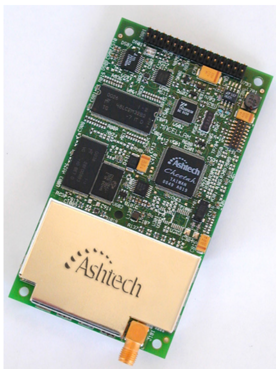
CP14
OEM Receiver
Reference Manual



CP14 Board

CP14 Sensor

Ashtech

Thales Navigation
471 El Camino Real
Santa Clara, CA USA 95050-4300

Phone and Fax Numbers

- **Main**
  - Voice: +1 408-615-5100
  - Fax: +1 408-615-5200
- **Sales**
  - US: 1-800-922-2401
  - International: +1 408-615-3970
  - Fax: +1 408-615-5200
- **In Europe (France)**
  - Tel: +33 2 28 09 38 00
  - Fax: +33 2 28 09 39 39
- **In South America**
  - Voice: +56 2 234 56 43
  - Fax: +56 2 234 56 47
- **Support**
  - US: 1 800-229-2400
  - International: +1 408-615-3980
  - Fax: +1 408-615-5200

Internet

- support@ashtech.com
- http://www.ashtech.com

Printed in the United States of America
Part Number: 630866, Revision A
February, 2002

Table of Contents

List of Figures

List of Tables

1

General Information

The CP14 GPS receiver processes signals from the Global Positioning System (GPS) satellite constellation to provide real-time position, velocity, and time measurements.

The CP14 uses fourteen discrete parallel channels for Coarse/Acquisition (C/A) code-phase (pseudo-range) measurements and carrier phase measurements on the L1 (1575.42 Mhz) band for the GPS.

The CP14 receives satellite signals through an L-band antenna and an external low-noise amplifier (LNA).

This chapter describes the CP14 hardware and functionality, describes the RF interface connector and the power/input/output connector, options, firmware upgrades, and power requirements and environmental specifications.

Table 1.1 summarizes performance specifications.

Table 1.1. CP14 Performance Specifications

<table>
<tr><th colspan="2">Position Accuracy</th></tr>
<tr><td>Horizontal CEP</td><td>40 cm</td></tr>
<tr><td>Horizontal (95%)</td><td>90 cm</td></tr>
<tr><td>Vertical (95%)</td><td>1.6 m</td></tr>
<tr><th colspan="2">Time to First Fix (TTFF)</th></tr>
<tr><td>Re-acquisition</td><td>3 seconds</td></tr>
<tr><td>Hot start</td><td>11 seconds</td></tr>
<tr><td>Warm start</td><td>35 seconds</td></tr>
<tr><td>Cold start</td><td>90 seconds</td></tr>
<tr><th colspan="2">Physical Specifications</th></tr>
<tr><td>Size</td><td>Board: 2.300” x 4.250” (± 0.005); 107.95 mm x 57 mm (± 0.13)
Sensor: 178 mm x 105 mm x 52 mm</td></tr>
<tr><td>Weight</td><td>Board: 2.8 oz
Sensor: 1 lb, 4 oz</td></tr>
<tr><td>Humidity</td><td>95% Non-condensing</td></tr>
<tr><td>Shock</td><td>RTCA DO-160C - op/crash safety:
• Operational — ± 40 G’s in the X, Y, or Z axis
• Non-operational — ± 75 G’s in the X, Y, or Z axis</td></tr>
<tr><td>Vibration</td><td>• MIL-STD-810E
  • Category 10: Minimum Integrity Test - General
• Sine Sweep:
  • 8.9 G’s
  • 5 to 200 Hz
  • 52 Hours/Axis</td></tr>
<tr><td>Acceleration</td><td>20 G</td></tr>
<tr><td>Maximum Speed</td><td>1,000 knots</td></tr>
<tr><td>Maximum Altitude</td><td>60,000 ft</td></tr>
</table>

Functional Description

Upon application of power, the CP14 runs a built-in self test of its internal memory, and thereafter periodically self-tests various functions during normal operation. Test results are stored for output on command. After self test, the CP14 initializes its battery-backed RAM. If the battery-backed RAM fails self-test (due, for example, to a low battery backup condition), the CP14 clears and reports the loss of stored data, then initializes its channels and begins searching for all satellites within the field of view of its antenna.

You can view the results of the start-up built-in diagnostics in the response from the **$PASHQ,HST** command (page 79). Results from the periodic operational diagnostics can be viewed in the results of the **$PASHQ,BIT** command (page 61).

The CP14 can track all GPS satellites as specified in the Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS-200, Revision B. All 32 satellite PRN (pseudo-random noise) code numbers are programmed into the CP14's firmware. There are active 24 satellites in the GPS constellation. As it acquires (locks on to) each satellite, the CP14 notes the time and collects almanac and ephemeris data for each orbiting satellite and stores this information in battery-backed memory.

- When tracking one satellite, the CP14 gets a time reference from that satellite's clock.
- When tracking three satellites, the CP14 computes and time-tags the horizontal position (2D) and velocity of its antenna. Input of an initial position estimate is not required. When it receives an appropriate command message from controller equipment through one of its serial communication ports, the CP14 sends the results of its computations to the designated port.
- With four locked satellites, the CP14 determines three-dimensional position and velocity. Stand-alone position accuracy is 2 meters Circular Error Probable (CEP) when Position Dilution of Precision (PDOP) is less than 4; velocity accuracy is 0.1 meter per second. Accuracy levels for position and velocity are subject to the US Government policy of Selective Availability (SA).

The CP14 can output single position/velocity, code-phase, and carrier phase independent measurements per second, with no interpolation or extrapolation from previous solutions. Position and velocity computations are performed simultaneously using all the satellites in view. The CP14 uses instantaneous doppler values from four satellites to compute dynamic speed, allowing velocity computations to be made independent of the last position fix. All measurements are referenced to the WGS-84 (World Geodetic System-1984) ellipsoid model.

The CP14 features 14-channel/14-Satellite All-In-View operation; each of up to 14 visible satellites can be assigned to a discrete channel for continuous tracking. Each satellite broadcasts almanac and ephemeris information every 30 seconds; this information is recorded in CP14 memory automatically.

Hardware Description

The CP14 is available as a board and as a sensor. From a functional point of view, the CP14 receiver consists of two major sections: The radio frequency (RF) section, and the digital section, where the signals from the GPS satellites are converted to digital format and processed.

Both the board and sensor versions of the CP14 have two RS-232 input/output (I/O) ports capable of two-way communication with external equipment, and a coaxial RF port for the antenna.

The RF port can accept GPS signals from the GPS antenna (page 23). The RF port also supplies power to the antenna/LNA through the cable, eliminating the necessity of a separate power cable for the antenna. Total power consumption (including the LNA) is approximately 2.0 watts for the board and 2.5 watts for the sensor.

Board Hardware Configuration

The CP14 board is the CP14 GPS receiver without the enclosure, back-up battery, or wide-range power supply. It requires a regulated input voltage of 5 VDC (±5%) or 3.3 VDC (±5%); typical power consumption is approximately 1.2 to 2.0 watts depending upon the configuration. User-entered parameters can be maintained in the CP14’s internal memory by connecting a 2.5- to 3.5-volt external battery to the appropriate pins on the J801 connector. The CP14 uses a standard SMA connector for RF input. Figure 1.1 shows the physical dimensions.

The 12- pin connector J101 on the side of the board is for factory use only.

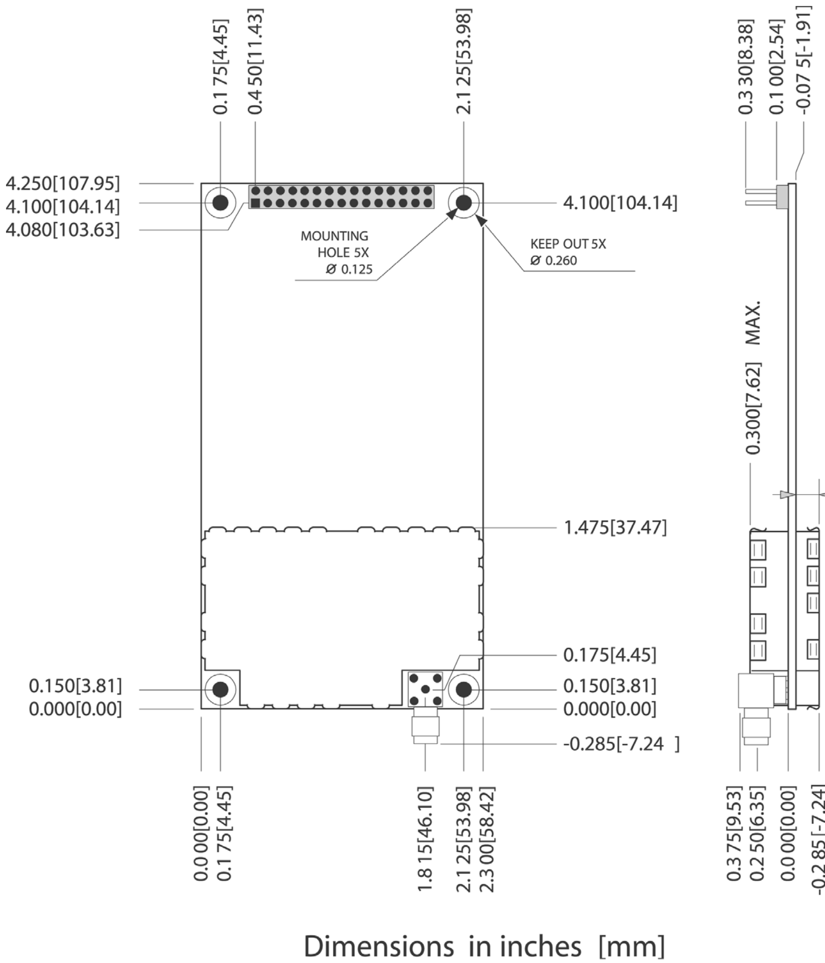


Figure 1.1. CP14 Board Dimensions—inches [mm]

Sensor Hardware Configuration

The CP14 sensor, Figure 1.2, contains the CP14 board, a wide-range power supply, and a back-up battery for internal memory, enclosed in a rugged aluminum enclosure. It can accept input voltage levels from 9 to 36 VDC, with typical power consumption approximately 2.2 watts.

Figure 1.2. CP14 Sensor

Status LEDs

The sensor has a status LED indicating GPS Status.

Board LEDs

The CP14 Board has a three-color LED on the board which indicates the status of the receiver. Upon power-up the status LED flashes red until a position has been computed. After computing a position, the status LED flashes yellow or green in between the red power status flash to indicate the status for each visible satellite.You can count the number of yellow or green flashes between the red flash to know the number of satellites visible in the sky. Table 1.2 indicates the color and status for the LED.

Table 1.2. CP14 Board LED Description

LED Color	Description
Long red flash (p sec)	CP14 is computing a position.
Short red flash (¼ sec)	CP14 lost the position computation.
Yellow Flash	Satellite is locked, but not used in position computation. No preamble found.
Short green flash (¼ sec)	Satellite is locked and available for position computation, but the ephemeris for the satellite has not been collected.
Long green flash (p sec)	Satellite and its ephemeris are available and used in the position computation.

The CP14 supports the use of external LEDs with the same features as the on-board

LEDs.

Sensor LED

The CP14 Sensor has a three-color LED on the front of the unit which indicates the status of the receiver. Upon power-up the status LED flashes red until a position has been computed. After computing a position, the status LED flashes yellow or green in between the red power status flash to indicate the status for each visible satellite.You can count the number of yellow or green flashes between the red flash to know the number of satellites visible in the sky. Table 1.3 indicates the color and status for the LED.

Table 1.3. CP14 Sensor LED Description

LED Color	Description
Long red flash (p sec)	CP14 is computing a position.
Short red flash (¼ sec)	CP14 lost the position computation.
Yellow flash	Satellite is locked, but not used in position computation.
Short green flash (¼ sec)	Satellite is locked and available for position computation, but the ephemeris for the satellite has not been collected.
Long green flash (p sec)	Satellite and its ephemeris are available for position computation. The satellite may or may not be used in the position computation.

Power Requirements and Connections

Table 1.4 defines the power requirements for the CP14 board and sensor.

Table 1.4. CP14 Board and Sensor Power Requirements

Requirement	Board	Sensor
Power supply	5 VDC regulated ± 5%	9 to 36 VDC Unregulated
Power consumption (typical)	1.2 watts GPS only 1.5 watts GPS + antenna/LNA	1.3 watts GPS only 1.7 watts GPS + antenna/LNA
Backup battery consumption (may vary with temperature)	• **5 μ watts typical, 50 μ watts maximum (external battery)** • **1μA (without input power applied)** • **0.3 μA (with input power applied)**	
External wiring	30 gauge or larger	

Power Consumption in Sleep Mode

The CP14 has a sleep mode in which the unit consumes significantly less power than in normal operation (about 7% of normal power for both 5 and 3.3 VDC). The sleep mode is particularly beneficial for operations which use batteries or solar panels for power. The **$PASHS,PWR** command sets the CP14 to sleep mode. The CP14 reactivates with serial activity or at designated times via session programming (page 105).

Power Connections

All power and input/output connections are made at the J801 connector for the board, and through the serial connector for the sensor. Attach the serial cable to the CP14 sensor, and then connect the power source to the serial cable.

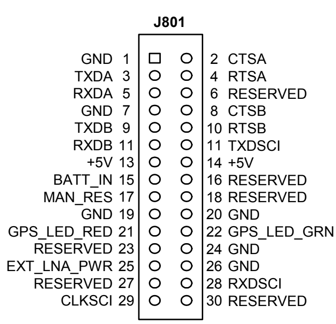
CAUTION

To avoid damage to the CP14 sensor, turn off the power source before connecting or disconnecting cables to or from the unit.

J801 is a 30-pin male dual inline 15 x 2 header connector. It provides a host of useful connections in addition to power and I/O, including a connection for an external LED, a connection for battery-backup for RAM maintenance, and an input for manual hardware reset. Figure 1.3 shows the J801 pin configuration and signal assignments.

CAUTION

To avoid damage to the CP14 board, ensure that pin 1 of the connecting cable is attached to pin 1 on J801 as indicated in the drawing.



