response messages to an external control device such as a desktop computer, output data to a separate data logging device, and

receive differential corrections from an RTCA base station. The steps below describe how to send commands to and receive responses from the GG12-Pro using an IBM-compatible personal computer. You can interface with the GG12-Pro using Evaluate Software™ or standard communication programs such a ProComm or Hyperterminal. To begin, simply connect port A or B of the GG12-Pro interface cable to COM1 on the computer.

The GG12-Pro's serial ports support full-duplex communication. The default protocol for transmitting or receiving data is 9600 baud, eight data bits, no parity, and one stop bit (8N1). In order for the GG12-Pro to communicate with another device, the baud rate setting of the GG12-Pro serial port and the serial port on the device with which it is interfaced must be the same.

DEFAULT SETTINGS	
Default parameters for GG12-Pro serial ports A and B are shown below:	
Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None

After connecting to the COM port and starting the communications program, you are ready to send commands. Letters in the command string can be typed in upper or lower case and are sent to the receiver by pressing **<Enter>**. The commands used with the GG12-Pro are divided into two groups, **set** and **query**. **Set** commands allow you to change the GG12-Pro's operating parameters and begin with the command string **$PASHS**. **Query** commands allow you request information from the GG12-Pro, such as the current operating parameters, current position, or differential GPS status. Query commands begin with the command string **$PASHQ**. The GG12-Pro responds to query and set commands by issuing an acknowledgement of a change in operating parameters or by issuing the specific information requested through a query. All GG12-Pro responses begin with the string **$PASHR**. To become familiar with GG12-Pro messages, try sending a few common commands to it and observe the responses:

1. Assuming that you are still connected to port A, enter the following command to query the GG12-Pro for the communication parameters of the serial port to which you are currently connected:

   $PASHQ,PRT

   The response message displays:

   $PASHR,PRT,A,5

The letter A in the response message indicates that the PC is connected to port A of the GG12-Pro; the number 5 is a code number indicating that port A is using the default data rate of 9600 baud.

2. Enter the following command to set the GG12-Pro to output comprehensive position information from port A once per second:

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

   After entering this command, the GG12-Pro outputs a message similar to the one shown below once per second:

   $PASHR,POS,0,09,002701.00,3721.08661,N,12156.11611,W,-00054.41,,047.27,000.44,-000.13,02.0,01.1,01.7,01.2,FA00*17

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

3. Enter the following command to set the GG12-Pro to output comprehensive satellite tracking information from port A once every five seconds:

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

   Upon receiving this command, the GG12-Pro outputs a message like the one shown below at five-second intervals:

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

   This data string contains the number of satellites locked, the PRN number, elevation, azimuth, and signal strength for each locked satellite, and also indicates whether a given satellite is used (U) or not used (-) to compute positions. See Chapter 4 for details on the commands and responses supported by the GG12-Pro.

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

   $PASHS,NME,ALL,A,OFF.

3

Operation

This chapter describes GG12-Pro operation, including command format, serial port configuration, operational status, satellite system modes, position modes, differential mode, and other aspects of receiver operation.

System Setup

If you are using equiptment other than Thales Navigation-supplied equipment with the GG12-Pro, it must comply with requirements listed in *Hardware Description* on page 4.

Applying power to the power input pins on the J801 connector starts GG12-Pro operation. Before applying power, connect any controller devices or data logging equipment to the input/output pins on the J801/J501 connector. Removing power from the power input pins on connector J801 stops GG12-Pro operation.

CAUTION
To avoid damaging the GG12-Pro, the power harness should always be connected to or disconnected from the J801 connector before the power supply is turned on

Message Formats

The GG12-Pro's two RS-232 ports (A and B) can receive command messages from an external control device such as a personal computer, send response messages to an external control device or a data logging device, and receive differential corrections from an RTCA base station.

GG12-Pro Input Messages

With the exception of differential correction messages, GG12-Pro input messages comprise **set** and **query** commands. These commands comply with the format defined in the NMEA 0183 standard to the following extent:

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

Input messages deviate from the NMEA standard as follows:

- Message headers are Ashtech proprietary.
- Message identifiers are Ashtech proprietary.

All **set** and **query** commands must be uppercase. All commands are sent by pressing **<Enter>**. A valid set command causes the GG12-Pro to return the **$PASHR,ACK*3D** (acknowledge) response message. A set command containing a valid $PASHS header followed by character combinations unrecognized by the GG12-Pro causes the GG12-Pro to respond with **$PASHR,NAK*30**, a "not acknowledge" response message indicating that the command is invalid. Valid query messages are acknowledged by return of the requested information. A query command containing a valid $PASHQ header followed by character combinations unrecognized by the GG12-Pro also causes the receiver to respond with **$PASHR,NAK*30.**

GG12-Pro Message Output

The GG12-Pro can be programmed to output data to another device at regular intervals. Output messages include standard NMEA messages, Ashtech NMEA-style messages, raw data messages, and ACK/NAK messages. With the exception of raw data messages, the data messages output by the GG12-Pro comply with NMEA 0183 standards:

- 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 messages and Ashtech NMEA-style messages contain hexadecimal checksum bytes
- Data items are separated by commas; successive commas indicate inapplicable or missing data (null fields)
- Messages end with **<CR><LF>**, the standard NMEA message terminator

Output messages deviate from the NMEA standard as follows:

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

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

Serial Port Configuration

The GG12-Pro receiver has two RS-232 serial ports that support two-way, full-duplex communication with an external device such as an office computer. On initial power-up, or after using the office computer to issue the **$PASHS,RST** (restore defaults) command, the protocol for transmitting or receiving data is 9600 baud, eight data bits, no parity, and one stop bit (8N1).

In order for the GG12-Pro to communicate with another device, the baud rate setting of the GG12-Pro serial port and the serial port on the device with which it is interfaced must be the same.The baud rate setting of the GG12-Pro's ports can be changed by issuing the **$PASHS,SPD** (set port speed) command. The data rate for each port can be set independently. You can select any standard data rate from 300 to 115,200 baud, but the settings for data bit, stop bit and parity are always 8N1. If you need to change the baud rate on one of the GG12-Pro's serial ports, you should change the baud rate of the GG12-Pro port first, and then change the baud rate of the external control device to match the new baud rate setting on the GG12-Pro port.

Checking GG12-Pro Status

Four query commands are available which prompt the GG12-Pro to output messages containing current parameter settings:

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

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

$PASHQ,PPR (position computation parameters)

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

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

$PASHQ,RTC,RPS (RTCA remote station parameters).

For more information on these commands, see Chapter 4.

On initial power-up, or after issuing the **command $PASHS,RST** (restore defaults), the GG12-Pro reverts to its default parameter settings. The response to the query command $PASHQ,NMO,A shown below contains the default parameter settings for NMEA message output on port A:

> $PASHR,NMO,A,5,001.0,12,LTN,000.0,POS,000.0,GGA,000.0,VTG,000.0,MSG,
> 000.0,GSA,000.0,GSV,000.0,SAT,000.0,RRE,000.0,ZDA,000.0,RMC,000.0,GST
> ,000.0,*73

This message contains the three-letter identifier for each NMEA and Ashtech NMEA-style message supported by the GG12-Pro (LTN, POS…GST). Each message is followed by a field containing the setting for the output interval. The zeroes (000.0) appearing in the output interval fields indicate that all messages are disabled for output by default.

The response to the query command $PASHQ,PPR shown below contains the default settings for GG12-Pro position computation parameters:

> $PASHR,PPR,1,0,40,4,4,5,N,N,N,GPG*08

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

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

> $PASHR,RWO,A,5,001.0,10,MCA,000.0,MBN,000.0,PBN,000.0,MIS,000.0,XYZ,
> 000.0,DIF,000.0,SNV,000.0,SAL,000.0,SNG,000.0,SAG,000.0*6B

Like the NMO message, the RWO message contains the three-letter identifiers for each raw data message supported by the GG12-Pro (MCA, MBN…SAG). Each message is again followed by a field containing the setting for output interval. As indicated by the zero values in these fields, all raw data messages are disabled for output by default.

The response to the query command $PASHQ,RTC,RPS shown below contains the default parameter settings for differential operation:

> $PASHR,RTC,RPS,0,,,N,,60,N*56

This message contains the setting for differential mode (0), the port used for input of differential corrections, the maximum age threshold for incoming differential corrections (60), and more. The zero appearing in the first field after the header and the empty data fields (,,,) indicate that differential operation is disabled by default.

GG12-Pro Operating Parameters

You can choose different settings for the parameters controlling GG12-Pro operation, including position modes, satellite system modes, fixed altitude modes, and more. For example, you can set the receiver to track GLONASS satellites only, or output NMEA messages or raw data messages at regular intervals. You can control if and when the GG12-Pro computes 2D positions, or you can enable ionospheric modelling to compensate for delays imposed on the satellite signals as they pass through the ionosphere.

If you want to keep any of your new parameter settings, you must save them before cycling power to the receiver. Cycling power to the receiver without saving new settings causes the factory default settings to be restored for all GG12-Pro operating parameters.

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

Saving Parameter Settings

When you change GG12-Pro operating parameters, you can save the new settings by issuing the following command:

   $PASHS,SAV,Y

You can verify that your new settings are in effect by issuing the query commands mentioned above to prompt the GG12-Pro for its current status. The response messages output for each query displays the new settings instead of the default parameters.

Satellite System Modes

The GG12-Pro can be set to use one of five satellite system modes. You can set the receiver in a single-system mode, in which it uses only GPS satellites or only the GLONASS satellites. You can select a dual-system mode that allows the receiver to track satellites from both systems. The user-defined mode allows you to set a specific number of channels to track GPS satellites, with any remaining channels automatically assigned to track GLONASS satellites.

Satellite system modes are selected using the set command **$PASHS,SYS**. In each of these modes, almanac and ephemeris data obtained from the satellites is used to determine channel assignments. For example, the satellite elevation obtained from the ephemeris data is used to prioritize the satellite search, with the highest priority given to satellites with the highest elevations (satellites at higher elevations are more likely to be visible to the receiver).

Single-System Modes

The single-system satellite modes set the GG12-Pro to track satellites from one system only. If you select GPS mode, the receiver will search for, acquire, and track only GPS satellites. If you select GLO mode, the receiver will search for, acquire, and track GLONASS satellites only.

Three tracking priorities are used in the single-system modes. The first priority is track satellites which are visible and above the position elevation mask. The second priority is to track satellites which are above the elevation mask, but are not visible due to some obstruction in the line of sight between the GG12-Pro antenna and the satellites. Suppose the almanac data indicates that ten satellites are above the elevation mask, but the receiver is only tracking eight of them. In this case, the GG12-Pro will devote two channels to look for the missing satellites. The search continues until the receiver is able to acquire the satellites or the almanac indicates that the satellites are no longer visible. The third priority is to track satellites which are visible, but are below the position elevation mask. The GG12-Pro can track satellites below the position elevation mask, but does not use data from these satellites for position computations. If the satellite rises above the elevation mask, the data from it can be incorporated seamlessly into the position computation. Use the set command **$PASHS,SYS** to change the satellite system mode.

- **GPS Mode**

  This mode sets the receiver to use the GPS system only. GLONASS satellites are not used. When this mode is enabled, the first priority is to track all visible GPS satellites above the elevation mask. The second priority is to track satellites which are above the elevation mask, but are not visible due an obstruction in the line of sight between the satellite and the GG12-Pro antenna. The third priority is to track satellites which are below the elevation mask.

- **GLO Mode**

  This mode sets the receiver to use the GLONASS system only. GPS satellites are not used. When this mode is enabled, the first priority is to track all visible GLONASS satellites above the elevation mask. The second priority is to track satellites which are above the elevation mask, but are not visible due an obstacle in the line of sight between the satellite and the GG12-Pro antenna. The third priority is to track satellites which are below the elevation mask.

Dual-System Modes

You can select either of two dual-system modes. GPG mode treats GPS as the primary system and GLONASS as the secondary system. GLG mode treats GLONASS as the primary system and GPS as the secondary system. Six tracking priorities are used when the GG12-Pro is set in one of the dual-system modes.

To illustrate, assume that the GG12-Pro is set in GPG mode. Suppose the GPS satellite almanac indicates that ten satellites are visible above the position elevation mask, and the GLONASS satellite almanac indicates that four satellites are visible above the position elevation mask. Next, suppose the receiver cannot track two of the GPS satellites due to some obstruction in the line of sight between the GG12-Pro antenna and the satellites. In this case, the receiver tracks and uses eight visible GPS satellites to compute positions, and dedicates two of its channels to look for the two missing GPS satellites. The two channels will continue to look for the missing satellites until it finds them or until it determines, based on the almanac information, that the two satellites are no longer visible. The two remaining channels are assigned to track two of the GLONASS satellites and use them in position computations.

To further illustrate satellite tracking in a dual-system mode, assume that the the GG12-Pro is in GPG mode. This time, suppose the GPS satellite almanac indicates that seven satellites are visible above the elevation mask, and the GLONASS almanac indicates that three satellites are visible above the position elevation mask. Next, suppose that one of the GPS satellites is not visible due to an obstruction in the line of sight between the GG12-Pro antenna and the satellite. The GG12-Pro will use six of its channels to track and use the six GPS satellites for position computations. It will use one of its channels to search for the missing satellite, and will continue the search until it finds the satellite or until it determines that the satellite is no longer visible. Three of the five remaining channels will be used to track the three GLONASS satellites. The last two channels will be used to track any GPS satellites that are visible, but below the position elevation mask. If, based on the GPS almanac, the receiver determines that there are no GPS satellites visible below the elevation mask, it will use the last two channels to track any GLONASS satellites that are visible but below the position elevation mask.

- **GPG Mode**

The first priority is to track GPS satellites that are above the elevation mask. The second priority is to track GPS satellites that are above the elevation mask, but are not visible due to some obstruction in the line of sight between the GG12-Pro antenna and the satellite. The third priority is to track GLONASS satellites that are above the elevation mask. The fourth priority is to track GLONASS satellites that are above the elevation mask, but are not visible due to some obstruction in the line of sight between the GG12-Pro antenna and the satellite. The fifth priority is to track GPS satellites that are below the elevation mask. The sixth priority is to track GLONASS satellites

that are below the elevation mask.

- **GLG Mode**

The first priority is to track GLONASS satellites that are above the elevation mask. The second priority is to track GLONASS satellites that are above the elevation mask, but are not visible due to some obstruction in the line of sight between the GG12-Pro antenna and the satellite. The third priority is to track GPS satellites that are above the elevation mask. The fourth priority is to track GPS satellites that are above the elevation mask, but are not visible due to some obstruction in the line of sight between the GG12-Pro antenna and the satellite. The fifth priority is to track GLONASS satellites that are below the elevation mask. The sixth priority is to track GPS satellites that are below the elevation mask.

User-Defined Mode

This mode allows you set a specific number of channels to track GPS satellites, with the remaining channels automatically assigned to track GLONASS satellites. For example, if you set seven channels to track GPS satellites, the remaining five channels are automatically assigned to track GLONASS satellites. This setting causes the GG12-Pro to act as two independent receivers, with the channels assigned to track GPS satellites functioning like a GG12-Pro set in GPS mode, and the channels assigned to track GLONASS satellites functioning like a GG12-Pro set in GLO mode. That is, the channels assigned to GPS and the channels assigned to GLONASS use the same three tracking priorities that are used when the receiver is set in a single-system mode. Specifying zero channels has the same effect as setting the GG12-Pro in GLO mode. Specifying 12 channels has the same effect as setting the GG12-Pro in GPS mode.

- **USE Mode**

This mode allows you to set a specific number of channels to track GPS satellites, with any remaining channels automatically assigned to track GLONASS satellites.

DEFAULT SETTING	
SYS	**GPS**

When the GG12-Pro is operating in remote differential mode, the highest satellite tracking priority is given to satellites for which valid differential corrections are available, regardless of the current setting for satellite system mode. That is, if the receiver is set in GLO mode but is getting valid differential corrections for five GPS satellites, it will track and use the five GPS satellites, while the remaining channels will continue to track GLONASS satellites.

Position Modes

You can set the GG12-Pro to compute positions in four different modes. The position mode setting determines the conditions under which the receiver can calculate a 2D or 3D position. Use the set command **$PASHS,PMD** to change the position mode.

- **Position Mode 0**

This mode sets the GG12-Pro to compute 3D positions only. When the GG12-Pro is set in a single-system satellite tracking mode, it must track at least four satellites with elevations equal to or above the position elevation mask to compute a position. The receiver stops computing positions if the number of satellites being tracked falls below four. Two-dimensional (2D) positions are not computed in this mode.

When the GG12-Pro is tracking satellites from both systems, it must track at least five satellites with elevations equal to or above the elevation mask to compute a position. The extra satellite is required because the receiver must solve the clock error for both satellite systems, and then calculate a time-shift value to synchronize GLONASS time to GPS time before it can compute a position. The receiver can continue computing positions when the number of satellites being tracked drops down to four if the time-shift is held to a fixed value, but stops computing positions if the number of satellites drops below four. See the following sections for more information on fixed time-shift modes.

- **Position Mode 1**

When the GG12-Pro is in a single-system mode, the receiver computes 3D positions when tracking four or more satellites. When the number of satellites being tracked drops to three, the GG12-Pro automatically begins computing a 2D position and holds the altitude to a fixed value. See the next section for information on fixed altitude modes. The receiver stops computing positions if the number of satellites being tracked falls below three.

When the GG12-Pro is tracking satellites from both systems, the receiver computes 3D positions when tracking five or more satellites. When the number of satellites being tracked drops down to four, the GG12-Pro automatically begins computing 2D positions, holding the altitude to a fixed value. When the number of satellites being tracked drops to three, the receiver can continue to compute 2D positions if the time-shift is held to a fixed value. See the following sections for more information on time-shift modes.

- **Position Mode 2**

This mode sets the GG12-Pro to compute 2D positions only; the altitude is held to a fixed value regardless of the number of satellites being tracked. When the receiver is set in a single-system mode, it must be tracking at least three satellites with elevations equal to or above the position elevation mask to compute a position. The receiver stops computing positions if the number of satellites being tracked falls below three.

When the receiver is tracking satellites from both systems, it must be tracking at least four satellites with elevations equal to or above the elevation mask to compute a 2D position. If the number of satellites drops to three, the GG12-Pro can continue to compute 2D positions if the time-shift is held to a fixed value. See the following sections for information on time-shift modes.

- **Position Mode 3**

When the GG12-Pro is set in a single-system satellite tracking mode, the following conditions must be met in order for the receiver to compute 3D positions: it must be tracking four or more satellites with elevations equal to or above the position elevation mask, and the calculated HDOP value must be less than the HDOP mask setting. If the GG12-Pro is tracking four or more satellites with elevations equal to or above the elevation mask, but the calculated HDOP is greater than the HDOP mask, the receiver computes 2D positions and holds the altitude to a fixed value. To compute 2D positions, the GG12-Pro must be tracking at least three satellites with elevations equal to or above the elevation mask, and the calculated HDOP value must be higher than the HDOP mask setting. If the receiver is tracking three satellites and the calculated HDOP is greater than the HDOP mask, or if the number of satellites being tracked drops below three, the receiver stops computing positions.

When the GG12-Pro is tracking satellites from both systems, there are two scenarios within which it can compute 3D positions:

- The receiver is tracking five or more satellites with elevations equal to or above the position elevation mask, and the calculated HDOP value is less than the HDOP mask setting.
- The receiver is tracking four satellites with elevations equal to or above the position elevation mask, the calculated HDOP value is less

than the HDOP mask setting, and the time-shift is held to a fixed value.

When tracking satellites from both systems, the GG12-Pro computes 2D positions under the following conditions:

- The receiver is tracking four satellites with elevations equal to or above the elevation mask, the calculated HDOP value is higher than the HDOP mask setting, and the time-shift value is not fixed.
- The receiver is tracking three satellites with elevations equal to or above the elevation mask, and the time-shift value is fixed.

DEFAULT SETTING	
PMD	Mode 0

Fixed Altitude Modes

Two modes define the altitude setting when the GG12-Pro is in fixed altitude mode. When the GG12-Pro is not tracking a sufficient number of satellites to compute a 3D position, it calculates a 2D position and holds the altitude to a fixed value. The **$PASHS,FIX** set command can be used to select one these modes.

- Fixed Altitude Mode 0

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

- **Fixed Altitude Mode 1**

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

DEFAULT SETTING	
FIX	Mode 0

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

Elevation Masks

You can set values for two elevation mask thresholds. The position elevation mask is one of the parameters that determines which satellites the receiver uses in the position computation. Data from a satellite with an elevation that is at or below the value chosen for the position elevation mask is not included in the position computation. Use the set command **$PASHS,PEM** to change the position elevation mask setting.

DEFAULT SETTING	
PEM	2°

The raw data elevation mask sets the threshold to determine from which satellites the receiver can get raw measurement data. The GG12-Pro will not output raw measurement data for a satellite with an elevation at or below the value chosen for the raw data elevation mask. Use the set command **$PASHS,ELM** to change the setting for the raw data elevation mask.

DEFAULT SETTING	
ELM	2°

DOP Masks

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

You can set mask values for 4 dilution of precision measurements. PDOP (Position Dilution of Precision) corresponds to the 3D position measurement (that is, latitude, longitude, and altitude, or east, north, and up). Use the command **$PASHS,PDP** to change the PDOP mask setting.

DEFAULT SETTING	
PDP	100000

HDOP (Horizontal Dilution of Precision) corresponds to the horizontal component of the 3D measurement. In simplistic terms, HDOP is like PDOP without the

vertical component. Use the command **$PASHS,HDP** to change the HDOP mask value.

DEFAULT SETTING	
HDP	**100000**

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

DEFAULT SETTING	
VDP	**100000**

TDOP (Time Dilution of Precision) corresponds to the time measurement bias between the satellite clocks and the receiver clock. Use the command **$PASHS,TDP** to change the TDOP mask value.

DEFAULT SETTING	
TDP	**100000**

Time-shift Mode

When the GG12-Pro is tracking both GPS and GLONASS satellites, it must use a time-shift value in order to synchronize GLONASS time with GPS time before it can compute positions. The time-shift value is calculated automatically when the receiver is tracking at least five satellites. Use the GTF set command **$PASHS,GTF** to set the GG12-Pro to use the calculated time-shift value or the time-shift value entered through the set command **$PASHS,DTG**:

• **Time-shift Mode 0**

This mode sets the receiver to use the most recently computed time-shift value.

• **Time-shift Mode 1**

This mode sets the receive to use the time-shift value entered through the set command **$PASHS,DTG**.

DEFAULT SETTING	
GTF	**Mode 0**

The time-shift value is not applicable if the GG12-Pro is set to track satellites from one system only.

Fixed Time-Shift Mode

When the GG12-Pro tracks satellites from both systems, it must track at least five satellites to calculate a time-shift value. After calculating the time-shift value, the GG12-Pro can still compute positions if the number of satellites being tracked drops to four or three by holding the time-shift value fixed, holding the altitude to a fixed value, or holding both the time-shift and the altitude to fixed values. Use the set command **$PASHS,GTM** to change the setting for fixed time-shift mode. The following three modes determine the conditions under which the time-shift is held to a fixed value:

- **Fixed Time-shift Mode 0**

The GLONASS system time-shift is never held fixed. Depending upon the position mode setting, the GG12-Pro can continue to compute positions when tracking four satellites if the altitude is held to a fixed value. When this mode is selected, the receiver stops computing positions when the number of satellites being tracked drops to three.

- **Fixed Time-shift Mode 1**

The GLONASS system time-shift is computed if the GG12-Pro is tracking five satellites, or if the receiver is tracking four satellites and the altitude is held to a fixed value. When the GG12-Pro is tracking only three satellites, it can compute positions if both the time-shift and the altitude are held to fixed values. If this mode is selected, the receiver stops computing positions when the number of satellites being tracked drops below three.

- **Fixed Time-shift Mode 2**

The GLONASS system time shift is always held to a fixed value regardless of the number of satellites being tracked. This setting allows the GG12-Pro to compute 3D positions when tracking four satellites, or 2D positions when tracking three satellites. The GG12-Pro stops computing positions when the number of satellites being tracked drops below three.

DEFAULT SETTING	
GTM	**Mode 1**

These modes are not applicable if the GG12-Pro is set to track satellites from one system only.

Computation Priority: Time-Shift Versus Altitude

When the GG12-Pro is tracking satellites from both systems, and it is not tracking a sufficient number of satellites to compute both a 3D position and the time-shift value, it holds either the altitude or the time-shift to a fixed value. If it is more important to compute a 3D position and the time-shift value is known, you can set the computation priority in favor of the altitude calculation and hold the time-shift to a fixed value. If your application demands an optimum time-shift value, you can set the computation priority in favor of the time-shift calculation and hold the altitude to a fixed value. Use the set command **$PASHS,GTP** to change the computation priority.

Enter the following command to set the computation priority in favor of the time-shift calculation:

$PASHS,GTP,Y

Enter the following command to set the computation priority in favor of the altitude calculation:

$PASHS,GTP,N

DEFAULT SETTING	
GTP	Y

Ionospheric and Tropospheric Modelling

The GG12-Pro can be set to use ionospheric and tropospheric models in its position computations to compensate for errors caused by ionospheric and tropospheric delay. The **$PASHS,ION,Y** set command enables the ionospheric modelling. The **$PASHS,TRO,Y** set command enables tropospheric modelling. This mode of operation is typically used to improve autonomous accuracy by minimizing the influence of the ionosphere or troposphere on the code phase of the GPS signal.

When the GG12-Pro is in differential mode (base or rover), ionospheric and tropospheric modeling should be disabled because differential GPS compensates for delays associated with the ionosphere and troposphere. When the receiver is in differential mode and ionospheric/tropospheric modelling is enabled, the receiver ignores corrections computed through these models.

The ionospheric model used by the GG12-Pro is based on the model defined in ICD-GPS-200, Revision B. Refer to the ARINC Research Corporation for more information on ICD-GPS-200:

ARINC Research Corporation

2250 E. Imperial Highway, Suite 450

El Segundo, CA 90245-3509

Tel: 310-524-1557

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

The tropospheric model is based on the Bean and Dutton model (Bean, Bradford R., and E.J. Dutton. *Radio Meteorology*. Dover, New York, 1986).

DEFAULT SETTING	
ION	**Enabled**
TRO	**Enabled**

NMEA Output

The GG12-Pro can output twelve NMEA and four Ashtech NMEA-style messages. The nine standard NMEA messages are:

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

The four Ashtech NMEA-style messages are:

- LTN: Position Output Latency message.
- POS: 3D Antenna Position message.
- SAT: Comprehensive Satellite Tracking Status message.
- SFS: OEM-specific navigation message

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

The output interval can be set individually, or you can set a global output interval for all messages being output with the set command **$PASHS,NME,PER**. The maximum update rate is 5 Hz. Depending upon the options installed, the output

interval can be set to any value between 0.2 and 999 seconds. The default setting for the output interval is one second. See Chapter 4 for more information on NMEA messages and Ashtech NMEA-style messages.

DEFAULT SETTING	
PER	**1 second.**

Raw Data Output (Optional)

The GG12-Pro has an optional feature that allows you to output raw data (also called real-time data) through serial ports A and B. Nine different messages can be output:

- MBN: Contains measurement data for each locked satellite in the Ashtech type 2 data structure.
- MCA: Contains measurement data for each locked satellite in the Ashtech type 3 data structure.
- MIS: Contains miscellaneous measurement data not available in the MBN and MCA messages.
- PBN: Contains position and velocity data.
- SAG: Contains GLONASS satellite almanac data in a proprietary format.
- SAL: Contains GPS satellite almanac data in a proprietary format.
- SNG: Contains GLONASS satellite ephemeris data
- SNV: Contains GPS satellite ephemeris data.
- XYZ: Contains 3D position data and range for each locked satellite.

All raw data messages are in binary format. The transmission protocol remains the same: 8 data bits, 1 stop bit, and no parity bit. Any combination of messages can be output through any of the serial ports, and the same messages can be output through different ports at the same time. The output interval is set by the **$PASHS,RCI** command, which can range between 0.2 and 999 seconds depending upon the option selected for the raw measurement update rate (5 or 2 Hz). Information on the structure and content for all the above messages can be found in "Raw Data Commands" section on page 108.

DEFAULT SETTING	
RCI	**10 seconds**

Differential Operation (Optional)

This section contains a general discussion of real-time differential operation, including basic concepts, sources of error, GG12-Pro commands related to differential GPS, plus format and content for the RTCA correction messages supported by the GG12-Pro. Differential remote [U] operation is available as an option.

When the GG12-Pro is set as a differential rover, the port which is designated to receive/send 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 will be able to 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 the range corrections 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 calculates a 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 technique yielding comparable accuracy.

When operating as a stand-alone receiver, the GG12-Pro can compute a position averaging ± 10 meters of accuracy with Selective Availability (SA) off. Stand-alone accuracy with SA on is worse, averaging ±100 meters. When receiving differential corrections, a GG12-Pro operating in differential remote mode can achieve sub-meter accuracy on average even with SA on.

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.

Sources of Error

The major sources of error affecting the accuracy of GPS range measurements are errors in satellite orbit estimation, errors in the satellite clock estimation, and errors introduced by the ionosphere, troposphere, multipath, and receiver noise in measuring satellite ranges. The first four sources of error are almost totally

removed by differential corrections. The residual error is typically 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 GG12-Pro, integrated doppler measurements are used to smooth the range measurements and reduce the errors resulting from receiver noise.

RMS noise, which is present from the moment a satellite is locked, contributes one meter of error to the range measurement each time a satellite is locked. 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 an SV, the error resulting from rms noise 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 GG12-Pro loses lock on a satellite and then reacquires it, the noise error goes back to one meter and smoothing starts from the one-meter level. The loss of lock to a satellite is rare in most applications, and typically happens only when the line of sight between the GG12-Pro antenna and the satellite is blocked by some 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 (the 3D position dilution of precision). PDOP is a function of satellite geometry, which refers to the positions of the satellites in relation to one another. Satellites that are close together have poor geometry.

RTCA Messages

When operating in differential remote mode, the GG12-Pro automatically processes RTCA differential messages through either serial port. To set the GG12-Pro for differential remote operation and to receive differential corrections through port B, enter the following set command:

$PASHS,RTC,REM,B

At present, the GG12-Pro supports only the RTCA Type 1 message, which contains differential corrections for individual satellites. To disable differential operation, enter the command below:

$PASHS,RTC,OFF

Although RTCA messages are in binary format, it is possible to convert them to ASCII format. You can query the MSG response message by entering the command:

$PASHQ,MSG

You can also set the receiver to output the MSG response message at regular intervals. For example, the command below sets the GG12-Pro to output MSG every five seconds from port A:

$PASHS,NME,MSG,A,ON,5

On initial power-up, or after issuing the **$PASHS,RST** command (restore defaults), differential operation is disabled, automatic differential mode is disabled, and the setting for the maximum age of an RTCA differential correction is 60 seconds, meaning that an incoming correction whose age is greater than 60 seconds is not used. If differential operation is enabled and automatic differential GPS mode is disabled, the GG12-Pro does not output positions if the differential correction data is unavailable or is older than the maximum age specified by the set command **$PASHS,RTC,MAX.** If differential operation and automatic differential mode are enabled, the GG12-Pro outputs uncorrected positions if differential correction data is unavailable or if the age of correction exceeds the maximum age setting.

Timing Pulse

When the timing pulse option [L] is installed, the GG12-Pro can output a timing pulse synchronized with GPS time to an accuracy of ±1 microsecond. The timing pulse is a TTL square wave output on pins 1, 2, 3, and 4 of the J801 connector, driving a 75-ohm impedance. The pulse is generated by default once every second (1PPS, or 1 pulse-per-second) with no offset from GPS time and with the rising edge of the pulse synchronized to GPS time.

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

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

Figure 3.1 shows timing pulse characteristics under default conditions. The pulse occurs when the signal goes high. 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 GG12-Pro is receiving differential corrections. The GG12-Pro must be computing positions and tracking a minimum of four

satellites in order for the one-microsecond accuracy and 45/190-nanosecond precision to be valid.
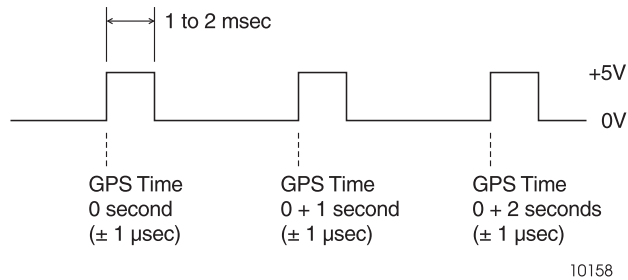
Figure 3.1. Timing Pulse Characteristics

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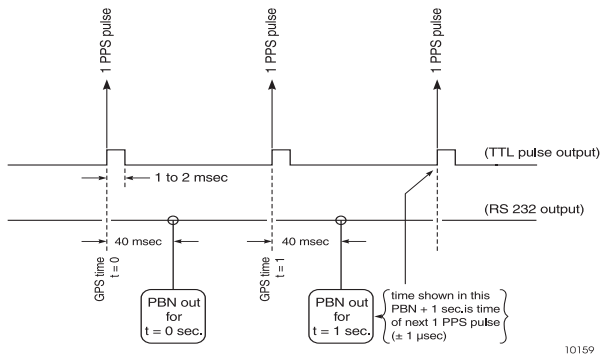
Figure 3.2. Relationship of GPS Time in PBN Record to 1PPS Pulse

Table 3.1 summarizes the default settings of the various parameters.