- **If pin 15 (BATT_IN) is not used, connect to ground (GND)**
- **If pin 17 (MAN_RES*) is not used, leave open**
- **If pin 17 (MAN_RES*) is used, it can be pulled to ground (GND) using a switch, or driven to ground with an open-collector gate.**

Figure 1.3. J801 Pin Configuration and Signal Assignments

To save user-entered parameters between power cycles, connect the external battery to the corresponding input pins on J801 and set the SAV parameter to Y.

Table 1.5 lists the J801 signal descriptions.

Table 1.5. J801 Signal Descriptions

Pin	Code	Description
Pin	Code	Description
01	GND	Ground for serial Port A
02	CTSA	RS-232 Port A clear to send
03	TXDA	RS-232 Port A transmit data
04	RTSA	RS-232 Port A request to send
05	RXDA	RS-232 Port A receive data
06	Reserved	
07	GND	Ground for serial Port B
08	CTSB	RS-232 Port B clear to send
09	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	TXDSCI	Synchronous communication Interface transmit data
13	+5V	+5 VDC input
14	+5V	+5 VDC input
15	BATT_IN	2.5-3.6 volt battery backup for memory and real-time clock
16	Reserved	
17	MAN_RES	Connect to ground for manual hardware reset
18	Reserved	
19	GND	Chassis common ground
20	GND	Chassis common ground
21	GPS_LED_RED	External LED control output, GPS status red, (3.3 Volts through 100 Ω)
22	GPS_LED_GRN	External LED control output, GPS status green, (3.3 Volts through 100 Ω)
23	Reserved	
24	GND	Chassis common ground
25	EXT_LNA_PWR	+5 VDC input to external antenna LNA (use only on 3.3V versions)

Table 1.5. J801 Signal Descriptions(continued)

Pin	Code	Description
26	GND	Chassis common ground
27	Reserved	
28	RXDSCI	Synchronous communication interface receive data
29	CLKSCI	Synchronous communication interface clock
30	Reserved	

Backup Power

Power consumption on the backup battery is 5 µW (typical) and 50 µW (maximum) with the external power supplies. The acceptable battery backup voltage range is 2.5 to 3.5 VDC.

Interfaces to External Equipment

CP14 Board Interfaces

The main interface to the CP14 board is through the J801 connector, as shown in Figure 1.4.

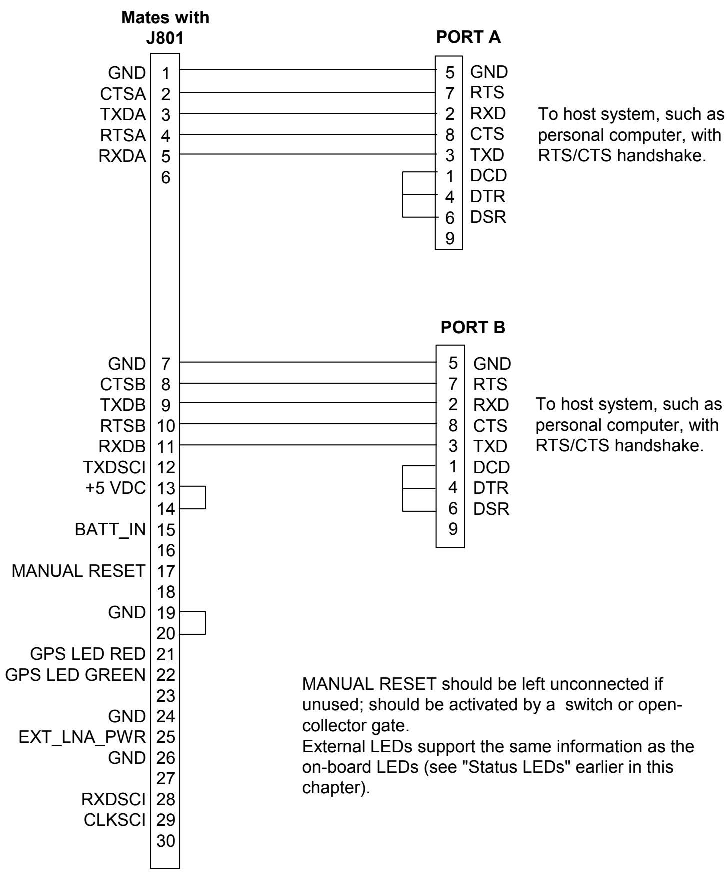


Figure 1.4. External Interfaces

CP14 Sensor Interfaces

The main interface to the CP14 sensor is through the serial connector on the front panel. Figure 1.5 shows the interface cable that plugs into the serial connector. Figure 1.6 shows the internal wiring for the interface cable.   .

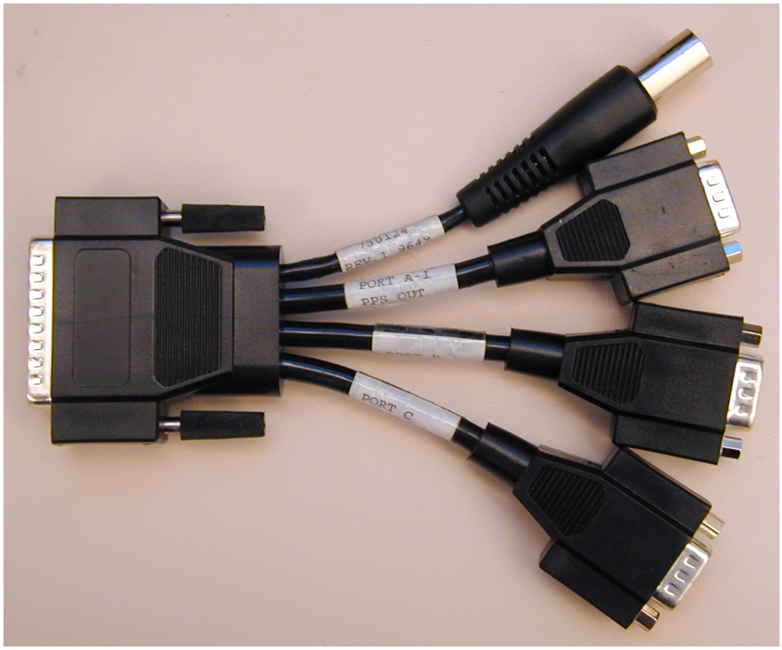


Figure 1.5. Interface Cable

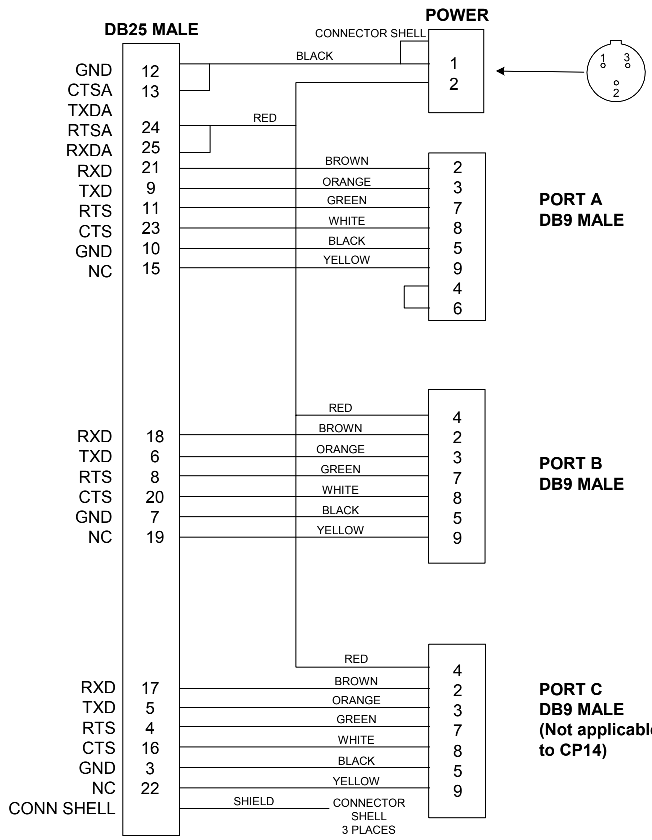


Figure 1.6. Internal Connections for Interface Cable

Radio Interference

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

Environmental Specifications

The operating temperature range of the CP14 is -30°C to +70°C; storage temperature range is -30°C to +85°C.

RF Connections

A 50-ohm coaxial cable connects the GPS antenna (with integrated LNA) to the CP14 RF connector. The CP14 can supply power to the LNA through the cable. All signals are received through the RF input.

The CP14 board's RF connector is a standard SMA female connector (TNC on the CP14 Sensor, see Figure 1.8). The SMA connector shell is connected to common ground on the CP14 board. The SMA center pin provides +4.8 VDC (to power the LNA) and accepts 1575 MHz RF input from the antenna; the RF and DC signals share the same path. The gain of the antenna LNA minus the loss of the cable is in between 20 and 30 dB.

CAUTION

The CP14 may be damaged if the RF connector center pin is not isolated from the DC ground. Use a DC block between the center pin and ground with the following characteristics:

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

Receiver Options

The CP14 has a few available options. The options that are set in the receiver determine which commands and features you can use.

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

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

where Table 1.6 defines the parameters.

Table 1.6. $PASHR,RIO Message Format

Field	Description
f1	Receiver name (maximum 10 characters)
f2	Main processor firmware version (maximum 10 characters)
f3	Channel firmware version (maximum 10 characters). If not applicable, this field is empty
f4	Option setting (maximum 42 characters). ASCII characters represent installed options. For option definitions, see Table 1.7
f5	Receiver serial number (maximum 20 characters). Underscores represent blank fields
cc	Checksum. XOR (exclusive or) of all characters between, but not including, the dollar sign ($) and asterisk (*) characters

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

Table 1.7 lists the options in the order in which they appear in the RIO response.

Table 1.7. CP14 Option Descriptions

Option	Description
[1 = 1 Hz]	Position/raw data update rate
[O]	Raw Data Output
[P]	Phase measurements

The following is a typical RIO response message:

$PASHR,RIO,CP14,GM00,,1OPBBBBBBBBBBBBBBB, 710029150420*4D:

Table 1.8 defines the parameters in this response message.

Table 1.8. Example RIO Response Message

Field	Description
$PASHR,RIO	Message header
CP14	Receiver type: CP14
GM00	Receiver firmware version
[empty field]	Channel firmware not available
$1OP_{BBBBBBBBBBBBBB}$	Options available: [1] 1 Hz position update rate [O] Raw data output [P] Carrier phase 15 underscores indicate options not applicable to CP14
710029150420	Receiver serial number
*4D	Checksum in hexadecimal

See Chapter 4, Command/Response Formats, for more information on the CP14 commands.

CAUTION!

Take the following precautions to avoid damaging your CP14 board:

1. Turn off power supply before connecting or disconnecting the I/O-power cable from the J801 connector.

2. Ensure that when connecting the I/O-power cable to connector J801, pin 1 is correctly oriented per Figure 1.1.

3. Connect pin 15 (BATT_IN) to ground if it is not being used. Leave pin 17 (MAN_RES) open if it is not being used.

4. Isolate the center pin on the CP14 antenna connector from DC ground. The DC block used between the center pin and DC ground should have the following characteristics:

- **1.15 maximum VSWR @ 1575 Mhz**
- **0.2 db maximum insertion loss**
- **5 VDC maximum**

5. Connect the RAM back-up battery to the appropriate pins on connector J801 and set the SAV parameter to Y.

Firmware Upgrades

CP14 firmware is stored in flash memory. New firmware may be loaded into the receiver through either serial port using a PC. Maintenance releases of firmware are available on a regular basis to fix known bugs and to implement new features.

When embedding the CP14 within another system, Thales Navigation recommends that external access to one of the receiver's serial ports be designed into the system for direct monitoring. For example, many system integrators use an internal data cable to connect one of the CP14 serial ports to an external DB9 connector.

CP14 Development Kits

There are two CP14 evaluation kits available for purchase:

- CP14 Sensor Development kit
- CP14 Board Development kit

These development kits are all-inclusive so you can fully test and identify the strengths of the CP14.

An important difference between the CP14 board and the CP14 sensor is the presence of a back-up battery for internal memory; the sensor has a back-up battery installed.

The CP14 Board Evaluation Kit, Figure 1.7, contains a CP14 board, an antenna, hardware accessories for power and interfacing, and software to communicate with the receiver and monitor its performance. A backup battery is in the 730096 connector.

Figure 1.7. CP14 Board Development Kit

The CP14 Sensor Development Kit, Figure 1.8, contains a CP14 receiver housed in an extruded aluminum enclosure, an antenna, hardware accessories for power and interfacing, and software to communicate with the receiver and monitor its performance.

The power and interface cable supplied with the Sensor Development Kit are used with other Thales Navigation products. Ports A and B are standard, port C is not usable with the CP14.