Table 3.1. Parameter Defaults

Parameter	Description	Default
SYS	System tracking mode	GPS
PMD	Position mode	Mode 0 - 3D only
FIX	Fixed altitude mode	Mode 0 - use most recent altitude
PEM	Position elevation mask	2 degrees
ELM	Raw date elevation mask	2 degrees
PDP	Position dilution of precision mask	100000
HDP	Horizontal dilution of precision mask	100000
VDP	Vertical dilution of precision mask	100000
TDP	Time dilution of precision mask	100000
GTF	Time shift mode	Mode 0 - most recently computed
ION	Ionospheric and tropospheric modeling	Both enabled
PER	NMEA output interval	1 second
RCI	Receiver recording interval	10 seconds
PPS	1 PPS output pulse	1 second, 0 offset, rising edge

4

Command/Response Formats

This chapter defines the format and content of the serial port commands that control and monitor the GG12-Pro. These commands set receiver parameters and request receiver status information and other data. You can communicate with the GG12-Pro with an office computer, using the Ashtech Evaluate™ software or any other standard serial communication software. Be aware that the baud rate and protocol of the computer COM port must match the baud rate and protocol of the receiver. The communication protocol is 8 data bits, 1 stop bit, and no parity (8,1,N).

All messages to the receiver are either **Set** commands or **Query** commands. **Set** commands typically change receiver parameters and initiate data output. **Query** commands typically request receiver status information. All set commands begin with the Ashtech header **$PASHS, and** all query commands begin with the Ashtech header **$PASHQ**. All commands must end with an **<Enter>** or **<CR><LF>** (Carriage Return/Line Feed) keystroke in order to send the command to the receiver. An optional checksum may precede the **<Enter>** characters.

The receiver responds to a query with a response message which begins with the header **$PASHR**. Response messages end with **<Enter>** or **<CR><LF>.** Some messages are functional only if an appropriate option is installed in the GG12-Pro.

When a command is sent to one of its serial ports, the GG12-Pro responds by outputting a message indicating acceptance or rejection of the command. In the case of query commands, the GG12-Pro either outputs a response message containing data relevant to the query, or sends a "NAK" (no acknowledge) response, indicating that the query command was invalid.

GG12-Pro serial port commands fall into four groups:

Receiver commands, described in detail on page 55
Raw data commands, described in detail on page 108
NMEA message commands, described in detail on page 147
RTCA differential commands, described in detail on page 244

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 characters or numbers depending upon the command. Table 4.1 describes symbols and the types of data represented by them, used to illustrate message structures in 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

The 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 GG12-Pro operating parameters, and **query** commands instruct the GG12-Pro 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, for example:

$PASHR,NAK*30

Set commands can be input to either serial port. When the GG12-Pro receives a valid set command, it returns an "acknowledged" (ACK) message, such as:

$PASHR,ACK*3D

If the set command is invalid, the GG12-Pro returns a NAK message.

The set command **$PASHS,SAV,Y** instructs the GG12-Pro to save user-entered operation parameters; the GG12-Pro returns **$PASHR,ACK*3D** to acknowledge that the command was valid and the instruction was carried out.

The set command **$PASHS,SAV** is incomplete, and would cause the GG12-Pro to flag it as an invalid command by responding with a "not acknowledged" response:

$PASHR,NAK*30.

The set command message structure is shown below:

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

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

An example is the **set** command used to set the HDOP mask value. To set the mask value to 6, this command would be entered as shown below:

$PASHS,HDP,6<Enter>

Query commands are used to request current GPS information and receiver status information such as port, baud rate, position information, and tracking information. Query commands can be sent to either serial port. Some query commands allow you to designate the port from which the response message is sent. The GG12-Pro acknowledges a valid query command 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

Commands

requested information is sent one time each time the command is issued, and is not repeated.

The query command message format is shown below:

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

Table 4.2 describes the structure of the query command.

Table 4.2. Query Command Structure

Field	Description
$	NMEA message start character
PASHQ	Proprietary Ashtech header for query messages
xxx	Message identifier, 3-character string
<optional query parameter>	Designates data port from which query response message is to be sent
*	Checksum delimiter
hh	Optional hexadecimal checksum

As an example, the query command **$PASHQ,TRO<Enter>** instructs the GG12-Pro to output a response message indicating whether tropospheric modeling is enabled (Y) or disabled (N), as shown below:

$PASHR,TRO,N*5F

The query command **$PASHQ,TR<Enter>** is incomplete, and causes the GG12-Pro to flag it as an invalid message by outputting the NAK response.

Table 4.3 lists the receiver set, query, and response message commands. The commands are grouped alphabetically by function (Antenna Position, Clock Parameters, etc.), and then listed alphabetically within each function. The commands are described in detail in the pages following Table 4.3. Since <Enter> or <CR><LF> are required for all commands, they are not shown.

Table 4.3. Receiver Commands and Response Messages

Command	Description	Page
Antenna Position		
$PASHS,ALT	Set ellipsoidal height of antenna. Default = 0.	60
$PASHS,POS	Set antenna position	84
$PASHQ,POS	Query current antenna position	84
$PASHR,POS	POS response message	84

Table 4.3. Receiver Commands and Response Messages (continued)

Clock Parameters		
$PASHS,DTG	Set GLONASS time-shift relative to GPS time. Default = 0.	62
$PASHQ,DUG	Query GPS/UTC time difference	62
$PASHR,DUG	DUG response message	62
$PASHS,GTF	Set GLONASS fixed time shift mode. Default = 0.	65
$PASHS,GTM	Enable/disable GLONASS fixed time shift. Default = 1.	66
$PASHS,GTP	Set priority for GLONASS system time shift computation. Default = Y.	67
$PASHS,TSC	Select GPS or GLONASS time scale. Default = GPS.	104
$PASHQ,TSC	Query current time scale setting	104
$PASHR,TSC	Time scale response message	105
Dilution of Precision (DOP)		
$PASHS,HDP	Set HDOP mask for position computation. Default = 100000.	67
$PASHS,PDP	Set PDOP mask for position computation. Default = 100000.	75
$PASHS,TDP	Set TDOP mask for GLONASS time shift. Default = 100000.	102
$PASHQ,TDP	Query current TDOP setting	102
$PASHS,VDP	Set VDOP mask for position computation. Default = 100000.	107
Ionospheric, Tropospheric Modeling		
$PASHS,ION	Enable/disable ionospheric modeling. Default = Y(enable).	72
$PASHQ,ION	Query ionospheric measurements	73
$PASHR,ION	ION response message	73
$PASHS,TRO	Enable/disable tropospheric modeling. Default = Y(enable).	103
$PASHQ,TRO	Query to see if tropospheric modeling is enabled or disabled	103
$PASHR,TRO	TRO response message	104
Memory		
$PASHS,INI	Clear battery-backed-up (BBU) memory	71
$PASHQ,BIT	Query results of built-in test (BIT)	60
$PASHR,BIT	BIT response message	60

Commands

Command/Response Formats **57**

Table 4.3. Receiver Commands and Response Messages (continued)

$PASHQ,HST	Query history of built-in tests	68
$PASHR,HST	HST response message	68
$PASHS,RST	Restore default parameter settings	95
$PASHS,SAV	Save parameters in battery-backed-up (BBU) memory	97
Position Computation		
$PASHS,FIX	Set fixed altitude mode. Default = 0.	65
$PASHS,PEM	Set elevation mask for position computation. Default = 2 degrees.	75
$PASHS,PMD	Set position computation mode. Default = Mode 0.	76
$PASHQ,PPR	Query parameter settings pertaining to position computation	77
$PASHR,PPR	PPR response message	77
RAIM (Receiver Autonomous Integrity Monitor)		
$PASHS,AIM	Sets receiver into RAIM mode	79
$PASHQ,AIM	Query the RAIM configuration	79
$PASHR,AIM	AIM response message	79
$PASHQ,PRM	Query the predictive RAIM (PRM) capability	81
$PASHR,PRM	PRM response message	82
$PASHS,BAR	Set barometric altitude	83
$PASHQ,BAR	Query barometric altitude setting	83
$PASHR,BAR	Barometric altitude response message	83
$PASHS,BAR	Set barometric altitude	83
$PASHQ,BAR	Query barometric altitude setting	83
$PASHR,BAR	Barometric altitude response message	83
Receiver Configuration		
$PASHS,POP	Set receiver update rate for position & raw measurements. Default = 2 Hz.	83
$PASHQ,PRT	Query port baud rate	90
$PASHQ,RID	Query receiver identification (Format 1)	91
$PASHQ,RIO	Query receiver identification (Format 2)	94

Table 4.3. Receiver Commands and Response Messages (continued)

$PASHS,SPD	Set baud rate of serial port. Default = code 5 (9600 baud).	97
$PASHS,SYS,GXX	Select satellite system modes, where GXX = GPS, GLO, GPG, or GLG	101
$PASHS,SYS,USE	Set number of channels to track GPS/GLONASS satellites. Default = all.	101
$PASHQ,ETI	Query elapsed time indicator	64
$PASHR,ETI	Elapsed time indicator response message	64
$PASHS,ETI,sss, CLR	Clear ETI indication using Thales proprietary password	65
Satellite Tracking Parameters		
$PASHS,SVP	Include/exclude satellites for position computation. Default = Y.	98
$PASHQ,SVP	Query satellites enabled/disabled for position computation	98
$PASHR,SVP	SVP response message	98
$PASHS,SVS	Include/exclude specific satellites for acquisition and tracking	99
$PASHQ,SVS	Query satellites enabled/disabled for acquisition and tracking. Default = Y.	100
$PASHR,SVS	SVS response message	100
$PASHS,USE	Include/exclude satellites for acquisition and tracking. Default = all.	105
$PASHS,USP	Include/exclude satellites for position computation. Default = all.	107
Timing Pulse Output		
$PASHS,PPS	Set period and offset of timing pulse. Default = 1 sec, 0 offset, rising edge.	88
$PASHQ,PPS	Query timing pulse parameters	89
$PASHR,PPS	Timing pulse response message	89

Commands

ALT: Set Ellipsoidal Height

$PASHS,ALT,f1

This command sets the ellipsoidal height of the antenna, where f1 can be any value from -99999.99 to **+**99999.99. The GG12-Pro uses the altitude value set by this command when computing 2D positions.

Example: Set ellipsoidal height of antenna to +100.25 meters:

$PASHS,ALT,+100.25

Example: Set ellipsoidal height of antenna to -30.1 meters:

$PASHS,ALT,-30.1

DEFAULT SETTING	
ALT	00000.00 meters

BIT: Query Results of Built-in Tests

$PASHQ,BIT,c

This command queries the results of the GG12-Pro self-test routine, also called power-up and continuous built-in test. The c parameter is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,BIT

The GG12-Pro runs the built-in test each time it is turned on and periodically while it is operating. The built-in test routine is a series of queries used to ascertain the status of several critical components and parameters. For example, built-in test checks whether receiver parameters stored in non-volatile memory have been corrupted by querying for a checksum. If the returned checksum does not match one in a list of acceptable checksum values, the GG12-Pro notes a failure in the BIT response message. The response message is output in the format:

$PASHR,BIT,c1,c2,c3*hh

Table 4.4 describes the response message structure.

Table 4.4. $PASHR,BIT Response Message Structure.

Parameter	Description	Range
c1	Low battery test, P = pass, F = fail. Indicates whether the battery in the real-time clock device has failed. This field takes the F state if the receiver does not detect voltage on the back-up battery pins. Note that this voltage should be provided externally (on the on-board connector).	P = pass F = fail
c2	Receiver parameters checksum/CRC test, indicates whether the receiver parameters stored in non-volatile memory have been corrupted. This field takes either the F or P state at start-up and remains at this state during turn-on. This field takes the F state if the receiver parameters checksum in BBU failed. This checksum failure usually happens after the receiver is disconnected from power. Note that it may take some time for the BBU contents to destroy; from a few seconds to a few minutes.	P = pass F = fail
c3	Fatal failure detection tests. Fatal failures include volatile and non-volatile memory failures, firmware checksum/CRC failure, and RS-232 serial port A or B failure. This field takes the F state if the receiver detected a fatal BIT error and went to soft reset. After soft reset this field should be F.	P = pass F = fail
*hh	Checksum, 2-character hex	

A typical BIT message could be:

$PASHR,BIT,P,P,P*57

with parameters as defined in Table 4.5.

Table 4.5. Typical BIT Message

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

Commands

Command/Response Formats 61

DTG: Set GLONASS Time-Shift Value Relative to GPS Time

$PASHS,DTG,f

This command sets the GLONASS system time-shift relative to GPS system time, where f is the time shift in microseconds. The f parameter represents the fractional part of the GPS/GLONASS system time offset. The GG12-Pro calculates the offsets for the integer seconds (leap seconds) and the integer hours automatically. The time shift has a range of +500.0000 to -500.0000 microseconds.

Example: Set GLONASS system time shift to -1.3 microseconds:

$PASHS,DTG,-1.3

DEFAULT SETTING	
DTG	**0.0000**

The GG12-Pro default time-shift mode sets the receiver to use the most recently computed GLONASS system time-shift value when the receiver goes into a fixed time-shift mode. Enter the command $PASHS,GTF,1 to use the time-shift value selected through the DTG command. See the GTM command for more information on fixed time-shift modes.

When you set this parameter, the time shift value selected should be as close as possible to the actual time shift value in order for the receiver to compute positions. As of November 1999, the fractional portion of the time shift value is approximately +1.3 microseconds.

DUG: Query GPS/UTC Time Difference

$PASHQ,DUG,c

Queries the time difference between UTC time and GPS time; c is the optional output serial port, A or B. If a port is not specified, the receiver sends the response to the current port.

$PASHR,DUG

The response message is output in the format:

$PASHR,DUG,struct

Table 4.6 describes the structure of the binary data structure.

Table 4.6. $PASHR,DUG Binary Data Structure

Type	Size	Content
unsigned short	2	Reference GPS week of current GPS-UTC time correction = ION[12] Wnt UTC reference week number (0-1023)
unsigned short	2	Reference GPS time of current GPS-UTC time correction = ION[11]*2**12 tot Reference time for UTC data
unsigned short	2	Current GPS-UTC time correction in seconds = ION[13] D tLS Delta time due to leap seconds
unsigned short	2	GPS week of correction's change when the last leap second was added to GPS time (0-1023)= ION[14] WNLSF Leap second become effective week number
unsigned short	2	Day number of correction's change when the last leap second was added to GPS time (1 to 7)= ION[15] DN Leap second become effective day number
unsigned short	2	New GPS-UTC time difference after correction in seconds = ION[16] D tLSF Delta time between GPS and UTC
unsigned short	2	Word checksum, computed by breaking the structure into 6 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total bytes	14	

The ION[x] references are from the $PASHR,ION,struct response. These parameters are described in the GPS ICD (contents of navigation information in subframe 4, page 18; ref: section 20.3.3.5.2.4)

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.

Example: **$PASHR,DUG,897,123,11,834,1,11*hh**

where the parameters are as defined in Table 4.7.

Table 4.7. Typical $PASHR,DUG Message Parameters

Parameter	Description
$PASHR,DUG	Header
897	Wnt UTC reference week number = 897
123	Reference GPS time of current GPS-UTC time correction = 123*4096 = 503,808 = day 5 (+1=6 (Friday)), 19:56:48
11	Current GPS-UTC time correction in seconds = 11
834	GPS week of correction's change = 834
1	Day number of correction's change = 1 (Sunday)
11	New GPS-UTC time difference after correction in seconds = 11
*hh	Checksum

ETI: Elapsed Time Indication

$PASHQ,ETI

This command requests the elapsed time, that is, the total number of operating hours. ETI is required for establishing the MTBF of the GG-12 Pro, specified as 38,000 hours. ETI is incremented whenever the receiver is turned on, starting from zero when the receiver is manufactured, and shows the total number of operating hours of the receiver, up to 100,000 hours, with a resolution of 0.1 hour.

 The format is

$PASHQ,ETI[,c]

where c is the receiver output port. By default this is the port the query is issued from.

$PASHR,ETI

The response message is in the format

$PASHR,ETI,d1,checksum

where d1 is the total number of operating hours of the receiver (ETI), from 0.1 to 99999.9 hours. The output format is ASCII

Examples:

$PASHR,ETI,25.7*cc , where cc is the checksum.

$PASHR,ETI,2049.1* cc , where cc is the checksum.

$PASHS,ETI,sss,CLR

This command clears the ETI. The format is

$PASHS,ETI,sss,CLR

where sss is a Thales proprietary password.

FIX: Set Fixed Altitude Mode

$PASHS,FIX,d

Sets the altitude hold position fix mode for the altitude used (for 2D position determination. For d = 0 (default), the most recent altitude is used in altitude hold position fix. The altitude is taken from either the altitude entered by the $PASHS,POS command, or the last altitude computed when VDOP is less than VDOP mask. For d = 1, only the most recently entered altitude is used. See also $PASHS,ALT.

Example: Set GG12-Pro in fixed altitude mode 1:

$PASHS,FIX,1

DEFAULT SETTING	
FIX	**d = 0**

GTF: Set GLONASS Time-Shift Mode

$PASHS,GTF,d

This command sets the GLONASS system time shift hold position fixed mode, where d is 0 or 1.

Time-shift Mode 0 (d = 0)

This mode sets the GG12-Pro to use the most recently computed GLONASS system time shift.

Time-shift Mode 1 (d = 1)

This mode sets the GG12-Pro to use the GLONASS system time shift value selected through the **$PASHS,DTG** command.

Example: Set GG12-Pro to use GLONASS system time shift value selected through the **$PASHS,DTG** command:

$PASHS,GTF,1

DEFAULT SETTING	
GTF	**Mode 0 (d = 0)**

The GTF command does not set the GLONASS system time shift value. This command determines what value is used for the time-shift when the GG12-Pro is in a fixed time-shift mode. This is either the most recently computed time shift value, or the time shift value selected through the DTG command.

GTM: Set GLONASS Fixed Time-Shift Mode

$PASHS,GTM,d

This command sets the fixed time shift mode, where d is 0, 1, or 2. This setting is applicable only when the GG12-Pro is tracking both GPS and GLONASS satellites. See GG12-Pro Operating procedures in Chapter 3 for more information on the different mode settings and how they are related. The fixed time-shift modes are described below.

Fixed Time-shift Mode 0 (d = 0)

The GLONASS system time-shift value is never held fixed. When set in this mode, the GG12-Pro uses the most recently computed time shift value. The GG12-Pro must be tracking a sufficient number of satellites (n) in order to compute the time-shift value. When this mode is selected, the GG12-Pro stops computing positions if the number of satellites tracked drops to n-1.

Fixed Time-shift Mode 1 (d = 1)

This mode sets the GG12-Pro to compute the GLONASS system time shift if it is tracking a sufficient number n of satellites to compute a position. If the number of satellites being tracked by the GG12-Pro is n-1, the most recent GLONASS system time-shift value that was computed while tracking n satellites is held fixed. In this mode, the receiver will continue to use this time-shift value until it is once again tracking n satellites. See $PASHS,PMD on page 76.

Fixed Time-shift Mode 2 (d = 2)

The GLONASS system time-shift is always held fixed. This setting allows the GG12-Pro to continue computing positions even when the number of satellites tracked drops to n-1. When this mode is selected, the receiver stops computing positions when the number of satellites being tracked drops to n-2.

Example: Select fixed time-shift Mode 2:

$PASHS,GTM,2

DEFAULT SETTING	
GTM	**Mode 1**

GTP: Set Computation Priority for Time Shift Vs. Altitude

$PASHS,GTP,c

This command allows you to set the priority of GLONASS system time-shift computation against altitude computation, where c is Y (yes) or N (no). Entering Y sets the receiver to compute GLONASS system time shift and hold altitude fixed. N sets the receiver to compute altitude and hold GLONASS system time shift fixed.

Example: Set altitude calculation as the computation priority:

$PASHS,GTP,N

DEFAULT SETTING	
GTP	**Y**

If GPS and GLONASS satellites are used in position computation, and both PMD and GTM are set to a value other than 0, (fix altitude or time shift when fewer than 5 satellites), the following conditions apply when GG12-Pro is tracking only 4 used satellites: Y (default) sets the receiver to compute GLONASS time-shift and hold altitude fixed. N sets the receiver to compute altitude and hold GLONASS time-shift fixed.

HDP: Set HDOP Mask Value

$PASHS,HDP,d

This command allows you to set the mask value for the Horizontal Dilution of Precision (HDOP), where d is a number between 0 and 99; the manual setting overrides the default setting of 100000. If the HDOP value computed by the GG12-Pro is higher than the HDOP mask value, the receiver automatically goes into fixed altitude mode. You can view the current HDOP mask value by entering the query command $PASHQ,PPR and checking field d4.

The GG12-Pro uses this value not as a limit for position computation, but only use it with the PMD = 3 mode (see $PASHS,PMD,d on page 76).

Example: Set HDOP mask to 6:

$PASHS,HDP,6

DEFAULT SETTING	
HDP	**100000**

HST: History of Built-in Tests

$PASHQ,HST

This command requests the history of built-in test failures. The response contains information about only one failure (if any) at a time. If the first optional parameter is omitted, then information about the last failure is returned. Otherwise the first optional parameter is the index of a particular failure. The latest failure has the biggest index.The format is

$PASHQ,HST,d,c

where d and c are as defined in Table 4.8.

Table 4.8. $PASHQ,HST Message Structure

Parameter	Description	Range
d	Index of a particular failure. The latest failure has the biggest index.	1 - ...
c	Output port for response message. By default the port the query is issued from.	A or B

$PASHR,HST

The response message contains information about only one failure (if any) at a time. If the first optional parameter is omitted, then information about the last failure is returned. Otherwise the first optional parameter is the index of a particular failure. The latest failure has the biggest index. The output is ASCII. The format is

$PASHR,HST,d0,d1[,d2,d3,d4,d5,m1,s1,d6]checksum

where the parameters are as defined in Table 4.9**.**

Table 4.9. $PASHR,HST Message Structure

Field	Description	Range
d0	Total number of operating hours of the receiver (ETI). ETI can be reset using a Thales proprietary ETI-clear command and password. See MTBF requirement.	0.1 – 99,999.9 hours
d1	Total number of failures in history. If zero, rest of message is omitted.	0 - ...
d2	Sequential index of this failure in the history.	1 - ...
d3	Day of failure	01 - 31
d4	Month of failure	01 – 12
d5	Year of failure	0000-9999
m1	UTC time of failure (hhmmss.ss) (hours, minutes, seconds)	000000.00...235959.00
s1	Turn-on failure or operational failure	TON or OPR
d6	Failure code explaining which built-in test failed (see Table 4.10 and Table 4.11 below)	1 - ...

Table 4.10. Codes for Turn-on Built-in Test Failures

Code	Description	Corresponding Bit of Label 352
1	Turn-on program RAM CRC test	11
2	Turn-on data RAM pattern test	12
3	Turn-on op-code check	13
4	Turn-on ROM CRC test	14
5	Bite test I/O NP TX #1 wraparound test IRS/FMS #1 input bus RX test	15
6	Reserved	16
7	Time mark TX test	17

Commands

Command/Response Formats 69

Table 4.11. Codes for Operational Built-in Test Failures

Code	Built-in Test	Corresponding Bit of Label 354
1	Operational program RAM CRC test	11
2	Operational program ROM CRC test	12
3	Operational op-code check	13
4	Task scheduler monitor test Foreground task check	14
5	Background monitor test	15
6	L1 ASIC 1 ms counter monitor Real-time execution monitor Watchdog timer monitor	16
7	Reserved	17
8	Stack overflow	18
9	Internal error messagew	19
10	Tracking performance monitor	20
11	Power supply undervoltage monitor	21
12	Program pin change test	22
13	Antenna short/open detect test	23
14	ARINC labels parity test	24

Examples:

$PASHR,HST,0*35

$PASHR,HST,3,2,25,05,2000,172345.00,OPR,4*35

$PASHS,HST,sss,CLR

This command clears the history of built-in test failures. The format is

$PASHS,HST,sss,CLR

where sss is a Thales proprietary password.

INI: Initialize 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, as listed in Table 4.12.

Table 4.12. $PASHS,INI Parameters

Parameter	Description	Range
d1	Receiver Port A baud rate: 0 - 300 5 - 9600 (default) 1 - 600 6 - 19200 2 - 1200 7 - 38400 3 - 2400 8 - 56800 4 - 4800 9 - 115200	0-9
d2	Receiver Port B baud rate - same as for Port A	0-9
d3	Reset memory 0 - No memory reset 1 - Reset internal memory 2 - Reset external memory 3 - Reset internal and external memory 5 - Warm start (clear ephemeris but not almanac or position/time (See Table 4.13 below)	0, 1, 2, 3, 5

Table 4.13. Memory Reset Codes

Code	Clear Receiver Parameters in BBU	Clear Ephemeris	Clear Almanac	Clear Latest Position	Clear RTC Time	Reset Channels	Restart Processor	Clear Receivers in RAM
0						x	x	
1	x	x	x	x	x	x	x	x
2								
3	x	x	x	x	x	x	x	x
5		x				x	x	x

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

In a receiver where external memory is present, several minutes may be required to initialize the external memory. Do not turn the receiver off until you have verified

Command/Response Formats   **71**

that the external memory has finished initializing.

See also $PASHS,SPD and $PASHS,RST

Example: Set Port A, B baud rate to 38400 bps, reset internal and external memory:

$PASHS,INI,7,7,3

Example: Restart processor, keep all ports at current speed, do not clear internal or external memory:

$PASHS,INI,,,0

Example: Restart processor, set A to 9600, B to 38400. Perform warm start of processor, clearing ephemeris but not position, time, or almanac:

$PASHS,INI,5,7,5

ION: Enable/Disable Ionospheric Modeling

$PASHS,ION,c

This command enables or disables ionospheric modeling, which is used to compensate for delays that occur as the GPS signals travel through the ionosphere, where c is either N (disable) or Y (enable). You can see whether ionospheric modeling is enabled or disabled by entering the query command **$PASHQ,PPR** (page 77**).**

The ionospheric model (Bean and Duton) is used by default whenever differential corrections are not in use. This exclusion may be overridden by the $PASHS,ION,N command.

The ionospheric model is not used by default whenever differential corrections are in use. This inclusion may be overridden by the $PASHS, ION,Y command.

The GG12-Pro applies the ionospheric model for both the GPS and GLONASS satellites. The set command $PASHS,ION,x message includes/excludes the ionospheric model from the position computation. The GLONASS satellites ionospheric corrections should be computed using the GPS ionospheric correction parameters.

Example: Enable ionospheric modeling:

$PASHS,ION,Y

DEFAULT SETTING	
ION	**Y (enabled)**

Ionospheric modeling should be enabled when the receiver is functioning in stand-alone (autonomous) mode. Ionospheric modeling is ignored when the receiver is set as an RTCA rover, regardless of the current ION setting, since differential corrections already compensate for ionospheric delays.

$PASHQ,ION,c1

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

$PASHR,ION

The ION response message is output in binary format:

$PASHR,ION,binary data string,checksum

where the elements in the binary data string are as defined in Table 4.14.

Table 4.14. $PASHR,ION Binary Data String

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).
double	8	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.

Command/Response Formats 73

Table 4.14. $PASHR,ION Binary Data String (continued)

Type	Size	Contents
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	Word checksum
Total characters	76 bytes	
The GG12-Pro does not calculate ionospheric parameters on its own. The ionospheric data shown in this table are obtained from subframe 4 of the GPS navigation message.		

PDP: Set PDOP Mask Value

$PASHS,PDP,d

This command sets the mask value for Position Dilution of Precision (PDOP), where d is a user-defined number between 0 and 99; this setting overrides the default setting of 100000. The receiver stops computing positions when the calculated PDOP value exceeds the PDOP mask value. You can view the current PDOP mask setting by entering the query command **$PASHQ,PPR** and checking field d3 (page 77.

Example: Set PDOP mask to 30:

$PASHS,PDP,30

DEFAULT SETTING	
PDP	100000

PEM: Set Position Elevation Mask Value

$PASHS,PEM,d

This command sets elevation mask for position computation, where d is 0 to 90 degrees. Default is 2 degrees. A satellite with elevation which is less than the elevation mask setting is excluded from position computation. You can view the current position elevation mask value with the **$PASHQ,PPR** query command and checking the PEM field.

Example: Set elevation mask to 15 degrees:

$PASHS,PEM,15

DEFAULT SETTING	
PEM	2°

Although the GG12-Pro does not use satellites in the position computation which have gone below the position elevation mask (PEM), you can still obtain raw data from these satellites as long as they are not below the raw data elevation mask (ELM).

PMD: Set Position Mode

$PASHS,PMD,d

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 2D to 3D positioning or is manually locked in 2D or 3D positioning mode, and, in 2D 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 d. See *Position Modes* in Chapter 3 for more information on the position mode settings.

Position Mode 0: Manual 3D Mode (d = 0)

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

Position Mode 1: Automatic 3D Mode (d = 1)

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 (2D positioning). With four satellites or more, altitude is computed (3D positioning).

Position Mode 2: Manual 2D Mode (d = 2)

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

Position Mode 3: Automatic 2D Mode (d = 3)

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 (2D positioning). With 4 satellites, altitude is computed (3D positioning) unless the calculated HDOP value is greater than HDOP mask setting.

Example: Select Position Mode 3:

$PASHS,PMD,3

DEFAULT SETTING	
PMD	**Mode 0**

PPR: Parameters Used for Position Computation

$PASHQ,PPR,c

This command queries the receiver parameters pertaining to position computation, where c is the port where the query is input. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PPR

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

$PASHR,PPR, d1,d2,d3,d4,d5,d6,c7,c8,c9,s10*hh

where the fields are as defined in Table 4.15.

Table 4.15. PPR Message Structure

Field	Description	Range
d1	Position mode setting 0 = Minimum 4 SVs 1 = 3 (2D0 or 4 (3D) SVs (default 2 = 3 SVs (2D) 4 (2D) if HDOP > mask	0 - 3
d2	Fixed altitude mode setting 0 = Use most recent altitude 1 = Use $PASHS,ALT value	0, 1
d3	PDOP mask setting - default = 100000	0 - 100000
d4	HDOP mask setting - default = 100000	0 - 100000
d5	VDOP mask setting - default = 100000	0 - 100000
d6	Position elevation mask (PEM) setting (degrees) - default = 2	0 - 90
c7	Indicates whether point positioning mode is enabled or disabled (always N)	Y (enabled) N (disabled)
c8	Indicates whether unhealthy satellites are included or excluded for position computation (always N)	Y (excluded) N (included)
c9	Indicates whether ionospheric modelling is enabled or disabled	Y (enabled) N (disabled)
s10	Indicates the current satellite system mode	GLO, GPS, GLG, GPG, USE
*hh	Checksum - 2 character hex	

Typical PPR response message:

$PASHR,PPR,1,0,40,4,4,5,N,N,N,GPG*08

Table 4.16 describes a typical response message.

Table 4.16. Typical PPR Response Message

Parameter	Description
$PASHR,PPR	Header
1	Indicates that the GG12-Pro is set in position mode 1
0	Indicates that the GG12-Pro is set in fixed altitude mode 0
40	Indicates that the current PDOP mask setting is 40
4	Indicates that the current HDOP mask setting is 4
4	Indicates that the current VDOP mask setting is 4
5	Indicates that the current position elevation mask setting is five degrees
N	Indicates that point positioning mode is disabled
N	Indicates that unhealthy satellites are excluded from position computations
N	Indicates that ionospheric modeling is disabled
GPG	Indicates that GPG is the current satellites system mode
*08	Checksum

RAIM: (Receiver Autonomous Integrity Monitor)

$PASHS,AIM,str

This command sets the RAIM mode, where str is one of the following 3-character strings:

OFF- Disables RAIM

NPA - Non-precision approach, alarm limit 0.030 nmi

TER - Terminal, alarm limit is 1.00 nmi.

ERT - En route, alarm limit is 2.00 nmi

n.nn - User-defined alarm limit between 0.015 and 4.00 kilometers

$PASHS,NME,AIM,x,s

Enables AIM 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.

$PASHQ,AIM

Queries the AIM response message.

$PASHR,AIM

The AIM response message is in the form:

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

where the structure is as defined in Table 4.17. Output format is ASCII.

Table 4.17. $PASHR,AIM Message Structure

Field	Description
s1	Current RAIM mode (3-character) Off-Turns RAIM off NPA-Non-precision approach, alarm limit 0.030 nmi TER-Terminal, alarm limit 1.00 nmi ERT-En route, alarm limit 2.00 nmi n.nn-User-defined 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 SV or poor geometry) 4-Error detected, rest of SV set not available
n	Number of channels - SV pairs

Table 4.17. $PASHR,AIM Message Structure (continued)

Field	Description
d2-d3	A pair of excluded channel and its corresponding SV, where d2 is the number of the excluded channel and d3 is the number of the corresponding SV
*cc	Checksum

When RAIM returns 0, no errors exceed the alarm limit. All computed satellite ranges are used in the position velocity calculation.

If the value returned is 1, RAIM has detected errors, and has excluded satellites with large range errors and corrected the position and velocity. If the quantity of channel-satellite pair does not exceed 1, the corrected position and velocities are acceptable for applications with a probability of 0.999. If the quantity of channel-satellite pair exceeds 1, then there is no assurance that the positions and velocities have been properly corrected. However, in many cases, RAIM corrects the results satisfactorily even under unfavorable conditions.