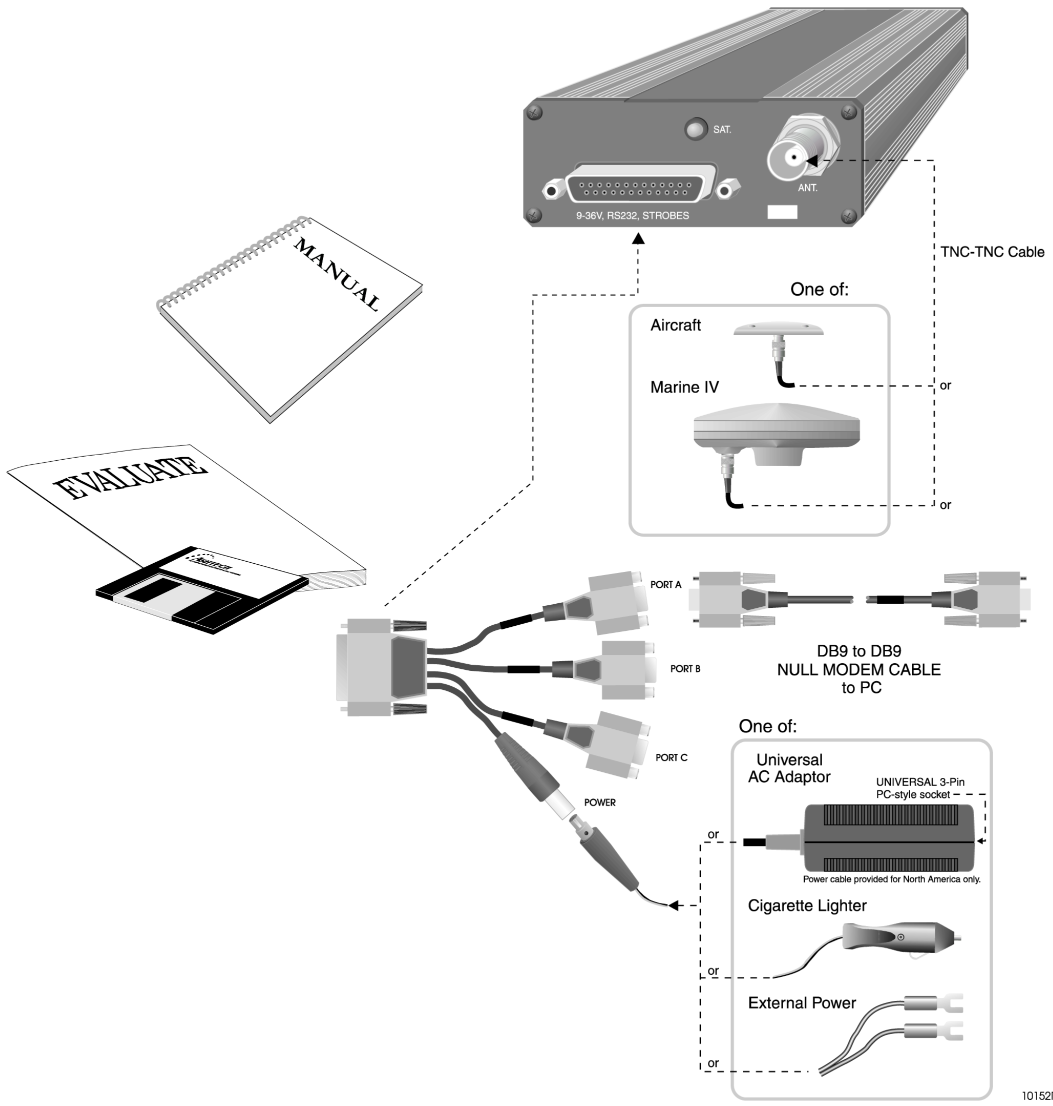


Figure 1.8. CP14 Sensor Development Kit

2

Getting Started

This chapter is intended to get you started using the CP14 receiver. Please see the chapters on General Information, Basic Operation, and Command/Response Formats for specific details regarding performance, power requirements, and commands.

This chapter discusses the following topics:

- Connecting the CP14 to power and the antenna
- Default parameters
- Communicating with the CP14 using standard communications software
- Sending common commands to the CP14

Connecting to the CP14

If you use equipment other than Thales Navigation-supplied with the CP14, it must comply with hardware specifications described on page 4.

Figure 2.1 shows how to connect the components in the CP14 Board system.

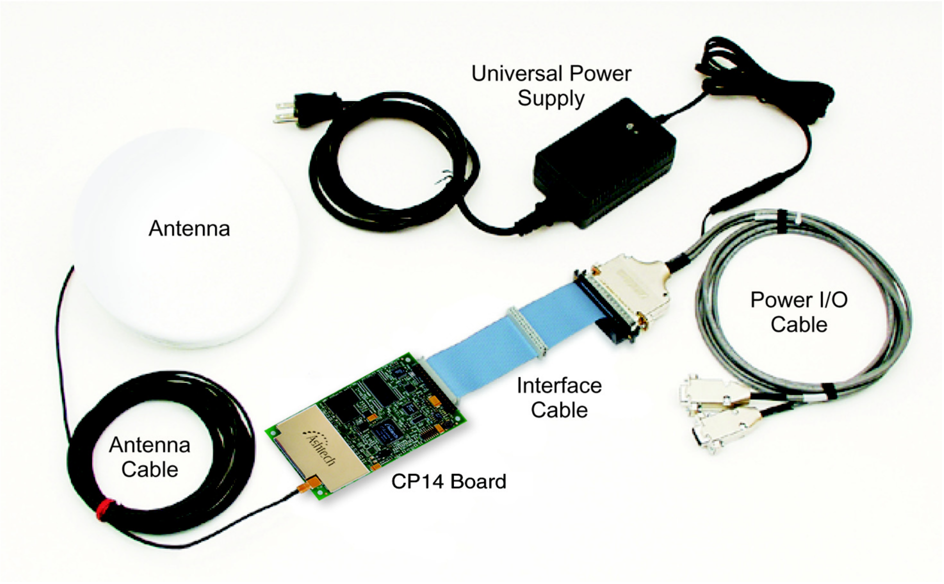


Figure 2.1. CP14 Board Connections

Power

CP14 Board

Before applying power to the CP14 board, connect any controller devices or data logging equipment to the input/output ports of the CP14 by way of connector J801.

CAUTION
To avoid damage to the CP14, always turn off the power supply before connecting or disconnecting power to the connector J801.

1. Connect the female plug on the power cable to the J801 male connector on the CP14.
2. Connect the power cable to the power supply.

   Once power is connected, the LED on the CP14 board flashes red.

When you apply power to the power input pins on connector J801, the CP14 starts operation.

When you remove power from the power input pins on connector J801, the CP14 stops operation.

Sensor

The power for the CP14 sensor connects through the serial connector on the unit.

CAUTION

To avoid damage to the CP14, always connect to cable to the CP14 Sensor before connecting the cable to the power source, and turn off the power supply before connecting or disconnecting power to the CP14.

1. Connect the serial cable to the serial port on the CP14.
2. Connect the power cable to the serial cable.
3. Connect the power cable to the power supply.

   Once power is connected, the LED on the CP14 flashes red.

Antenna

The CP14 is designed to work with an antenna Low-Noise Amplifier (LNA) that requires five volts and is isolated from DC ground. The gain of the antenna LNA minus the loss of the cable is between 20 and 30 dB. Table 2.1 defines the antenna requirements.

Table 2.1. Antenna Requirements

Requirement	Parameter
GPS Operational Band	1575 ±10 MHz
Polarization Type	Right hand circular
Axial Ratio	Less than 3 dB in zenith of up area
Antenna Gain for Elevation Angle of 10°	No less than -2.5 dB
Antenna gain for elevation Angle Greater than 15°	-1 to -2 dB
Antenna gain for elevation angle of 90°	~ +4 dB

Table 2.2 defines the antenna LNA requirements

Table 2.2. Antenna LNA Requirements

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

CAUTION

The CP14 may be damaged if the center pin of the SMA 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 at 1575 MHz**
- **Insertion loss 0.2 dB maximum**
- **Maximum applied voltage 5 VDC**

Connect the antenna cable directly to the antenna SMA connector on the CP14.

Once power is on and the antenna is connected, the CP14 acquires satellites (SVs or Space Vehicles) within the field of view of the antenna. As a channel in the CP14 locks on to a satellite, the LED flashes green or yellow between the red power flashes for every channel in use (i.e., locked satellites). See “Status LEDs” on page 6 for a description of the LED flashes.

Important Default Parameters

Communication Port Setup

Table 2.3 lists the default communication parameters of the CP14:

Table 2.3. CP14 Communication Parameters

Baud	Data Bits	Parity	Stop Bits
9600	8	None	One

When first establishing communications with the CP14, the communications interface must use this protocol.

Data Output Options

All the default data output commands are set to OFF. The CP14 does not output any data until you command it to do so.

Communicating with the CP14

After the CP14 is powered and running, you must send commands in order to receive data (such as antenna position). The following procedure describes how to send commands to and receive information from the CP14 using an IBM-compatible PC. You can interface with the CP14 using Evaluate Software™, RCS (Receiver Communication Software™), or standard communication programs such a ProComm or Hyperterminal. To begin, simply connect the standard 9-pin serial cable between port A on the CP14 and COM1 on the computer. When you are using other applications to communicate with the receiver, such as ProComm or HyperTerminal, verify that the <CR>/<LF> outgoing is enabled.

After setting up the interface for establishing communications with the CP14, you can send commands. The letters in the command can be typed in either UPPER or lower case. If you sent the command correctly, the CP14 responds.

The commands used with the CP14 are divided into two groups: set commands and query commands.

Use Set commands to change the CP14's operating parameters or turn on or off output messages. Set commands begin with the command string $PASHS.

Use Query commands to request information from the CP14, such as the current operating parameters, current position, or DGPS status. Query commands begin with the command string $PASHQ.

The CP14 responds to query and set commands by issuing an acknowledgement of a change in operating parameters or with the specific information requested through a query.

To become familiar with the CP14 messages, send a few common commands to the CP14 and observe the responses. In the following steps, command messages appear as COMMAND, and response messages appear as RESPONSE.

Chapters 5, 6, 7, and 8 contains details on these commands and responses, as well as the rest of the commands and responses supported by the CP14.

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

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

   This message indicates Port A of the CP14 is using its default communications setup 5: 9600 baud, eight data bits, no parity, and one stop bit.

   See “PRT: Serial Port Baud Rate” on page 97 for more information on this command.

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

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

   See “STA: Satellite Tracking Status” on page 109 for more information on this command.

3. If interfacing through port A, type **$PASHS,NME,POS,A,ON,1** and press **<Enter>**. This commands the CP14 to return comprehensive position information through port A at a set rate. The default rate for NME commands is once per second. The response message output rate is 1 HZ:

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

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

   See “POS: Position Message” on page 194 for more information on this command.

4. If interfacing through port A, type **$PASHS,NME,SAT,A,ON,1** and press **<Enter>**. This command tells the CP14 to return locked satellite information through port A at a set rate. The response message output rate is 1 Hz (default):

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

   The data string contains the number of satellites locked plus the elevation, azimuth, and signal strength for each locked satellite, and also indicates whether a given satellite is used (U) or not used (-).

   See “SAT: Comprehensive Satellite Tracking Data” on page 201 for more information on this command.

3

Basic Operation

This chapter covers a variety of CP14 operating parameters and options, including system setup, power-up, command format, serial port configuration, receiver settings and status, the satellite search algorithm, position modes, altitude hold definition, the ionospheric model, NMEA outputs, raw data outputs, and other options.

Message Formats

The CP14's two RS-232 ports, A and B, can receive command messages from an external control device, send response messages to an external control device (such as a PC), and output data to a separate data logging device.

CP14 Input Messages

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

- NMEA 0183 ASCII byte strings following a dollar sign ($) character
- Data fields are separated by commas
- Checksum character delimiter and NMEA checksum bytes are recognized by the CP14 but are optional. The hexadecimal checksum is computed by exclusive OR-ing all of the bytes in the message between, but not including, the dollar sign ($) and the asterisk (*).
- Messages end with the standard NMEA message terminator characters, [CRLF] (carriage return/line feed).

Input messages deviate from the NMEA standard as follows:

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

All command messages—set or query—can be composed in uppercase or lowercase characters. All command messages are sent by pressing **<Enter>**. A valid set command causes the CP14 to return the **$PASHR,ACK*3D** (acknowledge) response message. A set command containing a valid $PASHS header followed by character combinations unrecognized by the CP14 causes the receiver to respond with **$PASHR,NAK*30**, a “not acknowledge” response message indicating that the command is invalid. Valid query and messages are acknowledged by return of the requested information. All invalid query and general commands cause the CP14 to return the **$PASHR,NAK*30** “not acknowledged” response message.

CP14 Message Output

The CP14 can be programmed to send data to another device. Output messages include general receiver status messages, ACK/NAK messages, and GPS data messages. The general receiver status messages have free-form Ashtech formats. The acknowledged/not acknowledged messages and GPS data messages comply with NMEA 0183 standards as follows:

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

Serial Port Configuration

The CP14 receiver has two RS-232 serial ports that support two-way, full-duplex communication. The default protocol for transmitting or receiving data is 9600 baud, eight data bits, no parity, and one stop bit (8N1). The baud rate of the CP14 ports is adjustable using the **$PASHS,SPD** speed set command; the data bit, stop bit and parity protocol is always 8N1.

DEFAULT SETTINGS
The default parameters for the CP14 serial ports A and B: **•Baud Rate— 9600** **•Data Bits— 8** **•Stop Bits— 1** **•Parity— None**

On initial power-up, or after issuing the **$PASHS,INI** (receiver initialization) command or the **$PASHS,RST** (restore defaults) command, the default data rate is 9600 baud for both standardized CP14 serial ports. Both are capable to 115,200 baud for data transfer.

The baud rates must be the same between the CP14 serial port and the serial port on the device with which it is interfaced.

To maintain communication with the CP14 while changing the baud rate, issue the **$PASHS,SPD** (set port speed) to change the baud rate of the CP14 port, then change the baud rate of the command device to match the new baud rate setting on the CP14 port.

Session Programming

With the Session Programming feature, you can pre-set up to 10 observation sessions in the receiver. You can program the receiver to wake-up at a specified time and preform specified tasks such as output position and velocity data. In addition, you can set a session time offset that shifts the session start and end times by a predetermined amount every day.

Session programming can also be used to put the receiver into sleep mode. When the receiver is in sleep mode, most of the receiver functions are suspended which conserves power. Using preset session start times, the CP14 automatically wakes up in time to perform specified tasks for the next session and returns to sleep when the session is complete.

Session programming is enabled by the **$PASHS,SES** command. You must enable the individual sessions and set session parameters such as the start/stop times, recording interval, elevation mask, minimum number of satellites, and the data type for each session.

In addition, you need to set the mode (session in use switch), the session reference day, and the desired session offset. The mode is either Yes, No, or Sleep. If the mode is set to No, then session programming is disabled. If the mode is set to Yes, then session programming is enabled, and any enabled individual sessions are activated. if the mode is set to Sleep, then the receiver goes into sleep mode, once an activated session has completed. and the CP14 wakes just prior to the next session.

The session reference day is a mandatory parameter that determines both the start day of session programming data collection and is used in conjunction with the Offset to determine the session start and end times. The reference day must be set equal to or earlier than the current day, or else the sessions will not run. If the reference day is later than the current day, then the session start and end times decrement by the offset multiplied by the numbers of days between the current day and the reference day. For example, suppose you wish to collect data everyday for seven days observing the identical satellite window on each day. Since the GPS window moves backwards four minutes per day, set the offset to 0400 and set the reference day equal to the current day. For each subsequent day of data collection, all sessions will start and end four minutes earlier than the previous day. By the seventh day the sessions will start and end 28 minutes earlier than on day 1.

Daisy-Chain Mode

The Daisy-Chain mode establishes a communication link through the GPS receiver, between a PC or handheld and a peripheral device. When the GPS receiver is in Daisy-Chain mode, all commands entering one serial port are passed out through another serial port. The commands are not interpreted by the CP14. Use the **$PASHS,DSY** command to enable the Daisy-Chain mode and assign which serial ports to use.

A typical example of the use of Daisy-Chain mode is communicating with a radio through a handheld. The radio and handheld are not directly connected, but both are connected to the CP14 via separate serial ports. By enabling the Daisy-Chain mode between the two serial ports used by the handheld and radio, the handheld can communicate with the radio through the CP14.

For more information on the Daisy-Chain command, see ”DSY: Daisy Chain Communications Mode” on page 65.

Satellite Tracking

When the CP14 is powered on for the first time, or when the power and back-up battery have been disconnected, there is no almanac or ephemeris data in memory. In these cases, the CP14 assigns the first 12 elements of a 32-element table of SV PRN numbers to its 12 channels as it begins searching for satellites. If no ephemeris data are in memory, or if the data are older than ten hours, 30 to 60 seconds are needed to collect data. The CP14 synchronizes its clock to GPS time within six seconds of locking a satellite. After three or four satellites are locked and the almanac and ephemeris data are collected, the CP14 computes its first position. The CP14 continuously updates almanac, ephemeris, and position data in its battery-backed memory to help optimize satellite acquisition 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 CP14 restricts its satellite search to those satellites that should be visible based on this information. Under these conditions, the CP14 on average recomputes position in 10 to 15 seconds (hot start). If the almanac and ephemeris data are available in battery-backed memory, but the ephemeris data are more than ten hours old, the CP14 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 CP14 computes position in 60 to 90 seconds on average (cold start).

Parameter Settings and Status

On initial power-up or after issuing the **$PASHS,RST** (restore defaults) command, the CP14 reverts to its default parameter settings. The following three commands to query the CP14 for the current parameter status:

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

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

```
SPDA:5 SPDB:5 SPDC:5
GPS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
SYS:GPS DTM:W84 TDP:04
PMD:1 FIX:0 ALT:+00000.00 PDP:40 HDP:04 VDP:04 ERM:600,1200,30,60
PEM:05 SEM:OFF UNH:N ION:Y TRO:Y SAV:N
RTC:OFF PRT:A
SBA:SAM
NMEA: LTN POS GLL GXP GGA VTG GSN GSA GSV SAT GRS RRE ZDA GST GNS CRT GDC UTM
  UKO SUD DTM ALM
PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
  OFF OFF OFF OFF OFF OFF OFF OFF OFF
PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
  OFF OFF OFF OFF OFFOFF OFF OFF OFF
PER:001.00
```

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

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

```
RCI:020.00 MSV:3 ELM:05 SIT:????
RAW: MCA MBN PBN MIS XYZ DIF MSB GGB MCM CMB CT1 CT2 CT3 SNV SAL SNG SAG SNW SAW
PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
  OFF
PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
  OFF
```

Saving Parameter Settings

New parameter settings can be saved by issuing the set command, **$PASHS,SAV,Y**. You can verify that new settings are in effect by issuing query commands to prompt the CP14 for its current status. After the next power-up, the query response messages display the new settings instead of the default parameters. Issue the command **$PASHS,RST** to restore the default settings. If the SAV command is not entered, the new settings will be lost, and the default settings restored at the next power cycle.

Watchdog Timer

The CP14 has a watchdog timer. If the processor hangs up for any reason, the watchdog timer resets the receiver. On reset, the receiver uses the parameters most recently saved during the startup. If parameter settings were not saved, the receiver uses the default settings at startup.

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

Position and Navigation Modes

The CP14 can perform position computations and navigation solutions in several position modes and eight dynamic modes.

Position Modes (Least Squares Algorithm)

Use the **$PASHS,PMD** command allows you to set the position mode. See “PMD: Position Mode” section on page 94 for more information.

- Position Mode 0

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

- **Position Mode 1 (Default)**

  At least three satellites with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and the longitude are computed if three satellites are locked and the altitude is held fixed. For more information on fixed altitude modes, see ”Fixed Altitude Modes” on page 37. The receiver stops computing positions if the number of satellites tracked falls below three. All three polar coordinates are computed if more than three satellites are locked.

- **Position Mode 2**

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

- **Position Mode 3**

  At least three satellites with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and longitude are computed, and the altitude is held if only three satellites are locked. If more than three satellites are used and the HDOP is less than the specified HDOP mask, all three polar components are computed. If HDOP is higher than the specified HDOP mask, the CP14 automatically goes into the altitude hold mode. The receiver stops computing positions if the number of satellites tracked falls below three.

DEFAULT SETTINGS
$PASHS,PMD— Position Mode 1

Position Modes (Kalman Filter Algorithm)

The CP14 can operate in one of two position modes using the Kalman Filter Algorithm: 3D and 2D.

- Mode 0: 3D

3D mode is the standard and default mode of operation for the CP14. In 3D mode, four locked satellites are required to compute the initial position. After the initial fix, the CP14 can maintain operation regardless of the number of satellites tracked. When the number of tracked satellites drops to zero, the CP14 can maintain navigation operation depending on the Kalman filter prediction algorithm; this is the prediction mode. You can choose whether or not the CP14 operates in prediction mode. Position fixes obtained during the prediction mode are flagged “predicted” in GGA and other NMEA messages containing position information, regardless if the receiver is in stand-alone mode.

In the **$PASHS,KFP,PRI** command, you can set the maximum allowable length of time for the CP14 to operate in Prediction Mode (Prediction Interval).

The default interval for prediction mode is 10 seconds. After the prediction mode has timed-out, the CP14 needs at least four satellites in 3-D mode, and 3 satellites in 2-D mode, to reset its Kalman filter and resume positioning using the reference altitude set in the **$PASHS,FIX** command.

In addition, you can set the receiver to not computea position if the number of satellites used in the solution is less than a set number using **$PASHS,PMD** command.

If you have set the CP14 to Static KF mode and only 1 satellite is available, the position is still not considered predicted because Kalman filter, in this case, is nothing but sequential least squares. Altitude remains constant for the entire prediction interval.

If you set PMD to 1 or 3 (adaptive 2-D mode), the Kalman filter changes from 3-D to 2-D mode if the number of satellites drops below 4., and then the Kalman filter behaves as if PMD was set to 2. The Kalman filter does not reset when it changes from 2-D to 3-D mode.

The Kalman filter automatically resets when either the error mask is exceeded or if the prediction interval is longer than the set maximum interval value.

After the first set of four or more measurements is received after a total-satellite-outage period, the CP14:

- continues operation and uses the received measurements to update the running Kalman filter, if the Prediction Mode was ON
- resets the Kalman filter with the received measurements and resumes operation similar to a hot start.

- Mode 2: 2D

In 2D mode, the CP14 can only calculate latitude, longitude, and time; the altitude is held constant. Use the **$PASHS,ALT** and **$PASHS,FIX** commands to set the altitude.

When FIX is set to 1, the 2D altitude is the altitude entered using the **$PASHS,ALT** command. When FIX is set to 0, the altitude is the most recently determined altitude, which can be either that entered using the **$PASHS,ALT** command, or the altitude from the last computed height value computed when VDOP was less than VDOP mask.

The CP14 requires at least three satellites to be locked for the initial 2D position fix. After the initial fix, there is no required number of locked satellites. The CP14 continues to operate making use of the locked satellites, propagating its internal solution and reporting the predicted position until ERM or any other user set mask exceeds the set value.

You can use the **$PASHS,KFP,ON** command to enable the Kalman filter for prediction. Position fixes obtained during the prediction mode are flagged “predicted” in GGA messages.

If you set PMD to 2 (continuous 2-D mode), the Kalman filter is only initialized with the reference altitude, for all the next epochs the Kalman filter updates the position in correspondence with the current dynamic model and the parameters for this model (maximum velocity and acceleration) for the vertical direction should be ten times less than nominally.

If you have set the CP14 to Static KF mode and only 1 satellite is available, the position is still not considered predicted because Kalman filter, in this case, is nothing but sequential least squares.

In the **$PASHS,KFP,PRI** command, you can set the maximum allowable length of time for the CP14 to operate in Prediction Mode (Prediction Interval). The default for prediction mode is OFF and the default prediction interval is 10 seconds. After the prediction mode has timed-out, the CP14 needs at least four satellites to reset its Kalman filter and resume positioning.

In Prediction Mode, the calculation and output of all standard position and velocity components are maintained. The CP14 continues to operate in prediction mode until one of the user set masks exceeds its set limit; namely ERM and Prediction Interval.

Navigation Solutions

The CP14 can compute a navigation solution using either a least-squares or Kalman filter method. Use the **$PASHS,KFP,ON/OFF** command to select the navigation solution. Unless you set the CP14, the performance requirements shall apply equally, irrespective of the selected navigation solution.

The CP14 uses statistical testing algorithms to allow for fault detection and isolation in both least squares and Kalman filter modes. In Kalman filter, fault detection may be provided using standard f-test and w-test. You can select either a 2s (95%) or 3s (99%) threshold so that measurements with estimated errors outside this threshold are rejected. Upon exceeding such thresholds, the measurements are excluded from the navigation solution.

Anytime a position is computed and not reported through a serial port, the CP14 indicates this with warning flags. For example, if the position exceeds the ERM setting or PDOP setting, a warning flag indicates MASK EXCEEDED.

Dynamic Modes

You can specify the dynamic mode for the receiver using the **$PASHS,DYN,d1** command. The navigation solution uses expected dynamics for a given solution. Table 3.1 defines the CP14 dynamics modes.

Table 3.1. Dynamic Modes

Dynamic Mode	Description	Maximum Horizontal Velocity (m/s)	Maximum Vertical Velocity (m/s)	Maximum Horizontal Acceleration (m/s^2)	Maximum Vertical Acceleration (m/s^2)
1	Static	0	0	0	0
2	Quasi-Static *	0.1	0.02	0.1	0.02
3	Walking	2	0.5	1	0.5
4	Ship	20	1	1	0.5
5	Automobile	50	3	10	1.0
6	Aircraft	400	60	20	10
7	Unlimited	1000	1000	100	100
8	Adaptive Dynamic **	N/A	N/A	N/A	N/A

* Quasi-Static represents a static condition with some tolerance for slight movements within a decimeter or two. An example would be an antenna on a handheld pole or on the back of a person; obviously a person can try to be static but will inevitably move within a decimeter or two. This is unlike “Static” mode where the antenna is placed on a tripod or any other stationery structure with zero tolerance for actual movement.

*”Adaptive Dynamic adapts the filter dynamics settings to any of the modes 2 through 7 in real time allowing the switch from one mode to the other based on the witnessed behavior. Use one of the standard Adaptive filtering algorithms that monitor covariance behavior to determine dynamics model to use.

If you set the Dynamic mode to Static and enable the Kalman filter mode for the navigation solution (**$PASHS,KFP,ON)**, then the velocity values output by the receiver are always zero for both ground speed and vertical velocity.

If you want to determine the appropriate model for your application, choose the Adaptive Dynamic mode. If you select Mode 1 through 7, the CP14 will not accommodate the other dynamic modes. Adaptive Dynamic mode can never be static; under good, open sky, static conditions, the Kalman filter automatically changes to Quasi-Static mode.

DEFAULT SETTINGS
$PASHS,DYN— Adaptive Dynamic (8)

Fixed Altitude Modes

Two modes define the altitude setting when the CP14 is in altitude hold mode. The **$PASHS,FIX** set command can be used to select between these modes. See “FIX: Fixed Altitude Mode” section on page 74 for more information.

- Fixed Altitude Mode 0

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

- Fixed Altitude Mode 1

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

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

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

Point Positioning

The Point Positioning option improves the accuracy of a stand-alone absolute position of a stationary receiver from about 5 meters to less than one meter over a period of four hours, and can typically get down to the couple of meters level after ten hours. Point positioning uses an averaging technique to reduce the effects of Selective Availability (SA) and other fluctuating errors. You can set the Point Positioning mode with the $PASHS,PPO command (page 96). The Point Positioning option [T] must be set in the receiver for this command to work.

Geoid Model

The CP14 uses the Ohio State University 91A geoid model (OSU91A). For more information on OSU91A, refer to the Ohio State University:

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

The Ohio State University

Department of Civil and Environmental Engineering and Geodetic Science
470 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210   USA

Tel: 614-292-2771

Fax: 614-292-3780

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

Ionospheric Model

The CP14 can use ionospheric and tropospheric models in its position computations to compensate for errors caused by ionospheric and tropospheric delay when needed. This mode of operation is typically used to improve autonomous accuracy by minimizing the influence of the ionosphere and troposphere on the code phase of the GPS signal.

The ionospheric model used by the CP14 is based on the model defined in ICD-GPS-200, Revision B. The tropospheric model is based on the Bean and Dutton model. For more information on ICD-GPS-200, refer to ARINC Research Corporation:

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

Tel: 310-524-1557

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

Magnetic Variation Model

The CP14 uses the Joint US/UK 1995 Epoch World Magnetic Model (WMM-95). For more information on WMM-95, refer to the USGS National Geomagnetic Information Center:

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

Tel: 303-273-8475

Fax: 303-273-8450

Web: http://geomag.usgs.gov

NMEA Outputs

The CP14 can output a variety of NMEA messages and Ashtech-format NMEA-style messages. Standard NMEA messages are output as a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards (version 3.0). Ashtech-format NMEA-style messages are also output in a comma-delimited string of ASCII characters, but may deviate slightly from NMEA standards. For example, the maximum length of a standard NMEA message is eighty characters, but the length of some Ashtech-format messages goes beyond eighty characters.

Both NMEA messages and Ashtech-format NMEA-style messages begin with a dollar sign ($) and end with a carriage return/line feed <CR><LF> delimiter.

Any combination of these messages can be output through either serial port at the same time, and you can even choose to send the same message to output through both ports. The output rate is determined by the **$PASHS,NME,PER** command, and can be set to any value between 0.05 and 999 seconds depending upon the update rate option installed (20, 10, 5, 2 or 1 Hz). For more information see Chapter 7, NMEA Commands.

The default setting for the output interval is one second. See Chapter 4, Command/ Response Formats, for more information on NMEA messages and Ashtech-format NMEA-style messages.

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

Raw Data Output

The CP14 has a standard feature that allows you to output raw data (also called real-time data) through serial ports A and B. Five different messages can be output:

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

All raw data messages are in binary format. The transmission protocol remains the same: 8 data bits, 1 stop bit, and no parity bit. Any combination of messages can be output through any of the serial ports, and the same messages can be output through different ports at the same time. The output interval is determined by the **$PASHS,RCI** command, and can be set to any rate between 0.05 and 999 seconds depending upon which option has been selected for the raw measurement update rate (20, 10, 5, 2, or 1 Hz). Only 1 Hz update rate is available for CP14. For more information on the structure and content of the above messages, see Chapter 6, Raw Data Commands.