If the value returned is 2, RAIM has detected a problem but can not eliminate the questionable satellites because of too few satellites (e.g., 5 satellites in view). In this case, the computed position and velocity do not meet the probability of 0.999.

If the value returned is 3, the satellite geometry is poor and detection is unavailable. This value is always returned if the number of satellites is less than 5.

Finally, if the value returned is 4, RAIM indicates that errors exist (the response contains channel-satellite pair), but fails to correct positions and velocities. In such cases, you can exclude questionable satellites by using the $PASHS,USE or $PASHS,SVS commands.

$PASHQ,PRM

Queries the predictive RAIM capability. The query is in the form:

$PASHQ,PRM, m2,c1,m3,c2,hh,mm,c1c2c3.....c32,b*cc

where the structure is as defined in Table 4.18.

Table 4.18. $PASHQ,PRM Command Structure

Field	Description	Range
$PASHQ,PRM	Header	
m2	Latitude component of position in degrees and decimal minutes (ddmm.mmmmmm)	0 – 90
c1	Latitude sector, N = North, S = South	N or S
m3	Longitude component of position in degrees and decimal minutes (dddmm.mmmmmm) degree part with leading zeros	0 to 180
c2	Longitude sector E = East, W = West	E or W
hh	Hour of requested time tag.	0 -23
mm	Minutes of requested time tag.	0-59
c1c2c3...c32	Select SVs that are used in predictive RAIM evaluation, where: c = Y, SV is used. c = N, SV is not used. Up to 32 SVs may be selected. SVs are entered in order of PRN number. If fewer than 32 are specified, the rest are set to Y. Only the characters Y and N are accepted. This field may be omtiied, in which case all SVs are used.	
b	Include or not barometric altitude in predictive RAIM evaluation where: c = Y, barometric altitude is used. c = N, barometric altitude is not used.	Y or N
*cc	Checksum	

$PASHR,PRM

Predictive RAIM response message. The response message is in the form:

$PASHR,PRM,hh,mm,c1c2c3.....c32,b,ct,ca[,7(cv[,hil,vil])]*cc

Table 4.19 defines the structure of the PRM response message. .

Table 4.19. $PASHR,PRM Response Message Structure

Parameter	Description	Range
hh	Hour of requested time tag.	0-23
mm	Minutes of requested time tag.	0-59
c1c2c3.....c32	Select SVs that are used in predictive RAIM evaluation, where: c = Y, SV is used. c = N, SV is not used. Up to 32 SVs may be selected. SVs are entered in order of PRN number. If fewer than 32 are specified, the rest are set to Y. Only the characters Y and N are accepted. This field may be omitted, in which case all SVs are used.	Y or N
b	Include/exclude barometric altitude in predictive RAIM evaluation where: b = Y, barometric altitude is used. b = N, barometric altitude is not used.	Y or N
ct	Time determined flag ct = Y, time was not determined. ct = N, time was determined	Y or N
ca	Almanac not valid flag ca = Y, almanac is not valid. ca = N, almanac is valid	Y or N
Field below is output when both ct and ca are N. When both flags are N, next followed 7 sequences. Each represented horizontal and vertical integrity values at time tags 0,-5 min,5 min,-10 min,10 min,-15 min,15 min from input hour and minute		
cv	Horizontal and vertical limits validity flag cv = Y, limits valid. cv = N, limits not valid	Y or N
Fields below are output when cv field is Y		
hil	Horizontal integrity value (nautical miles)	0-16
vil	Vertical integrity value (nautical miles)	0-16
*cc	Checksum	

Examples:

Predictive RAIM not available because time not determined:

$PASHR,PRM,20,33,,N,Y,N*xx:

Predictive RAIM not available because almanac is not valid:

$PASHR,PRM,20,33,,N,Y,Y*xx

Horizontal and vertical integrity values evaluated for all 7 points:

$PASHR,PRM,20,33,,N,N,N,Y,0.089,0.211,Y,0.091,0.204,Y,0.310,0.244,Y, 0.410,0.219,Y,0.104,0.252,Y,0.108,0.212,Y,0.102,0.253*xx

Horizontal and vertical integrity values evaluated for 6 points (missed values for - 5 min time tag):

$PASHR,PRM,20,33,,N,N,N,Y,0.089,0.211,N,Y,0.310,0.244,Y,0.410,0.219,Y, 0.104,0.252,Y,0.108,0.212,Y,0.102,0.253*xx

In the above examples, all SVs include PRAIM values evaluation (missed $c_1c_2c_3....c_{32}$ field).

BAR: Set Barometric Altitude

$PASHS,BAR,d1
This command sets the barometric altitude, where d1 is the barometric altitude used in RAIM calculation. The valid range is -9999 to +99999 meters.

$PASHQ,BAR,x
The associated query command outputs the BAR response message on port x, where x is the optional output port, A or B.

$PASHR,BAR,d1
BAR response message, where d1 is the barometric altitude, in meters, that was used in the RAIM calculation.

POP: Set Position and Raw Data Update Rate

$PASHS,POP,d
This command sets the GG12-Pro's internal update rate for position and raw data, where d is 2 or 5 (Hz). Two indicates that position and raw data will be computed internally twice per second; five indicates that position and raw data will be computed internally five times per second. The default is 2. Changes made to the

POP setting are not saved with the **$PASHS,SAV,Y** command.

DEFAULT SETTING	
POP	2

POS: Set 3D Antenna Position

$PASHS,POS,d1f1,c1,d2f2,c2,f3

This command optimizes the GG12-Pro's satellite search pattern by entering a 3D antenna reference position into the receiver. This command is typically used when the receiver is turned on for the first time, or when the receiver has been moved more than 500 miles from the location in which it was last powered on. It is not necessary to use exact coordinates. Inputting approximate coordinates for your current position enables the receiver to restrict its satellite search pattern to include only those satellites which should be visible in that particular area at that particular time. In the command structure, d1f1 is latitude, c1 is latitude direction, d2f2 is longitude, c2 is longitude direction, and f3 is altitude, as detailed in Table 4.20.

Table 4.20. $PASHS,POS Command Structure

Parameter	Description	Range
d1f1	d1 - degree part of latitude f1 - minute part of latitude	0-90 degrees 0-59.9999 minutes
c1	Direction of latitude	S(outh) or N(orth)
d2f2	d2 - degree part of longitude f2 - minute part of longitude	0-180 degrees 0-59.999 minutes
c2	Direction of longitude	E(ast) or W(est)
f3	Altitude in meters	± 99999.99

$PASHQ,POS,c

This command allows you to query the receiver's current 3-D position, where c 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 POS response message is in the format shown below:

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

Table 4.21 defines the format of the POS response message.

Table 4.21. $PASHR,POS Message Format

Parameter	Description	Range
d1	Raw/differential position 0: Raw; position is not differentially corrected 1: Position is differentially corrected with RTCM code	0 - 1
d2	Number of SVs used in position fix	3 -12
m1	Current UTC time of position fix (hhmmss.ss)	00-235959.50
m2	Latitude component of position in degrees and decimal minutes (ddmm.mmmmmm)	0 - 90
c1	Latitude sector, N = North, S = South	N or S
m3	Longitude component of position in degrees and decimal minutes (dddmm.mmmmmm)	0 - 180
c2	Longitude sector E = East, W = West	W or E
f1	Altitude above WGS-84 reference ellipsoid in meters. For 2D position computation this item contains the altitude held fixed.	±30000.000
f2	Reserved	
f3	True track/course over ground in degrees	0 - 359.9
f4	Speed over ground in kilometers per hour	0 - 999.9
f5	Vertical velocity in decimeters per second	±999.9
f6	PDOP - position dilution of precision	0 - 100000
f7	HDOP - horizontal dilution of precision.	0 - 100000
f8	VDOP - vertical dilution of precision.	0 - 100000
f9	TDOP - time dilution of precision.	0 - 100000
s	Firmware version ID	4-char string
*cc	Checksum	

Typical POS response message:

$PASHR,POS,0,09,002701.00,3721.08661,N,12156.11611,W, 00054.41,,047.27,000.44,-000.13,02.0,01.1,01.7,01.2,FA00*17

Command/Response Formats 85

Table 4.22 describes a typical POS response message.

Table 4.22. Typical POS Response Message

Item	Description
$PASHR	Header.
POS	Message identifier.
0	Indicates that the position is computed autonomously (computed without the aid of differential corrections)
09	Indicates that the receiver is using nine satellites to compute a position
164152.90	UTC time reference (00:27:01.00)
3721.06962	Current latitude (37°21.08661')
N	Latitude sector
12156.11611	Current longitude (121°56.11611')
W	Longitude sector
-00054.41	Current altitude (referenced to the WGS-84 ellipsoid)
,,	Reserved data field
047.27	Current course over the ground (that is, 47.27° from true north)
000.44	Current speed over the ground (knots)
+000.13	Current vertical velocity (receiver ascending at 0.13 meters per second)
02.0	Current PDOP
01.1	Current HDOP
01.7	Current VDOP
01.2	Current TDOP
FA00	Firmware version number
*17	Checksum

If the GG12-Pro is unable to compute a position, the POS response message is in the format:

$PASHR,POS,0,,,,,,,,,,,,,,,,GH00*05

The GG12-Pro uses the WGS-84 ellipsoid only. The PZ-90 ellipsoid, which is the ellipsoid reference for the GLONASS system, is not used.

PPR: Position Computation Parameters

$PASHQ,PPR,c

This command queries the current position computation parameters, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PPR

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

$PASHR,PPR,d1,d2,d3,d4,d5,d6,c7,c8,c9,s10*hh

Table 4.23 defines the response message format.

Table 4.23. $PASHR,PPR Message Format

Field	Description	Range
d1	Position mode setting	0 - 3
d2	Fixed altitude mode setting	0, 1
d3	PDOP mask setting	0 - 100000
d4	HDOP mask setting	0 - 100000
d5	VDOP mask setting	0 - 100000
d6	Position elevation mask (PEM) setting; measured in degrees	0 - 90
c7	Indicates if point positioning mode is enabled or disabled (always N)	Y (enabled) N (disabled)
c8	Indicates whether unhealthy satellites are included or excluded for position computation (always N)	Y (included) N (excluded)
c9	Indicates whether ionospheric modeling is enabled or disabled	Y (enabled) N (disabled)
s10	Indicates the current satellite system mode	GLO, GPS, GLG, GPG, USE
*hh	Checksum	2-character hex

Typical PPR response message:

$PASHR,PPR,1,0,40,4,4,5,N,N,N,GPG*08

Table 4.24 describes a typical PPR response message.

Table 4.24. Typical PPR Response Message

Parameter	Description
$PASHR,PPR	Header
1	Indicates that the GG12-Pro is set in position mode 1
0	Indicates that the GG12-Pro is set in fixed altitude mode 0
40	Indicates that the current PDOP mask setting is 40
4	Indicates that the current HDOP mask setting is 4
4	Indicates that the current VDOP mask setting is 4
5	Indicates that the current position elevation mask setting is five degrees
N	Indicates that point positioning mode is disabled
N	Indicates that unhealthy satellites are excluded from position computations
N	Indicates that ionospheric modeling is disabled
GPG	Indicates that GPG is the current satellites system mode
*08	Checksum

PPS: Timing Pulse Parameters

$PASHS,PPS,d1,f1,c1

The GG12-Pro can generate a timing pulse with programmable period and offset. The timing pulse is generated by default once every second (1PPS) with its rising or falling edge synchronized to the GPS time. This command allows you to change the period and the offset (from the current time scale reference) of the pulse, where d_1 is the period of the pulse in seconds with a range between 0 to 60, f_1 is the offset, and c_1 selects rising of falling edge. The minimum setting depends upon the receiver update rate, which is dependent upon the installed position update rate or raw data update options. The f_1 parameter is the offset from GPS time in milliseconds, with 10ns resolution (range between -999.9999 and +999.9999). The c_1 parameter determines whether the GPS time is synchronized with the rising edge of the pulse (R) or the falling edge of the pulse (F), as summarized in Table 4.25.

Table 4.25. $PASHS,PPS Command Structure

Parameter	Description	Range
d1	Period of PPS pulse (seconds)	0 - 60.0
f1	Offset of PPS signal from top of GPS second (milliseconds)	± 999.9999
c1	Selects edge of pulse R = rising, F = falling	R of F

Example: Configure timing pulse to have a period of 2 seconds, offset of 10 milliseconds, and synchronized with falling edge of pulse:

$PASHS,PPS,2,10,F

$PASHQ,PPS,c
This command queries the timing pulse parameters, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PPS
The PPS response message is output in the format:

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

Table 4.26 defines the response message format.

Table 4.26. $PASHR,PPS Message Format

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

Typical PPS response message:

$PASHR,PPS,1.0000,000.0000,R*58

Table 4.27 describes a typical PPS response message.

Table 4.27. Typical PPS Response Message

Parameter	Description
1.0000	Indicates that the period of the timing pulse is set to one second
000.0000	Indicates that there is no offset from the current time scale reference
R	Indicates that the synchronization is on the rising edge of the pulse
*hh	Checksum

DEFAULT SETTING	
PPS	R

See Timing Pulse on page 50 for more information on the conditions surrounding the generation and accuracy of the timing pulse.

PRT: Query Serial Port Baud Rate

$PASHQ,PRT

This command queries the baud rate code of the GG12-Pro serial port to which you are currently connected.

$PASHR,PRT

The PRT response is message is in the format:

$PASHR,PRT,c,d*hh

Table 4.28 defines the format of the PRT response message.

Table 4.28. $PASHR,PRT Message Format

Parameter	Description	Range
c	Identifier for the serial port to which you are currently connected.	A, B
d	Baud rate code 0 = 300　　　　6 = 19200 1 = 600　　　　7 = 38400 2 = 1200　　　8 = 56800 3 = 2400　　　9 = 115200 5 = 9600	1 - 9
hh	Checksum, 2-character hex	

DEFAULT SETTING	
PRT	**Code 5 (9600 baud)**

The data rate for GG12-Pro serial ports is set by using the $PASHS,SPD command.

RID: Query Receiver Identification Parameters (Format 1)

$PASHQ,RID,c

This command queries receiver identification parameters, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,RID

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

$PASHR,RID,s1,s2,s3*hh

Table 4.29 defines the format of the RID response message.

Table 4.29. $PASHR,RID Response Message Format

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

Fourteen options are available for the GG12-Pro. Each option is represented by a letter or number in a prescribed 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 4.30 lists the available options.

Table 4.30. Available Options

Option	Description
[5 = 5 Hz] [2 = 2 Hz] [1 = 1 Hz]	Position update rate
[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
[_]	Reserved option field
[_]	Reserved option field
[L]	Timing pulse output (1PPS)
[_]	Reserved option field
[G]	Geoid model
[M]	Magnetic variation model
[_]	Reserved option field
[_]	Reserved option field
[S]	GLONASS tracking

The absence of dashes in the RID response message indicate that all of the available options have been installed, as shown in the following typical example:

$PASHR,RID,GG,FA00,55OPU__L_GM__S*00

Table 4.31 describes a typical RID response message.

Table 4.31. Typical $PASHR,RID Response Message

Field	Description
$PASHR	Header
RID	Message identifier
GG	Receiver type identifier
FA00	Firmware version number
5	5 Hz update rate (0.2 seconds) installed for raw data update option
5	5 Hz update rate (0.2 seconds) installed for position update option
O	Raw data output option installed
P	Carrier phase tracking option installed
_	Reserved option field
_	Reserved option slot
L	Timing pulse output option installed
_	Reserved option field
G	Geoid model option installed
M	Magnetic variation model option installed
_	Reserved option field
_	Reserved option field
S	GLONASS tracking option installed
*00	Checksum

Command/Response Formats 93

RIO: Query Receiver Identification Parameters (Format 2)

$PASHQ,RIO,c

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

$PASHR,RIO

The RIO 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 4.32 defines the RIO response message structure.

Table 4.32. $PASHR,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 (max 10 characters). This field is empty for the GG12-Pro.
s4	Option list (max 42 characters). ASCII characters represent options not available. For option definitions, see Table 4.30.
s5	Receiver serial number (maximum 20 characters). Underscores represent blank fields
*hh	Checksum. XOR of all characters between the dollar sign ($) and the asterisk (*), but not including the dollar sign and asterisk

Typical RIO response message:

$PASHR,RIO,GG12,FA00,,55OPU__L_GM__S,00000000000000000000*08

Table 4.33 describes a typical RIO response message.

Table 4.33. Typical $PASHR,RIO Response Message

Field	Description
$PASHR	Header
RIO	Message identifier
GG12	Receiver model identifier
FA00	Firmware version number
,,	Reserved data field
5	5 Hz update rate (0.05 seconds) installed for raw data update option
5	5 Hz update rate (0.05 seconds) installed for position update option
O	Raw data output option installed
P	Carrier phase tracking option installed
U	Differential remote option installed
_	Reserved option field
_	Reserved option field
L	Timing pulse output option installed
_	Reserved option field
G	Geoid model option installed
M	Magnetic variation model option installed
_	Reserved option field
_	Reserved option field
S	GLONASS tracking option installed
000…0	Receiver serial number
*6A	Checksum

See Table 4.30 on page 92 for available options.

RST: Restore Default Parameters

$PASHS,RST

This command restores parameters to their default values, and restarts the receiver processor. After issuing the RST command, you can query RAW (raw data output parameters), and RTC (RTCA and differential GPS parameters) to obtain default settings. Table 4.34 lists the parameters reset by this command.

Table 4.34. Parameters Reset by RST Command

Parameter	Description	Value
Recording: INTVL	Recording interval	1
Min SV	Minimum SVs to record	3
ELV mask	Elevation mask	10
POS ELV mask	Elevation mask	5
PDOP mask	Positional Dilution-Of-Precision	100000
HDOP mask	Horizontal Dilution-Of -Precision	100000
VDOP mask	Vertical Dilution-Of-Precision	100000
ION model	Use ionospheric and tropospheric models to compute position	N
Differential: Mode	Differential mode setting (disabled/remote)	Disabled
Output Port	Output port for differential data (A or B)	Port A
AUTO DIFF	If automatic switch position from differential to stand-alone mode	Off
Port Setup: NMEA	Whether or not to send NMEA message out	Off
Interval	NMEA message sending interval (in NMEA options menu)	1
NMEA MESSAGE	All NMEA messages	OFF
MBEN	Measurement data	OFF
PBEN	Position data	OFF
SNAV	Ephemeris data (in binary only)	OFF
SALM	Almanac data (in binary only)	OFF
Baud rate	Speed to output real time message	9600
RCVR CTRL: SAV	Save current parameters in BBU memory	N
Individual satellites	Whether or not to select and track this satellite (max 12 SVs can be tracked at the time)	Y

SAV: Save Parameter Settings

$PASHS,SAV,c

This command enables or disables saving of user-entered parameters in battery-backed memory (BBU) when the receiver is turned off. If c is set to Y, user-entered parameters are saved until default settings are restored through the RST or INI commands. If c is set to N, default parameters are restored each time power is cycled.

User-entered parameters cannot be saved unless a back-up battery is wired to appropriate pins on the J801 connector. Without a back-up battery, user-entered parameters are lost after each power cycle even if the SAV parameter is set to Y.

SPD: Set Serial Port Baud Rate

$PASHS,SPD,c,d

This command allows you to set the baud rate for the GG12-Pro's serial ports, where c is port A or B and d is a code number between 0 and 9 corresponding to the baud rates listed in Table 4.35. The default baud rate is 9600.

Table 4.35. GG12-Pro Baud Rate Codes

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

Examples:

Set baud rate of port A to 19200:

$PASHS,SPD,A,6

Set baud rate of port B to 4800:

$PASHS,SPD,B,4

If you change the baud rate of the GG12-Pro's serial port, be sure that the serial port of the device to which the GG12-Pro port is connected is set to the same baud rate.

Use the query command $PASHQ,PRT to obtain the baud rate setting for the GG12-Pro serial port to

which you are connected.

DEFAULT SETTING	
SPD	Code 5 (9600 baud)

SVP: Include/Exclude Satellites for Position Computations

$PASHS,SVP,s

This command allows you to include or exclude specific satellites for use in position computations, where s is a 56-character string where each character is a Y (include) or N (exclude). Unlike most of the other set commands, the c parameters are not separated by commas. A satellite which has been excluded can still be acquired and tracked, but is not used in computing positions. All satellites are included for position computation by default. The parameters s1 through s32 correspond to GPS satellites PRN numbers 1 through 32; parameters s33 through s56 correspond to GLONASS satellite PRN numbers 1 through 24. It is not necessary to enter a setting for all 56 satellites when using this command.

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

$PASHS,SVP,YYYYYYYYYNYYYYN

This command excludes satellites 10 and 15 from the position computation, but does not change the settings for satellites 16 through 56

Example: To exclude satellites 51 and 56 (GLONASS PRN numbers 19 and 24) from position computations:

$PASHS,SVP,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYNYYYYN

The $PASHS,SVP command is similar to the SVS command except that under SVP, a channel continues to track the satellites; the NEMA message $PASHR,SAT will contain information about these satellites - they will be marked as unused in position computation.

$PASHQ,SVP,c

This command queries the current SVP settings, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SVP

The SVP esponse message contains the current SVP settings for all 56 satellites.

The format of the response message is similar to the format of the SVP set command:

$PASHR,SVP,s1s2s3…s56*hh

Table 4.36 defines the response message structure.

Table 4.36. $PASHR,SVP Message Structure

Field	Description	Range
s1 - s56	Indicates whether a satellitesis included (Y) or excluded (N) for position computations	Y, N
*hh	Checksum	2-character hex

Typical SVP message:

$PASHR,SVP,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY*0D

Table 4.37 describes a typical SVP response message.

Table 4.37. Typical SVP Response Message

Parameter	Description
$PASHR,SVP	Header
YYY…Y	Indicates that all 56 PRN numbers are included for position computations
*0D	Checksum

DEFAULT SETTING	
SVP	**Y (satellite included)**

SVS: Include/Exclude Satellites for Acquisition and Tracking

$PASHS,SVS,c1,c2,c3…c56

This command includes or excludes specific satellites for acquisition and tracking, where c is Y (include) or N (exclude). Like the SVP set command, the c parameters are not separated by commas. The receiver will not track a satellite which has been excluded by this command. All satellites are included for acquisition and tracking by default. The parameters c1 through c32 correspond to GPS satellites PRN numbers 1 through 32; parameters c33 through c56 correspond to GLONASS satellite PRN numbers 1 through 24. It is not necessary to enter a setting for all 56 satellites when using this command.

Examples

Exclude satellites 4 and 7 from the position computation:

$PASHS,SVS,YYYNYYN

This command excludes satellites 4 and 7 from being acquired and tracked, but does not change the settings for satellites 8 through 56

Exclude satellites 48 and 55 (GLONASS PRN numbers 16 and 23):

$PAHS,SVS,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYNYYYYYYYNY

$PASHQ,SVS,c1

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

$PASHR,SVS

The response message contains the current SVP settings for all 56 satellites. The format of the response message is similar to the SVP set command:

$PASHR,SVS,c1c2c3…c56*hh

Table 4.38 describes the response message structure.

Table 4.38. $PASHR,SVS Message Structure

Field	Description	Range
c1 - c56	Indicates whether a satellites is included (Y) or excluded (N) for acquisition and tracking	Y, N
*hh	Checksum, 2-character hex	

Typical SVS message:

$PASHR,SVS,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY*0E

Table 4.39 describes the SVS response message format.

Table 4.39. $PASHR,SVS Message Format

Parameter	Description
$PASHR,SVP	Header
YYY…Y	Indicates that all 56 PRN numbers are included for acquisition and tracking
*0E	Checksum

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

SYS: Set Satellite System Mode

$PASHS,SYS,s1

This command sets the satellite system tracking mode. The s1 string can be any of the following:

GLO—Sets the GG12-Pro to track satellites from the GLONASS system only.

GPS—Sets the GG12-Pro to track satellites from the GPS system only.

GLG—Sets GG12-Pro to track satellites from both systems, with GLONASS set as primary system and GPS as secondary system.

GPG—Sets GG12-Pro to track satellites from both systems, with GPS as primary system and GLONASS as secondary system.

USE - User-selectable mix of GPS and GLONASS channels

Example: Set the GG12-Pro to track GPS satellites only:

$PASHS,SYS,GPS

When in GPG or GLG mode, the receiver tracks all visible satellites from the primary system that are above the elevation mask, and as many of the secondary system (above the elevation mask) that it can with the remaining channels. If, based on the almanac, the receiver knows that it is not tracking all the available primary satellites (above the mask angle), then it keeps one channel searching for these satellites. The elevation mask that controls this is the mask set by $PASHS,PEM.

$PASHS,SYS,USE,d1

This command allows you to set a specific number of channels to track GPS satellites. Any remaining channels are automatically assigned to track GLONASS

Commands

Command/Response Formats **101**

satellites. For example, if d1 is 7, channels 1 through seven are assigned to track GPS satellites, and channels 8 through 12 are assigned to track GLONASS satellites. If d1 is 12, all twelve channels are assigned to track GPS satellites, which has the same effect as entering the command **$PASHS,SYS,GPS**. Entering zero for d1 has the same effect as entering the command **$PASHS,SYS,GLO**. You can obtain the current setting for satellite system mode by entering the query command **$PASHQ,PPR** and checking field s10 (page 77).

DEFAULT SETTING	
SYS	**GPG**

TDP: Set Time Shift DOP Mask

$PASHS,TDP,d1

This command sets the mask value for GLONASS Time Shift Dilution of Precision, where d1 is a number between 0 and 99; the manual setting overrides the default setting of 100000. The DOP value is not applicable if the GG12-Pro is tracking satellites from one system only. If the DOP value calculated by the GG12-Pro is higher than the DOP mask value, the GG12-Pro automatically goes into fixed time-shift mode.

Example: Set GLONASS DOP mask value to 6:

$PASHS,TDP,6

$PASHQ,TDP,c1

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

$PASHR,TDP

The GLONASS DOP response message is output in the format:

$PASHR,TDP,d1*hh

Table 4.40 describes the response message format.

Table 4.40. $PASHR,TDP Message Format

Parameter	Description	Range
d1	DOP mask value	0 - 99
*hh	Checksum, 2-character hex	

Typical GLONASS DOP response message:

 $PASHR,TDP,4*2C

Table 4.41 describes a typical GLONASS DOP response message.

Table 4.41. Typical GLONASS DOP message

Field	Description
$PASHR,TDP	Header
4	Indicates that the GLONASS DOP mask value is set to 4
*2C	Checksum

DEFAULT SETTING	
TDP	**100000**

TRO: Enable/Disable Tropospheric modeling

$PASHS,TRO,c1

This command enables or disables tropospheric modeling, where c1 is Y (enable) or N (disable).

Tropospheric modeling is used to compensate for the delays imposed on the satellite signals as they pass through the troposphere. The tropospheric model (Bean and Duton) is used by default whenever differential corrections are not in use; this condition may be overridden by the $PASHS,TRO,N command.

The tropospheric model is not used by default whenever differential corrections are in use. This inclusion may be overridden by the $PASHS,TRO,Y command.

The GG12-Pro uses the tropospheric model for both GPS and GLONASS. Default is Y (enabled).

Example: Enable tropospheric modeling:

$PASHS,TRO,Y

$PASHQ,TRO,c1

This command queries whether tropospheric modeling is enabled or disabled, where c1 is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,TRO

The TRO response message is output in the format:

$PASHR,TRO,c1*hh

where c1 is Y (enabled) or N (disabled), and *hh is a checksum.

Typical TRO response message:

 $PASHR,TRO,N*5F

Table 4.42 describes a typical TRO response message.

Table 4.42. Typical TRO Message

Field	Description
$PASHR,TRO	Header
N	Indicates that tropospheric modeling is disabled
*5F	Checksum

DEFAULT SETTING	
TRO	**Y (enabled)**

TSC: Set Time Scale Reference

$PASHS,TSC,s1

This command sets the time scale reference for GG12-Pro data output, where s1 is GPS (GPS system time) or GLO (GLONASS system time). The TSC command sets the time reference of the output interval for NMEA message, Ashtech NMEA-style messages, raw data messages, and the output of the timing pulse.

The time scale setting determines whether the signal received time that appears in the PBN message is milliseconds of the week (GPS) or milliseconds of the day (GLONASS). The time scale setting does not affect time values in NMEA messages, which are referenced to UTC (Universal Time Coordinated).

Example: Set time scale reference to GLONASS system time:

$PASHS,TSC,GLO

$PASHQ,TSC,c1

This command queries the current time scale setting, where c1 is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,TSC

The TSC response message format is:

$PASHR,TSC,s1*hh

Table 4.43 describes the TSC response message format.

Table 4.43. $PASHR,TSC Message Format

Parameter	Description	Range
s1	Indicates whether the time scale is referenced to GPS system time or GLONASS system time	GPS or GLO
*hh	Checksum, 2-character hex	

Typical TSC response message:

$PASHR,TSC,GPS*58

Table 4.44 describes a typical TSC response message.

Table 4.44. Typical TSC message

Field	Description
$PASHR,TSC	Header
GPS	Indicates that time scale is referenced to GPS system time
*58	Checksum

DEFAULT SETTING	
TSC	**GPS**

USE: Select Satellites for Acquisition and Tracking

$PASHS,USE,d1,c2

This command can be considered a short-hand version of the SVS command. Like the SVS command, the USE command allows you to exclude specific satellites from being acquired and tracked, where d1 is the satellite number (01 through 56) and c2 is Y (include) or N (exclude). Satellite numbers 1 through 32 correspond to GPS PRN numbers 1 through 32; satellite numbers 33 through 56 correspond to GLONASS PRN numbers 1 through 24. All satellites are included for tracking by default.

The USE command is more direct than the SVS command. In order to exclude a

Command/Response Formats 105

particular satellite, say satellite 56, with the SVS command, you would have to enter a string of 56 characters, entering Y for characters 1 through 55 and N for character 56. To exclude satellite 56 with the USE command requires far fewer characters:

$PASHS,USE,56,N

Table 4.45 describes the USE command structure.

<div align="center">

Table 4.45. $PASHS,USE Command Structure

</div>

Parameter	Description	Range
d1	PRN number of satellite, or 3-character string	1-56 or ALL, GPS, or GLO
c2	Enable or disable PRN tracking	Y or N

$PASHS,USE,s1,c1

This version of the USE command lets you include or exclude satellites on a global and semi-global basis, where s1 is ALL, GPS, or GLO; and c1 is Y (include) or N (exclude). When s1 is ALL, you can choose to include or exclude the entire set of GPS and GLONASS satellites. When s1 is GPS, you can choose to include or exclude the entire set of GPS satellites. When s1 is GLO, you can choose to include or exclude the entire set of GLONASS satellites.

Example: Include all GLONASS satellites:

$PASHS,USE,GLO,Y

Example: Include PRN 12:

$PASHS,USE,12,Y

Example: Include all SVs:

$PASHS,USE,ALL,Y

Example: Disable all GPS SVs:

$PASHS,USE,GPS,N

DEFAULT SETTING	
USE	**Y (All satellites included)**

USP: Select Satellites Used in Position Computation

$PASHS,USP,d1,c2

This command is a short-hand version of the SVP command. Like the SVP command, USP lets you include or exclude specific satellites for position computations, where d1 is the satellite number (01 through 56) and c2 is Y (include) or N (exclude). Satellite numbers 1 - 32 correspond to GPS PRN numbers 1 through 32; satellite numbers 33 - 56 correspond to GLONASS PRN numbers 1 through 24. All satellites are included for position computations by default.

The USP command is more direct than the SVP command. For example, to exclude satellite 45 with the SVP command, you would enter a string of 45 characters, entering Y for characters 1 through 44 and N for character 45.

To exclude satellite 45 with USP, you can use a much shorter command string:

$PASHS,USP,45,N

$PASHS,USP,s1,c1

This version of the USP command allows you to include or exclude satellites on a global and semi-global basis, where s1 is ALL, GPS, or GLO; and c1 is Y (include) or N (exclude). When s1 is ALL, you can choose to include or exclude the entire set of GPS and GLONASS satellites. When s1 is GPS, you can choose to include or exclude the entire set of GPS satellites. When s1 is GLO, you can choose to include or exclude the entire set of GLONASS satellites.

Example: Exclude all GPS satellites:

$PASHS,USP,GPS,N

DEFAULT SETTING	
USP	Y (All satellites included)

VDP: VDOP Mask

$PASHS,VDP,d1

This command sets the mask value for Vertical Dilution of Precision (VDOP), where d1 is a number between 0 and 99; this manual setting overrides the default setting of 100000. If the VDOP value computed by the GG12-Pro is higher than the VDOP mask value, the receiver automatically goes into fixed altitude mode. You can view the current VDOP mask value by entering the query command $PASHQ,PPR (page 77)and checking field d5.

Commands

Example: Set VDOP mask to 6:

$PASHS,VDP,6

DEFAULT SETTING	
VDP	**100000**

Raw Data Commands

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

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

$PASHS,RAW,s1,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, DIF, etc.), c1 is the port designator for message output, s2 is ON or OFF, and f1 is the numeric output interval setting supporting a range of 0.2 to 999 seconds. The **query** commands prompt the receiver to output the corresponding response message one time only. Message output prompted by a query command occurs independently of any related message output settings. Some examples are presented below.

Example: Enable output of MBN message on port A at five-second interval:

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

Example: Disable output of MBN message on port B:

$PASHS,RAW,MBN,B,OFF

Example: Query MBN message and output response message on port B:

$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 currently active port.