DEFAULT SETTINGS
Output interval setting for raw data messages is 1 second.

Jam Immunity

The CP14 provides jam immunity against in-band and out-of-band interference.

For in-band interference, the CP14 can suppress in-band jamming signals while maintaining signal tracking, horizontal accuracy and acquisition time requirements. You can set the in-band jam immunity with the **$PASHS,AJM,ON/OFF** command (default is OFF).

Out-of-band jam immunity is available all the time with no special settings required.

Datums

The receiver normally computes and outputs positions in the WGS-84 coordinate reference frame. However, it is possible to output positions in NMEA messages in a number of different pre-defined datums, as well as in a user-defined datum.

To set the receiver to output positions in a different datum, use the **$PASHS,DTM** command. Once set to a different datum, then all position outputs in NMEA messages such as GGA and GLL and the position are referenced to the chosen datum. For a list of datums, see Table 5.12, “Predefined Datums and Associated Reference Ellipsoids,” on page 66.

If the list of datums does not include a datum of interest to the user, a user-defined datum may be created and supplied to the receiver. This is done using the command **$PASHS,UDD** command along with the **$PASHS,DTM** command. Prior to using these commands, the user must first define the required parameters including the length of the semi-major axis and amount of flattening in the reference ellipsoid, and the translation, rotation, and scale between the user-defined system and WGS-84.

After issuing the $PASHS,DTM,USR command, the receiver internally transforms positions *from* the reference datum (WGS-84) *to* the user-defined datum. In standard text books, however, the datum transformations are given *from* local datums *to* WGS-84. To simplify entering the transformation

parameters, the translation, rotation, and scale parameters are defined *from* the local datum *to* WGS-84.

To use this datum for the position computation and measurements, use the $PASHS,DTM,USR command after defining the datum parameters.

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

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

where $\varepsilon_{rx} = \varepsilon_x$ expressed in radians, similarly for ε_{ry} and ε_{rz}.

Example: Define local datum as the WGS-72 datum

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

`$PASHS,DTM,USR`

This implements the transformations listed in Table 3.2 and below in the following equation:

Table 3.2. Ellipsoid Parameters for WGS-72 and WGS-84

Datum	Reference Ellipsoid	a[m]	1/f
WGS-72	WGS-72	6378135.0	298.26
WGS-84	WGS-84	6378137.0	298.257223563

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

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

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

Internally, the receiver implements the transformation *from* WGS-84 *to* WGS-72. Figure 3.1 demonstrates the change in the coordinate systems.

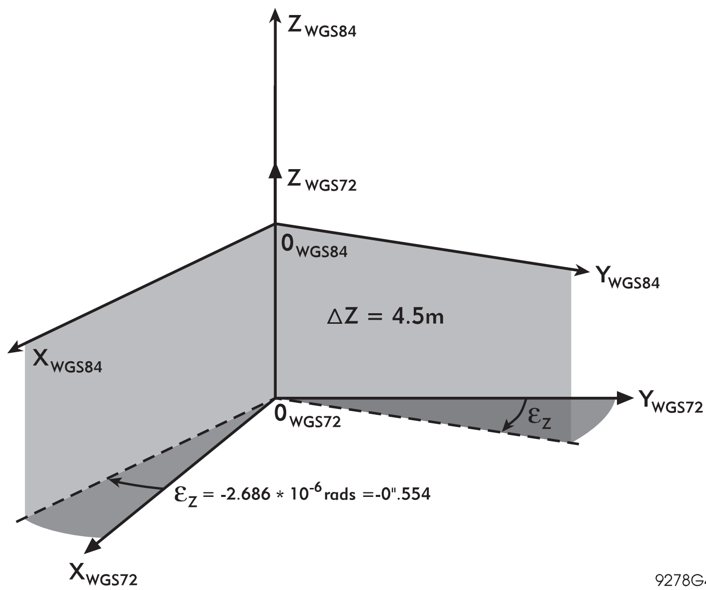


Figure 3.1. Rotation and Translation Between Coordinate Systems

4

Coordinate Transformation

This chapter discusses the coordinate transformation features of your receiver.

Background

GPS determines the three-dimensional positions of surveyed points based on the WGS-84 datum. These coordinates are either presented as geocentric Cartesian coordinates (X,Y,Z) values or geodetic coordinates (latitude, longitude, ellipsoidal height).

There are circumstances where it would be desirable to have positions represented in a different reference frame or format, i.e. based on a different datum or projected onto a plane (grid coordinates).

The CP14 provides the following on-board tools to transform WGS-84 coordinates into various formats and reference frames:

1. Datum-to-Datum transformation

   Using this feature, WGS-84 coordinates can be transformed into coordinates based on another datum.

2. Datum-to-Grid conversion

   With this tool, a grid system can be defined to convert geodetic coordinates into grid coordinates.

3. Elevation Modeling

   Using an on-board geoid model, ellipsoidal heights can be transformed into orthometric heights using this capability.

Table 4.1 provides an overview of user coordinate transformation functions for your receiver.

Table 4.1. User Coordinate Transformation Functionalities

Transformation	Description
Datum to Datum	3D (7-parameter) datum transformation between two Cartesian XYZ systems associated with the WGS-84 datum and local datum defined by the user.
Datum to Grid	Data projected from a geodetic system, associated with WGS-84 or a user-defined datum and a specified grid system. Map Projections Supported • Mercator (EMER) • Transverse Mercator (TM83) • Oblique Mercator (OM83) • Stereographic (Polar and Oblique) (STER) • Lambert Conformal Conic (2 standard parallels) (LC83) Special Map Projections Specific to NAD27 • Transverse Mercator 27 (TM27 and TMA7) • Oblique Mercator 27 (OM83) • Lambert Conformal Conic 27 (LC27)
Elevation Modeling	Interpolation of geoidal undulations

The remainder of this chapter describes in more detail the coordinate transformation features of your receiver.

Datum to Datum

The receiver normally computes and outputs positions in the WGS-84 coordinate reference frame. However, it is possible to output positions in NMEA messages in a number of different pre-defined datums, as well as in a user-defined datum.

To set the receiver to output positions in a different datum, use the **$PASHS,DTM** command. Once set to a different datum, then all position outputs in NMEA messages such as GGA and GLL are referenced to the chosen datum. For a list of datums, see Table 5.12, “Predefined Datums and Associated Reference Ellipsoids,” on page 66.

If the list of datums does not include a datum of interest to you, you can define a datum and load it on the receiver, using the **$PASHS,UDD** command along with the **$PASHS,DTM** command. Prior to using these commands, define the required parameters including the length of the semi-major axis and amount of flattening in the reference ellipsoid, and the translation, rotation, and scale between the user-defined system and WGS-84.

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

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

where $e_{rx} = e_x$ expressed in radians, similarly for e_{ry} and e_{rz}.

Example: Define local datum as the WGS-72 datum

Send the following commands to the receiver:

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

$PASHS,DTM,UDD

This implements the transformations listed in Table 4.2 and below.

Table 4.2. Ellipsoid Parameters for WGS-72 and WGS-84

Datum	Reference Ellipsoid	a[m]	1/f
WGS-72	WGS-72	6378135.0	298.26
WGS-84	WGS-84	6378137.0	298.257223563

$\Delta x = \Delta y = 0$

$\Delta z = 4.5$ meters

$m = 0.23 \times 10^{-6}$

$\varepsilon_x = \varepsilon_y = 0$

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

in the following equation:

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

After issuing the **$PASHS,DTM,UDD** command, the receiver internally transforms positions ***from*** the reference datum (WGS-84) ***to*** the user-defined datum. In standard text books, however, the datum transformations are given ***from*** local datums ***to*** WGS-84. To simplify entering the transformation parameters, the translation, rotation, and scale parameters are defined ***from*** the local datum ***to*** WGS-84.

Figure 4.1 illustrates the change in the coordinate systems.

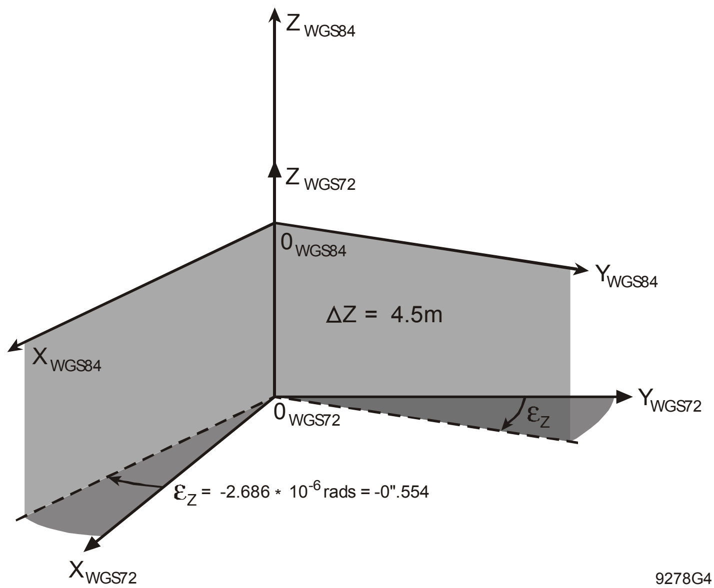


Figure 4.1. Rotation and Translation Between Coordinate Systems

After transforming the datum, the receiver computes geodetic coordinates in the defined system. All coordinates output by the receiver are in this new system.

Do not forget to issue the $PASHS,DTM,UDD command after defining the transformation parameters with the $PASHS,UDD command. Otherwise, the newly entered parameters are not used.

Datum to Grid

Use this transformation to generate coordinates in an <x,y> rectangular system, based on the user's location and mapping requirements or local standard. The user may select any projection along with any base datum for output.

Convert geodetic coordinates into grid coordinates by defining a grid system utilizing one of the supported projection types (Figures 5.2 - 5.6).

CAUTION
Although almost any projection or combination of datums and projections is mathematically possible, some are inappropriate with respect to the project scope or geographic area.

To set the receiver to supply grid coordinates:

1. Select the projection type that best fits your needs.
2. Define the grid system, using this projection type, with the **$PASHS,UDG** command. This command defines the grid system to be used.
3. Enable the grid system with the **$PASHS,GRD,UDG** command. The receiver computes grid coordinates in the system defined.
4. To access the grid coordinates, use either the **$PASHQ,GDC** command to query for one output of the current coordinates, or use the **$PASHS,NME,GDC** command to set the receiver to continuously output the current coordinates.

There is one exception when configuring the receiver to compute and output grid coordinates. If you are interested in computing and outputting WGS-84-based UTM coordinates, there is no need to define the grid system in the receiver. The parameters for WGS-84 UTM are pre-set in the receiver. To use them, set the receiver to output grid coordinates using either the **$PASHQ,UTM** command to query for one output of the current coordinates, or the **$PASHS,NME,UTM** command to set the receiver to continuously output the current coordinates.

Check the GDC message for the currently assigned datum.

Projection Types

The following graphics represent the different types of projections available for the receiver.

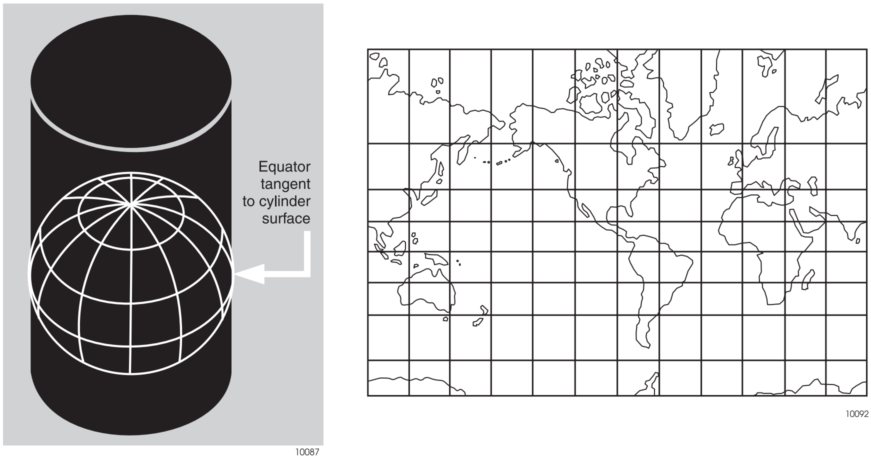


Figure 4.2. Mercator

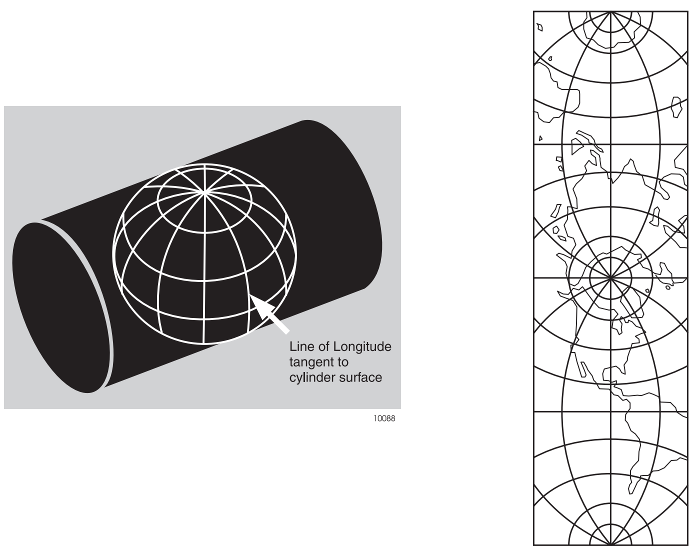


Figure 4.3. Transverse Mercator

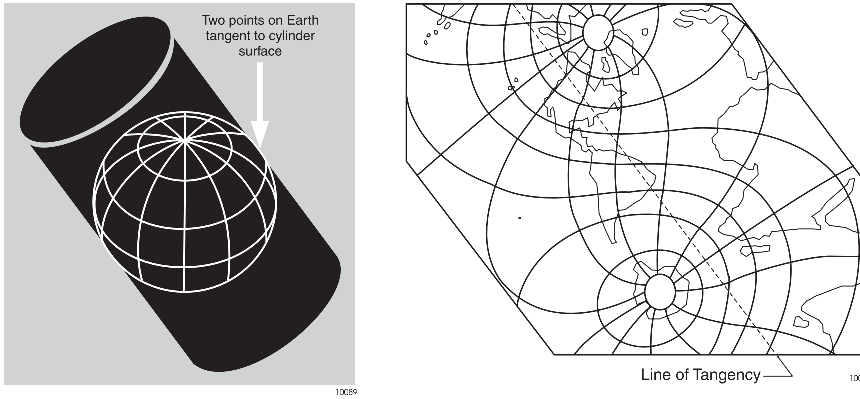


Figure 4.4. Oblique Mercator

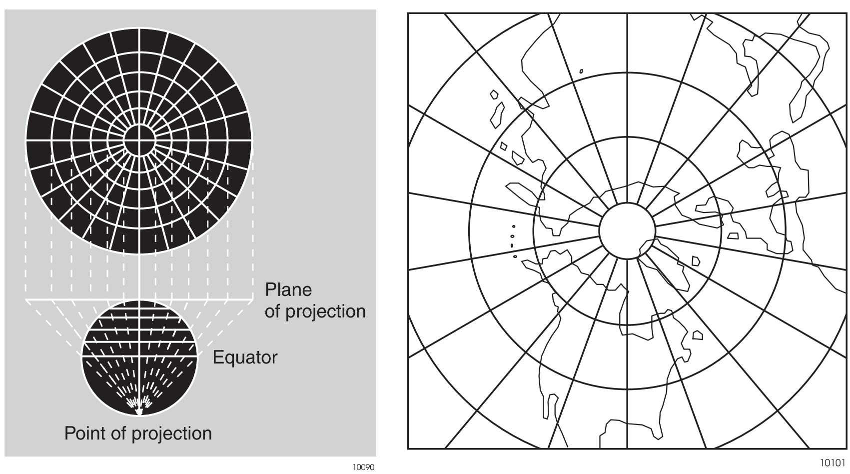


Figure 4.5. Stereographic

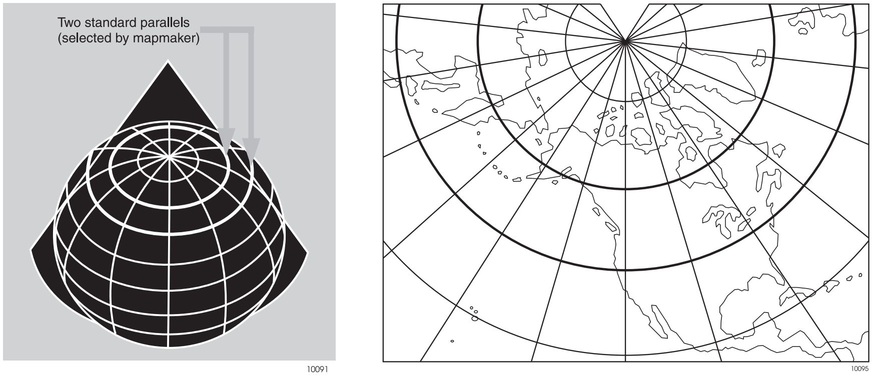


Figure 4.6. Lambert Conformal Conic

Elevation Modeling

In addition to computing and outputting geodetic and cartesian coordinates in different systems, the receiver can compute and output elevations in different systems.

By default, the receiver computes and outputs ellipsoidal heights. In some messages, the geoid separation is included, computed from the internal global model, relative to WGS-84.

To set the receiver to compute and output orthometric heights, use the **$PASHS,HGT,GEO** command. After setting this command, the receiver outputs orthometric heights using the internal global geoid model. Be aware that the internal geoid model used in this calculation is very coarse. Orthometric heights derived from this model could be in error by a meter or more.

If separation is included in the message, it is calculated by adding the difference between WGS-84 and a user- or pre-defined datum to the WGS-84-based geoid separation. An exception to this is the GGA message which ONLY outputs WGS-84-based geoid heights and separation, as per NMEA specifications.

5

Receiver Commands

Chapters 5 through 8 cover the formats and content of the serial port commands through which the CP14 receiver is controlled and monitored. These serial port commands set receiver parameters and request receiver status information and other data. Use Evaluate™ software or any other standard serial communication software to communicate with the receiver. Note that the baud rate and protocol of the computer COM port must match the baud rate and protocol of the receiver port for commands and responses to be successfully transmitted and received. The communication protocol is 8 data bits, 1 stop bit, and no parity.

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

When a command is sent to one of its serial ports, the CP14 responds by outputting a message indicating the acceptance or rejection of the command. In the case of query commands, the CP14 either outputs a response message containing data relevant to the query or sends a “NAK” response, indicating that the query command was invalid. All CP14 response messages begin with the string **$PASHR**, including status messages that are set for output at regular intervals from either of the CP14’s serial ports.

CP14 serial port commands fall into seven groups:

- Receiver commands— discussed in this chapter
- Raw data commands— discussed in Chapter 6
- NMEA message commands— discussed in Chapter 7

The following chapters discuss each type of command. Within each section, the commands are listed alphabetically and described in detail. A description of the command, the command structure, the range and default states of command parameters, and an example of how a given command is used are presented for each command. These parameters may be either characters or numbers depending upon the command. Table 5.1 lists the symbols and the types of data represented by them used to illustrate message structures in the ASCII format:

Table 5.1. Command Parameter Symbols

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

Receiver Commands

Receiver commands allow you to change or query the status of various operating parameters such as elevation mask, antenna altitude, position mode, etc. In this context, set commands are used to change the CP14's operating parameters. Query commands prompt the CP14 to output status messages for parameter settings and receiver operation.

If an invalid set or query command is issued, a "not acknowledged" (NAK) response is output:

$PASHR,NAK*30

Set command messages can be sent through serial port. When the CP14 receives a valid set command message, it returns an "acknowledged" (ACK) message:

$PASHR,ACK*3D

The CP14 returns a NAK message if the command is invalid. For example, the set command **$PASHS,SAV,Y<Enter>** instructs the CP14 to save user-entered operation parameters; the CP14 returns **$PASHR,ACK*3D** to acknowledge that the command was valid and the instruction was carried out. The set command **$PASHS,SAV<Enter>** is incomplete, and would cause the CP14 to flag it as an invalid command by responding with a "not acknowledged" response:

$PASHR,NAK*30.

The set command message structure is as follows:

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

The header field always contains **$PASHS**. The command identifier field contains a three character string and is followed by the command parameters. The checksum is strictly optional. All set commands are terminated with an **<Enter>** or **<CR><LF>** keystroke. All command string elements between the dollar sign ($) and the asterisk (*), including the command parameters, are comma delimited; that is, the header, the ID string, and the individual command parameters are separated by commas. For example, the following command sets the HDOP mask value to 6:

$PASHS,HDP,6<Enter>

Query commands are used to request current GPS information and receiver status information such as baud rate settings, position information, and tracking information. Query command messages can be sent to either of the CP14's serial ports. Most query commands allow you to designate the port from which the response message is sent. The CP14 acknowledges a valid query command message by sending the requested response message through the specified port. If the port is not specified in the query command, the response is sent from the same port which received the query. The requested information is sent once each time the command is issued and is not repeated.

The query command message format is as follows:

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

Table 5.2 contains descriptions of the query command elements.

Table 5.2. Query Command Structure

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

The query command **$PASHQ,CRR** instructs the CP14 to output a response message indicating the currently selected code correlation mode:

$PASHR,CRR,E*5E

The query command **$PASHQ,CR<Enter>** is incomplete, and causes the CP14 to flag it as an invalid message by outputting the NAK response.

Table 5.3 contains a list of the set and query commands falling into the category of receiver commands. The commands are listed alphabetically by function, and then alphabetically within each function. The commands are described in detail in the pages following Table 5.3.

Table 5.3. Receiver Commands

Command	Description	Default	Page
ANTENNA POSITION			
$PASHS,ALT	Set ellipsoidal height of antenna	0.00 m	59
$PASHS,ANH	Set antenna slant height	—	59
$PASHQ,ANH	Query antenna slant height	—	60
$PASHS,ANT	Set antenna offset parameter	—	60
$PASHQ,ANT	Query antenna offset parameters	—	60
DILUTION OF PRECISION (DOP)			
$PASHS,HDP	Set HDOP mask for position computation	4	78
$PASHS,PDP	Set PDOP mask for position computation	40	93

Table 5.3. Receiver Commands (Continued)

Command	Description	Default	Page
$PASHS,VDP	Set VDOP mask for position computation	4	128
IONOSPHERIC AND TROPOSPHERIC MODELING			
$PASHS,ION	Enable/disable ionospheric modeling		82
$PASHQ,ION	Query ionospheric measurements	Y	82
MEMORY, POWER, AND DIAGNOSTICS			
$PASHQ,BIT	Query operational diagnostics	—	61
$PASHQ,HST	Query start-up diagnostics results	—	79
$PASHS,INI	Clear internal and BBU memory	—	81
$PASHS,POW	Set the battery power capacity	—	95
$PASHQ,POW	Query battery power capacity	—	96
$PASHS,PWR,OFF	Turn the receiver power off	—	98
$PASHS,RST	Restore default parameter settings	—	102
$PASHS,SAV	Save parameters to memory	N	102
VELOCITY COMPUTATION			
$PASHS,DAP	Set the Doppler averaging interval	—	64
$PASHQ,DAP	Query the Doppler averaging interval	—	64
$PASHS,DYN	Set dynamic mode	8	70
$PASHS,SMV	Set speed filtering	—	107
$PASHQ,SMV	Query the speed filtering	—	108
$PASHS,LPS	Set third-order loop tracking parameters		87
$PASHQ,LPS	Query third-order loop tracking parameters		87
SESSION PROGRAMMING			
$PASHS,EPG	Set the kinematic epoch counter	—	71
$PASHS,SES,PAR	Set the session programming parameters	—	104
$PASHS,SES,SET	Set individual session parameters	—	105
Satellite Tracking Parameters			
$PASHS,UTS	Synchronize measurements and coordinates with GPS system time	Off	128
$PASHS,SUI	Enable satellite usage indicator	Off	109
$PASHS,SVP	Set satellites for position computation	Y	111

Table 5.3. Receiver Commands (Continued)

Command	Description	Default	Page
$PASHQ,SVP	Query satellites in position computation	—	111
$PASHS,SVS	Set satellites for acquisition and tracking	Y	112
$PASHQ,SVS	Query satellites for acquisition and tracking	—	112
$PASHS,USE	Designate individual satellites for tracking	All	127
$PASHS,USE,ALL	Include/exclude all satellites for tracking	All	127
$PASHS,USP	Designate individual satellitesfor position computation	All	127
$PASHQ,STA	Query for currently locked satellites	—	109
$PASHQ,UTS	Query time synchronization	—	128
$PASHQ,VIS	Query for visible satellites	—	129
POSITION COMPUTATION			
$PASHS,ERM	Set error masks for position computations	AUT: 600, 1200 DIF: 30, 60	72
$PASHS,FIX	Set fixed altitude mode	0	74
$PASHS,PEM	Set elevation mask for position computation	5°	94
$PASHS,PMD	Set position computation mode	1	94
$PASHS,PPO	Enable/disable point positioning	—	96
$PASHQ,PPR	Query position parameters	—	97
$PASHS,SCM	Set smoothing counter mask	Off	102
$PASHQ,SCM	Query smoothing counter mask	—	103
$PASHS,SEM	Set secondary elevation mask	Off	103
KALMAN FILTER			
$PASHS,KFP	Set the Kalman filter	Off	84
$PASHQ,KFP	Query the Kalman filter parameters	—	84
$PASHS,KFP,FDE	Set the Kalman filter fault detection and elimination	99	85
$PASHS,KFP,PRI	Set the Kalman filter prediction interval	10 sec	85
$PASHS,KPI	Set the coordinates for Kalman filter initialization	—	86
TRANSFORMATIONS			
$PASHS,DTM	Select reference datum	WGS-84	66
$PASHS,FUM	Select UTM zone to be held fixed	N	74
$PASHS,FZN	Enable/disable fixed UTM zone mode	—	75

Table 5.3. Receiver Commands (Continued)

Command	Description	Default	Page
$PASHQ,GDC	Query position as rendered in user-defined grid coordinates	—	75
$PASHS,GRD	Set datum to grid transformation	—	77
$PASHS,HGT	Set the height selection model	—	78
$PASHQ,HGT	Query the height selection model	—	79
$PASHS,LGS	Set grid to grid transformation	NON	86
USER-DEFINED TRANSFORMATIONS			
$PASHS,UCT,UDD,APT	Add a point for datum transformation	—	113
$PASHS,UCT,UDD,CAL	Calculate datum transformation parameters	—	114
$PASHQ,UCT,UDD,CAL	Query the datum transformation parameters	—	114
$PASHS,UCT,UDD,EST	Estimate a datum transformation	—	115
$PASHS,UCT,UDH,APT	Add a point for a local geoidal surface transformation	—	116
$PASHS,UCT,UDH,CAL	Calculate local geoidal surface transformation parameters	—	114
$PASHQ,UCT,UDH,CAL	Query local geoidal surface transformation parameters	—	114
$PASHS,UCT,UDH,EST	Estimate a local geoidal surface transformation	—	117
$PASHS,UCT,UG4,APT	Add a point for a grid transformation	—	117
$PASHS,UCT, UG4,CAL	Calculate grid transformation parameters	—	118
$PASHQ,UCT,UG4,CAL	Query the grid transformation parameters	—	118
$PASHS,UCT,UG4,EST	Estimate the grid transformation	—	118
$PASHS,UD4	Set user-defined datum to datum parameters	WGS-84	119
$PASHS,UDD	Set user-defined datum	—	119
$PASHQ,UDD	Query user-defined datum	—	119
$PASHS,UDG	Set user-defined datum to grid transformation	—	122
RECEIVER CONFIGURATION			
$PASHS,AJM	Enable/disable jam immunity	Off	58
$PASHQ,AJM	Query jam immunity status	—	58
$PASHQ,CLK	Query clock status	—	62
$PASHS,CTS	Enable/disable RTS/CTS handshaking protocol	Off	63
$PASHQ,CTS	Query current RTS/CTS setting	—	63

Table 5.3. Receiver Commands (Continued)

Command	Description	Default	Page
$PASHS,DSY	Set serial ports for daisy chain communication	Off	65
$PASHQ,DUG	Query UTC-GPS time difference	—	69
$PASHS,LPS	Set loop tracking parameters	10, 3, 1	87
$PASHQ,LPS	Query loop tracking parameter setting	—	87
$PASHS,LTZ	Set local zone time	00hr 00 min	89
$PASHS,OOP	Set the order of the output messages	—	90
$PASHQ,OOP	Query the order of the output messages	—	90
$PASHQ,PAR	Query current receiver parameter settings	—	90
$PASHQ,PRT	Query port baud rate	9600	97
$PASHQ,RID	Query receiver identification (Format 1)	—	98
$PASHQ,RIO	Query receiver identification (Format 2)	—	100
$PASHS,SMI	Set code measurement smoothing	100 sec 1° order	107
$PASHQ,SMI	Query the code measurement smoothing	—	107
$PASHS,SNM	Set signal-to-noise mask	0	
$PASHS,SPD	Set baud rate of serial port	—	108

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

AJM: In-Band Jam Immunity

$PASHS,AJM,x

This command enables or disables in-band jam immunity where x is ON or OFF.