Response Message Structure

Real-time response messages are output in binary format:

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

The header is **$PASHR**. The message identifier field contains a 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 upon 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 Carriage Return/Line Feed (**<CR><LF>**). The MBN message format is as follows:

$PASHR,MBN,binary data string,checksum<CR><LF>

Table 4.46 summarizes the raw data commands and response messages.

Table 4.46. Raw Data Commands and Response Messages

Command	Description	Page
General Command For Controlling Raw Data Output		
$PASHS,RAW	Enable/disable output of raw data messages	130
$PASHS,RAW,ALL	Disable output of all raw messages on specified serial port	131
Almanac data		
$PASHS,RAW,SAG	Enable/disable GLONASS raw almanac data message	135
$PASHQ,SAG	Query GLONASS almanac data	135
$PASHR,SAG	SAG response message	135
$PASHS,RAW, SAL	Enable/disable GPS raw almanac data message	136
$PASHQ,SAL	Query GPS almanac data	136
$PASHR,SAL	SAL response message	137
Differential GPS data		
$PASHQ,DIF	Query differential status data	112
$PASHR,DIF	DIF response message	112
Ephemeris data		
$PASHS,RAW,SNG	Enable/disable GLONASS raw ephemeris data message	138
$PASHQ,SNG	Query GLONASS ephemeris data	139

Table 4.46. Raw Data Commands and Response Messages (continued)

Command	Description	Page
$PASHR,SNG	SNG response message	139
$PASHS,RAW,SNV	Enable/disable GPS raw ephemeris data message	142
$PASHQ,SNV	Query GPS ephemeris data	142
$PASHR,SNV	SNV response message	142
Measurement data		
$PASHS,RAW,MBN	Enable/disable raw measurement data (MBN) message	119
$PASHQ,MBN	Query raw measurement data in the Ashtech type 2 data structure	119
$PASHR,MBN	MBN response message	119
$PASHS,RAW,MCA	Enable/disable raw measurement data (MCA) messages in Ashtech type 3 data structure	121
$PASHQ,MCA	Query raw measurement data (MCA) in Ashtech type 3 data structure	121
$PASHR,MCA	MCA response message	121
$PASHS,RAW,MIS	Enable/disable raw data output miscellaneous message	125
$PASHQ,MIS	Query miscellaneous raw measurement data	126
$PASHR,MIS	MIS response message	126
Position data		
$PASHS,RAW,PBN	Disable/enable raw position data message	129
$PASHQ,PBN	Query receiver raw position data	129
$PASHR,PBN	PBN response message	129
$PASHQ,XYZ	Query raw position data for each satellite being tracked	146
$PASHR,XYZ	XYZ response message	146
Raw Data Parameters		
$PASHS,ELM	Set elevation mask for raw data output	118
$PASHR,ELM	ELM response message	118
$PASHS,MSV	Set minimum number of satellites for raw data output.	129
$PASHQ,RWO	Query raw data parameters.	132
$PASHR,RWO	RWO response message	133

Table 4.46. Raw Data Commands and Response Messages (continued)

Command	Description	Page
$PASHS,RCI	Set output interval for raw data messages.	131

DIF: Diagnostic Data for Differential Operation

$PASHQ,DIF,c

This command allows you to query status of differential operation, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

Example: Send differential diagnostic message to port B:

$PASHQ,DIF,B

$PASHR,DIF

The DIF message contains the time at which the satellite signals were received, and a variety of flags indicating specific errors in differential operation. For example, the GG12-Pro will not use a differential correction if the age of corrections exceeds the receiver's maximum age setting, or when there is an IOD (Issue of Data) mismatch between the ephemeris data in the correction message and the ephemeris data obtained directly from the satellites. The setting for Automatic Differential Mode ($PASHS,RTC,AUT) determines whether the GG12-Pro stops outputting positions or outputs autonomous positions when invalid differential corrections are received. If the auto differential mode is enabled, the receiver outputs autonomous positions when a received differential correction is invalid. If auto differential mode is disabled, the receiver will stop outputting positions until it receives valid corrections for four or more of the satellites it is tracking. Issue the query command $PASHQ,RTC,RPS to see whether auto differential is enabled or disabled.

The response message is in the format:

$PASHR,DIF,differential mode diagnostics data structure, checksum

where the data structure is as defined in Table 4.47. Output format is binary.

Table 4.47. $PASHR,DIF Differential Diagnostics Data Structure

Field	Bytes	Content
long RcvTime	4	Signal received time in milliseconds of week of GPS system time or in milliseconds of week/day of GLONASS system time. This is the time tag for all measurements and position data. This is the same as "rcvtime" in the PBN binary response message.

Table 4.47. $PASHR,DIF Differential Diagnostics Data Structure (continued)

Field	Bytes	Content
unsigned short DiffModeStatus	2	Differential mode status for position fix computation: Bit 15 differential corrections not applied because age of corrections exceeds the number of seconds set with the $PASHS,RTC,MAX Set Command message. Bit 14 differential corrections not applied because less than 4 corrections are available for the satellites used in the position computation. Bit 13 differential corrections not applied because AEB=1111 (base station unhealthy). Bit 12 differential corrections not applied because AEB=1110 (acceleration error unbounded). Bit 11 differential corrections not applied because PDOP would exceed the PDOP mask set with the $PASHS,PDP Set Command message. Bit 10 The most recently received RTCA Type 1 message was discarded because it failed the CRC check. Differential mode shall not be dropped because of a CRC failure; the most recent Type 1 message received previously with valid CRC shall continue to be used. Bits 9-0 reserved.
unsigned long GpsIodExcSats	4	Each bit is a separate "GPS IOD Mismatch Exclude Flag" for a GPS satellite. The most significant bit corresponds to PRN 32. When a GPS satellite has been excluded from being used to compute position because of an IOD mismatch between the differential corrections message and the current ephemeris data, its corresponding GPS IOD Mismatch Exclude Flag bit is set.
unsigned long GloIodExcSats	4	Each bit is a separate "GLONASS IOD Mismatch Exclude Flag" for a GLONASS satellite. The most significant bit corresponds to PRN 32, thus bit 23 corresponds to PRN 24. When a GLONASS satellite has been excluded from being used to compute position because of an IOD mismatch between the differential corrections message and the current ephemeris data, its corresponding GLONASS IOD Mismatch Exclude Flag bit is set.
unsigned long GpsInvExcSats	4	Each bit is a separate "GPS Corrections Invalid Exclude Flag" for a GPS satellite. The most significant bit corresponds to PRN 32. When a GPS satellite has been excluded from being used to compute position because the $\sigma_{pr,gnd}$ field of the Type 1 message equals "11111111", indicating that the corrections are invalid, its corresponding GPS Corrections Invalid Exclude Flag bit is set.
unsigned long GloInvExcSats	4	Each bit is a separate "GLONASS Corrections Invalid Exclude Flag" for a GLONASS satellite. The most significant bit corresponds to PRN 32, thus bit 23 corresponds to PRN 24. When a GLONASS satellite has been excluded from being used to compute position because the $\sigma_{pr,gnd}$ field of the Type 1 message equals "11111111", indicating that the corrections are invalid, its corresponding GLONASS Corrections Invalid Exclude Flag bit is set.

Commands

Command/Response Formats **113**

Table 4.47. $PASHR,DIF Differential Diagnostics Data Structure (continued)

Field	Bytes	Content
checksum	2	The checksum is computed by breaking the structure into 11 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
total chars	24	
unsigned short [DiffModeStatus]	2	Bits 10 through 15 are used as flags to indicate whether the received differential corrections were used in the position computation. A non-zero state for any of bits 10-15 indicates that the receiver has ignored the correction. Each of bits 10-15 also denotes the specific error condition which caused the corrections to be ignored. • Bit 15 - Differential correction not applied because the age of correction exceeds the maximum age value set through the $PASHS,RTC,MAX command • Bit 14 - Differential correction not applied because corrections are available for fewer than four of the satellites being tracked by the receiver • Bit 13 - Differential correction not applied due to unhealthy base station (AEB=111) • Bit 12 - Differential correction not applied due to an unbounded acceleration error (AEB=110) • Bit 11 - Differential correction not applied because the calculated PDOP value exceeds the PDOP mask value set through the $PASHS,PDP command • Bit 10 - The most recently received RTCA type 1 message is ignored because it failed the CRC check. The receiver will continue outputting corrected positions using the most recent RTCA type 1 message having a valid CRC • Bits 0 through 9 are reserved
unsigned long [GpsIodExcSats]	4	Each bit is used as a flag to indicate whether an IOD mismatch has occurred for a given GPS satellite (1-32), with the most significant bit corresponding to PRN 32. The receiver stops using a satellite for position computation when the ephemeris IOD received from the satellite does not match the ephemeris IOD for that satellite contained in the correction message. The receiver then sets the bit representing that particular satellite to a non-zero state
usigned long [GloIodExcSats]	4	Each bit is used as a flag to indicate whether an IOD mismatch has occurred for a given GLONASS satellite (1-32), with the most significant bit corresponding to PRN 32. The receiver stops using a satellite for position computation when the ephemeris IOD received from the satellite does not match the ephemeris IOD for that satellite contained in the correction message. This condition causes the receiver to set the bit representing that particular satellite to a non-zero state

Table 4.47. $PASHR,DIF Differential Diagnostics Data Structure (continued)

Field	Bytes	Content
unsigned long [GpsInvExcSats]	4	Each bit is used as a flag to indicate whether corrections are invalid for a given GPS satellite (1-32), with the most significant bit corresponding to PRN 32. The receiver excludes a satellite from position computation when the bits used to define UDRE (User Differential Range Error) in the RTCA type 1 message indicate that corrections for that satellite are invalid. Corrections for a given satellite are invalid when the six bits corresponding to UDRE are all in a non-zero state (UDRE=111111). This condition causes the receiver to set the bit representing that particular satellite to a non-zero state
unsigned long [GloInvExcSats]	4	Each bit is used as a flag to indicate whether corrections are invalid for a given GLONASS satellite (1-32), with the most significant bit corresponding to PRN 32. The receiver excludes a satellite from position computation when the bits used to define UDRE (User Differential Range Error) in the RTCA type? message indicate that corrections for that satellite are invalid. Corrections for a given satellite are invalid when the six bits corresponding to UDRE are all in a non-zero state (UDRE=111111). This condition causes the receiver to set the bit representing that particular satellite to a non-zero state
checksum	2	The checksum is computed by breaking the structure into 11 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total chars:	24	

Commands

Command/Response Formats   **115**

$PASHS,RAW,DIF

Enables or disables the differential mode diagnostics data message [optionally at a given period]. The command structure is:

$PASHS,RAW,DIF,c,s,f

where the parameters are as defined in Table 4.48

Table 4.48. $PASHS,RAW,DIF Parameters

Parameter	Description	Range
c	Receiver port to send data out	A or B
s	Turns on or off data output	ON or OFF
[f]	Optional period for message	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec 1 second increment from 1... 999 seconds
If the output is set without a period, the period set by the $PASHS,NME,PER command is used. If a $PASHS,NME,PER command is sent after individual NMEA message output periods were set, the previous individual message period is superceded by the more recent NME,PER value. The binary messages default output period is controlled by $PASHS,RCI command and $PASHS,RAW,xxx,c,s,yyy.yy and may affect the output period of individual binary messages.		

$PASHS,DLY

Specifies a pseudorange measurement offset for each GLONASS frequency channel in order to correct for in-band group delay variations caused by antenna LNA filtering. The GG12-Pro subtracts the specified group delay offset from the pseudorange measured for the GLONASS satellite assigned to the corresponding frequency channel. The command structure is:

$PASHS,DLY,f,…,f

where the parameters are as defined in Table 4.49.

Table 4.49. $PASHS,DLY Command Structure

Parameter	Description
f,…f	Specify group delay offsets for up to 32 GLONASS frequency channels, where f is the group delay offset in nanoseconds ranging from 0 to 999.9. The group delay offset fields in the message are ordered corresponding to increasing frequency channel number from -7 to +24 (that is, -7, -6, -5, ..., +22, +23, +24). If a field in the message is left empty then the corresponding group delay offset for that frequency channel is not changed. If fewer than 32 fields are specified in the message, then the group delay offsets for the frequency channels corresponding to the unspecified fields are not changed. Default group delay is 0 for all frequency channels.

Example:

$PASHS,DLY,,,,,,,,25.3,45.6,,,33.8,45.7

$PASHQ,DLY,c
Requests a pseudorange measurement offset for each GLONASS frequency channel, where c is the output port, A or B.

$PASHR,DLY,f….f
Response message to the $PASHQ,DLY query. The response message lists the current values of the group delay offset parameters corresponding to the 32 GLONASS frequency channels, where the parameters are as defined in Table 4.50.

Table 4.50. $PASHR,DLY Group Delay Parameters

Field	Description	Range
f,…,f	f is a group delay offset in nanoseconds ranging from 0 to 999.9. The group delay offset fields in the message are ordered corresponding to increasing frequency channel number from -7 to +24 (that is, -7, -6, -5, ..., +22, +23, +24).	0-999.9

Example:

$PASHR,DLY,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,25.3,45.6,0.0,0.0, 0.0,33.8,45.7,45.7,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0

ELM: Set Elevation Mask for Output of Raw Measurements

$PASHS,ELM,d

This command sets the minimum elevation for the output of raw measurement data (MBN or MCA), where d, the elevation mask angle, 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 will not output raw measurement data for any tracked satellites with an elevation of 10° or lower.

ELM affects raw measurement output, and output of RTCM Type 18 and 19 messages. PEM affects the position solution and base station output of RTCM Types 1, 3, 9, 31, and 34 messages.

For autonomous mode the PEM should be set to 0 because the benefit of the lower PDOPs made possible by extra satellites outweighs the penalties caused by the higher multipath of the low satellites. For RTCM differential, the PEM should be set to 4 degrees for the base station, and 5 degrees for the remote in order to minimize the number of corrections sent, but still send corrections for all satellites above the remote receiver's elevation mask.

Example: Set elevation mask at ten degrees:

$PASHS,ELM,10

DEFAULT SETTING	
ELM	**2°**

$PASHQ,ELM

This command queries the current raw data elevation mask setting.

$PASHR,ELM

The response message is in the format

$PASHR,ELM,d1*hh

where d1 is the elevation mask and *hh is the checksum.

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 4.51

Table 4.51. $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	Update rate	See Table 4.71on page 149

$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,struct

where *struct* is as defined in Table 4.52.

Table 4.52. $PASHR,MBN Structure

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 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	Doppler (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 4.53 defines the format of the MBN warning flag.

Table 4.53. 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

Enables/disables MCA Type 3 raw measurement data.

$PASHQ,MCA,c1,s2[,f3]

This command queries raw satellite measurement data contained in the Ashtech Type 3 data structure, where c1 is the optional output serial port, s2 is ON or OFF, and f3 is the optional raw message interval as described in Table 4.71. If a port is not specified, the receiver sends the response to the current port.

$PASHR,MCA

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

Commands

Command/Response Formats   **121**

The structure of the message is:

$PASHR,MCA, Ashtech Type 3 data string,checksum

where the data string is as defined in Table 4.54.

Table 4.54. $PASHR,MCA Type 3 Data String

Field	Bytes	Content
unsigned short [sequence tag]	2	Sequence ID number in units of 50 ms, modulo 30 minutes. The sequence tag in MCA is the same time measurement as the time tag in MIS (page 126), but in different units.
unsigned char [left]	1	Number of remaining MCA messages to be sent for current epoch. GG12-Pro outputs a separate MCA message for each tracked satellite
unsigned char [svprn]	1	Satellite PRN number (1 - 56)
unsigned char [elev]	1	Elevation angle (degrees) of the satellite referenced in [svprn]
unsigned char [azim]	1	Azimuth angle of the satellite referenced in [svprn] in increments of 2°
unsigned char [chnind]	1	Channel (1 - 12) assigned to the satellite referenced in [svprn]
Measurement data derived from the C/A code (29 bytes):		
unsigned char [warning]	1	See Table 4.55
unsigned char [goodbad]	1	Indicates the quality of the position measurement: •0 - Measurement not available; no additional data will be sent. •21 - The satellite is below the PEM elevation mask. •22 - Code and/or carrier phase has been measured. •23 - Code and/or carrier phase has been measured, and navigation message was obtained, but measurement(s) not used to compute position. •24 - Code and/or carrier phase measured, navigation message was obtained, and measurement(s) used to compute position
char [polarity_known]	1	This number is either zero or five: • 0 - the satellite has just been locked • 5 - meaning the first frame of the navigation message has been found
unsigned char [ireg]	1	Signal-to-noise measurement (db Hz) for the satellite referenced in [svprn]

Table 4.54. $PASHR,MCA Type 3 Data String (continued)

Field	Bytes	Content
unsigned char [qa_phase]	1	Not used; always zero
double [full phase]	8	Full carrier phase (measured in cycles) of the satellite referenced in [svprn]. This data is available only if the carrier phase option is installed
double [raw_range]	8	Raw range (in seconds) to the satellite referenced in [svprn] using the following formula: receiver time - transmitted time = raw range (Note: There is an eleven-second difference between GPS system time and GLONASS system time. If the time scale is set to GPS, the [raw_range] measurement for GLONASS satellites contains an extra eleven-second integer. If the time scale is set to GLONASS, the [raw_range] measurement for GPS satellites has an extra eleven- second integer
long [doppler]	4	Doppler measurement (10^{-4} Hz) for the satellite referenced in [svprn]
long [smoothing]	4	Bits 31-24 represent the [smooth_count]. They are unsigned and normalized, and indicate the amount of smoothing: • 0 - Unsmoothed • 1 - Least smoothed • 100 - Most smoothed Bits 23-0 represent [smooth_corr]. Bit 23 (most significant bit) is the sign and bits 22 through 0 are the least significant bits representing the magnitude of the correction in centimeters
unsigned char [checksum]	1	The checksum is a bytewise exclusive OR (XOR) of all bytes from sequence_tag (just after header) to the last byte in [smoothing]
Total bytes	37	

Command/Response Formats 123

Commands

The MCA message is output in binary format according to the setting chosen for the recording interval ($PASHS,RCI). One MCA message is output for each locked satellite with an elevation equal to or greater than the elevation mask ($PASHS,ELM), and only if the number of locked satellites is equal to or greater than minimum satellite mask ($PASHS,MSV). The MCA message is not output after a fatal failure has been detected.

Table 4.55 defines the MCA warning flag structure.

Table 4.55. MCA Warning Flag Structure

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

MIS: Miscellaneous Raw Measurements

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

This command enables/disables miscellaneous data (MIS) message on port x where c1 is A or B, s2 is ON or OFF, and f3 is an optional output rate as detailed in Table 4.71 on page 149.

The MIS message is a raw binary data message containing miscellaneous data as described below.

- Time tags for measurements and position data that are accurate to 1 microsecond. If the time tags are not integer milliseconds, then the fractional millisecond portion of the time tag is included.
- The number of satellites tracked and the number of satellites used in the position fix for each satellite system (GLONASS and GPS).
- Mode Status for the position fix computation, indicating whether or not altitude or GLONASS time shift was held fixed, whether or not differential corrections were applied, and whether almanac or ephemeris was used to compute the position fix.
- Geoidal Separation.
- HDOP and VDOP.
- Age of the differential corrections used in the position fix computation.
- Most recently computed GLONASS time shift relative to the GPS time with the same resolution as in the $PASHS,DTG set command message.
- GPS Nav Flag bit for each GPS satellite. When navigation data is collected from a GPS satellite, a GPS Nav Flag bit is set for any of the following reasons:

    The User Range Accuracy (URA) Flag ("accuracy alert", bit 18 of the Hand-Over-Word (HOW)) is set; there is a parity error in 3 successive words of the navigation data;

    All bits in the navigation data are 1's;

    All bits in the navigation data alternate between 1's and 0's.

    When a GPS Nav Flag is set, the corresponding satellite is excluded from the position computation using the $PASHS,SVP message.

- A GLONASS Nav Flag bit for each GLONASS satellite. When navigation data is collected from a GLONASS satellite, a GLONASS Nav Flag bit is set for any of the following reasons:

    There is a parity error on three successive lines of the navigation data;

    Ephemeris time offset (time scale shift) equals zero;

All three components of the satellite ephemeris coordinates or velocity vector equal zero;

All bits in the navigation data are 1's;

All bits in the navigation data alternate between 1's and 0's.

When a GLONASS Nav Flag is set, the corresponding satellite is excluded from the position computation using the $PASHS,SVP message.

• A GPS Exclude Flag bit for each GPS satellite.

A GPS Exclude Flag bit is set if a GPS satellite has been excluded from being used in the position computation, either automatically by the receiver, or manually with the $PASHS,SVP command.

• A GLONASS Exclude Flag bit for each GLONASS satellite.

A GLONASS Exclude Flag bit is set if a GLONASS satellite has been excluded from being used in the position computation, either automatically by the receiver, or manually with the $PASHS,SVP command.

$PASHQ,MIS,c1

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

$PASHR,MIS

The MIS message is output once each recording interval, even if a position fix has not been computed. The Position Mode field of the MIS message indicates whether a position fix has been computed. The MIS message is not output after a fatal failure has been detected.

The structure of the MIS message is:

$PASHR,MIS,miscellaneous raw measurements, checksum

where the miscellaneous raw measurements data structure is as defined in Table 4.56.

Table 4.56. $PASHR,MIS Raw Measurement Data Structure

Field	Bytes	Content
Long RcvTime	4	Signal received time in milliseconds of week of GPS system time or in milliseconds of week/day of GLONASS system time. This is the time tag for all measurements and position data. This is the same as "rcvtime" in the PBN binary response message.
Unsigned short RcvTimeFrac	2	Fraction of "rcvtime" field in $PASHR,PBN message in microseconds, ranging from 0 to 999 μs. Receive Time (μs) = rcvtime(ms) * 1000 + RcvTimeFrac
Unsigned short NumGpsSatsUsed	1	Number of GPS satellites used in position computation.
Unsigned short NumGloSatsUsed	1	Number of GLONASS satellites used in position computation.
Unsigned short NumGpsSatsTrkd	1	Number of GPS satellites being tracked.
Unsigned short NumGloSatsTrkd	1	Number of GLONASS satellites being tracked.
Unsigned short PositionMode	2	Mode status for position fix computation: Bit 15 Bit 14 (MSBit is 15, LSBit is 0) 0 0 Altitude not held fixed. 0 1 Last computed altitude held fixed. 1 0 Externally supplied altitude held fixed. Bit 13 Bit 12 0 0 GLONASS time shift not held fixed. 0 1 Last computed GLONASS time shift held fixed. 1 0 Externally supplied GLONASS time shift held fixed. Bit 11 Bit 10 0 0 Position not computed. 0 1 Raw; position not differentially corrected, ephemeris data used to compute position fix. 1 0 Differential Corrections applied. 1 1 Almanac (not ephemeris) used to compute position fix. Bits 9-0 reserved.
Signed short GeoidalSeparation	2	Geoidal separation in meters multiplied by 100.
Unsigned short HDOP	2	HDOP multiplied by 100.
Unsigned short VDOP	2	VDOP multiplied by 100.

Command/Response Formats 127

Table 4.56. $PASHR,MIS Raw Measurement Data Structure (continued)

Field	Bytes	Content
unsigned short ModZCnt	2	Modified Z-count (with a resolution of 0.2 seconds and an acceptable range of 20 minutes) from the RTCA Type 1 message containing the differential corrections used in the position computation.
Float GloTimeShift	4	Current GLONASS time shift relative to GPS time in microseconds, ranging from 0.0000 to +/-5000000.0000us.
Unsigned long GpsNavFlags	4	Each bit is a "GPS Nav Flag" for a GPS satellite. The most significant bit corresponds to PRN 32. When navigation data is collected from a GPS satellite, a GPS Nav Flag bit is set for any of the following reasons: the User Range Accuracy (URA) Flag ("accuracy alert") is set; there is a parity error in 3 successive words of the navigation data; all bits in the navigation data are 1's; all bits in the navigation data alternate between 1's and 0's.
Unsigned long GloNavFlags	4	Each bit is a "GLONASS Nav Flag" for a GLONASS satellite. The most significant bit corresponds to PRN 32, thus bit 23 corresponds to PRN 24. When navigation data is collected from a GLONASS satellite, a GLONASS Nav Flag bit is set for any of the following reasons: there is a parity error on three successive lines of the navigation data; ephemeris time offset (time scale shift) equals zero; all three components of the satellite ephemeris coordinates or velocity vector equal zero; all bits in the navigation data are 1's; all bits in the navigation data alternate between 1's and 0's.
Unsigned long GpsExcSats	4	Each bit is a "GPS Exclude Flag" for a GPS satellite. The most significant bit corresponds to PRN 32. When a GPS satellite has been excluded from being used to compute position, its corresponding GPS Exclude Flag bit is set.
Unsigned long GloExcSats	4	Each bit is a "GLONASS Exclude Flag" for a GLONASS satellite. The most significant bit corresponds to PRN 32, thus bit 23 corresponds to PRN 24. When a GLONASS satellite has been excluded from being used to compute position, its corresponding GLONASS Exclude Flag bit is set.
Checksum	2	The checksum is computed by breaking the structure into 11 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total chars	42	

After decoding the first set of valid ephemeri, the GG12-Pro continuously decodes additional ephemeri as they arrive. If a new ephemeris is confirmed faulty, the GG12-Pro rejects the corrupted/erroneous frames and sub-frames, does not use them to replace the existing ephemeris in memory, and sets the Nav flag bits to reflect the problem with the newly received ephemeris. The previously received good ephemeris continues as valid and is used in the navigation solution. The Nav flag resets only when a new set of good ephemeri is received.

MSV: Set Minimum Satellites for Raw Measurement Output

$PASHS,MSV,d1

This command sets the minimum number of satellites the receiver is required to track in order for it to output raw measurement data (MBN, MCA, etc.), where d1 is a number between 1 and 9. The receiver will stop outputting measurement data if the number of satellites it is tracking falls below this minimum.

Examples: Record data if at least 4 satellites are being tracked:

$PASHS,MSV,4

DEFAULT SETTING	
MSV	3

PBN: Raw Position Data

$PASHS,RAW,PBN

Enables raw position data message. The command structure is

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

where c1 is the port (A or B) to output the message, s2 is ON or OFF, and f3 is an otptional period as defined in Table 4.71 on page 149.

$PASHQ,PBN,c

This command queries raw position data, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,PBN

The PBN response 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, position structure

Table 4.57 defines the response message position structure.

Table 4.57. Raw Position (PBN) Position Structure

Field	Bytes	Content
long rcvtime	4	Signal received time in milliseconds of week of GPS system time or in milliseconds of week/day of GLONASS system time (see commands $PASHS,TSC and $PASHS,SYS for more information). If GLONASS system time scale is chosen, operation (rcvtime % day) produces GLONASS system time (a time within a day) in all cases. This is the time tag for all measurements and position data.
char sitename	4	Set to user-entered string, or four question marks ???? if empty
double navx	8	Antenna position ECEF x coordinate 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 navtdot	4	Receiver clock drift in meters per second.
unsigned short PDOP	2	PDOP multiplied by 100.
unsigned short checksum	2	The checksum is computed by breaking the structure into 27 unsigned shorts, adding, and taking the least significant 16 bits of the result.
total characters	56	

RAW: Enable/Disable Output of Raw Data Messages

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

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

Example: Enable MBN message on port A with an output interval of five seconds:

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

You can disable the output of one message without affecting the other messages. For example, the following command disables the output of the MBN message while leaving the output of DIF and PBN unaffected on port A:

$PASHS,RAW,MBN,A,OFF

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

$PASHS,RAW,ALL,A,OFF

Turns off all raw binary message outputs to the specified port.

RCI: Set Output Interval for Raw Messages

$PASHS,RCI,f

This command allows you to set a global output interval for all raw messages, where f is the value for the output interval as defined in Table 4.58. This command overrides individual settings for output interval. That is, if the SNG message is enabled for output at intervals of two seconds and the MBN message is enabled for output at intervals of ten seconds, using the RCI command to set an output interval of five seconds will reset the output interval of both messages to five seconds. You can view the current raw data output interval setting by entering the query command **$PASHQ,RWO** and checking the third field after the message identifier.

Table 4.58. 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 second 1 second from 1 second to 999 seconds
5 Hz	5	0.2-999	0.2 second from 0.2 to 1second 1 second from 1 second to 999 seconds

DEFAULT SETTING	
RCI	10 seconds

If the output of an individual message is set without a period, the raw message rate

set by the $PASHS,RCI command is used.   If a $PASHS,RCI command is sent after individual RAW message output periods were set, the previous individual message period is superceded by the more recent RCI value. Setting an indivividual RAW message output period affects only the serial port output of this message, and not the data recording period.

Example: Set recording interval to 0.5 second for both RAW messages and data recording

$PASHS,RCI,0.5

The GG12-Pro is designed to synchronize raw message output with the hour rollover, so that messages output from multiple receivers can be synchronized regardless of when they were turned on. An output interval of 0.7 seconds is not allowed because it overlaps the hour rollover, which corrupts synchronization between multiple receivers.

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

Example: Set global raw data output interval to 5 seconds:

$PASHS,RCI,5

RWO: Query Raw Data Message Output Parameters

$PASHQ,RWO,c1,c2

This command allows to query raw data message output parameters, where c1 identifies the port for which you are requesting raw data output parameters and c2 is the port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

Example 1: Set GG12-Pro to send a response message from port A which contains raw data output parameters for port B:

$PASHQ,RWO,B,A

Example 2: Set GG12-Pro to send response message from port A which contains raw data output parameters for port A:

$PASHQ,RWO,A,A

Example 3: Set GG12-Pro to send a response message containing raw data output parameters for the port to which you are currently connected:

$PASHQ,RWO

If you enter this command while connected to port A, the response message contains raw data output parameters for port A. If you enter this command while connected to port B, the response message contains raw data output parameters

for port B.

$PASHR,RWO

The response message contains the serial port identifier, the baud rate code for the serial port, the global output interval setting (RCI), the number of raw data messages available for output, the three-letter identifier for each raw data message supported by the GG12-Pro (MCA, MBN…SAG), and the output interval for each message.

The response is output in the format:

$PASHR,RWO,c1,d2,f3,d4,{s5,f6}hh

Table 4.59 defines the RWO response message structure.

Table 4.59. $PASHR,RWO Message Structure

Field	Description	Range
c1	Serial port reference for raw data message output parameters	A, B
d2	Baud rate code for the referenced serial port (see SPD command): 0 = 300 6 = 19200 1 = 600 7 = 38400 3 = 1200 8 = 57600 4 = 4800 9 = 115200 5 = 9600	0 - 9
f3	Global output interval setting (seconds; see RCI command)	0.2 - 999
d4	The number of raw data messages that can be output by the GG12-Pro. Ten messages are supported at present	10
s5	The three-letter message identifier for each raw data message supported by the GG12-Pro	LTN, POS, GGA, VTG, MSG, GSA, GSV, SAT, RRE, ZDA, RMC,GST
f6	Individual output interval setting for each raw data message	0.2 - 999
*hh	Checksum, 2-character hex	

Typical RWO response message:

$PASHR,RWO,A,5,001.0,10,MCA,000.0,MBN,010.0,PBN,001.0,MIS,000.0, XYZ,000.0,DIF,000.0,SNV,000.0,SAL,000.0,SNG,000.0,SAG,000.0*6B

Table 4.60 describes a typical RWO response message.

Command/Response Formats 133

Table 4.60. Typical RWO Response Message

Parameter	Description
$PASHR,RWO	Header
A	Indicates that serial port A is being referenced in the response
5	Code number indicates that the data rate for port A is 9600 baud
0001.0	Global output interval setting for raw data messages
10	Indicates that ten raw data messages are available for output
MCA	Raw measurement data message in the Ashtech type 3 data structure
000.0	Indicates that the MCA message is not enabled for output
MBN	Raw measurement data message in the Ashtech Type 2 data structure
010.0	Indicates that the MBN message is enabled for output once every ten seconds
PBN	Raw position data message
001.0	Indicates that the PBN message is enabled for output once each second
MIS	Miscellaneous measurement data message
000.0	Indicates that the MIS message is not enabled for output
XYZ	3D satellite position message
000.0	Indicates that the XYZ message is not enabled for output
DIF	Differential diagnostic message
000.0	Indicates that the DIF message not enabled for output
SNV	GPS ephemeris data message
000.0	Indicates that the SNV message is not enabled for output
SAL	GPS satellite almanac data message
000.0	Indicates that the SAL message is not enabled for output
SNG	GLONASS ephemeris data message
000.0	Indicates that the SNG message is not enabled for output
SAG	GLONASS satellite almanac data message
000.0	Indicates that the SAG message is not enabled for output
*6B	Checksum

SAG: GLONASS Satellite Almanac Data

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

This command enables or disables the GLONASS raw almanac data message, where c1 is A or B (port), s2 is ON or OFF, and f3 is optional output rate as defined in Table 4.71 on page 149.

$PASHQ,SAG,c

This command queries GLONASS satellite almanac data, where c is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAG

This message does not output until the GG12-Pro has completed downloading the current GLONASS almanac file. The receiver begins downloading the almanac file automatically, which takes about two or three minutes. Alternatively, with the aid of software, a current GLONASS almanac file from another receiver can be manually downloaded into the GG12-Pro. A separate almanac message is output for each satellite being tracked. The SAG 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,GLONASS satellite almanac data

Table 4.61 defines the response message structure.