$PASHQ,AJM

This command queries the in-band jam immunity setting.

$PASHR,AJM

The response is in the format:

$PASHR,AJM,x

where x is ON or OFF.

DEFAULT SETTING
AJM—OFF

ALT: 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 CP14 uses the altitude value set through this command when it is computing 2D positions.

Example

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

$PASHS,ALT,-30.1

DEFAULT SETTING
ALT—00000.00 meters

ANH: Antenna Height

$PASHS,ANH,f

This command sets the antenna height where f is from 0.0 to 6.4 meters.

Example:

Enter the following command to set the antenna height to 3.534 meters.

$PASHS,ANH,3.534

$PASHQ,ANH,[c]

This command queries the antenna height entered into the receiver, where c is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

Example

Enter the following command to query antenna offsets to port A.

$PASHQ,ANH,A

$PASHR,ANH

The response is in the format:

$PASHR,ANH,f

where f is the antenna height in meters.

ANT: Set Antenna Offsets

$PASHS,ANT,f1,f2,f3,m1,x1

This command sets the antenna offsets from reference point to antenna phase center. Table 5.4 defines the parameters.   .

Table 5.4. Antenna Offsets Settings

Parameter	Description	Range	Unit
f1	Antenna height: height measured from the reference point to the antenna edge	0 to 6.4	meters
f2	Antenna radius: the distance from the antenna phase center to the antenna edge	0.0 to 9.9999	meters
f3	Antenna offset: the offset set from the antenna phase center to the antenna ground plane.	0.0 to 99.9999	meters
m1	Horizontal azimuth measured from the reference point to the antenna phase center with respect to north (WGS-84).	0 to 180.00	ddmm.mm
x1	Horizontal distance measured from the reference point to the antenna phase center.	0 to 99.9999	meters

This command affects message type 1, 9, and 3 significantly.

Example

Enter the following command to set antenna height to 1.678 meters, antenna radius to 0.1737 meters, and the offset to 0.5 meters.

$PASHS,ANT,1.678,0.1737,0.5,0000.00,0.0<Enter>

$PASHQ,ANT,c

This command queries the current antenna offset parameters, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

Example

Enter the following command to query antenna offsets to port A.

$PASHQ,ANT,A

$PASHR,ANT

The response is in the format:

$PASHR,ANT,f1,f2,f3,m1,x1*cc

where Table 5.5 defines the response format.

Table 5.5. ANT Message Structure

Parameter	Description	Range	Unit
f1	antenna height: height measured from the reference point to the antenna edge	0—64.000	meter
f2	antenna radius: the distance from the antenna phase center to the antenna edge	0.0—9.9999	meter
f3	antenna offset: the offset set from the antenna phase center to the antenna ground plane.	0.0—99.9999	meter
m1	Horizontal azimuth measured from the reference point to the antenna phase center with respect to north (WGS-84).	0 to 180.00	ddmm.mm
x1	Horizontal distance measured from the reference point to the antenna phase center.	0 to 99.9999	meters
*cc	Checksum	00-FF	n/a

BIT: Operational Diagnostic Tests

$PASHQ,BIT,[c1]

This commands queries for the results of the periodic operational diagnostic tests, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

The response message is output in the format:

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

Table 5.6 defines the response message parameters.

Table 5.6. $PASHR,BIT Response Parameters

Parameter	Description	Range
c1	Low battery test, Indicates whether the battery in the real-time clock device has failed.	P = Pass F = Fail
c2	Receiver parameters checksum/CRC test, Indicates whether the Receiver Parameters stored in non-volatile memory have been corrupted.	P = Pass F = Fail

Table 5.6. $PASHR,BIT Response Parameters

Parameter	Description	Range
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.	P = Pass F = Fail
*cc	Checksum	00-FF

CLK: Clock Status

$PASHQ,CLK,[c1]

This command queries the real-time UTC clock status, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

The time in the CLK command is UTC.

The response message is output in the format:

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

Table 5.7 defines the format for d1 through d88:

Table 5.7. $PASHQ,CLK Format

Parameter	Description	Range
d1	Year	0 to 99
d2	Month	1 to 12
d3	Date	1 to 31
d4	Day of the week	1 to 7
d5	Hour	0 to 23
d6	Minute	0 to 59
d7	Second	0 to 59
d8	Time Difference— the time lapse after the last write to RTC	0 to 2^{32}
*hh	The hexadecimal checksum is computed by exclusive O-Ring all of the bytes in the message between, but not including, the $ and the *. The result is *hh where h is a hex character.	0-9 and A-F

Typical CLK response:

$PASHR,CLK,96,12,04,4,13,25,20,14*05

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

CTS: Handshaking Protocol

$PASHS,CTS,c1,s1

This command enables or disables the CTS/RTS (Clear To Send/Request To Send) handshaking protocol on one or all of the CP14's serial ports. The c1 parameter is the optional port designator (A, B, or C); s1 is ON or OFF.

If a port is not designated, the command applies the change to the port from which the command was sent. Handshaking is enabled on both ports by default. Handshaking requires five connections for each serial port (CTS, TXD, GND, RTS, RXD). When handshaking is disabled, only three connections are required (TXD, GND, RXD). See Figure 1.3 on page 12 for a diagram of the J801 pin configuration.

Example

Enter the following command to disable handshaking on port A:

$PASHS,CTS,A,OFF

$PASHQ,CTS,[c1]

This command queries the current CTS setting, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CTS

The response message is output in the format:

$PASHR,CTS,c1,s1*hh

Table 5.8 defines the parameters.

Table 5.8. $PASHR,CTS Format

Parameter	Description	Range
c1	Port identifier	A, B, C
s1	Current CTS setting	ON, OFF
hh	Checksum	2-character hex

Typical CTS response:

$PASHR,CTS,A,ON*70

Table 5.9 defines the response message.

Table 5.9. Typical CTS Message

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

DEFAULT SETTING
CTS—OFF

DAP: Doppler Averaging Interval

$PASHS,DAP,f1

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

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

Example

Enter the following command to set the time interval for doppler averaging to 5 seconds:

$PASHS,DAP,5

$PASHQ,DAP,[c1]

This command queries the doppler averaging interval range, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,DAP

The response message is output in the format:

$PASHR,DAP,f1*hh

Table 5.8 defines the parameters.

Table 5.10. $PASHR,DAP Format

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

DSY: Daisy Chain Communications Mode

$PASHS,DSY,c1,c2

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

$PASHS,DSY,OFF

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

Table 5.11 lists several daisy chain commands and their effects.

Table 5.11. Daisy Chain Commands

Command	Effect
$PASHS,DSY,A,B	Redirects data going into port A over to port B. Can be issued to either port
$PASHS,DSY,B,A	Redirects data going into port B over to port A. Can be issued to either port
$PASHS,DSY,A,OFF	Turns off redirection from A. Can be issued to either port
$PASHS,DSY,B,OFF	Turns off redirection from B. Can be issued to either port
$PASHS,DSY,A,B $PASHS,DSY,B,A	Both commands must be entered to enable bi-directional daisy chain mode. If you are connecting to the CP14 through port A, enter $PASHS,DSY,B,A first. If you are interfacing to the CP14 through port B, enter $PASHS,DSY,A,B first
$PASHS,DSY,OFF	Disables daisy chain on all ports. Can be issued from any port

DEFAULT SETTING
DSY—OFF

DTM: Set Reference Datum

$PASHS,DTM,UDD

This commands allow you to select a user-defined datum type to use as a reference for position computations and measurements. Parameters for the user-defined datum are entered with the **$PASHS,UDD** command described on page 119.

$PASHS,DTM,s1

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

A 3-character string that defines a particular datum

USR (User-Defined Datum— Parameters for user-defined datum are entered with the **$PASHS,UDD** command described on page 119.

Table 5.12 lists the available predefined datums and associated reference ellipsoids.

Table 5.12. Predefined Datums and Associated Reference Ellipsoids

Datum ID	Reference Ellipsoid	Offset in meters (dX,dY,dZ)	Datum Description
ARF	Clarke 1880	-143, -90, -294	ARC 1950 (Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe
ARS	Clarke 1880	-160, -8, -300	ARC 1960 (Kenya, Tanzania)
AUA	Australian National	-133, -48, 148	ANS66 Australian Geodetic Datum 1966 (Australia, Tasmania Island)
AUG	Australian National	-134, -48, 149	ANS84 Australian Geodetic Datum 1984 (Australia, Tasmania Island)
BOO	International 1924	307, 304, -318	Bogota, Bogota Observatory (Columbia)
CAI	International 1924	-148, 136, 90	Campo, S. American Campo Inchauspe (Argentina)
CAP	Clarke 1880	-136, -108, -292	Cape (South Africa)
CGE	Clarke 1880	-263, 6, 431	Carthage (Tunisia)
CHI	International 1924	175, -38, 113	Chatham 1971 (Chatham, New Zealand)
CHU	International 1924	-134, 229, -29	S. American Chua Astro (Paraguay)
COA	International 1924	-206, 172, -6	S. American Corrego Alegre (Brazil)
EUA	International 1924	-87, -96, -120	European 1950 (Western Europe: Netherlands, Austria, France, F.R. of Germany, Switzerland, Denmark)
EUE	International 1924	-104, -101, -140	European 1950 (Cyprus)

Table 5.12. Predefined Datums and Associated Reference Ellipsoids (Continued)

Datum ID	Reference Ellipsoid	Offset in meters (dX,dY,dZ)	Datum Description
EUF	International 1924	-130, -117, -151	European 1950 (Egypt)
EUH	International 1924	-117, -132, -164	European 1950 (Iran)
EUJ	International 1924	-97, -88, -135	European 1950 (Sicily)
EUS	International 1924	-86, -98, -119	European 1979 (Austria, Netherlands, Finland, Norway, Spain, Sweden, Switzerland)
FAH	Clarke 1880	-346, -1, 224	Oman
GAA	International 1924	-133, -321, 50	Gandajika Base (Rep. of Maldives)
GEO	International 1924	84, -22, 209	Geodetic Datum 1949 (New Zealand)
HJO	International 1924	-73, 46, -86	Hjorsey 195 (Iceland)
INA	Everest	214, 836, 303	Indian 1 (Thailand, Vietnam)
INM	Everest	289, 734, 257	Indian 2 (India, Nepal, Bangladesh)
IRL	Modified Airy	506, -122, 611	Ireland 1965
KEA	Modified Everest	-11, 851, 5	Kertau 1948 (West Malaysia, Singapore)
LIB	Clarke 1880	-90, 40, 88	Liberia 1964
LUZ	Clarke 1866	-133, -77, -51	Luzon (Philippines excluding MindanoaIs.)
MAS	Bessel 1841	639, 405, 60	Massawa (Eritrea, Ethiopia)
MER	Clarke 1880	31, 146, 47	Merchich (Morocco)
MIN	Clarke 1880	-92, -93, 122	Minna (Nigeria)
NAC	Clarke 1866	-8, 160, 176	NAD27 N. American CONUS 1927 (North America)
NAD	Clarke 1866	-5, 135, 172	AK27 N. American Alaska 1927 (Alaska)
NAE	Clarke 1866	-10, 158, 187	CAN27 N. American Canada 1927 (Canada including Newfoundland Island)
NAH	Clarke 1880	-231, -196, 482	Nahrwan (Saudi Arabia)
NAN	Clarke 1866	-6, 127, 192	Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico)
NAR	GRS1980	0, 0, 0	GRS80 North American 1983
OEG	Helmert 1906	-130, 110, -13	Old Egyptian
OGB	Airy 1830	375, -111, 431	OSG Ordnance Survey of Great Britain 1936 (England, Isle of Main Scotland, Shetland Islands, Wales)
OHA	Clarke 1866	61, -285, -181	OLDHW Old Hawaiian

Table 5.12. Predefined Datums and Associated Reference Ellipsoids (Continued)

Datum ID	Reference Ellipsoid	Offset in meters (dX,dY,dZ)	Datum Description
PIT	International 1924	185, 165, 42	Pitcairn Astro 1967 (Pitcairn Island)
QAT	International 1924	-128, -283, 22	Qatar National (Qatar)
QUO	International 1924	164, 138, -189	Qornoq (South Greenland)
SAN	S. American 1969	-57, 1, -41	SAMER69 S. American 1969 (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyan, Peru, Paraguay, Venezuela, Trinidad, Tobago)
SCK	Bessel 1841 Namibia	616, 97, -251	Schwarzeck (Namibia)
TIL	Everest	-689, 691, -46	Timbalai 1948 (Brunei, East Malaysia, Sarawak, Sabah)
TOY	Bessel 1841	-128, 481, 664	Tokyo (Japan, Korea, Okinawa)
USR	User Defined	user defined	User defined
W72	WGS-72	0, 0, +4.5	WGS-72 World Geodetic System - 72
W84	WGS-84	0, 0, 0	WGS-84 World Geodetic System - 84
ZAN	International 1924	-265, 120, -358	Zanderij (Surinam)

Table 5.13 lists the predefined ellipsoids.