Table 4.61. SAG Satellite Almanac Data Structure

Field	Bytes	Content
short	2	Satellite number [1,...,24]
short	2	Satellite GLONASS frequency number [-7,...,24]
short	2	Satellite health 0 = bad, 1 = good
float	4	Eccentricity ε_n^A
long	4	Reference day number N^A (days in range 1 to 1461)
float	4	Correction to inclination Δi_n^A (semicircles)
float	4	Longitude of first ascension node λ_n^A (semicircles)
float	4	Reference time of longitude of first node $t_{\lambda n}^A$ (seconds)
float	4	Argument of perigee ω_n^A (semicircles)
float	4	af_0 correction to mean value (43200 sec) of Draconic period ΔT_n^A (seconds)
float	4	af_1 = d(af_0)/dt (sec/sec)
float	4	Satellite clock offset (seconds)
unsigned short	2	Checksum computed by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result.
total bytes	44	

SAL: GPS Satellite Almanac Data

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

This command enables or disables the GPS raw almanac data message, where c1 is A or B (port), s2 is ON or OFF, and f3 is the optional output rate as defined in Table 4.71 on page 149.

$PASHQ,SAL,c

This command queries GPS satellite almanac data, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAL

The GG12-Pro does not output this message until it has downloaded the current GPS almanac file. Downloading is automatic, taking about 12 minutes. A current almanac file from another receiver can be manually downloaded. A separate almanac message is output for each satellite being tracked. The SAL message contains satellite health, almanac week number, and a variety of orbital measurements. The SAL message is output:

- Immediately after the enabling command, for all SVs,
- On the GPS hour mark (XX:00:00) for all SVs, and
- On the IODA (Issue of Data Almanac) change, for the changed satellite.

The response message is in the format:
$PASHR,SAL,GPS satellite almanac data structure,checksum
Table 4.63 describes the response message structure.

Table 4.62. $PASHR,SAL GPS Satellite Almanac Data Structure

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, and taking the least significant 16 bits of the result.
Total bytes	70	

Command/Response Formats 137

Table 4.63. $PASHR,SAL GPS Satellite Almanac Data Structure

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	

SNG: GLONASS Satellite Ephemeris Data

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

This command enables or disables the GLONASS satellite ephemeris data message, where the parameters are as defined in Table 4.64.

Table 4.64. SNG Period and Increment

Parameter	Description	Range
c	Selects receiver port for output	A or B
s	Enables or disables output	ON or OFF
f	Update rate	See Table 4.71on page 149

Example: Output SNG message on port B at period set by $PASHS,RCI:

$PASHS,RAW,SNG,B,ON

Example: Output SNG message on port C at 0.5-second period:

$PASHS,RAW,SNG,C,ON,0.5

$PASHQ,SNG,c
This command queries ephemeris data from each GLONASS satellite being tracked, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

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

The message is output in the format:

$PASHR,SNG,ephemeris data ,checksum

where the SNG ephemeris data string is as defined in Table 4.65.

Table 4.65. SNG Ephemeris Data String

Type	Bytes	Content
long [k]	4	Start time of the 30-second frame in satellite time scale t_k from which the ephemeris data is derived; time modulo one day (seconds)
short [Dn]	2	Day number of 30-second frame; modulo four-year period counting from beginning of last leap year, which corresponds to parameter t_b (t_b is set within this day number). This parameter varies within the range 1 to 1461. If day number = 0, the day number is unknown (absent in navigation frame).
long [Tb]	4	Ephemeris data reference time within the day expressed in GLONASS system time scale = UTC + 3 hours (seconds)
float [Gn]	4	Frequency offset γ_η of the on-board frequency standard at t_b (dimensionless)
float [tn]	4	Bias t_n between satellite time scale and GLONASS system time scale at t_b (seconds)
double [r(3)]	8*3	Satellite ECEF (PZ-90) X, Y, Z coordinates (km)

Table 4.65. SNG Ephemeris Data String (continued)

Type	Bytes	Content
float [rt(3)]	4*3	Satellite ECEF (PZ-90) velocity X', Y', Z'(km/sec)
float [rtt(3)]	4*3	Satellite perturbation acceleration X", Y", Z" due to moon and sun (km/sec/sec)
double [Tc]	8	Bias between GLONASS system time scale and UTC + 3 hours time scale τ_c (seconds)
char [En]	1	Age of ephemeris parameter E_n (interval from moment when ephemeris data was last uploaded to t_b)
char [P]	1	Combined 3-bit flag (contains Ï1, Ï2, Ï3, see GLONASS ICD)
char [Bn]	1	Satellite health status flag (0 = good, 1 = bad)
char [freq_num]	1	Satellite frequency channel number [-7,...,24]
short [sys_num]	2	Satellite system number (satellite number [1,...,24])
unsigned short [checksum]	2	Word checksum computed by breaking the structure into 40 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total bytes	82	(95 for structure plus header and <CR><LF>)

Notation used:

    ¨ Bn - satellite health status bit

    ¨ t n - satellite clock bias

    ¨ g n - satellite frequency offset

    ¨ t c - the bias between the GLONASS system clock and UTC(SU)

    ¨ NA - day number (1, 1461)

    ¨ dn - number of the day within which the ephemeris data reference time tb is specified. In turn, dn is defined within four-year cycle counting from the beginning of the last leap year. If both GPS and GLN satellites are locked during a session and the absolute current time is available thanks to GPS data downloaded, then dn can be easily calculated through WN (GPS week number). If only GLN satellites are locked and processed during a session, then the receiver checks whether a GLN almanac is available. If there is no GLN almanac at all or it is too old, then dn is taken equal to zero. If an adequate GLN almanac is available, then the receiver determines on which day within the range [-3 + NA , 3 + NA] the satellite coordinates at tb based on the almanac data fit in with the known "ephemeris coordinates" the best. This very day is taken as dn

This response is issued for every GLONASS satellite being tracked.

The broadcast ephemeris from a GLONASS satellite does not contain the SV slot number. This information is derived from the almanac. When the GG-12 has ephemeris data for a satellite but no almanac data (this occurs at startup, before the almanac had been fully transmitted), the SV number is set to zero. Nevertheless receiver computes the correct position. Once the almanac has been received, the SV number is updated. Output format is binary.

See also: $PASHS,RAW,SNG,c,ON

Commands

Command/Response Formats 141

SNV: GPS 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 optional update rate as defined in Table 4.66.

Table 4.66. SNV Period and Increment

Parameter	Description	Range
c	Selects receiver port for output	A or B
s	Enables or disables output	ON or OFF
f	Update rate	See Table 4.71on page 149

$PASHQ,SNV,c

This command queries ephemeris data from each GPS satellite being tracked, where c is Y (enable) or N (disable) command to save user parameters in memory.

Example:

$PASHQ,SNV

$PASHR,SNV

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

- Immediately after the enabling command, for all SVs above the horizon that are being tracked,
- On the 15-minute mark of GPS time (XX:15:00, XX:30:00....) for all SVs above the horizon that are being tracked,
- On IODE change, for the changed satellite, and
- When a new SV is locked on, for the new satellite.

The message is output in the format:

$PASHR,SNV,ephemeris data string

where the SNV ephemeris data string is as defined in Table 4.67.

Table 4.67. SNV Ephemeris Data String

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

Command/Response Formats 143

Table 4.67. SNV Ephemeris Data String (continued)

Type	Bytes	Content
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
char res	1	Reserved character.
checksum	2	The checksum is computed by breaking the structure into 65 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total Bytes:	132	

This response is issued for every GPS SV being tracked. For more detailed definitions see ICD-GPS-200. URA is a coded field, with values 0..15   URA <=6 implies SV range error <= 2**(1+(URA/2)) meters 7 <=URA<=14 implies SV range error <= 2**(URA-2) meters.

URA	Meters
0	2864
1	2.89128
2	410256
3	5.711512
4	8121024
5	11.3132048
6	16144096
7	32 15 no prediction possible, use SV at own risk

Example: $PASHQ,SNV,A

XYZ: 3D Satellite Positions

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

This command sets whether or not to output computed satellite XYZ positions in WGS-84 coordinates, computed from ephemeris data and current position, for all GPS and GLONASS satellites being tracked. The output is a binary message. Each coordinate is a double precision floating point value (8 bytes). The command structure is defined in Table 4.68.

Table 4.68. XYZ Period and Increment

Parameter	Description	Range
c1	Selects receiver port for output	A or B
s2	Enables or disables output	ON or OFF
f3	Update rate	See Table 4.71on page 149

$PASHQ,XYZ,c1

This command queries the 3D position for each tracked satellite, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,XYZ

In addition to satellite positions, the XYZ message also contains the time at which the satellite signals were received and a pseudorange value which has been corrected to eliminate atmospheric delays and uncertainties resulting from the differences in velocity between the GG12-Pro and the satellites (relativistic errors).

The XYZ message is output in the format below:

$PASHR,XYZ,satellite position data string,checksum

Table 4.69 describes the response message structure.

Table 4.69. XYZ Satellite Position Data String

Field	Bytes	Content
long [rcvtime]	4	Time at which the signal was received in milliseconds of the week referenced to GPS system time, or milliseconds of the day referenced to GLONASS system time. This time tag is used as a reference for all time and position measurements
short [Total Satellites]	2	Total number of satellites appearing in the message
short [sv_1]	2	PRN number of the satellite (1 - 56) being tracked on channel 1 of the GG12-Pro
double [satx_1]	8	X coordinate of the satellite being tracking on channel 1 of the GG12-Pro; referenced to WGS-84
double [saty_1]	8	Y coordinate of the satellite being tracking on channel 1 of the GG12-Pro; referenced to WGS-84
double [satz_1]	8	Z coordinate of the satellite being tracking on channel 1 of the GG12-Pro; referenced to WGS-84
double [range_1]	8	Corrected pseudorange of the satellite referenced in [sv_1]
(These rows are repeated for each channel that is tracking a satellite. That is, if the GG12-Pro is tracking seven satellites, these rows are repeated seven times; if the GG12-Pro is tracking twelve satellites, these rows are repeated twelve times.)		
checksum	2	The checksum is computed by breaking the structure into unsigned shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: minimum = 42; maximum = 416		

NMEA Commands

NMEA commands allow you to set the output parameters for NMEA messages and Ashtech NMEA-style messages. These commands can be sent to the GG12-Pro through either serial port. All NMEA messages and Ashtech NMEA-style messages are disabled by default. The general format is:

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

In this context, **set** commands enable the output of NMEA messages at regular intervals or disable message output, where s1 is a 3-character identifier (GGA, VTG, SAT, etc.), c2 is the output port designator (A or B), s3 is ON or OFF, and f4 is the optional output rate in seconds. **Query** commands prompt the receiver to output the designated response message one time only. Message output prompted by a query command occurs independently of any related message output settings. Table 4.70 lists the the three-character NMEA message identifiers.

Table 4.70. NMEA Three-Character Message Identifiers

NMEA 3-Character Identifier	Message Content
AIM	Autonomous Integrity Monitor message
ALL	All messages
GGA	GPS position message
GSA	DOP and active satellite used
GSV	Satellites in view
GST	Error statistics (ellipse and RMS)
LTN	Latency message
MSG	Base station message
PER	NMEA send interval
POS	Position message
RMC	Minimum position, course/speed message
RRE	Range residual error message
SAT	Satellite status message
SFS	OEM-specific GPS navigation message
VTG	Velocity/course message
ZDA	Time and date message

As an example, to enable the output of the POS message on port A at five-second intervals, you would enter the following command:

$PASHS,NME,POS,A,ON,5

Similarly, to disable the output of the GGA message on port B, you would enter the command:

$PASHS,NME,GGA,B,OFF

And to query the POS message and designate port B for the output of the response message, you would enter the 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 output as a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards (version 2.1). Astech's NMEA-style messages also output in a comma-delimited string of ASCII characters, but may deviate slightly from NMEA standards. For example, the maximum length of a standard NMEA message is eighty characters, but the length of some Ashtech messages are variable (i.e., SAT) and may go beyond 80 characters. One message which deviates significantly from NMEA standards is the XYZ message, which outputs in binary format. 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 0.2 and 999 seconds. The default output interval is one second.

Standard NMEA messages have the following structure:

HEADER,DATA*CHECKSUM<CR><LF>

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

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

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

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

The structure of non-standard NMEA messages is:

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, outputs as follows:

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

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

NME: Enable/Disable NMEA Message Output and Interval

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

This command allows you to control the output of NMEA messages and Ashtech NMEA-style messages. Use the **$PASHQ,NMO** query command (page 170) to view the messages available to output. All messages are disabled for output by default. Each message is enabled for output individually.

The s1 parameter is the three-letter message identifier (GGA, LTN, POS, etc.), c1 is the port designator for message output, s2 is ON or OFF, and f1 is the value for the message output interval. The range of the value for the output interval depends on the output option selected. The f1 parameter allows you to set the output interval for each individual message. You can set the GGA and VTG messages to be output every two seconds, but have the SAT message output at ten-second intervals. Table 4.71 outlines the options and ranges for the output interval:

Table 4.71. Output Interval Settings for NMEA Messages

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

TThe GG12-Pro synchronizes the NMEA message output with the hour rollover, so that message output from multiple receivers can be synchronized regardless of when they were turned on. An output interval of 0.7 is not allowed because it overlaps the hour rollover, which corrupts the

synchronization of message output between multiple receivers.

Example: Output POS message from port B at five-second intervals:

$PASHS,NME,POS,B,ON,5

Output POS message on port B:

$PASHS,NME,POS,B,OFF

Table 4.72 summarizes the NMEA commands.

Table 4.72. NMEA Commands and Response Messages

Command	Description	Page
General Command for Controlling NMEA Message Output		
$PASHS,NME,str	Enables or disables output of NMEA messages and Ashtech NMEA-style messages, set interval for message output.	149
$PASHS,NME,ALL	Disables the output of all NMEA and Ashtech NMEA-style messages on an individual serial port	170
Differential Base Station Data		
$PASHQ,MSG	Query differential base station data	165
Latency Information		
$PASHQ,LTN	Query position output latency	164
$PASHR,LTN	LTN response message	164
NMEA Output Parameters		
$PASHQ,NMO	Query current NMEA output parameter settings	170
$PASHR,NMO	NMO response message	170
$PASHS,NME,SFS	Enables/disables GPS navigation response message	186
$PASHQ,SFS	Query GPS navigation message	186
$PASHR,SFS	SFS response message	187
Position Data		
$PASHQ,GGA	Query GPS position information	152
$GPGGA	GPS position response message	152
$PASHS,NME,POS	Enable/disable position message	179
$PASHQ,POS	Query position message	180

Table 4.72. NMEA Commands and Response Messages (continued)

Command	Description	Page
$PASHR,POS	POS response message	180
$PASHQ,RMC	Query minimum position, course/speed message	174
$GPRMC	RMC response message	174
Residual Data		
$PASHQ,RRE	Query satellite residual and position error information	175
$GPRRE	GPS RRE response message	175
$GLRRE	GLONASS RRE response message	179
Satellite Data		
$PASHQ,GSA	Query DOPs/satellite used	155
$GPGSA	GPS GSA response message	155
$GLGSA	GLONASS GSA response message	156
$PASHQ,GST	Query pseudorange error statistics	159
$GPGST	GST response message	159
$PASHQ,GSV	Query all satellites in view	161
$PASHQ,SAT	Query satellite status information	183
$PASHR,SAT	SAT response message	183
Time And Date		
$GPZDA	ZDA response message	190
Course And Speed		
$PASHQ,VTG	Query velocity/course information	188
$GPVTG	VTG response message	188

Commands

Command/Response Formats 151

GGA: 3D GPS Position with UTC

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

This command enables/disables the NME GGA position message, where c is A or B (port), s is ON or OFF, and f is the optional output rate as listed in Table 4.71.

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

The configuration for periodic output would be:

$GPGGA,d1d2f1,d3f2,c1,d4f3,c2,d5,d6,f4,_d7,M,_f5,M,d8,d9*hh

$PASHQ,GGA,c

Queries the GGA message (GPS position with UTC), where c is the optional output port, A or B. If a port is not specified, the receiver sends the response to the current port.

$GPGGA

This message does not output unless positions are being computed. In addition to a 3D 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 GG12-Pro can be set to output the GGA message at regular intervals by using the command **$PASHS,NME**.

The GGA message output is in the format:

$GPGGA,d1d2f1,d3f2,c1,d4f3,c2,d5,d6,f4,_d7,M,_f5,M,d8,d9*hh

where the message structure is as defined in Table 4.73.

<div align="center">**Table 4.73:** $GPGGA Message Structure</div>

Parameter	Description	Range
m1	UTC time (hhmmss.ss) of the position fix	000000.00 to 235959.90
m2	Latitude of the position fix (ddmm.mmmmm)	0° - 90°
c3	Latitude sector	N(orth) S(outh)
m4	Longitude of the position fix (dddmm.mmmmm)	0° - 180°
c5	Longitude sector	E(ast) W(est)
d6	Position fix type: 1 - Autonomous position 2 - Corrected position (code differential)	1, 2
d7	Number of SVs used in position computation	3 - 12
d8	HDOP (horizontal dilution of precision)	00.0 - 99.9
f9	Altitude above Mean Sea Level (geoidal height)	-1000.00 to 18000.00
c10	Altitude unit of measure (always M)	M(eters)
d11	Geoidal separation value	-9999.9 to +9999.9
c12	Geoidal separation unit of measure (always M)	M(eters)
d13	Age of differential corrections (seconds)	0 - 99
d14	Differential base station ID number	0 - 1023
hh	Checksum	2-character hex

Typical GGA message:

$GPGGA,220620.00,3721.08482,N,12156.11302,W,1,12,00.9, +00039.10,M, -0031.33,M,,,*4E

Table 4.74 describes a typical GGA messages.

Table 4.74. Typical GGA Message

Item	Description
$GPGGA	Header
220620.00	Time of position fix (22:06:20.00)
3721.08482	Latitude (37°21.08482′)
N	North
12156.11302	Longitude (121°56.11302′)
W	West
1	Indicates that the position was computed autonomously
12	Number of satellites used in position computation
00.9	HDOP
+00039.10	Altitude
M	Altitude unit of measure (meters)
-0031.33	Geoidal separation value
M	Geoidal separation unit of measure (meters).
,,	Age of differential corrections (field empty because position was computed autonomously)
,*	Base station ID number (field empty because position was computed autonomously)
*4E	Checksum

GSA: DOP and Active Satellites

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

This command enables/disables the NME GSA message, where c is A or B (port), s is ON or OFF, and f is the optional period as detailed in Table 4.71 on page 149.

$PASHQ,GSA,c1

This command allows you to query the GSA message, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port. The GG12-Pro outputs two GSA messages. One of the messages contains information for the GPS satellites, the other for GLONASS satellites.

$GPGSA

This version of the GSA message lists the indicators for current position mode ($PASHS,PMD,d on page 76), the GPS satellites used for the position computation, and the values for PDOP, HDOP, and VDOP. This message does not output until positions are computed.

The response message is in the format:

$GPGSA,c1,d1,{d2,}n f1,f2,f3*hh   (GPS) or

$GLGSA,c1,d1,{d2,}n f1,f2,f3*hh   (GLONASS)

Table 4.75 describes the GSA message format.

Table 4.75. $GPGSA Message Format

Parameter	Description	Range
c1	Mode: M -manual, A - automatic	M or A
d1	Mode: 1- fix not available, 2 - 2D, 3 - 3D	1 -3
d2	PRN being used in solution (empty for unused fields)	1 - 56
n	Maximum number of SVs used	1 - 12
f1	PDOP	0 - 100000
f2	HDOP	0 - 100000
f3	VDOP	0 - 100000
*hh	The hexadecimal ckecksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hexcharacter.	0-9 and A-F

Typical $GPGSA message:

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

Table 4.76 describes a typical GSA message.

Table 4.76. Typical $GPGSA Message

Field	Description
$GPGSA	Header
A	Indicates automatic 2D/3D switching mode
3	Indicates 3D position mode
18	GG12-Pro channel 1 locked on GPS satellite 18; satellite 18 used in position computations
01	GG12-Pro channel 2 locked on GPS satellite 1; satellite 1 used in position computations
14	GG12-Pro channel 3 locked on GPS satellite 14; satellite 14 used in position computations
19	GG12-Pro channel 4 locked on GPS satellite 19; satellite 19 used in position computations
22	GG12-Pro channel 5 locked on GPS satellite 22; satellite 22 used in position computations
04	GG12-Pro channel 6 locked on GPS satellite 4; satellite 4 used in position computations
16	GG12-Pro channel 7 locked on GPS satellite 16; satellite 16 used in position computations
27	GG12-Pro channel 8 locked on GPS satellite 27; satellite 27 used in position computations
03	GG12-Pro channel 9 locked on GPS satellite 3; satellite 3 used in position computations
24	GG12-Pro channel 10 locked on GPS satellite 24; satellite 24 used in position computations
,,	Indicates that this channel (11) is not locked on a GPS satellite or that the locked satellite is not being used in position computations
,,	Indicates that this channel (12) is not locked on a GPS satellite or that the locked satellite is not being used in position computations
01.4	Current PDOP value
00.9	Current HDOP value
01.1	Current VDOP value
*08	Checksum

$GLGSA

This version of the GSA message also contains the 2 position mode indicators and the current values for PDOP, HDOP, and VDOP, but lists the GLONASS satellites being used to compute position. In addition, leading zeroes in the DOP fields are suppressed. This message does not output until positions are being computed. The GLONASS version of the GSA message has the format listed in Table 4.75.

Typical $GLGSA message:

$GLGSA,A,3,,,,,,,,,,,45,54,1.4,0.9,1.1*22

Table 4.78 describes a typical GSA message.

Table 4.77. Typical $GLGSA Message

Field	Description
$GLGSA	Header.
A	Indicates automatic 2-D/3-D switching mode.
3	Indicates 3D position mode.
,,	Indicates that this channel (1) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (2) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (3) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (4) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (5) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (6) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (7) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (8) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (9) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (10) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations.
45	GG12-Pro channel 11 locked on GLONASS satellite 24; satellite 24 used in position computations
54	GG12-Pro channel 12 locked on GLONASS satellite 24; satellite 24 used in position computations
1.4	Current PDOP value
0.9	Current HDOP value
1.1	Current VDOP value
*22	Checksum

Command/Response Formats 157

Table 4.78. Typical $GLGSA Message

Field	Description
$GLGSA	Header.
A	Indicates automatic 2-D/3-D switching mode.
3	Indicates 3D position mode.
,,	Indicates that this channel (1) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (2) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (3) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (4) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (5) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (6) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (7) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (8) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (9) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations
,,	Indicates that this channel (10) is not locked on a GLONASS satellite or that the locked satellite is not used in position computations.
45	GG12-Pro channel 11 locked on GLONASS satellite 24; satellite 24 used in position computations
54	GG12-Pro channel 12 locked on GLONASS satellite 24; satellite 24 used in position computations
1.4	Current PDOP value
0.9	Current HDOP value
1.1	Current VDOP value
*22	Checksum

GST: Pseudorange Error Statistics

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

This command enables/disables the NME GST message, where c is A or B (port), s is ON or OFF, and f is the optional period in seconds, as detailed in Table 4.71 on page 149.

$PASHQ,GST,c

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

$GPGST

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

The message format is:

$GPGST,f1,f2,f3,f4,f5,f6,f7,f8,*hh

where the GST parameters are as described in Table 4.79.

Table 4.79. GPGST Message Format

Parameter	Description	Range
f1	UTC time of GGA fix associated with this sentence (hhmmss.ss)	000000.00.. ...235959.95
f2	RMS value of standard deviation of range inputs to navigation process. Must be related to the other fields in the following way: (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 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)	0.00...99.99
f4	Standard deviation of semi-minor axis of error ellipse (meters)	0.00...99.99
f5	Orientation of semimajor axis of error ellipse,(degrees from true N	0.00...359.99
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	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0 - 9 and A-F

Example: Output GST message on port B at the PER period:

$PASHS,NME,GST,B,ON

Example: Output GST message on port A at a 2-second period:

$PASHS,NME,GST,A,ON,2

You need this information to decide whether a float solution is accurate enough or not (since a float solution could have an error of several meters, or only a few centimeters, or anything in between). It is acceptable to provide null fields in this message, as long as you provide the following minimum information:

UTC time of the GGA fix associated with this sentence

RMS value of the standard deviation of the range inputs to the navigation process

Standard deviation of latitude error (meters)

Standard deviation of longitude error (meters)

Standard deviation of altitude error (meters)

GST is implemeted with 2 digits resolution after the decimal point for the standard deviation fields (i.e. 1cm resolution).

The assumption is that there is no bias, thus rms=sdev.

Output format: ASCII

See also: $PASHS,NME,GST,c,s

$PASHQ,RRE,A[,c]

Example: $PASHQ,GST,B

Response:$GPGST,211956.2,0.02,,,,0.01,0.02,0.04*hh

$GPGSV

$GPGSV,d1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,d14,d15,d16,d17,d18,d19*hh

$GLGSV,d1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,d14,d15,d16,d17,d18,d19*hh

Typical GST message:

$GPGST,220632.00,0022.29,,,,0016.98,0009.12,0023.08*70

Table 4.80 describes a typical GST message.

Table 4.80. Typical GST Message

Field	Description
$GPGST	Header
220632.00	UTC time of the position fix
0022.29	RMS value of the standard deviation of satellite range inputs (1-sigma position error)
empty field	This field not implemented
empty field	This field not implemented
empty field	This field not implemented
0016.98	Standard deviation of the latitude error (meters)
0009.12	Standard deviation of the longitude error (meters)
0023.08	Standard deviation of the altitude error (meters)
*70	Checksum

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

GSV: Satellites in View

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

This command enables/disables the NME GSV message, where c is A or B (port), s is ON or OFF, and f is the optional output rate as detailed in Table 4.71 on page 149.

$PASHQ,GSV,c

This command queies the GSV message, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port.

$GPGSV

The GSV response message contains the PRN number, elevation, azimuth, and signal-to-noise ratio 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, and so on.

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,d19*hh

<div style="text-align: right">Commands</div>

Table 4.81 defines the GSV message format.

Table 4.81. $GPGSV Message Format

Parameter	Description	Range
d1	Total number of messages	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	SNR	0 - 99 dB
d8 - d11	Same as d4-d7 but for second satellite	
d12 - d15	Same as d4-d7 but for third satellite	
d16 - d19	Same as d4-d7 but for fourth satellite	
*hh	The hexadecimal ckecksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Typical GSV message:

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

Table 4.82 describes a typical GSV message.

Table 4.82. Typical GSV Message

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

LTN: Position Output Latency

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

This command enables/disables the NME LTN message, where c is A or B (port), s is ON or OFF, and f is the optional output rate as listed in Table 4.71.

$PASHQ,LTN,c

This command is a request for a number of milliseconds (latency) from a reference mark (second) to availability of data.

$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 upon the number of satellites tracked and the number of satellites used in the position solution.

Comment: d is an integer number of milliseconds being required that position would be available, i.e. a latency in getting current position within a second interval.

The response is a one-field message containing information on the number of milliseconds it takes the receiver to compute a position (from the measurement tag time) and prepare data to be transmitted through the serial port. This number is dependent upon the number of locked satellites.

 This message conveys the time elapsed between the time the latest position was computed on, and the moment when the first character of LTN message ($) was sent to the port. The elapsed time is computed by means of counting the number of ASIC interruptions. The period of ASIC interruptions is also known. So it's possible to work out the time elapsed between any two events. "the time the latest position was computed on" is the time for which we compute the latest position (this is the time tag displayed in GGA, POS,..). Usually this is a UTC second (if we have 1 Hz position update) or half-second (if we have 2 Hz position update). The measurements are sampled in hardware not exactly on UTC second or half-second, but according to receiver clock. Then the measurements are extrapolated to the UTC second/half-second and the position is computed. So LTN message contains delay since the moment on which we compute the latest position (this the time tag displayed in GGA, POS,..). LTN is always the first message to output. So the delay in LTN message doesn't depend on other messages being output (all of them are output after LTN).

The message response is output in the format:

$PASHR,LTN,d*hh

where d is an integer number of milliseconds assigned for latency and *hh is a checksum.

Typical LTN message:

 $PASHR,LTN,38*05

Table 4.83 describes a typical LTN message.

Table 4.83. Typical $PASHR,LTN Message

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

MSG: Differential Base Station Data

$PASHS,NME,MSG,c1,s2[,f3]

This command enables/disables the NME MSG message, where c1 is A or B (port), s2 is ON or OFF, and f3 is the optional period, as detailed in Table 4.71 on page 149.

$PASHQ,MSG,c1

This command queries the MSG message, where c1 is the optional output serial port. If a port is not specified, the receiver sends the response to the current port. This command is ignored if the GG12-Pro is not sending or receiving differential corrections.

$GPMSG

The MSG messages contain base station status data for incoming RTCA messages, including base station ID number, current Z count, current GPS time, base station health status, 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 messages generated for RTCA message type 1, fields d8 through d12 are repeated n times, where n is the number of locked satellites when the GG12-Pro outputs the message.

The MSG format for RTCA message types 1, 2, 9, 31, and 34 is:

$GPMSG,d1,d2,f1,d3,d4,d5,d6d7d8{,d9,d10,_f2,_f3,d11}*hh

The format for types 3 and 32 is:

$GPMSG,d1,d2,f1,d3,d4,d5,d6d7d8,_f2,_f3,_f4*hh

The format for types 16 and 36 is:

$GPMSG,d1,d2,f1,d3,d4,d5,d6d7d8,s*hh

The type 2 format is similar to type 1 but the meaning of differential corrections for range and range rate in type 2 is a correction to correction. The number of satellites available is up to 24 except for the 5 Hz option, where the processor load limits the number of available locked satellites to 16.

The receiver outputs a response only when it is in RTCM differential base mode with a position fix being computed. The serial port used for RTCM corrections must be different from the port currently connected to the request terminal.

Table 4.84 defines the various MSG message formats.

Table 4.84. MSG Data Fields

Field	Description	Range
Common part of message types 1, 2, 3, 9, 16, 31, 32, 34, 36		
d1	RTCM message type	1, 2, 3, 9, 16, 31, 34, 36
d2	Station identifier	0 - 1023
f1	Z count	0 - 9999.9
d3	Sequence number	0 - 9
d4	Station health	0 - 7
d5	Total number of characters following the time tag	0 - 999
d6d7d8	Current GPS time of position fix (hhmmss.ss)	0-23 hours 0-59 minutes 0-59.99 seconds
Remainder of message for types 1, 2, 9, 31, 34		
d9	User differential range error (UDRE)	0-9
d10	Satellite PRN number	1-32
f2	Pseudo range correction (PRC) in meters	±9999.99
f3	Range rate correction (RRC) in meters/sec	±9.999
d11	Issue of data ephemeris (IODE)	0-999
Remainder of message for types 3, 32		
f2	Station X componentt	±999999.99
f3	Station Y component	±999999.99
f4	Station Z component	±999999.99
Remainder of message for types 16, 36		
s	Text message from base receiver	Up to 32 chars
*hh	Checksum for all types	

Typical MSG message for RTCA type 1:

$GPMSG,01,0000,2220.0,1,0,127,003702.00,2,12,-81.30, +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,-0.004,145*7A

where the parameters are as defined in Table 4.85.

Command/Response Formats

Table 4.85. Typical MSG message for RTCA Type 1

Parameter	Description
$GPMSG	Header
01	RTCM message type
0000	Station ID
2220.0	Z count in seconds and tenths
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 satellite 12
12	Satellite PRN number
-81.30	PRC for satellite 12
+0.026	RRC for satellite 12
235	IODE for satellite 12
2	UDRE for satellite 13
13	Satellite PRN number
+0022.86	PRC for satellite 13
+0.006	RRC for satellite 13
106	IODE for satellite 13
2	UDRE for satellite 26
26	Satellite PRN number
-0053.42	PRC for satellite 26
-0.070	RRC for satellite 26
155	IODE for satellite 26
2	UDRE for satellite 02
02	Satellite PRN number

Table 4.85. Typical MSG message for RTCA Type 1 (continued)

Parameter	Description
+0003.56	PRC for satellite 02
+0.040	RRC for satellite 02
120	IODE for satellite 02
2	UDRE for satellite 27
27	Satellite PRN number
+0047.42	PRC for satellite 27
-0.005	RRC for satellite 27
145	IODE for satellite 27
7A	Checksum

Commands

Command/Response Formats   **169**

The modified Z count provides the reference time for all parameters in the RTCA type 1 message. It is calculated to a resolution of 0.2 seconds over the acceptable range of twenty minutes. For more information on the modified Z count as it is used in the RTCA type 1 message, see Appendix A in Document No. RTCA/DO-217: *Minimum Aviation System Performance Standards DGNSS Instrument Approach System: Special Category I (SCAT I)*.

$PASHS,NME,PER,f

This command sets a global output interval for all NMEA messages and Ashtech NMEA-style messages currently enabled for output, where f is the value for the output interval, as detailed in Table 4.71. This command overrides individual settings for output interval. That is, if the GGA message is enabled for output at intervals of two seconds and the SAT message is enabled for output at intervals of ten seconds, using the PER command to set an output interval of five seconds resets the output interval of both messages to five seconds.

Example: Set global NMEA output interval to five seconds:

$PASHS,NME,PER,5

$PASHS,NME,ALL,c,OFF

This command disables all NMEA messages and Ashtech NMEA-style messages on a single port, where c is the port designator (A or B).

Example: Disable output of all NMEA messages on port A:

$PASHS,NME,ALL,A,OFF

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

NMO: Query NMEA Output Parameters

$PASHQ,NMO,c1,c2

This command allows you to query the output parameters of NMEA messages and Ashtech NMEA-style messages, where c1 is the serial port being queried, and c2 is the port to which the response will be sent; if a port is not specified, the receiver sends the response to the current port.

$PASHR,NMO

The response message contains the parameter settings for NMEA message output, including the a serial port being used, the baud rate of the serial port, a three-letter identifier for each NMEA and Ashtech NMEA-style message supported by the GG12-Pro, and the output interval setting for each message.

The message is output in the format:

$PASHR,NMO,c1,d2,f3,d4,((s5,f6) x d4)*hh

Table 4.86 defines the NMO message format.

Table 4.86. $PASHR,NMO Message Format

Field	Description	Range
c1	RTCM output port	A or B
d2	Baud rate code for the referenced serial port: 0 = 300 6 = 19200 1 = 600 7 = 38400 3 = 1200 8 = 57600 4 = 4800 9 = 115200 5 = 9600	0 - 9
f3	Default output interval in seconds:	Same as defined in Table 4.71.
d4	Number of pairs of output strings and period for updat to follow	15
s5	The three-letter message identifier for each NMEA and Ashtech NMEA-style message supported by the GG12-Pro	LTN, POS, GGA, VTG, MSG, GSA, GSV, SAT, RRE, ZDA, RMC,GST
d6	Update period for message type	0 = message not output 0.05...999 (see f3 above)
*hh	Checksum 2-character hex	0-9 and A-F

Typical NMO response message:

$PASHR,NMO,A,5,001.0,12,LTN,000.0,POS,000.0,GGA,005.0,VTG, 005.0,MSG,000.0,GSA,000.0,GSV,000.0,SAT,000.0,RRE,000.0,ZDA, 000.0, RMC,000.0,GST,000.0,*70

Table 4.87 describes a typical NMO message.

Table 4.87. Typical NMO Response Message

Parameter	Description
$PASHR,NMO	Header
A	Indicates that serial port A is referenced in the response
5	This code number indicates that the data rate for port A is 9600 baud
0001.0	Global output interval setting for NMEA messages and Ashtech NMEA-style messages
12	Indicates that 12 NMEA and Ashtech NMEA-style messages are available for output
LTN	Position output latency message
000.0	Indicates LTN message not enabled for output
POS	3D antenna position message
000.0	Indicates POS message not enabled for output
GGA	3D GPS position message
005.0	Indicates that the GGA message is enabled for output at five-second intervals
VTG	Course and speed over the ground message
005.0	Indicates that the VTG message is enabled for output at five-second intervals
MSG	Differential base station status message
000.0	Indicates that the MSG message not enabled for output
GSA	DOP and active satellites message
000.0	Indicates that the GSA message is not enabled for output
GSV	Satellites in view message
000.0	Indicates that the GSV message is not enabled for output
SAT	Comprehensive satellite tracking status message
000.0	Indicates that the SAT message is not enabled for output
RRE	Satellite range residuals and position error message
000.0	Indicates that the RRE message is not enabled for output
ZDA	Time and date message
000.0	Indicates that the ZDA message is not enabled for output
RMC	Recommended minimum position and course message
000.0	Indicates that the RMC message is not enabled for output
GST	Pseudorange error statistics message
000.0	Indicates that the GST message is not enabled for output
*70	Checksum

Commands

Command/Response Formats   **173**

RMC: Recommended Minimum Position and Course

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

This command enables/disables the NME RMC message, where c is A or B (port), s is ON or OFF, and f is the optional output rate in seconds, as detailed in Table 4.71 on page 149.

$PASHQ,RMC,c

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

$GPRMC

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

The message is output in the format:

$GPRMC,f1,c2,f3,c4,f5,c6,f7,f8,s9,f10,c11*hh

where the parameters are as defined in Table 4.88.

Table 4.88. $GPRMC Message Format

Parameter	Description	Range
f1	UTC time of the position fix (hhmmss.ss)	000000.00 to 235959.95
c2	Status	A = data valid V = navigation receiver warning
f3	Latitude (ddmm.mmmm)	0000.0000 to 8959.9999
c4	Latitude direction	N(orth) S(outh)
f5	Longitude (dddmm.mmmmmm)	00000.000000 to 17959.999999
c6	Longitude direction	E(ast) W(est)
f7	Speed over ground (knots)	000.00 to 999.99
f8	Course over ground (degrees), referenced to true north	000.00 to 359.99
s9	Date (ddmmyy)	010100 to 123199
f10	Magnetic variation (degrees)	00.00 to 99.99

c11	Direction of magnetic variation:
	    Easterly variation - subtract from true north
	    Westerly variation - add to true north
		E(ast)
		W(est)

*hh	Checksum 2-character hex	0-9 and A-F

Typical RMC message:

$GPRMC,220701.00,A,3721.0831,N,12156.1152,W,000.23,256.46,211099,15.19,E*4A

Table 4.89 describes a typical RMC message.

Table 4.89. Typical RMC Message

Parameter	Description
220701.00	UTC time of position fix (hhmmss.ss)
A	Valid position
3721.0831	Latitude
N	Latitude direction
12156.1152	Longitude
W	Longitude direction
000.23	Speed over ground (knots)
256.46	Course over ground (degrees true)
211099	21 October 1999
15.19	Magnetic variation, degrees
E	Easterly variation (subtract from true course)
*4A	Checksum

RRE: Satellite Range Residuals and Position Error

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

This command enables/disables the NME RRE message, where c is A or B (port), s is ON or OFF, and f is the optional output rate in seconds as described in Table 4.71 on page 149.

$PASHQ,RRE,c

This command queries the RRE message, where c is the optional output serial port. If a port is not specified, the receiver sends the response to the current port. The GG12-Pro outputs two RRE messages: **$GPRRE** and **$GLRRE**. **$GPRRE** contains information for the GPS satellites. **$GLRRE** contains information for the GLONASS satellites.

$GPRRE

This message contains residual error values for the each pseudorange measurement and RMS values for horizontal and vertical position error for the GPS

satellites. The satellites are listed in the order in which they were acquired. The RRE message does not output unless positions are being computed. Residual errors and position errors are computed only if a minimum of 5 locked satellites are used to compute position; otherwise zero values are registered in the data fields.

The message is output in ASCII in the format:

$GPRRE,d1,{d2,_f1}n,f2,f3*hh

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

When GLONASS satellites are locked, the receiver outputs this message for GPS satellites and also for GLONASS satellites (see new NMEA standard). For the 5Hz option, processor load limits the number of available locked satellites to 16. A range residual (xxx.x) is computed for each satellite used in position computation. Residuals and position errors are not computed unless at least 5 satellites (ss) are used in position computation. The response message for the set and query command is output in two messages with different headers. The first message, GPRRE, displays the range residuals for each GPS satellite used in position computation, plus the position error for the (mixed GG) system:

$GPRRE,qq,ss,sxxx.x,...hhhh.h,vvvv.v*cc

Similarly, the second message, GLRRE, displays the range residuals for each GLONASS satellite used in position computation, plus the position error for the mixed GG system:

$GLRRE,qq,ss,sxxx.x,...hhhh.h,vvvv.v*cc <GG ONLY>

Example: **$PASHQ,GSN,B**

Response:

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

5 GPS SVs (18 RRE +000.2 meters, 29 RRE +000.2, 22 RRE-000.1,19 RRE -0000.1, 28 RRE +000.5, 0002.0 Hor RMS, 0001.3 VertRMS

$GLGRRE,03,45,+000.4,36,+000.2,52,-000.2,0002.0,0001.3*76

3 GLONASS SVs (45 RRE +000.4 meters, 36 RRE +000.2, 52RRE -000.2,0002.0 Hor RMS, 0001.3Vert RMS

See also: **$PASHS,NME,RRE,c,s**

Table 4.90 defines the message format.

Table 4.90. RRE Message Format

Parameter	Description	Range
d1	The number of satellites used to compute position	1-total channels
d2	PRN number for each of the satellites used in position computation	1 - 56
f1	Magnitude of the residual range error (meters) for each satellite used in position computation	-999.9 to +999.9
n	Number of SVs tracked	1-total channels
f2	Horizontal position error (meters)	-9999.9 to +9999.9
f3	Vertical position error (meters)	
*hh	Checksum 2 character hex	0-9 and A-F

Typical $GPRRE message:

**$GPRRE,10,18,-038.9,01,+018.4,14,-006.5,19,001.7,22,+015.3,04,+032.5,16,+0
05.1,27,-014.5,03,+000.1,24,-010.6,0018.8,0022.7*74**

Table 4.91 describes a typical RRE message.

Table 4.91. Typical $GPRRE Message

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

$GLRRE

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

The message is output in the format:

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

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

Typical $GLRRE message:

$GLRRE,2,45,+004.6,54,-000.3,0018.8,0022.7*51

Table 4.92 describes a typical RRE message.

Table 4.92. Typical $GLRRE Message

Field	Description
$GLRRE	Header for GLONASS-based RRE message
10	Number of GLONASS satellites used to compute positions
18	PRN number of the first GLONASS satellite acquired
-038.9	Range residual of first GLONASS satellite (meters)
01	PRN number of the second GLONASS satellite acquired
+018.4	Range residual for second satellite (meters)
0018.8	Horizontal position error (meters)
0022.7	Vertical position error (meters)
*76	Checksum

POS: Position Message

Enables/disables the position message. The structure is:

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

where the fields are as defined in Table 4.93.

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Table 4.93. POS Command Structure

Field	Description	Range
c	Receiver port to send data out	A or B
s	Turns on or off data output	ON or OFF
[f]	Optional period for message	1 Hz: 1... 999 seconds. Increment 1 sec 2 Hz: 0.5 sec from 0.5 sec to 1.0 second 1 second increment from 1... 999 seconds 5 Hz: 0.2 sec from 0.2 sec to 1.0 sec 1 second increment from 1... 999 seconds
If the output is set without a period, the period set by the $PASHS,NME,PER command is used. If a $PASHS,NME,PER command is sent after individual NMEA message output periods were set, the previous individual message period is superceded by the more recent NME,PER value.		

$PASHQ,POS,c

This command allows you to query the receiver's current 3-D position, where c 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 POS response message is in the format shown below:

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

Table 4.21 defines the format of the POS response message.

Table 4.94. $PASHR,POS Message Format

Parameter	Description	Range
d1	Raw/differential position 0: Raw; position is not differentially corrected 1: Position is differentially corrected with RTCM code	0 - 1
d2	Number of SVs used in position fix	3 -12
m1	Current UTC time of position fix (hhmmss.ss)	00-235959.50
m2	Latitude component of position in degrees and decimal minutes (ddmm.mmmmmm)	0 - 90
c1	Latitude sector, N = North, S = South	N or S
m3	Longitude component of position in degrees and decimal minutes (dddmm.mmmmmm)	0 - 180
c2	Longitude sector E = East, W = West	W or E
f1	Altitude above WGS-84 reference ellipsoid in meters. For 2D position computation this item contains the altitude held fixed.	±30000.000
f2	Reserved	
f3	True track/course over ground in degrees	0 - 359.9
f4	Speed over ground in knots per hour	0 - 999.9
f5	Vertical velocity in meters per second	±999.9
f6	PDOP - position dilution of precision	0 - 100000
f7	HDOP - horizontal dilution of precision.	0 - 100000
f8	VDOP - vertical dilution of precision.	0 - 100000
f9	TDOP - time dilution of precision.	0 - 100000
s	Firmware version ID	4-char string
*cc	Checksum	

Typical POS response message:

**$PASHR,POS,0,09,002701.00,3721.08661,N,12156.11611,W,
00054.41,,047.27,000.44,-000.13,02.0,01.1,01.7,01.2,FA00*17**

Command/Response Formats **181**

Table 4.22 describes a typical POS response message.

Table 4.95. Typical POS Response Message

Item	Description
$PASHR	Header.
POS	Message identifier.
0	Indicates that the position is computed autonomously (computed without the aid of differential corrections)
09	Indicates that the receiver is using nine satellites to compute a position
164152.90	UTC time reference (00:27:01.00)
3721.06962	Current latitude (37°21.08661')
N	Latitude sector
12156.11611	Current longitude (121°56.11611')
W	Longitude sector
-00054.41	Current altitude (referenced to the WGS-84 ellipsoid)
,,	Reserved data field
047.27	Current course over the ground (that is, 47.27° from true north)
000.44	Current speed over the ground (knots)
+000.13	Current vertical velocity (receiver ascending at 0.13 meters per second)
02.0	Current PDOP
01.1	Current HDOP
01.7	Current VDOP
01.2	Current TDOP
FA00	Firmware version number
*17	Checksum

If the GG12-Pro is unable to compute a position, the POS response message is in the format:

$PASHR,POS,0,,,,,,,,,,,,,,,,GH00*05

The GG12-Pro uses the WGS-84 ellipsoid only. The PZ-90 ellipsoid, which is the ellipsoid reference for the GLONASS system, is not used.

SAT: Comprehensive Satellite Tracking Data

$PASHS,NME,SAT,c,s[,f]

This command enables/disables the NME SAT message, where c is A or B (port), s is ON or OFF, and f is the optional output rate as defined in Table 4.71 on page 149.

$PASHQ,SAT,c

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

Example: SAT message on port B at the PER period:

$PASHS,NME,SAT,B,ON

Example: SAT message on port A at 2-second period:

$PASHS,NME,SAT,A,ON,2

$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,c}n*hh

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

Table 4.96 defines the SAT message format.

Table 4.96. $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 in degrees	0° - 359°
d4	Satellite elevation angle in degrees	0° - 90°
d5	Satellite signal-to-noise ratio (dbHz)	0 - 99
c6	Indicates whether the locked satellite is used in position computations: • A "U" indicates that the satellite is being used in position computations • A dash (-) indicates satellite is not being used in position computations	U or -
n	The fields from d2 to c are repeated d1 times for each locked satellite	
*hh	Checksum	2-character hex

Typical SAT message:

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

Table 4.97 describes a typical SATmessage.

Table 4.97. Typical SAT Message

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

SFS:GPS Navigation Response Message

This command enables/disables the GPS navigation response message. The structure is:

$PASHS,NME,SFS,c,s[,f]

where the parameters are as defined in Table 4.98.

Table 4.98. $PASHS,SFS Period and Increment

Parameter	Description	Range
c	Selects receiver port for output	A or B
s	Enables or disables output	ON or OFF
f	Update rate	See Table 4.71 on page 149

Example:

$PASHS,NME,SFS,A,ON

$PASHQ,SFS

This command requests the SFS message. The format is

$PASHQ,SFS,c

where c is the output port, A or B.

$PASHR,SFS

The SFS response message is in the format:

$PASHR,SFS,m1,c2,d3,m4,c5,m6,c7,f8,f9,d10,f11,c12,d13,d14*cc

where the parameters are as defined in Table 4.99. Output format is ASCII.

Table 4.99. $PASHR,SFS Resonse Message Format

Parameter	Description	Range
m1	UTC time of position fix (hhmmss.ss)	00-235959.50
c2	Status field. If position is available then SFS message is output, status field is set to 'A', and coordinate fields contain some valid data; if position is not available then SFS message is still output, status field is set to 'V', and coordinate fields are empty.	A or V
d3	Current HDOP value	0 - 100000
m4	Latitude (ddmm.mmmmmm)	0 - 90
c5	Latitude sector, N = North, S = South	N or S
m6	Longitude component of position in degrees and decimal minutes (dddmm.mmmmmm)	0 - 180
c7	Longitude sector E = East, W = West	E or W
f8	Groundspeed (knots)	0 - 999.99
f9	True track (degrees)	0 - 359.99
d10	UTC Date (ddmmyy)	
f11	Magnetic variation (degrees)	0 - 359.99
c12	Direction of magnetic Variation	E or W
d13	Geoidal height in meters	−9999 to 99999
d14	Vertical velocity in meters/second	±999.9
*cc	Checksum	

Example:

$PASHR,SFS,_*cc

VTG: Velocity and Track Over Ground

$PASHS,NME,VTG,c1,s2[,f3]

This command enables/disables the NME VTG message, where c1 is A or B (port), s2 is ON or OFF, and f3 is the optional output period as listed in Table 4.100.

Table 4.100. VTG Period and Increment

Parameter	Description	Range
c1	Selects receiver port for output	A or B
s2	Enables or disables output	ON or OFF
f 3	Update rate	See Table 4.71on page 149

Example: Output VTG message on port B at the PER period:

$PASHS,NME,VTG,B,ON

Example: Output VTG message on port A with 2-second period:

$PASHS,NME,VTG,A,ON,2

$PASHQ,VTG,c1

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

$GPVTG

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

$GPVTG,f1,T,f2,M,f3,N,f4,K*hh

where the parameters are as defined in Table 4.101.

Table 4.101. VTG Message Structure

Parameter	Description	Range
f1,T	COG (Course Over Ground) and T for true north	0 - 359
f2,M	COG and M for magnetic variation north	0 - 359
f3,N	SOG (Speed Over Ground) and N for knots	0 - 999.99
f4,K	SOG (Speed Over Ground) and K for km/hr	0 - 999.99
*hh	The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

This response appears if only position is available. Mean speed accuracy for the GG12-Pro DGPS is: 0.05 knots = 2.5 cm/s. The output format is ASCII.

Typical VTG message:

$GPVTG,179.00,T,193.00,M,000.11,N,000.20,K*3E

Table 4.102 describes a typical VTG message.

Table 4.102. 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,c,s[,f]

This command enables/disables the NME ZDA message, where c is A or B (port), s is ON or OFF, and f is the optional period for the message, as listed in Table 4.71 on page 149.

Example: Output ZDA on port A with a period of 2 seconds:

$PASHS,NME,ZDA,A,ON,2

$GPZDA

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

The message has the following format:

$GPZDA,m1,d1,d2,d4,d5*hh

Table 4.103 defines the ZDA message structure.

Table 4.103. $GPZDA Message Structure

Field	Description	Range
m1	UTC time hhmmss.ss (hours, minutes, seconds	
d1	Current day	01 - 31
d2	Current month	01 - 12
d3	Current year	0000-9999
d4	Local zone offset from UTC time, where s = sign and hh = hours	-13 to +13
d5	Local zone offset from UTC time, where mm = minutes with same sign as shh	
*hh	Checksum	

Typical ZDA message:

$GPZDA,222835.10,21,07,1999,-07,00*4D

Table 4.104 describes a typical ZDA message.

Table 4.104. 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

Commands

Command/Response Formats **191**

Detailed ARINC 429 I/O Data Structure

The GG12-Pro incorporates two ARINC 429 input ports that are programmable for high-speed or low-speed operation. The ARINC ports are embedded in connector J801, from which it receives initialization data and PRAIM requests from either the INS (Inertial Navigation System) or the FMS (Flight Management System).

The interface parameters fall into three categories:

>High-speed INS Data Input
>Low-speed FMS Data Input
>Data Output

Each I/O parameter is assigned a 3-digit label number. Table 4.105 summarizes the I/O parameters by label number and function; labels are listed here in the **_ORDER OF TRANSMISSION_**.

Table 4.105. Summary of ARINC 429 Interface I/O Labels

Label	Function	Page
High-Speed INS Data Input		
High-Speed INS Input Label 310	Present position latitude	208
High-Speed INS Input Label 311	Present position longitude	208
High-Speed INS Input Label 125	Universal Coordinated Time (UTC)	200
High-Speed INS Input Label 260	Date	207
High-Speed INS Input Label 361	Inertial altitude	209
High-Speed INS Input Label 143	Destination longitude	200
High-Speed INS Input Label 144	Destination latitude	201
High-Speed INS Input Label 146	Satellite deselection 1	201
High-Speed INS Input Label 152	Destination Estimated Time of Arrival in UTC	202
High-Speed INS Input Label 167	Alternate waypoint Estimated Time of Arrival in UTC	203
High-Speed INS Input Label 170	Satellite deselection 2	204
High-Speed INS Input Label 204	Baro-corrected altitude	205
High-Speed INS Input Label 214	Alternate waypoint latitude	206

Table 4.105. Summary of ARINC 429 Interface I/O Labels (continued)

Label	Function	Page
High-Speed INS Input Label 216	Alternate waypoint longitude	207
Low-Speed FMS Data Input		
Low-Speed FMS Data Input Label 125	Universal Coordinated Time (UTC)	211
Low-Speed FMS Data Input Label 260	Date	220
Low-Speed FMS Data Input Label 143	Destination longitude	212
Low-Speed FMS Data Input Label 144	Destination latitude	212
Low-Speed FMS Data Input Label 146	Satellite deselection 1	213
Low-Speed FMS Data Input Label 152	Destination ETA in UTC	215
Low-Speed FMS Data Input Label 167	Alternate waypoint ETA in UTC	215
Low-Speed FMS Data Input Label 170	Satellite deselection 2	216
Low-Speed FMS Data Input Label 214	Alternate waypoint latitude	218
Low-Speed FMS Data Input Label 216	Alternate waypoint longitude	218
Low-Speed FMS Data Input Label 150	Universal Coordinated Time (UTC)	214
Low-Speed FMS Data Input Label 040	Set altitude	210
Low-Speed FMS Data Input Label 041	Set latitude	210
Low-Speed FMS Data Input Label 042	Set longitude	211
Data Output		
Output Label 273	Sensor status	
Output Label 126	Satellite deselection 1	227
Output Label 127	Satellite deselection 2	228
Output Label 143	Approach Horizontal Integrity Limit (HIL)	230
Output Label 144	Approach Vertical Integrity Limit (VIL)	231
Output Label 343	Destination Horizontal Integrity Limit (HIL)	238
Output Label 344	Destination Vertical Integrity Limit (VIL)	239
Output Label 346	Alternate waypoint HIL	240
Output Label 347	Alternate waypoint VIL	241

Commands

Command/Response Formats **193**

Table 4.105. Summary of ARINC 429 Interface I/O Labels (continued)

Label	Function	Page
Output Label 162	Destination ETA	233
Output Label 163	Alternate waypoint ETA	233
Output Label 076	Altitude MSL	220
Output Label 101	Horizontal Dilution of Precision (HDOP)	221
Output Label 102	Vertical Dilution of Precision (VDOP)	221
Output Label 103	True track	222
Output Label 110	Latitude	222
Output Label 111	Longitude	223
Output Label 112	Ground speed	223
Output Label 120	Latitude fine	224
Output Label 121	Longitude fine	224
Output Label 130	Horizontal Integrity Limit (HIL)	228
Output Label 133	Vertical Integrity Limit (VIL)	228
Output Label 136	Vertical Figure of Merit (FOM)	229
Output Label 165	Vertical velocity	234
Output Label 166	North/south velocity	234
Output Label 174	East/west velocity	234
Output Label 247	Horizontal Figure of Merit (FOM)	235
Output Label 260	Date	236
Output Label 125	Universal Coordinated Time (UTC)	224
Output Label 140	UTC Fine	229
Output Label 141	UTC Fine Fractions	230
Output Label 150	Universal Coordinated Time (UTC)	232
Output Label 377	Equipment ID	243
Output Label 355	GNSS fault summary	242
Output Label 352	Turn-on test status	239
Output Label 354	Maintenance operational test status	240

Table 4.105. Summary of ARINC 429 Interface I/O Labels (continued)

Label	Function	Page
Output Label 356	Maintenance (user-defined)	242

ARINC 429 High-Speed Input

Table 4.106 lists the labels of the high-speed INS data inputs in the **order of transmission**. All labels are formatted and output as described in High-Speed Data Input Label Structures on page 200.

Table 4.106. Overview of ARINC 429 High-Speed INS Data Inputs

Oct Lbl	Parameter	Format	Units	Range	Sig Bits	Resolution	Interval Max ms
310	Pres Pos Lat	BNR	Deg	± 180	18	0.000687	125
311	Pres Pos Lon	BNR	Deg	± 180	18	0.000687	125
125	UTC	BCD	Hr:Min	23:59.9	6BCD	0.1	1000
260	Date	BCD	D:M:YR	N/A	6BCD	1	1000
361	Inertial Alt..	BNR	Ft	131,072	20	0.125ft	62.5 (b)
143	Dest Long	BNR	Deg	± 180	18	0.000687	(a)
144	Dest Lat	BNR	Deg	± 180	18	0.000687	(a)
146	Sat Desel # 1	DISC	N/A	N/A	17	N/A	(a)
152	Dest ETA	BNR	Hr:Min	23:59	11	1 min	(a)
167	Alt Dest ETA	BNR	Hr:Min	23:59	11	1 min	(a)
170	Sat Desel # 2	DISC	N/A	N/A	17	N/A	(a)
204	Baro Corr Alt	Bin	Ft	131,072	17	1 ft	62.5
214	Alt Dest Lat	BNR	Deg	± 180	18	0.000687	(a)
216	Alt Dest Lon	BNR	Deg	± 180	18	0.000687	(a)

(a) Burst at 1/sec for 3 seconds anytime data changes
(b) Inertial altitude is derived from a third-order loop using vertical acceleration and altitude as inputs.
   The altitude input is baro altitude if available either from a DADS (label 204) or a synchro. If baro alti-
   tude is not available but pressure altitude is (label 203 or synchro), pressure altitude is used. Inerital
   altitude accuracy is ARINC 706± 5 ft.   The ARINC 706 DADS accuracy requirement is
   ± 20 ft at 10,000 fr; ± 40 ft at 30,000 ff; ± 80 ft at 50,,000 ft.

Commands

ARINC 429 Low-Speed Input

Table 4.107 lists the low-speed FMS data input labels in the **order of transmission**. All labels are formatted and output as described in Low-Speed FMS Data Input Label Structures on page 210.

Table 4.107. Overview of ARINC 429 Low-Speed FMS Data Inputs

Oct Lbl	Parameter	Format	Units	Range	Sig Bits	Resolution	Interval
125	UTC	BCD	Hr,Min	23:59.9	5Fig	0.1 min	1hz
260	Date	BCD	D,Mo,Yr	N/A		N/A	1hz
143*	Dest Long	BNR	Deg	± 180	18	0.000687	(a)
144*	Dest Lat	BNR	Deg	± 180	18	0.000687	(a)
146*	Sat Desel # 1	DISC	N/A	N/A	17	N/A	(a)
152*	Dest ETA	BNR	Hr:Min	23:59	11	1 min	(a)
167*	Alt Dest ETA	BNR	Hr:Min	23:59	11	1 min	(a)
170*	Sat Desel # 2	DISC	N/A	N/A	17	N/A	(a)
214*	Alt Dest Lat	BNR	Deg	± 180	18	0.000687	(a)
216*	Alt Dest Lon	BNR	Deg	± 180	18	0.000687	(a)
150	Universal Coordinated Time	BNR	Hr:mn:Sc	23:59:59	17	N/A	1 Hz
041	Set latitude	BCD	Deg,Min	± 90°	6Fig	0.1 min	(b)
042	Set longitude	BCD	Deg,Min	± 180°	6Fig	0.1 min	(b)
040	Set altitude	BCD	Feet	79,999	5Fig	1 foot	(b)
* Labels and data not present until FMS is modified for PRAIM. (a) Burst at 1/sec for 3 seconds any time data changes. (b) Burst of 2/sec for 1 second or 500 ms burst with each label transmitted every 12 ms.							

ARINC 429 Output

The GG12-Pro provides two ARINC 429 output ports that are programmable for high-speed or low-speed operation. Both ports output data as summarized in Table 4.108 at the rate of 1/sec; the GG12-Pro output port clock rates are determined by the the high/low speed input discrete. The GG12-Pro formats and outputs labels 273, 126, 127, 143, 144, 343, 344, 346, 347, 076, 101, 102, 103, 110, 111, 112, 120, 121, 130, 133, 136, 162, 163, 165, 166, 174, 247, 260, 125, 355, 354, 352, 356, 140, 141, 150, 377 as described in ARINC 743 and ARINC 429.

The navigation data block starts with status lablel 273 and ends with measurement time labels 140, 141, 150, and Equipment ID label 377. Label 377 is output at the end of the navigation data block for each GPS epoch. The time from label 273 to label 377 is less than 200 ms. All labels are formatted and output as described in Data Output Label Structures on page 219.

<div align="center">Table 4.108. Overview of ARINC 429 Data Outputs</div>

Octal Label	Parameter	Units and Range	Significant Bits	Resolution
273	Sensor status	Dis	N/A	N/A
126	Desel Sat #1	Dis	20	N/A
127	Desel Sat #2	Dis	20	N/A
143	Approach HIL	16 NM	17	1.2E-4
144	Approach VIL	32768 FT	18	0.125
343	Dest HIL	16 NM	17	1.2E-4
344	Dest VIL	32768 FT	18	0.125
346	Alt Dest HIL	16 NM	17	1.2E-4
347	Alt Dest VIL	32768 FT	18	0.125
076	Altitude(MSL)	$\pm131{,}072$ft	20	0.125
101	HDOP	1024	15	0.03125
102	VDOP	1024	15	0.03125
103	True track	±180 deg	15	0.0054931640625
110	Latitude	±180 deg	20	0.0017166137695
111	Longitude	±180 deg	20	0.0017166137695

Command/Response Formats 197

Table 4.108. Overview of ARINC 429 Data Outputs (continued)

Octal Label	Parameter	Units and Range	Significant Bits	Resolution
112	Ground speed	± 4096 knots	15	0.125
120	Latitude, fine	0.000172deg	11	8.3984E-8
121	Longitude, fine	0.000172deg	11	8.3984E-8
130	Current HIL	16NM	17	1.2E-4
133	Current Vertical Integrity Limit	32,768ft	18	0.125
136	VFOM	32768ft	18	0.125
162	Destination ETA	HR:MIN 23:59	11	1 MIN
163	ALT destination ETA	HR:MIN 23:59	11	1 MIN
165	Vertical velocity	32,768Ft/min	15	1.0
166	North/south velocity	4096 Kts	15	0.125
174	East/west velocity	4096 Kts	15	0.125
247	Horizontal Figure of Merit FOM	16 nm	18	0.000061035
260	Date	D:M:Y, BCD	6	1 Day
125	UTC	H:M, BCD	5	0.1 Min
355	Fault summary	DISCRETE	21	--
352	Maintenance	N/A	N/A	N/A
354	Maintenance	N/A	N/A	N/A
356	Maintenance	N/A	N/A	N/A
140	UTC fine	1.0 Sec, Bnr	20	0.9536743μsec
141	UTC fine fractions	0.9536743usec	10	0.9313225nsec
150	UTC	H:M:S to 23:59:59	17	1 sec
377	Equipment ID	N/A	N/A	N/A

Time Mark Discrete

Two time mark output discretes are provided as defined in ARINC 743A-3, Attachment 8. Each time mark output can drive three 330-ohm loads. The leading edge of the time mark is synchronized with the GPS second within 2 usec in the presence of SA. Pulse width is variable from 0.825 msec (tik period) to 1.65 msec 2xtik period)

Fault Annunciator Discrete

A fault annunciator discrete indicates a fault if BIT detects a critical sensor fault which adversely affects navigation and time outputs. The discrete is ground = fault, open = normal, sinking 250 mA. The discrete is preserved when the GG12-Pro is reset because of the fault. The discrete is reset when the GG12-Pro is powered down, by manual reset, or when a reset due to low temperature resets the fault output.

SDI Input Discretes

Two open/ground input discretes, SDI1 and SDI2, define the GG12-Pro identity in multi-receiver installations, as listed in Table 4.109. These inputs are read by the processor and reported on the labels transmitted out on the ARINC output buses.

Table 4.109. SDI Discrete Configuration

SDI1	SDI2	GG12-Pro Identity
Open (0)	Open (0)	Not used
Open (0)	Ground (1)	Unit 1 (L)
Ground (1)	Open (0)	Unit 2 (R)
Ground (1)	Ground (1)	Unit 3 (C)

Speed Input Discretes

One open/ground discrete SPD selects the ARINC 429 output bus speed. Open = high speed (100 KHz), ground = low speed (approximately 12.5 KHz). This command is read by the processor and used to set the bus speed. Symbol 187 \f "Symbol"\ is 10 12.5 KHz.

High-Speed Data Input Label Structures

The high-speed ARINC 429 data input labels are described in Table 4.110 through Table 4.123, listed in **label numerical sequence**.

Table 4.110. High-Speed INS Data Input Label 125 (BCD) - UTC

Bits	Description	Range	Resolution
1 – 8	Label number (always 01010101)		
9 - 10	Source/destination identifier		
11 - 14	Tenths of minute	0.0 - 0.9	0.1
15 - 18	Minutes	0 - 9	1
19 - 22	Tens of minute	0 - 5	1
23 - 26	Hour	0 - 3	1
27 - 29	Tens of hour	0 - 2	1
30 - 31	Status matrix	00 – Normal operation (+) 01 – No computed data 10 – Functional test 11 – Normal operation (-)	
32	Parity (odd)		

Table 4.111. High-Speed INS Data Input Label 143 (Binary) - Destination Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100011)		
9 - 10	Source/destination identifier		
11 - 28	Destination longitude	± 180 degrees	0.000686645508
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.112. High-Speed INS Data Label144 (Binary) - Destination Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100100)		
9 - 10	Source/destination identifier		
11 - 28	Destination latitude	+/- 180 degrees	0.000686645508
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.113. High-Speed INS Data Input Label 146 (Discrete) - Satellite Deselection 1

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100110)		
9 - 10	Source/destination identifier		
11	Deselection type	0 – Destination predictive RAIM 1 – Alternate predictive RAIM	
12 - 13	Reserved	Always 00	
14	Satellite #16	0 – Enable 1 – Deselect	
15	Satellite #15	0 – Enable 1 – Deselect	
16	Satellite #14	0 – Enable 1 – Deselect	
17	Satellite #13	0 – Enable 1 – Deselect	
18	Satellite #12	0 – Enable 1 – Deselect	

Command/Response Formats

Table 4.113. High-Speed INS Data Input Label 146 (Discrete) - Satellite Deselection 1

Bits	Description	Range	Resolution
19	Satellite #11	0 – Enable 1 – Deselect	
20	Satellite #10	0 – Enable 1 – Deselect	
21	Satellite #9	0 – Enable 1 – Deselect	
22	Satellite #8	0 – Enable 1 – Deselect	
23	Satellite #7	0 – Enable 1 – Deselect	
24	Satellite #6	0 – Enable 1 – Deselect	
25	Satellite #5	0 – Enable 1 – Deselect	
26	Satellite #4	0 – Enable 1 – Deselect	
27	Satellite #3	0 – Enable 1 – Deselect	
28	Satellite #2	0 – Enable 1 – Deselect	
29	Satellite #1	0 – Enable 1 – Deselect	
30 - 31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure Warning	
32	Parity (odd)		

Table 4.114. High-Speed INS Data Label 152 (Binary) - Destination ETA

Bits	Description	Range	Resolution
1 – 8	Label number (always 01101010)		
9 - 10	Source/destination identifier		

Table 4.114. High-Speed INS Data Label 152 (Binary) - Destination ETA

Bits	Description	Range	Resolution
11	Baro-corrected alternate waypoint	0 – Baro-correction not applied 1 – Baro-correction applied	
12 - 13	Spare		
14 - 15	Requesting FMS SDI	00 – Not defined 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	ETA request sequence bit	Sequence bit distinguishes consecutive requests with same ETA.	1
17	Spare		
18 - 23	Minutes	0 - 59	1
24 - 28	Hours	0 - 23	1
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.115. High-Speed INS Data Input Label 167 (Binary) - Alternate WP ETA

Bits	Description	Range	Resolution
1 – 8	Label number (always 01110111)		
9 - 10	Source/destination identifier		
11	Baro-corrected alternate way-point	0 – Baro-correction not applied 1 – Baro-correction applied	
12 - 13	Spare		
14 - 15	Requesting FMS SDI	00 – Not defined 01 – FMS 1 10 – FMS 2 11 – FMS 3	

Command/Response Formats 203

Table 4.115. High-Speed INS Data Input Label 167 (Binary) - Alternate WP ETA

Bits	Description	Range	Resolution
16	ETA request sequence bit	Sequence bit distinguishes consecutive requests with same ETA.	1
17	Spare		
18 - 23	Minutes	0 - 59	1
24 - 28	Hours	0 - 23	1
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.116. High-Speed INS Data Label 170 (Discrete) Satellite Deselection 2

Bits	Description	Range	Resolution
1 – 8	Label number (always 01111000)		
9 - 10	Source/destination identifier		
11	Deselection type	0 - Destination predictive RAIM 1 - Alternate predictive RAIM	
12 - 13	Reserved	Always 00	
14	SVID 32	0 – Enable 1 – Deselect	
15	SVID 31	0 – Enable 1 – Deselect	
16	SVID 30	0 – Enable 1 – Deselect	
17	SVID 29	0 – Enable 1 – Deselect	
18	SVID 28	0 – Enable 1 – Deselect	

Table 4.116. High-Speed INS Data Label 170 (Discrete) Satellite Deselection 2

Bits	Description	Range	Resolution
19	SVID 27	0 – Enable 1 – Deselect	
20	SVID 26	0 – Enable 1 – Deselect	
21	SVID25	0 – Enable 1 – Deselect	
22	SVID24	0 – Enable 1 – Deselect	
23	SVID 23	0 – Enable 1 – Deselect	
24	SVID 22	0 – Enable 1 – Deselect	
25	SVID 21	0 – Enable 1 – Deselect	
26	SVID 20	0 – Enable 1 – Deselect	
27	SVID 19	0 – Enable 1 – Deselect	
28	SVID 18	0 – Enable 1 – Deselect	
29	SVID 17	0 – Enable 1 – Deselect	
30 - 31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Table 4.117. High-Speed INS Data Input Label 204 (Binary) - Baro-Corrected Altitude

Bits	Description	Range	Resolution
1 – 8	Label Number (always 10000100)		
9 - 10	Source/destination identifier		

Table 4.117. High-Speed INS Data Input Label 204 (Binary) - Baro-Corrected Altitude

Bits	Description	Range	Resolution
11	0	0	
12 - 28	Baro Corrected Altitude	131,072 ft	1
29	Sign Matrix	0 – Up 1 – Down	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.118. High-Speed INS Data Input Label 214 (Binary) - Alternate WP Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 10001100)		
9 - 10	Source/destination identifier		
11 - 28	Alternate waypoint latitude	+/- 180 degrees	0.000686645508
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.119. High-Speed INS Data Input Label 216 (Binary) - Alternate WP Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 10001110)		
9 - 10	Source/destination identifier		
11 - 28	Alternate waypoint longitude	± 180 degrees	0.000686645508

Table 4.119. High-Speed INS Data Input Label 216 (Binary) - Alternate WP Longitude

Bits	Description	Range	Resolution
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.120. High-Speed INS Data Input Label 260 (BCD) - Date

Bits	Description	Range	Resolution
1 – 8	Label number (always 10110000)		
9 - 10	Source/destination identifier		
11 - 14	Year	0 - 9	1
15 - 18	Tens of Year	0 - 9	1
19 - 22	Month	1 - 9	1
23	Tens of Month	0 - 1	1
24 - 27	Day	1 - 9	1
28 - 29	Tens of Day	0 - 3	1
30 - 31	Status matrix	00 – Normal operation (+) 01 – No computed data 10 – Functional test 11 – Normal operation (-)	
32	Parity (odd)		

Table 4.121. High-Speed INS Data Input Label 310 (Binary) - Present Position Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 11001000)		

Command/Response Formats 207

Table 4.121. High-Speed INS Data Input Label 310 (Binary) - Present Position Latitude

Bits	Description	Range	Resolution
9 - 28	Present position latitude	+/- 180 degrees	0.000171661377
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.122. High-Speed INS Data Input Label 311 (Binary) - Present Position Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 11001001)		
9 - 28	Present position longitude	+/- 180 degrees	0.000171661377
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.123. High-Speed INS Data nput Label 361 (Binary) - Inertial Altitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 11110001)		
9 - 28	Inertial altitude	131,072 ft	0.125

Table 4.123. High-Speed INS Data nput Label 361 (Binary) - Inertial Altitude

Bits	Description	Range	Resolution
29	Sign matrix	0 – Plus 1 – Minus	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Command/Response Formats   **209**

Low-Speed FMS Data Input Label Structures

The ARINC 429 FMS data input label structures are described in Table 4.124 through Table 4.137, listed in **label numerical sequence**.

Table 4.124. Low-Speed INS Data Input Label 040 (BCD) - Set Altitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 00100000)		
9 - 10	Source/destination identifier		
11 - 29	Set altitude	± 79999 ft	1
30 - 31	Status matrix	00 – Plus 01 –No computed data 10 – Functional test 11 – Minus	
32	Parity (odd)		

Table 4.125. Low-Speed INS Data Input Label 041 (BCD) - Set Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 00100001)		
9 - 12	Minute tenth	0.0 - 0.9	0.1
13 - 16	Minute unit	0 - 9	1
17 - 20	Minute ten	0 - 5	1
21 - 24	Degree	0 – 9	1
25 - 28	Degree ten	0 - 8	1
29	Degree hundred	Always 0	
30 - 31	Status matrix	00 – North 01 – No computed data 10 – Functional test 11 – South	
32	Parity (odd)		

Table 4.126. Low-Speed INS Data Input Label 042 (BCD) - Set Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 00100010)		
9 - 12	Minute tenth	0.0 - 0.9	0.1
13 - 16	Minute unit	0 - 9	1
17 - 20	Minute ten	0 - 5	1
21 - 24	Degree	0 – 9	1
25 - 28	Degree ten	0 - 8	1
29	Degree hundred	0 - 1	1
30 - 31	Status matrix	00 – East 01 – No computed data 10 – Functional test 11 – West	
32	Parity (odd)		

Table 4.127. Low-Speed INS Data Input Label 125 (BCD) - Universal Coordinated Time

Bits	Description	Range	Resolution
1 – 8	Label number (always 01010101)		
9 - 10	Source/destination identifier		
11 - 14	Tenth of minute	0.0 - 0.9	0.1
15 - 18	Minute	0 - 9	1
19 - 22	Tens of minute	0 - 5	1
23 - 26	Hour	0 - 3	1
27 - 29	Tens of hour	0 - 2	1
30 - 31	Status matrix	00 – Normal operation (+) 01 – No computed data 10 – Functional test 11 – Normal operation (-)	
32	Parity (odd)		

Command/Response Formats 211

Table 4.128. Low-Speed INS Data Input Label 143 (Binary) - Destination Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100011)		
9 - 10	Source/destination identifier		
11 - 28	Destination longitude	+/- 180 degrees	0.000686645508
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.129. Low-Speed INS Data Input Label 144 (Binary) - Destination Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100100)		
9 - 10	Source/destination identifier		
11 - 28	Destination latitude	+/- 180 degrees	0.000686645508
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.130. Low-Speed INS Data Input Label 146 (Discrete) - Satellite Deselection 1

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100110)		
9 - 10	Source/destination identifier		
11	Deselection type	0 – Destination predictive RAIM 1 – Alternate predictive RAIM	
12 - 13	Reserved	Always 00	
14	Satellite #16	0 – Enable 1 – Deselect	
15	Satellite #15	0 – Enable 1 – Deselect	
16	Satellite #14	0 – Enable 1 – Deselect	
17	Satellite #13	0 – Enable 1 – Deselect	
18	Satellite #12	0 – Enable 1 – Deselect	
19	Satellite #11	0 – Enable 1 – Deselect	
20	Satellite #10	0 – Enable 1 – Deselect	
21	Satellite #9	0 – Enable 1 – Deselect	
22	Satellite #8	0 – Enable 1 – Deselect	
23	Satellite #7	0 – Enable 1 – Deselect	
24	Satellite #6	0 – Enable 1 – Deselect	
25	Satellite #5	0 – Enable 1 – Deselect	
26	Satellite #4	0 – Enable 1 – Deselect	

Command/Response Formats

Table 4.130. Low-Speed INS Data Input Label 146 (Discrete) - Satellite Deselection 1

Bits	Description	Range	Resolution
27	Satellite #3	0 – Enable 1 – Deselect	
28	Satellite #2	0 – Enable 1 – Deselect	
29	Satellite #1	0 – Enable 1 – Deselect	
30 - 31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Table 4.131. Low-Speed INS Data Input Label 150 (Binary) - Universal Coordinated Time

Bits	Description	Range	Resolution
1 - 8	Label number (always 01101000)		
9 - 10	Source/destination identifier		
11	GNSS time source	1- Time source is GNSS 0 - Otherwise	
12 - 28	Universal Coordinated Time (UTC)	23:59:59	1.0 sec
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.132. Low-Speed INS Data Input Label 152 (Binary) - Destination ETA

Bits	Description	Range	Resolution
1 – 8	Label number (always 01101010)		
9 - 10	Source/destination identifier		
11	Baro-corrected alternate waypoint	0 – Baro-correction not applied 1 – Baro-correction applied	
12 - 13	Spare		
14 - 15	Requesting FMS SDI	00 – Not defined 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	ETA request sequence bit	Sequence bit used to distinguish consecutive requests with same ETA.	1
17	Spare		
18 - 23	Minutes	0 - 59	1
24 - 28	Hours	0 - 23	1
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.133. Low-Speed INS Data Input Label 167 (Binary) - Alternate WP ETA

Bits	Description	Range	Resolution
1 – 8	Label number (always 01110111)		
9 - 10	Source / destination identifier		
11	Baro-corrected alternate waypoint	0 – Baro-correction not applied 1 – Baro-correction applied	

Command/Response Formats 215

Table 4.133. Low-Speed INS Data Input Label 167 (Binary) - Alternate WP ETA

Bits	Description	Range	Resolution
12 - 13	Spare		
14 - 15	Requesting FMS SDI	00 – Not defined 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	ETA request sequence bit	Sequence bit used to distinguish consecutive requests with same ETA.	1
17	Spare		
18 - 23	Minutes	0 - 59	1
24 - 28	Hours	0 - 23	1
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.134. Low-Speed INS Data Input Label 170 (Discrete) - Satellite Deselection 2

Bits	Description	Range	Resolution
1 – 8	Label number (always 01111000)		
9 - 10	Source/destination identifier		
11	Deselection type	0 - Destination predictive RAIM 1 - Alternate predictive RAIM	
12 - 13	Reserved	Always 00	
14	SVID 32	0 – Enable 1 – Deselect	
15	SVID 31	0 – Enable 1 – Deselect	
16	SVID 30	0 – Enable 1 – Deselect	

Table 4.134. Low-Speed INS Data Input Label 170 (Discrete) - Satellite Deselection 2

Bits	Description	Range	Resolution
17	SVID 29	0 – Enable 1 – Deselect	
18	SVID 28	0 – Enable 1 – Deselect	
19	SVID 27	0 – Enable 1 – Deselect	
20	SVID 26	0 – Enable 1 – Deselect	
21	SVID25	0 – Enable 1 – Deselect	
22	SVID24	0 – Enable 1 – Deselect	
23	SVID 23	0 – Enable 1 – Deselect	
24	SVID 22	0 – Enable 1 – Deselect	
25	SVID 21	0 – Enable 1 – Deselect	
26	SVID 20	0 – Enable 1 – Deselect	
27	SVID 19	0 – Enable 1 – Deselect	
28	SVID 18	0 – Enable 1 – Deselect	
29	SVID 17	0 – Enable 1 – Deselect	
30 - 31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Commands

Command/Response Formats 217

Table 4.135. Low-Speed INS Data Input Label 214 (Binary) - Alternate WP Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 10001100)		
9 - 10	Source/destination identifier		
11 - 28	Alternate waypoint latitude	+/- 180 degrees	0.000686645508
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.136. Low-Speed INS Data Input Label 216 - Alternate WP Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 10001110)		
9 - 10	Source/destination identifier		
11 - 28	Alternate waypoint longitude	+/- 180 degrees	0.000686645508
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.137. Low-Speed INS Data Input Label 260 (BCD) - Date

Bits	Description	Range	Resolution
1 – 8	Label number (always 10110000)		
9 - 10	Source/destination identifier		
11 - 14	Year unit	0 - 9	1
15 - 18	Tens of year	0 - 9	1
19 - 22	Month unit	1 - 9	1
23	Tens of month	0 - 1	1
24 - 27	Day unit	1 - 9	1
28 - 29	Tens of day	0 - 3	1
30 - 31	Status matrix	00 – Normal operation (+) 01 – No computed data 10 – Functional test 11 – Normal operation (-)	
32	Parity (odd)		

Data Output Label Structures

The bit structures of the ARINC 429 data output labels are described in Table 4.138 through Table 4.172, listed in **label numerical sequence**.

Table 4.138. Output Label 076 (Binary) - Altitude (MSL)

Bits	Description	Range	Resolution
1 – 8	Label number (always 00111110)		
9 - 28	Altitude (MSL)	131,072 ft	0.125
29	Sign matrix	0 – Plus 1 – Minus	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.139. Output Label 101 (Binary) - Horizontal Dilution of Precision (HDOP)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01000001)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	Horizontal dilution of precision (HDOP)	1024	0.031
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.140. Output Label 102 (Binary) - Vertical Dilution of Precision (VDOP)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01000010)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	Vertical dilution of precision (VDOP)	1024	0.031
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.141. Output Label 103 (Binary) - True Track

Bits	Description	Range	Resolution
1 – 8	Label number (always 01000011)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	True track	+/- 180 degrees	0.005493164063
29	Sign matrix	0 – Plus 1 – Minus	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.142. Output Label 110 (Binary) - Latitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 01001000)		
9 - 28	Latitude	+/- 180 degrees	0.00171661377
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Command/Response Formats   221

Table 4.143. Output Label 111 (Binary) - Longitude

Bits	Description	Range	Resolution
1 – 8	Label number (always 01001001)		
9 - 28	Longitude	+/- 180 degrees	0.00171661377
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.144. Output Label 112 (Binary) - Ground Speed

Bits	Description	Range	Resolution
1 – 8	Label number (always 01001010)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	Ground speed	4096 knots	0.125
29	Sign matrix	Always 0	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.145. Output Label 120 (Binary) - Latitude Fine

Bits	Description	Range	Resolution
1 – 8	Label number (always 01010000)		
9 - 10	Source/destination identifier		
11 - 17	Pad	Always 0000000	
18 - 28	Latitude fine	0.000172 degree	8.38×10^{-8}
29	Sign matrix	0 – North 1 – South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.146. Output Label 121 (Binary) - Longitude Fine

Bits	Description	Range	Resolution
1 – 8	Label number (always 01010001)		
9 - 10	Source/destination identifier		
11 - 17	Pad	Always 0000000	
18 - 28	Longitude fine	0.000172 degree	8.38×10^{-8}
29	Sign matrix	0 – East 1 – West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Commands

Command/Response Formats   **223**

Table 4.147. Output Label 125 (BCD) Universal Coordinated Time (UTC)

Bits	Description	Range	Resolution
1 - 8	Label number (always 01010101)		
9 - 10	Source/destination identifier		
11 - 14	Minute tenth	0.0 - 0.9	0.1
15 - 18	Minute unit	0 - 9	1
19 - 22	Minute ten	0 - 5	1
23 - 26	Hour	0 - 3	1
27 - 29	Hour ten	0 - 2	1
30 - 31	Status matrix	00 – Normal operation (+) 01 – No computed data 10 – Functional test 11 – Normal operation (-)	
32	Parity (odd)		

Table 4.148. Output Label 126 (Discrete) - Satellite Deselection 1

Bits	Description	Range	Resolution
1 – 8	Label number (always 01010110)		
9-10	Source/destination identifier (SDI)		
11	Deselection type	0 - Destination Predictive RAIM 1 - Alternate Predictive RAIM	
12 - 13	Reserved	Always 00	
14	SVID 16	0 – Enable 1 – Deselect	
15	SVID 15	0 – Enable 1 – Deselect	
16	SVID 14	0 – Enable 1 – Deselect	

Table 4.148. Output Label 126 (Discrete) - Satellite Deselection 1   (continued)

Bits	Description	Range	Resolution
17	SVID 13	0 – Enable 1 – Deselect	
18	SVID 12	0 – Enable 1 – Deselect	
19	SVID 11	0 – Enable 1 – Deselect	
20	SVID 10	0 – Enable 1 – Deselect	
21	SVID 9	0 – Enable 1 – Deselect	
22	SVID 8	0 – Enable 1 – Deselect	
23	SVID 7	0 – Enable 1 – Deselect	
24	SVID 6	0 – Enable 1 – Deselect	
25	SVID 5	0 – Enable 1 – Deselect	
26	SVID 4	0 – Enable 1 – Deselect	
27	SVID 3	0 – Enable 1 – Deselect	
28	SVID 2	0 – Enable 1 – Deselect	
29	SVID 1	0 – Enable 1 – Deselect	
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure Warning	
32	Parity (odd)		

Commands

Command/Response Formats   **225**

Table 4.149. Output Label 127 (Discrete) - Satellite Deselection 2

Bits	Description	Range	Resolution
1 – 8	Label number (always 01010111)		
9-10	Source/destination identifier (SDI)		
11	Deselection type	0 - Destination predictive RAIM 1 - Alternate predictive RAIM	
12 - 13	Reserved	Always 00	
14	SVID 32	0 – Enable 1 – Deselect	
15	SVID 31	0 – Enable 1 – Deselect	
16	SVID 30	0 – Enable 1 – Deselect	
17	SVID 29	0 – Enable 1 – Deselect	
18	SVID 28	0 – Enable 1 – Deselect	
19	SVID 27	0 – Enable 1 – Deselect	
20	SVID 26	0 – Enable 1 – Deselect	
21	SVID25	0 – Enable 1 – Deselect	
22	SVID24	0 – Enable 1 – Deselect	
23	SVID 23	0 – Enable 1 – Deselect	
24	SVID 22	0 – Enable 1 – Deselect	
25	SVID 21	0 – Enable 1 – Deselect	
26	SVID 20	0 – Enable 1 – Deselect	

Bits	Description	Range	Resolution
27	SVID 19	0 – Enable 1 – Deselect	
28	SVID 18	0 – Enable 1 – Deselect	
29	SVID 17	0 – Enable 1 – Deselect	
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure Warning	
32	Parity (odd)		

Table 4.150. Output Label 130 (Binary) - Horizontal Integrity Limit (HIL)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01011000)		
9-10	Source/destination identifier (SDI)		
11	Bit detection of satellite failed	1 – When receiver's RAIM detects a satellite failure 0 - Otherwise	
12 - 28	Horizontal Integrity limit (HIL)	16 NM	1.2×10^{-4}
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Commands

Command/Response Formats

Table 4.151. Output Label 133 (Binary) - Vertical Integrity Limit (VIL)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01011011)		
9-10	Source/destination identifier (SDI)		
11 - 28	Vertical Integrity Limit (VIL)	32,768ft	0.125
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.152. Output Label 136 (Binary) - Vertical Figure of Merit (FOM)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01011110)		
9-10	Source/destination identifier (SDI)		
11 - 28	Vertical Figure of Merit (FOM)	32,768ft	0.125
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.153. Output Label 140 (Binary) - Universal Coordinated Time - Fine

Bits	Description	Range	Resolution
1 - 8	Label number (always 01100000)		
9 - 28	Universal Coordinated Time (UTC) Fine	1.0 sec	0.9536743 µsec

Table 4.153. Output Label 140 (Binary) - Universal Coordinated Time - Fine (continued)

Bits	Description	Range	Resolution
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.154. Output Label 141 (Binary) - Universal Time Coordinated - Fine Fractions

Bits	Description	Range	Resolution
1 - 8	Label number (always 01100001)		
9 - 10	Source/destination identifier		
11 - 18	Pad	Always 00000000	
19 - 28	UTC fine fractions	0.9536743 µsec	0.9313225 nsec
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.155. Output Label 143 (Binary) - Approach Horizontal Integrity Limit (HIL)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100011)		
9-10	Source/destination identifier (SDI)		
11	0	0	
12 - 28	Approach Horizontal Integrity Limit (HIL)	NM	1.2×10^{-4}
29	Sign matrix	Always 0	

Command/Response Formats   **229**

Table 4.155. Output Label 143 (Binary) - Approach Horizontal Integrity Limit (HIL) (continued)

Bits	Description	Range	Resolution
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.156. Output Label 144 (Binary) - Approach Vertical Integrity Limit (VIL)

Bits	Description	Range	Resolution
1 – 8	Label number (always 01100100)		
9-10	Source/destination identifier (SDI)		
11 - 28	approach Vertical Integrity Limit (VIL)	FT	0.125
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.157. Output Label 150 (Binary) - Universal Time Coordinated (UTC)

Bits	Description	Range	Resolution
1 - 8	Label number (always 01101000)		
9 - 10	Source/destination identifier		
11	GNSS system used	1 - GNSS time source 0 - Otherwise	
12 - 28	Universal Coordinated Time (UTC)	23:59:59	1.0sec
29	Sign matrix	Always 0	

Table 4.157. Output Label 150 (Binary) - Universal Time Coordinated (UTC)

Bits	Description	Range	Resolution
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.158. Output Label 162 (Binary) - Destination ETA

Bits	Description	Range	Resolution
1 – 8	Label number (always 01110010)		
9-10	Source/destination identifier (SDI)		
11	Reserved for "baro-corrected was applied"	0 - Baro-correction not applied 1 - Baro-correction applied	
12	Invalid almanac	0 - Almanac valid 1 - Almanac invalid	
13	Request bus designator	0 - Response to Port 1 bus 1 - Response to Port 2 bus	
14 - 15	FMS request designator	00 – Powerup state 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	ETA request sequence bit		
17	Date/time	0 - GNSSU has determined times 1 - GNSSU has not determined time	
18 - 23	Destination ETA minutes	0 - 59	1
24 - 28	Destination ETA hours	0 - 23	1
29	Reserved	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Command/Response Formats   **231**

Table 4.159. Output Label 163 (Binary) - Alternate WP ETA

Bits	Description	Range	Resolution
1 – 8	Label number (always 01110011)		
9-10	Source/destination Identifier (SDI)		
11	Reserved for "baro-corrected was applied"	0 - Baro-correction not applied 1 - Baro-correction applied	
12	Invalid almanac	0 - Almanac valid 1 - Almanac invalid	
13	Request bus designator	0 - Response to Port 1 bus 1 - Response to Port 2 bus	
14 - 15	FMS request designator	00 – Powerup state 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	ETA request sequence bit		
17	Date/time	0 – GNSSU has determined time 1 - GNSSU has not determined time	
18 - 23	Minutes	0 - 59	1
24 - 28	Hours	0 - 23	1
29	Reserved	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.160. Output Label 165 (Binary) - Vertical Velocity

Bits	Description	Range	Resolution
1 – 8	Label number (always 01110101)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	Vertical velocity	32,768 ft/min	1.0
29	Sign matrix	0 - Up 1 - Down	
30 - 31	Status matrix	00 - Failure warning 01 - No computed data 10 - Functional test 11 - Normal operation	
32	Parity (odd)		

Table 4.161. Output Label 166 (Binary) - North/South Velocity

Bits	Description	Range	Resolution
1 – 8	Label number (always 01110110)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	North/south velocity	4096 Kt	0.125
29	Sign matrix	0 - North 1 - South	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Command/Response Formats 233

Table 4.162. Output Label 174 (Binary) - East/West Velocity

Bits	Description	Range	Resolution
1 – 8	Label number (always 01111100)		
9 - 10	Source/destination identifier		
11 - 13	Pad	Always 000	
14 - 28	East/West velocity	4096 Kt	0.125
29	Sign matrix	0 - East 1 - West	
30 - 31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.163. Output Label 247 (Binary) - Horizontal Figure of Merit (FOM)

Bits	Description	Range	Resolution
1 – 8	Label number (always 10100111)		
9-10	Source/destination identifier (SDI)		
11 - 28	Horizontal Figure of Merit (FOM)	16 nm	0.000061035
29	Sign matrix	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.164. Output Label 273 (Discrete) - Sensor Status

Bits	Description	Range	Resolution
1 – 8	Label number (always 10111011)		
9-10	Source/destination identifier (SDI)		
11	MSB of satellites visible	1 - more than 15 visible 0 - 15 or less visible	
12	DADS / FMS status	0 - Present 1 - Not present	
13	DADS / FMS source	0 - Primary 1 - Secondary	
14	IRS / FMS status	0 - Present 1 - Not present	
15	IRS / FMS source	0 - Primary 1 - Secondary	
16-19	Number of satellites visible	0- 15	
20-23	Number of satellites tracked	0 - 15	
24-28	GNSS sensor operational mode	01000 - Acquisition 01100 - Navigation 11111 - Fault	
29	MSB of satellites tracked	1 - More than 15 visible 0 - 15 or less visible	
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Table 4.165. Output Label 343 (Binary) - Destination Horizontal Integrity Limit (HIL)

Bits	Description	Range	Resolution
1 – 8	Label number (always 11100011)		
9-10	Source/destination identifier (SDI)		
11 - 13	Integrity sequence counter	000 - Acknowledge 001 – HIL at ETA 010 – HIL at ETA-5min 011 – HIL at ETA+5min 100 – HIL at ETA-10min 101 – HIL at ETA+10min 110 – HIL at ETA-15min 111 – HIL at ETA+15min	
14 - 15	FMS request designator	00 - Powerup 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	Sequence bit	Echoes sequence bit recerved from fms	
17	PRAIM unavailable	0 – Available 1 - Unavailable	
18 - 28	Destination Horizontal Integrity Limit HIL	NM	1.2×10^{-4}
29	Reserved	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.166. Output Label 346 (Binary) - Alternate WP HIL

Bits	Description	Range	Resolution
1 – 8	Label number (always 11100110)		
9-10	Source/destination identifier (SDI)		
11 - 13	Integrity sequence counter	000 - Acknowledge 001 – HIL at ETA 010 – HIL at ETA-5min 011 – HIL at ETA+5min 100 – HIL at ETA-10min 101 – HIL at ETA+10min 110 – HIL at ETA-15min 111 – HIL at ETA+15min	
14 - 15	FMS request designator	00 - Powerup 01 - FMS 1 10 - FMS 2 11 - FMS 3	
16	Sequence bit	Echoes sequence bit received from FMS	
17	PRAIM unavailable	0 - Available 1 - Unavailable	
18 - 28	Alternate WP HIL	NM	1.2×10^{-4}
29	Reserved	Always 0	
29	Sign matrix	Always 0	
30-31	Status matrix	00 - Failure warning 01 - No computed data 10 - Functional test 11 - Normal operation	
32	Parity (odd)		

Command/Response Formats 237

Table 4.167. Output Label 347 (Binary) - Alternate WP VIL

Bits	Description	Range	Resolution
1 – 8	Label number (always 11100111)		
9-10	Source/destination identifier (SDI)		
11 - 13	Integrity sequence counter	000 - Acknowledge 001 – HIL at ETA 010 – HIL at ETA-5min 011 – HIL at ETA+5min 100 – HIL at ETA-10min 101 – HIL at ETA+10min 110 – HIL at ETA-15min 111 – HIL at ETA+15min	
14 - 15	FMS request designator	00 - Powerup 01 – FMS 1 10 – FMS 2 11 – FMS 3	
16	Sequence bit	Echoes sequence bit received from FMS	
17	PRAIM unavailable	0 – Available 1 - Unavailable	
18 - 28	Alternate WP VIL	NM	1.2×10^{-4}
29	Reserved	Always 0	
30-31	Status matrix	00 – Failure warning 01 – No computed data 10 – Functional test 11 – Normal operation	
32	Parity (odd)		

Table 4.168. Output Label 352 (Discrete) - Turn-on Test Status

Bit	Description	Range	Resolution
1 – 8	Label number (always 11101010)		
9 - 10	Source/destination identifier (SDI)		
11	Turn-on program RAM CRC test status	0 - OK 1 - Test failed	
12	Turn-on data RAM pattern test status	0 - OK 1 - Test failed	
13	Turn-on op-code check status	0 – OK 1 – Test failed	
14	Turn-on ROM CRC test status	0 – OK 1 – Test failed	
15	Turn-On BITE test I/O-1 NP TX #1 wrap-around test and turn-on IRS/FMS #1 input bus RX test status	0 – Ok 1 – Test failed	
16	Reserved	0 – OK 1 – Test failed	
17	Turn-on time mark TX test status	0 – Ok 1 – Test failed	
18-29	Reserved	Always 0	
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Commands

Command/Response Formats

Table 4.169. Output Label 354 (Discrete) - Maintenance Operational Test Status

Bits	Description	Range	Resolution
1 – 8	Label number (always 11101100)		
9 - 10	Source/destination identifier (SDI)		
11	Operational prog. RAM CRC test status	0 - OK 1 - Test failed	
12	Operational prog. ROM CRC test status	0 - OK 1 - Test failed	
13	Operational op-code check status	0 - OK 1 - Test failed	
14	Operational task scheduler monitor test and operational foreground task check status	0 - OK 1 - Test failed	
15	Operational background monitor test status	0 - OK 1 - Test failed	
16	Operational L1 ASIC 1 ms counter monitor test and operational real-time execution monitor test and operational watch dog timer monitor test status	0 – Ok 1 – Test failed	
17	Reserved	Always 0	
18	Operational stack overflow test status	0 – OK 1 – Test failed	
19	Operational internal error interrupt test status	0 – OK 1 – Test failed	
20	Operational tracking performance monitor test status	0 – OK 1 – Test failed	
21	Operational power supply undervoltage monitor status	0 – OK 1 – Test failed	
22	Operational program pin change test status	0 – OK 1 – Test failed	
23	Operational antenna short/open detect test status	0 – OK 1 – Test failed	
24	ARINC labels parity test status	0 – OK 1 – Test failed	
25-29	Reserved	Always 0	

Table 4.169. Output Label 354 (Discrete) - Maintenance Operational Test Status

Bits	Description	Range	Resolution
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Table 4.170. Output Label 355 (Discrete) - GNSS Fault Summary

Bits	Description	Range	Resolution
1 – 8	Label number (always 11101101)		
9 - 10	Source/destination identifier (SDI)		
11 - 17	Reserved	Always 0000000	
18	IRS Bus #3 status	0 – Active 1 – No activity	
19	AUX Data Link #2 bus status	0 – Active 1 – No activity	
20	AUX Data Link #1 bus status	0 – Active 1 – No activity	
21	DADS Bus #2 status	0 – Active 1 – No activity	
22	DADS Bus #1 status	0 – Active 1 – No activity	
23	IRS Bus #2 status	0 – Active 1 – No activity	
24	IRS Bus #1 status	0 – Active 1 – No activity	
25	GNSS status	0 – Normal Op 1 – Failed	
26	GNSS RF interface status	0 – Normal Op 1 – Failed	
27	GNSS sensor unit	0 – Normal Op 1 – Failed	

Commands

Command/Response Formats **241**

Table 4.170. Output Label 355 (Discrete) - GNSS Fault Summary (continued)

Bits	Description	Range	Resolution
28	BITE test inhibit	0 – Normal Op 1 – Test inhibit	
29	CFDS/CMC command wd ack	0 – Acknowledge 1 – No acknowledge	
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure warning	
32	Parity (odd)		

Table 4.171. Output Label 356 (Discrete) - Maintenance (User-Defined)

Bits	Description	Range	Resolution
1 – 8	Label number (always 11101110)		
9 - 10	Source/destination identifier (SDI)		
11 - 29	Reserved	Always 0	
30-31	Status matrix	00 – Normal operation 01 – No computed data 10 – Functional test 11 – Failure Warning	
32	Parity (odd)		

Table 4.172. Output Label 377 (BCD) - Equipment ID

Bits	Description	Range	Resolution
1 - 8	Label number (always 11111111)		
9 - 10	Source/destination identifier		
11 - 14	Equipment ID	Always 0000	
15 - 18	Equipment ID	Always 0000	
19 - 22	Equipment ID	Always 1011	
23 - 29	Spare	Always 0000000	
30 - 31	Status matrix	00 – Normal operation (+) 01 – No computed data 10 – Functional test 11 – Normal operation (-)	
32	Parity (odd)		

Commands

RTCA Commands

RTCA commands allow you to control and monitor the operation of the GG12-Pro in GPS-only remote differential mode. These commands are available even if the remote differential option [U] is installed.

All but two of the RTCA 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,RPS**. This command is used to monitor differential parameters and status.

There is one response message, **$PASHR,RTC,RPS**.

Table 4.173 summarizes the RTCA commands. The GG12-Pro can accept RTCA Type 1 messages only.

Table 4.173. RTCA Commands and Response Messages

Command	Description	Page
$PASHS,RTC,AUT	Enable/disable auto differential mode	244
$PASHS,RTC,MAX	Set maximum age of RTCA differential corrections	245
$PASHS,RTC,OFF	Disable differential mode	246
$PASHS,RTC,REM	Set receiver to operate as differential remote station	246
$PASHQ,RTC,RPS	Query RTCA remote station parameter setting	246
$PASHR,RTC,RPS,	General response message for RTCA commands	246
$PASHS,RTC,STI	Set station identification of base or remote	248
$PASHS,RTC,SYS	Set system strategy for acquisition	249

AUT: Enable/Disable Automatic Differential Mode

$PASHS,RTC,AUT,c

This command enables or disables automatic differential mode, where c 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 RTCA 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 query command **$PASHQ,RTC** and checking the AUT field.

This command requires receiver options D or U.

Example: Enable auto differential mode:

$PASHS,RTC,AUT,Y

DEFAULT SETTING	
RTC,AUT	**Y**

MAX: Set Maximum Age Threshold for Differential Corrections

$PASHS,RTC,MAX,d

This command sets the maximum age for incoming RTCA differential corrections, where d 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.

Example: Set maximum age to 30 seconds:

$PASHS,RTC,MAX,30

DEFAULT SETTING	
RTC,MAX	**60**

Example: Set maximum age for GPS to 100 seconds:

$PASHS,RTC,MAX,GPS,100

Example: Set maximum age for GLONASS to 50 seconds:

$PASHS,RTC,MAX,GLO,50

OFF: Disable Differential Operation

$PASHS,RTC,OFF

This command disables differential operation, when the receiver is set as a base station or a remote station. Requires RTCM Differential option D or RTCM Remote option U to be installed in the GG12-Pro.

You can view the current RTCA mode setting by entering the query command **$PASHQ,RTC** and checking the MODE field.

REM: Set Receiver in Differential Remote Station Mode

$PASHS,RTC,REM,c

This command sets the GG12-Pro to operate as an RTCA differential remote station. The c parameter designates the input port (A or B) for differential corrections.

You can view the current RTCA mode setting by entering the query command **$PASHQ,RTC,RPSC** and checking the first field after the header.

Example: Set receiver as a differential remote station with port B as input port for RTCA differential corrections:

$PASHS,RTC,REM,B

RPS: Query RTCA Rover Operating Parameters

$PASHQ,RTC,RPS

This command queries remote differential operating parameters.

$PASHR,RTC,RPS,h1,h2,h3,h4,h5,h6,h7

This message contains information on the current operating mode, the maximum age setting for incoming differential corrections, whether automatic differential mode is enabled or disabled, and more.

The message is output in the format:

$PASHR,RTC,RPS,d1,c2,d3,c4,d5,d6,c7,*hh

Table 4.174 defines the RTC,RPS message format.

Table 4.174. $PASHR,RTC,RPS Message Format

Field	Description	Range
h1	Current operating mode: • 0 - Autonomous mode • 1 - Remote differential mode	0,1
h2	Indicates which port is being used to receive differential corrections	A, B
h3	Remote differential station ID number. The sequence 0000 indicates that the receiver can accept corrections from any RTCA base station. Any other sequence indicates that the receiver can only receive corrections from an RTCA base station programmed with the same sequence	0000 - 1023
h4	Current automatic differential mode: • Y - Automatic differential mode is enabled • N - Automatic differential mode is disabled	Y, N
h5	The communication quality factor between the differential base station and the differential remote station. This value is defined as follows: (the number of good messages/the total number of messages) x 100	0-999
h6	The maximum age (seconds) setting for incoming differential correction messages. Incoming messages whose age is at or below the max age threshold are used; incoming messages whose age is above this threshold are ignored. The default maximum age setting is 60 seconds	0 - 9999
h7	Always N. Indicates whether the receiver is checking (Y) or not checking the sequence number of incoming correction messages	Y, N
*hh	Checksum, 2-character hex	

Typical $PASHR,RTC,RPS message:

$PASHR,RTC,RPS,1,B,0000,N,,60,N*11

Command/Response Formats 247

Table 4.175 describes a typical RTC,RPS message.

Table 4.175. Typical $PASHR,RTC,RPS Message

Field	Description
$PASHR,RTC,RPS	Message header
1	Indicates that the GG12-Pro is in remote differential mode
B	Indicates that the GG12-Pro is set to receive corrections on port B
0000	Indicates that the GG12-Pro can receive RTCA corrections from any RTCA base station
N	Indicates that automatic differential mode is not enabled
,,	Null field
60	Indicates that the maximum age setting for incoming correction messages is 60 seconds
N	Indicates that message sequence checking is disabled
*11	Checksum

STI: Set Differential Remote Station ID

$PASHS,RTC,STI,d

This command sets differential station identification numbers, where d is any number between 0000 and 1023. A remote station with the ID number 0000 can receive corrections from any RTCA 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: Set differential station ID number to 0001.

$PASHS,RTC,STI,0001

DEFAULT SETTING	
RTC,STI	0000

SYS: Set System Strategy for Acquisition

$PASHS,RTC,SYS,c

This command changes the strategy for acquiring satellites in differential mode if differential corrections are being received.

If c is set to Y the receiver decides what to track based on the differential corrections it happens to be getting; e.g. it means the receiver tracks the highest available satellites for which it currently has differential corrections that are less than max age set by $PASHS,RTC,MAX.

If there are more satellites with valid differential corrections than the channels, the receiver will track the satellites with highest elevation. If there are fewer satellites with valid differential corrections than the channels, then for the rest of the channels the receiver will try to track satellites according to current basic strategy (set by the $PASHS,SYS command).

Once the receiver stops receiving the corrections and the corrections are out of date, then the basic strategy is invoked.

If c is set to N, then the basic strategy prevails whether the receiver is receiving the corrections or not

Example: Use basic strategy:

$PASHS,RTC,SYS,N

Command Defaults

Table 4.176 summarizes the default settings of the commands.

Table 4.176. Command Defaults

Command	Default
Elevation mask (ELM)	02 degrees
Position elevation mask (PEM)	02 degrees
HDOP mask	100000
PDOP mask	100000
TDOP mask	100000
VDOP mask	100000
RS-232 output period of ASCII messages*	1 Hz
RS-232 output period of binary messages	10
RS-232 baud rate	A = 9600, B = 9600
Satellites disabled for tracking (SVS,USE)	All enabled
Satellites disabled for position solution (SVP,USP)	All enabled
Navigation system (SYS=GPS)	GPS only
Troposphere corrections usage	Used
Ionosphere corrections usage	Used
Time scale (TSC)	GPS
RS-232 messages	All disabled
ARINC messages	All enabled
Time mark period*	1 sec
Time mark offset	0
Altitude fix mode ($PASHS,FIX)	0
Antenna position ($PASHS,ALT)	0.0
Antenna offsets ($PASHS,ANT)	Zeros
Set position computation mode (PMD)	0
* Internal receiver processing rate (POP) may be higher than 1 Hz.	

A

GPS and GLONASS Concepts

When the Global Positioning System (GPS) became operational in 1993, it promised to provide a new utility as pervasive and as useful as the telephone. However, GPS has certain limitations that become apparent in certain applications. These limitations are dramatically reduced by the augmentation of GPS with the Russian GLObal NAvigation Satellite System (GLONASS). The Ashtech GG12™ GPS+GLONASS receiver uses GLONASS satellites in addition to GPS satellites, providing a system even more reliable and more accurate than either system alone.

Ashtech's GG12 is the world's first fully integrated GPS+GLONASS receiver for easy integration with electronic displays, vehicle tracking, flight management survey, and mapping systems.

Background

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

Availability

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

fewer, with the possibility that the GPS receiver has too few satellites to compute position.

Accuracy

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

Differential Position Accuracy

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

Also, because SA causes GPS errors to change constantly and rapidly, Differential GPS corrections must be sent every few seconds. GLONASS errors are natural errors (such as orbit errors) and these change very slowly, so Differential GLONASS corrections need to be sent much less frequently than those for DGPS.

Figure A-1 shows how position precision decays as the age of corrections increases. For each particular age, 95% of the position errors sampled were less than or equal to the value on the graph. Approximately 400 positions were sampled for each age.

Test conditions: 10° elevation mask, correction rate: 90 seconds, HDOP less than or equal to 4, number of GLONASS satellites used in position computation greater than or equal to 4.
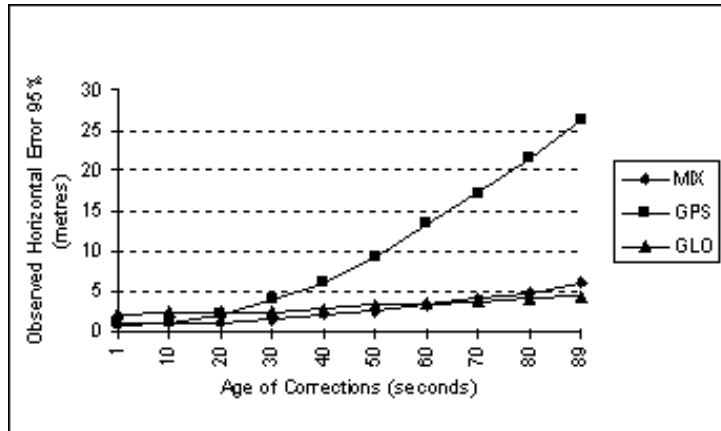
Figure A.1. GG12 Code Differential Horizontal Position Decay

When a position is not differentially corrected, SA degrades the position accuracy from the GPS constellation to about 100 meters (2-sigma, 95%). The GLONASS constellation does not implement SA, so position accuracy improves as GLONASS satellites are added to a mixed system. The attained accuracy is proportional to the number of healthy GLONASS satellites above the elevation mask. When the number of healthy GLONASS satellites is fewer than five, accuracy degrades.

Basic Concepts

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

The GPS satellite clocks are all synchronized. Similarly, the GLONASS satellites are all synchronized with each other. But GPS time is not synchronized with GLONASS time. Thus, the receiver clock must solve for two errors: The error with GPS time, and the error with GLONASS time. These two clock errors, plus

latitude, longitude, and altitude, give 5 unknowns, which are solved by having 5 satellites (or more) in view.

If the altitude is known, the GG12 can be set to hold the altitude to a fixed value. This removes one unknown, and only four satellites are needed to compute positions. The GG12 also determines the time offset, or time-shift, between GPS and GLONASS time. You can set the receiver to hold the time-shift to a fixed value, which eliminates another unknown. In this case, only three satellites are needed for a 2D position, or four for a 3D position. Any combination of GPS & GLONASS satellites work. The GG12 seamlessly integrates the two systems into one 48-satellite constellation.

Signal Structure

GPS and GLONASS have similar signal structures.

- Both transmit on two frequency bands, LI and L2
- Both have PRN codes in the LI frequency band, known as Coarse/Acquisition (C/A) code for GPS, and standard (S) code for GLONASS
- Both transmit almanac and ephemerides at a data rate of 50 bus. The GG12 tracks the LI C/A and S codes from both GPS and GLONASS
- Both have PRN codes that repeat every one millisecond (C/A for GPS and S for GLONASS)

Differences in Signal Structure

The difference between GPS and GLONASS signal structures is that GPS uses the same frequencies but different PRN codes for each satellite (CDMA, or Code Division Multiple Access). GLONASS uses the same PRN codes for each satellite, but different frequencies within the LI and L2 bands (FDMA, or Frequency Division Multiple Access). A PRN code identifies each GPS satellite. GPS PRN codes are numbered from 1 through 32, 24 of which are used for the full constellation. GLONASS satellites are identified by their orbital slot number. There are 24 orbital slots, numbered sequentially 1 through 24. The satellite takes the number of the orbital slot it occupies.

Differences in Implementation

The major difference in implementation between GPS and GLONASS is that GPS has SA on both C/A and P codes. The codes are deliberately degraded by dithering the transmit time. GLONASS has no deliberate degradation. GPS encrypts the P code on both L1 and L2, and the encrypted code is classified. This is known as AS (Anti-Spoofing). GLONASS has no encryption.

GPS and GLONASS satellites transmit orbit information about the satellites in almanacs. Each satellite transmits an almanac which tells the receiver which satellites are operating and where they are. This is how the receiver knows which satellites are above the horizon. GPS satellites are identified in their almanac by their PRN numbers, while GLONASS satellites are identified by their orbital slot (ID) numbers. Each slot number has an associated carrier number in the almanac which tells the GG12 receiver which frequency the satellite is on.

Each GPS satellite transmits at an L1 frequency of 1575.42 MHz, and at an L2 frequency of 1227.60 MHz. Each GLONASS satellite transmits at an L1 frequency of 1602 + K(9/16 MHz), and at an L2 frequency of 1246 + K(7/16 MHz). K is the carrier number given in the almanac for each satellite. Currently K is in the range 1 through 24. The GG12 is an L1-only receiver.

Changes are planned for the GLONASS frequency plan:

- **Stage 1—**The carrier numbers will be assigned in such a way as to avoid the frequencies in the band 1610.6-1613.8 MHz used in Radio Astronomy. This means the carrier number assignments K= 16, 17, 18, 19, 20 will not be used. To compensate for the lost frequencies, identical frequencies will be used for two satellites on opposite sides of the earth.
- **Stage 2**—2000 to 2005 - The next Generation of GLONASS-M satellites will use the carrier number assignments 1 through 12.
- **Stage 3**—Beyond 2005 - The GLONASS-M satellites will use the carrier number assignments (-7 through +4). Carriers 5 and 6 will be used for interaction with the ground control segment.

These changes in frequency will have no effect on the GG12, because the capability to handle any of the carrier number assignments is built-in, and the satellite almanac always tells the receiver which carrier number to use for each satellite.

The satellite ephemerides are like a high-precision almanac. They tell the receiver precisely where the satellite is. Each satellite (both GPS and GLONASS) transmits its own ephemerides. The GPS satellites provide their positions in terms of the WGS- 84 (World Geodetic System, 1984) while the GLONASS satellites provide positions in the PZ-90 reference system (sometimes called PE-90 Parameters of the Earth, 1990 or E90). The GG12 converts GLONASS satellite positions into WGS-84 coordinates and computes positions in WGS-84 coordinates.

Satellite Orbits

The orbits of GPS and GLONASS are similar. GPS satellites orbit in 6 planes, 4 satellites per plane. GLONASS uses 3 planes, 8 satellites per plane. The GLONASS inclination is slightly higher (64.8°) than GPS (55°). The orbits of both systems are circular, and with similar radii.

Geoid Model

The GG12 uses the OSU-91A geoid model. Grid size is 5 x 5 degrees, and the interpolation technique is similar to the GPS ICS algorithm. Expected accuracy when the actual position is on a grid point is 0.5 to 0.6 meters, in accordance with the OSU-91 specification. Expected accuracy when the actual position is halfway between grid points is better than 8 meters. For more information on OSU91A, please refer to:

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

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

Magnetic Model

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

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

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

Comparison of GPS and GLONASS

Table A.1 compares the operating characteristics of GPS and GLONASS.

Table A.1. Comparison of GPS and GLONASS

Parameter	GPS	GLONASS
SIGNAL STRUCTURE		
C/A Code (L1)		
Code rate	1.023 MHz	0.511 MHz
Chip length	293 m	587 m
Selective availability	Yes	No
P Code		
Code rate	10.23 MHz	5.11 MHz
Chip length	29.3 m	58.7 m
Selective availability	Yes	No
Encryption (anti-spoofing)	Yes	No
Signal separation	CDMA	FDMA
Carrier frequency	• 1575.42 MHz • 1227.60 MHz	• 1602 + Kx9/16 MHZ, where K is within the range -7 to +24 • 1246 + Kx7/16 MHz, where K is within the range -7 to +24
SATELLITES		
Number	24	24
Planes	6	3
Satellites per plane	4, unevenly spaced	8, evenly spaced
Orbital inclination	55°	64.8°

Parameter	GPS	GLONASS
Orbital radius	26560 km	25510 km
Orbital period	11 hours 58 minutes	11 hours 15 minutes
NAVIGATION MESSAGE		
Duration	12.5 minutes	2.5 minutes
Capacity	37500 bits	7500 bits
Time reference	UTC (US Naval Observatory)	UTC (SU, Russia)
Geodetic datum	WGS-84	PZ-90

GPS and GLONASS System Time

GPS system time is equal to UTC time + the number of leap seconds added since 1980 (currently 13 seconds). GLONASS system time is equal to UTC time + 3 hours. There is an additional GLONASS time-shift relative to GPS time of approximately -28.6 microseconds. Therefore, when UTC time equals 00:00:00.000000, GPS system time equals 00:00:12.000000, and GLONASS system time equals 00:02:59.9999714. In other words, GLONASS system time leads GPS system time by 3 hours minus the number of leap seconds plus the sub-second time shift value, which is currently equal to 2:59:47.9999714 (as of 30 June 1997).

NMEA 0183 Standards

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

The following messages apply specifically to GPS, and are supported by the GG12.

- GGA—Global positioning system fix data
- GSA—GPS DOP and active satellites
- GRS—GPS range residuals for each satellite

As of January 1997, the NMEA 0183 Standards Committee was in the process of finalizing the definition of messages for GLONASS information. When these messages are finalized, Ashtech will comply with NMEA GLONASS standards in the GG12. For more information on NMEA messages and decisions, see the NMEA web page, *http://www.coastalnet.com/nmea/*.

B

Floating Point Data Representation

The GG12 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:

$\quad$ 1.101 (binary) which is equal to:

$\quad$ $2^0 + 2^{-1} + 2^{-3}$ (decimal) which is equal to:

$\quad$ 1 + 0.5 + 0.125 (decimal) which is equal to:

$\quad$ 1.625 (decimal).

The Represented Value

The value of the number being represented is equal to the exponent multiplied by the fractional value, with the sign specified by the sign bit field.

If both the exponent field and the fraction field are equal to zero, the number being represented will also be zero.

Note that in some systems (Intel-based PCs in particular) the order of the bytes will be reversed.

Single-Precision Float

The single precision format uses four consecutive bytes, with the 32 bits containing a sign bit field, an 8-bit biased exponent field, and a 23-bit fraction field. The exponent has a bias of 7F (hexadecimal). The fraction field is precise to 7 decimal digits. The single-precision format can represent values in the range $1.18*10^{-38}$ to $3.4*10^{38}$ (decimal), Table B-1.

Table B.1. Single-Precision Format

31-28	27-24	23-20	19-16	15-12	11-8	7-4	3-0	
S EXPONENT		FRACTION						VALUE
0000	0000	0000	0000	0000	0000	0000	0000	0.0
0011	1111	1000	0000	0000	0000	0000	0000	1.0
1111	1111	1111	1111	1111	1111	1111	1111	NAN (not a number)
0011	1111	0100	0000	0000	0000	0000	0000	0.75

In Table B-1, the value 1.0 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.

2. The exponent field is equal to 7F (hexadecimal). The exponent is calculated by subtracting the bias value (7F) from the exponent field value. The result is 0.

   7F - 7F = 0

   The exponent multiplier is equal to 2^0, which is equal to 1 (decimal).

3. The fraction field is equal to .0. After adding the implicit normalized bit, the fraction is equal to 1.0 (binary). The fraction value is equal to 2^0 (decimal), which is equal to 1 (decimal).

4. The value of the number is positive 1*1= 1.0 (decimal).

In Table B-1, the value 0.75 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.

2. The exponent field is equal to 7E (hexadecimal). The exponent is calculated by subtracting the bias value (7F) from the exponent field value. The result is -1 (decimal).

   7E - 7F = -1

   The exponent multiplier is equal to 2^{-1}, which is equal to 0.5 (decimal).

3. The fraction field is equal to .1 (binary). After adding the implicit normalized bit, the fraction is equal to 1.1 (binary). The fraction value is equal to $2^0 + 2^{-1}$ (decimal), which is equal to 1 + 0.5 (decimal), which is equal to 1.5 (decimal).

4. The value of the number is positive 0.5*1.5 = 0.75 (decimal).

Double-Precision Float

The double-precision format uses eight consecutive bytes, with the 64 bits containing a sign bit field, an 11-bit biased exponent field, and a 52-bit fraction field. The exponent has a bias of 3FF (hexadecimal). The fraction field is precise to 15 decimal digits. The double-precision format can represent values in the range $9.46*10^{-308}$ to $1.79*10^{308}$ (decimal), Table B-2.

Table B.2 Double-Precision Format

63-60	59-56	55-62	51-48	47-44	43-40	...	15-12	11-8	7-4	3-0	
S EXPONENT FRACTION											VALUE
0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0.0
0011	1111	1111	0000	0000	0000	...	0000	0000	0000	0000	1.0
1111	1111	1111	1111	1111	1111	...	1111	1111	1111	1111	NAN (not a number)
0011	1111	1110	1000	0000	0000	...	0000	0000	0000	0000	0.75

In Table B-2, the value 1 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.

2. The exponent field is equal to 3FF (hexadecimal). The exponent is calculated by subtracting the bias value (3FF) from the exponent field value. The result is 0 (decimal).

    3FF - 3FF = 0

    The exponent multiplier is equal to 2^0, which is equal to 1 (decimal).

3. The fraction field is equal to .0 (binary). After adding the implicit normalized bit, the fraction is equal to 1.0 (binary). The fraction value is equal to 2^0 (decimal), which is equal to 1 (decimal).

4. The value of the number is positive 1*1 = 1.0 (decimal).

In Table B-2, the value 0.75 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.

2. The exponent field is equal to 3FE (hexadecimal). The exponent is calculated by subtracting the bias value (3FF) from the exponent field value. The result is -1 (decimal).

    3FE - 3FF = -1

3. The fraction field is equal to .1 (binary). After adding the implicit normalized bit, the fraction is equal to 1.1 (binary). The fraction value is equal to $2^0 + 2^{-1}$ (decimal), which is equal to 1 + 0.5 (decimal), which is equal to 1.5 (decimal).

4. The value of the number is positive 0.5*1.5 = 0.75 (decimal).

C
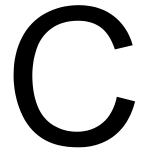
Global Product Support

If you have any problems or require further assistance, customer support can be reached through the following channels:

- telephone
- email
- Internet

Please refer to the reference documentation before contacting customer support. Many common problems are identified within the documentation, and suggestions are offered for solving them.

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: (408) 615-3980

Fax Line: (408) 615-5200

Email: support@ashtech.com

Ashtech Europe Ltd., Oxfordshire, UK

Voice: +44 -(0)1993-886766

Fax: +44 -(0)1993-886767

Solutions for Common Problems

- Check cables and power supplies. Many hardware problems result from failures in these components.
- If the problem seems to be with your computer, reboot the computer to clear its RAM memory.
- If you are experiencing receiver problems, reset the receiver. The reset command (**$PASHS,RST**) 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 customer support. Please have the following information in hand:

Table C.1. Product Information

Information Category*	Your actual numbers
Receiver model	
Receiver serial #	
Firmware version #	
Options	
A brief description of the problem	

* The receiver model name, the firmware version number, the receiver serial number, and a list of installed options can be obtained by issuing the query command $PASHQ,RIO (request receiver identification).

Corporate Web Page

You can obtain data sheets, news on upcoming products and product updates, GPS status information, application notes, and other useful information from the Thales Navigation Internet web page. Helpful features such as answers to frequently asked questions (FAQs) and list of authorized distributors are included on the web page. Use the following URL:

http://www.thales-navigation.com

Repair Centers

In addition to repair centers in California and England, authorized distributors in 27countries can assist you with your service needs.

Thales Navigation

Santa Clara, California

Voice: (408) 615-3980

or (800) 229-2400

Fax: (408) 615-5200

Ashtech Europe Ltd., Reading, UK

Voice: +44(0)118-931 9604

Fax: +44(0)118-931 9601

D

Built-in Tests

This appendix presents data that an OEM may find useful in testing and troubleshooting the GG12-Pro.

Turn-On Tests

The BITE tests listed in Table D.1. are performed at turn-on.

Table D.1. BIT Tests at Turn-on

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
Turn-on program RAM CRC test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 352 bit 11 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
Turn-on data RAM pattern test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 352 bit 12 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
Turn-On Op-Code Check	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 352 bit 13 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
Turn-On ROM CRC Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 352 bit 14 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
urn-On Bite Test I/O-1 NP TX #1 Wraparound Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 352 bit 15 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
Turn-On IRS/ FMS #1 Input Bus RX Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 1 Set 352 bit 15 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
Turn-On Time Mark TX Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 1 Set 352 bit 17 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset

Maintenance Data

Maintenance Data   **269**

Operational Tests

Table D.2. lists the tests used to check operation of the GG12-Pro.

Table D.2. Operational Tests

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
SYSRD240 10. Operational Prog. RAM CRC Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 11 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD241 11. Operational Prog. ROM CRC Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 12 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD242 12. Operational Op-Code Check	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 13 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD243 13. Operational Task Scheduler Monitor Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 14 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
SYSRD244 14. Operational Background Monitor Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 15 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD242 12. Operational Op-Code Check	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 13 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD243 13. Operational Task Scheduler Monitor Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 14 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD244 14. Operational Background Monitor Test	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 15 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset

Maintenance Data

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
SYSRD247 18. Operational Foreground Task Check	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 14 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD248 19. Operational Stack Overflow	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 18 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD249 20. Operational Internal Error Interrupt	Fault	Output labels 273, 352, 354, 355, 356 at least one time before reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 19 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn. After reset, output all data as appropriate for then current condition.	Go to receiver reset
SYSRD251 22. Operational Watch Dog Timer Monitor	Fault	Output labels 273, 352, 354, 355, 356 right after reset Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 354 bit 16 to 1 Set 355 bit 27 to 1 If any data is output before reset then set output data SSM to Fail Warn	Go to receiver reset

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
SYSRD252 23. Operational Power Supply Undervoltage Monitor (triggered if Power Supply Voltage drops below 4.4. Volts)	Fault	A. When Power Monitor Failure is detected: - Terminate all ARINC output (because it is unreliable) - Flag this condition in BBU/SRAM - Soft reset B. After the reset, if the failure condition still exists: - Still do not send any ARINC outputs - Soft Reset C. After the reset, if fault condition does not exist: (& the flag in BBU/SRAM indicates prior occurrence of the failure): - Set FAULT discrete output - Record BITE history - Transmit ARINC outputs with: - SSM of Labels 273, 352, 354, 355, 356 set to NORMAL All other SSM = FAIL WARN Label 273, bits 24-28 = 1 Label 354, Bit 21 = 1 Label 355, bit 27 = 1 (Clear the flag in BBU/SRAM) D. If voltage does not recover and goes bellow hard-reset threshold: Don't do anything. Treat this just like any normal power-off.	Go to receiver reset
SYSRD250 21. Operational Tracking Performance Monitor (no satellites are locked for 10 minutes)	Fault	Continue output of all labels Set 354 bit 20 to 1 until the situation is cleared (the first satellite is locked) Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24-28 to 11111 Set 355 bit 27 to 1 Set output data SSMs to Fail Warn	Continue execution
SYSRD253 24. SDI Pin Change Monitor	No Fault	Set Bit 22, Label 354 to 1 Store in BITE history	Continue Normal Operation using SDI as recorded at turn on

Test	Fault Discrete Status In Case Of Failure	ARINC Output In Case Of Failure	Further Actions In Case Of Failure
SYSRD254 25. ARINC H/L Speed Select Monitor	No Fault	Set Bit 22, Label 354 to 1 Store failure in BITE history	Continue normal operation using the setting recorded at turn on
SYSRD255 26. Operational Antenna Short/ Open Detect Test	Fault	Continue output of all labels Set 354 bit 23 to 1 until next turn-on Set SSMs of labels 273, 352, 354, 355, 356 to Normal Set 273 bits 24 - 28 to 11111 Set 355 bit 25 to 1 Set 355 bit 26 to 1 Set 355 bit 27 to 1 Set output data SSMs to Fail Warn	Continue Execution
SYSRD256 27. Operational ARINC Parity Test (see Note 2 below)	Ok	When a parity failure is detected, the following actions will be taken: 1. Discard data 2. Set bit 24 in Maintenance Label 354 3. Store event in BITE history 4. Continue output of all labels	Continue Execution

NOTES

1.When ground speed is 10kts or greater for 5 seconds, assume the vehicle is in flight for the purpose of these tests.

2.FMS/INS input ARINC data recognized by the GG12-Pro shall be tested for parity. ARINC Parity test is considered failed when 2 out of 3 consecutive data words have been received with bad parity. Data shall be discarded whenever bad data is received regardless of the filter. If fresh data is received that passes parity test Bit 24 of Label 354 shall be cleared.

Maintenance Words Format: Label 352 - Turn-on Test Status

Corresponding to each test, bit will change from zero to one in case of failure, as listed in Table D.3.

Table D.3 Turn-on Test Status

Bit	Corresponding Test(s)
11	1. Turn-On Program RAM CRC Test
12	2. Turn-On Data RAM Pattern Test
13	3. Turn-On Op-Code Check
14	4. Turn-On ROM CRC Test
15	5. Turn-On Bite Test I/O-1 NP TX #1 Wraparound Test 7. Turn-On IRS/FMS #1 Input Bus RX Test
16	Reserved
17	8. Turn-On Time Mark TX Test
18	Reserved
19	Reserved
20	Reserved
21	Reserved
22	Reserved
23	Reserved
24	Reserved
25	Reserved
26	Reserved
27	Reserved
28	Reserved
29	Reserved

Operational Test Status - Label 354

Corresponding to each test bit will change from a zero to a one in case of failure, as listed in Table D.4.

Table D.4 Operational Test Status

Bit	Corresponding Test(s)
11	10. Operational Prog. RAM CRC Test
12	11. Operational Prog. ROM CRC Test
13	12. Operational Op-Code Check
14	13. Operational Task Scheduler Monitor Test 18. Operational Foreground Task Check
15	14. Operational Background Monitor Test
16	15. Operational L1 ASIC 1 ms Counter Monitor 16. Operational Real-Time Execution Monitor 22. Operational Watch Dog Timer Monitor
17	Reserved
18	19. Operational Stack Overflow
19	20. Operational Internal Error Interrupt
20	21. Operational Tracking Performance Monitor
21	23. Operational Power Supply Undervoltage Monitor
22	24. Operational SDI Pin Change Monitor 25. Operational ARINC H/L Speed Select Monitor
23	26. Operational Antenna Short/Open detect Test
24	27. Operational ARINC Parity Test
25	Reserved
26	Reserved
27	Reserved
28	Reserved
29	Reserved

Fault Summary

Table D.5 summarizes fault reporting.

Table D.5 Label 355 - Fault Summary

Bits	Meaning	Range	Resolution
1 – 8	Label Number (Always '11101101')		
9 - 10	Source / Destination Identifier (SDI)		
11 - 17	Reserved	Always '0000000'	
18	IRS Bus #3 Status	0 – Active 1 – No Activity	
19	AUX Data Link #2 Bus Status	0 – Active 1 – No Activity	
20	AUX Data Link #1 Bus Status	0 – Active 1 – No Activity	
21	DADS Bus #2 Status	0 – Active 1 – No Activity	
22	DADS Bus #1 Status	0 – Active 1 – No Activity	
23	IRS Bus #2 Status	0 – Active 1 – No Activity	
24	IRS Bus #1 Status	0 – Active 1 – No Activity	
25	GNSS Status	0 – Normal Op 1 – Failed	
26	GNSS RF Interface Status	0 – Normal Op 1 – Failed	
27	GNSS Sensor Unit	0 – Normal Op 1 – Failed	
28	Bite Test Inhibit	0 – Normal Op 1 – Test Inhibit	
29	CFDS/CMC Command Wd Ack	0 – Acknowldge 1 – No Acknowledge	

Bits	Meaning	Range	Resolution
30-31	Status Matrix	00 – Normal Operation 01 – No Computed Data 10 – Functional Test 11 – Failure Warning	
32	Parity (Odd)		

Index

Numerics

A