Table 5.13. Predefined Ellipsoids

Ellipsoid	a (metres)	1/f	f
Airy 1830	6377563.396	299.3249647	0.00334085064038
Modified Airy	6377340.189	299.3249647	0.00334085064038
Australian National	6378160.0	298.25	0.00335289186924
Bessel 1841	6377397.155	299.1528128	0.00334277318217
Clarke 1866	6378206.4	294.9786982	0.00339007530409
Clarke 1880	6378249.145	293.465	0.00340756137870
Everest (India 1830)	6377276.345	300.8017	0.00332444929666
Everest (W. Malaysia and Singapore)	6377304.063	300.8017	0.00332444929666
Geodetic Reference System 1980	6378137.0	298.257222101	0.00335281068118
Helmert 1906	6378200.0	298.30	0.00335232986926

Table 5.13. Predefined Ellipsoids

Ellipsoid	a (metres)	1/f	f
International 1924	6378388.0	297.00	0.00336700336700
South American 1969	6378160.0	298.25	0.00335289186924
World Geodetic System 1972 (WGS-72)	6378135.0	298.26	0.00335277945417
World Geodetic System 1984 (WGS-84)	6378137.0	298.257223563	0.00335281066475

Example

Select New Zealand Geodetic Datum 1949 for position computation:

$PASHS,DTM,GEO

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

DEFAULT SETTING
DTM—WGS-84

DUG: GPS/UTC Time Difference

$PASHQ,DUG,[c1]

This command queries the time difference between UTC time and GPS time; c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,DUG

The response message is output in the format:

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

Table 5.14 defines the binary data string parameters.

Table 5.14. $PASHR,DUG Format

Binary Type	Size	Content
unsigned short	2	Reference week
unsigned short	2	Reference time
unsigned short	2	GPS-UTC time (seconds)

Table 5.14. $PASHR,DUG Format

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

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

DYN: Dynamic Mode

$PASHS,DYN,d1

This command sets the dynamic mode under for the receiver where Table 5.15 defines d1. The navigation solution uses expected dynamics for a given solution.

Table 5.15. Dynamic Modes

d1 (Dynamic Mode)	Description	Maximum Horizontal Velocity (m/s)	Maximum Vertical Velocity (m/s)	Maximum Horizontal Acceleration (m/s^2)	Maximum Vertical Acceleration (m/s^2)
1	Static	0	0	0	0
2	Quasi-Static *	0.1	0.02	0.1	0.02
3	Walking	2	0.5	1	0.5
4	Ship	20	1	1	0.5
5	Automobile	50	3	10	1.0
6	Aircraft	1000	1000	100	100
7	Unlimited	1000	1000	100	100
8	Adaptive Dynamic **	N/A		N/A	N/A

* Quasi-Static represents a static condition with some tolerance for slight movements within a decimeter or two. An example would be an antenna on a handheld pole or on

the back of a person; obviously a person can try to be static but will inevitably move within a decimeter or two. This is unlike “Static” mode where the antenna is placed on a tripod or any other stationery structure with zero tolerance for actual movement.

** Adaptive Dynamic adapts the filter dynamics settings to any of the modes 2 through 7 in real time allowing the switch from one mode to the other based on the witnessed behavior. Use one of the standard Adaptive filtering algorithms that monitor covariance behavior to determine dynamics model to use.

If you are unsure which is the appropriate model for your application, choose the Adaptive Dynamic mode. If you select Mode 1 through 7, the CP14 will not accommodate the other dynamic modes.

DEFAULT SETTINGS
$PASHS,DYN— **Adaptive Dynamic (8)**

EPG: Kinematic Epoch Counter

$PASHS,EPG,d1

This command sets the number of epochs for recording at a site where d is the number of epochs and ranges from 0 to 999. The command is used during kinematic surveys, when you want to occupy a site for a set amount of time. When the number of epoch goes to zero, the site name will automatically set to ???? indicating that the receiver is in motion.

Example

Enter the following command to set the number of epochs in the kinematic epoch counter to 20.

$PASHS,EPG,20

The site name must be set with the $PASHS,SIT command BEFORE the epoch counter works.

ERM: Set Position Error Mask Values

$PASHS,ERM,s1,d1,d2

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

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

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

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

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

Example

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

$PASHS,ERM,AUT,5,10

$PASHS,ERM,ALL,d1,d2

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

Example

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

$PASHS,ERM,ALL,2,4

DEFAULT SETTING			
ERM	**Positioning Mode**	**Horizontal Mask**	**Vertical Mask**
	Autonomous	**600 m**	**1200 m**
	Code Differential	**300 m**	**600 m**

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

$PASHQ,ERM,c1

This command queries the error mask values for AUT, DIF, and CPD modes.c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,ERM

The response is in the format:

$PASHR,ERM,d1,d2,d3,d4,d5,d6

where Table 5.16 defines the response format.

Table 5.16. ERM Message Structure

Parameter	Definition
d1	Error mask horizontal setting for AUT.
d2	Error mask vertical setting for AUT.
d3	Error mask horizontal setting for DIF.
d4	Error mask vertical setting for DIF.

Table 5.16. ERM Message Structure

Parameter	Definition
d5	Error mask horizontal setting for CPD. This function is not yet implemented.
d6	Error mask vertical setting for CPD. This function is not yet implemented.

FIX: Fixed Altitude Mode

$PASHS,FIX,d1

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

- Fixed Altitude Mode 0

  The most recently recorded antenna altitude is used. The altitude value is taken either from the altitude entered through the **$PASHS,ALT** command or from the last altitude computed in which the VDOP value is lower than the value entered for the VDOP mask
- Fixed Altitude Mode 1

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

Example

Enter the following command to set the CP14 in fixed altitude mode 1:

$PASHS,FIX,1

DEFAULT SETTING
FIX—Mode 0

FUM: Fix UTM Zone

$PASHS,FUM,c1

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

Example

Enter the following command to enable the fixed zone setting:

$PASHS,FUM,Y

DEFAULT SETTING
FUM—N

FZN: Select Fixed UTM Zone

$PASHS,FZN,d1

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

Example

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

$PASHS,FZN,10

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

$PASHQ,GDC,[c1]

This command queries the current position according to the user-defined grid coordinate system selected through the UDG command, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port. The response message does not output unless the following three conditions are met:

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

$PASHR,GDC

The response message is output in the format:

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

Table 5.17 defines the parameters.

Table 5.17. GDC Message Structure

Parameter	Description	Range
m1	UTC of position in hours, minutes, and decimal seconds (hhmmss.ss)	000000.00 to 235959.90
s2	Map projection type	EMER, TM83, OM83, LC83, STER, LC27, Tm27, TA22
f3	Easting (x) of the user grid coordinate (meters)	-9999999.999 to +9999999.999
f4	Northing (y) of the user grid coordinate (meters)	-9999999.999 to +9999999.999
d5	Positioning mode Indicator • 1: Autonomous position • 2: CPD float position or RTCM differential • 3: Carrier Phase differential (CPD) fixed	Always 1
d6	Number of GPS satellites being used	3 to 12
f7	Horizontal Dilution of Position (HDOP)	00.0 to 99.9
f8	Altitude (meters)	-9999999.999 to +9999999.999
M	Altitude units	M(eters)
f9	Geoidal separation in meters w.r.t. selected datum and Geoid Model	-999.999 to +999.999
d10	Empty field	
s11	Empty field	
s12	Datum type	W84, USR
*hh	Checksum	2-character hex

Typical GDC response message:

$PASHR,GDC,015151.00,EMER,588757.623,+4136720.056,1,04,03.8,0001 2.123,M,-031.711,M,,,W84*2A

Table 5.18 defines the response message.

Table 5.18. Typical GDC Response Message

Item	Significance
015151.00	UTM time
EMER	Equatorial Mercator map projection
588757.623	User Grid easting coordinate (x)
4136720.056	User Grid northing coordinate (y)
1	Autonomous position
04	Number of satellites used to compute position
03.8	HDOP
00012.123	Altitude of position
M	Altitude units (M=meters)
-031.711	Geoidal separation w.r.t. selected datum
M	Geoidal separation units (M = meters)
W84	Datum is WGS-84
2A	Checksum

GRD: Datum to Grid Transformation (Map Projection)

$PASHS,GRD,s1

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

Example

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

$PASHS,GRD,UDG

HDP: HDOP Mask Value

$PASHS,HDP,d1

This command sets the value of the HDOP mask, where d1 is a number between 0 and 99.9. If the HDOP value computed by the CP14 is higher than the HDOP mask value, the receiver will automatically go into fixed altitude mode. You can view the current HDOP mask value by entering the query command $PASHQ,PAR and checking the HDP field.

Example

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

$PASHS,HDP,6

DEFAULT SETTING
HDP—4

HGT: Height Model Selection

$PASHS,HGT,s

This command sets the height model used in the position output, where is a 3-character string defined in Table 5.19.

Table 5.19. $PASHS,HGT Parameter

Height Selection (s)	Altitude Output in GDC	Geoidal Separation in GDC	GGA Altitude
ELG	Ellipsoidal	Geoidal table	Geoidal
ELU	Ellipsoidal	User-defined local geoid	Geoidal
GEO	Geoidal	Geoidal table	Geoidal
UDH	Geoidal	User-defined local geoid	Geoidal

- ELG: (default) ellipsoidal height output, with worldwide geoidal model used for geoidal separation field. (mean-sea-level)
- GEO: geoidal orthometric height output using worldwide geoidal model, also used for geoidal separation field.

This does not affect the position output in the B-file or in the PBN message which are ECEF and always with respect to WGS-84.

To remain NMEA standard, the GGA message always outputs the elevation for the geoidal elevation for both ELG and GEO, and the local orthometric elevation for both ELU and UDH and not the ellipsoidal elevation.

Example

Enter the following command to set geoidal height in the position output.

$PASHS,HGT,GEO

$PASHQ,HGT,c

This command queries the height model selection where c is the optional output port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

Example

Enter the following command to query the height model to port B.

$PASHQ,HGT,B

$PASHR,HGT

The response message is in the form:

$PASHR,HGT,s*cc<CR><LF>

where s is the 3 character string that denotes the current height setting (ELG, ELU, UDH, or GEO).

HST: Start-up Diagnostic Results

$PASHQ,HST,[d1],[c1]

This command queries for the results of start-up diagnostics, where d1 is the test number from 1 to 20 and 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. If you do not specify d1, this command returns information on the most recently run diagnostic test.

$PASHR,HST

The response message is output in the format:

$PASHR,HST,d1,d2,d3,d4,d5,m1,h1*cc

Table 5.20 defines the response message parameters.

Table 5.20. $PASHQ,HST Response Parameters

Parameter	Description	Range
d1	The total number od failures in the history. If this value is zero, then the rest of the message is omitted.	0 to 20
d2	The sequential index number of this failure in history.	1 to 20
d3	The day of the failure	01 to 31
d4	The month of the failure	01 to 12
d5	The year of the failure	0000 to 9999
m1	UTC time of failure (hhmmss.ss)	000000.00 to 235959.00
h1	The results of the built-in self-test • Bit 0: 1—All tests conducted; 0—One or more test not conducted • Bit 1: 1—All tests passed; 0—One or more tests failed • Bit 2: 1—WDI test conducted; 0—WDI test not conducted • Bit 3: 1—WDI test passed; 0—WDI test failed • Bit 4: 1—RTC test conducted; 0—RTC test not conducted • Bit 5: 1—RTC test passed; 0—RTC test failed • Bit 6: 1—DuratA test conducted; 0—DuratA test not conducted • Bit 7: 1—DuratA test passed; 0—DuratA test failed • Bit 8: 1—DuratB test conducted; 0—DuratB test not conducted • Bit 9: 1—DuratB test passed; 0—DuratB test failed • Bit 10: 1—ASIC test conducted; 0—ASIC test not conducted • Bit 11: 1—ASIC test passed; 0—ASIC test failed • Bit 12: 1—SDRAM test conducted; 0—SDRAM test not conducted • Bit 13: 1—SDRAM test passed; 0—SDRAM test failed • Bit 14: 1—BBU test conducted; 0—BBU test not conducted • Bit 15: 1—BBU test passed; 0—BBU test failed • Bit 16: 1—FLASH test conducted; 0—FLASH test not conducted • Bit 17: 1—FLASH test passed; 0—FLASH test failed • Bit 18: 1—TMS test conducted; 0—TMS test not conducted • Bit 19: 1—TMS test passed; 0—TMS test failed	0 to FFFFF
*cc	Checksum	00-FF

Typical Response Messages

$PASHR,HST,0*35

The above response message indicates that no tests failed.

$PASHR,HST,2,2,25,05,2000,172345.00,23003*35

The above response message indicates the following:

- Two tests failed in the second index
- The failed tests occurred on the 25th day of the 5th month of year 2000, at UTC time of 17:23:45.00.
- The test results: 23003 indicate that
  - All tests were conducted
  - All tests passed
  - SDRAM test was conducted and passed
  - FLASH test was conducted and passed

INI: Initialize the Receiver

$PASHS,INI,d1,d2,d3,d4

This command clears receiver memory and reset serial port baud rates, where d1, d2, and d3 are baud rate setting codes for ports A and B, and d4 is the memory reset code. Table 5.21 and Table 5.22 list the code numbers and the settings associated with them.

Table 5.21. Serial Port Baud Rate Codes

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

Table 5.22. Memory Reset Codes

Reset Memory Code	Action
0	No memory reset
1	Reset internal memory (user settings)

Table 5.22. Memory Reset Codes (Continued)

Reset Memory Code	Action
2	Reset external memory (battery-backed RAM including ephemeris, almanac, time, date, last position, etc.)
3	Reset internal and external memory

Example

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

$PASHS,INI,4,6,6,1

The INI command is not fully functional with the CP14. Since the CP14 does not contain a memory area for data storage, the reset memory code for external memory (2) has no effect on the receiver. Resetting internal memory (1), or resetting internal and external memory (3) have the same effect. The parameter settings for this command were maintained for the CP14 in order to preserve consistency with other Thales Navigation receivers.

ION: Ionospheric and Tropospheric Modelling

$PASHS,ION,c1

This command enables or disables the use of ionospheric modelling, which is used to compensate for delays that occur as the GPS signals travel through the ionosphere, where c1 is either N (disable) or Y (enable). You can see whether ionospheric modelling is enabled or disabled by entering the **$PASHQ,PPR** command.

Example

Enter the following command to enable ionospheric modelling:

$PASHS,ION,Y

DEFAULT SETTING	
ION	Y

$PASHQ,ION,[c1]

This command queries the current ionospheric data generated by the GPS satellites, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,ION

The response message is output in binary format:

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

Table 5.23 describes the elements in the binary data string:

Table 5.23. $PASHR,ION Format

Type	Size	Contents
float	4	α_0 ionospheric parameter (seconds)
float	4	α_1 ionospheric parameter (sec. per semicircle)
float	4	α_2 ionospheric parameter (sec. per semicircle)
float	4	α_3 ionospheric parameter (sec. per semicircle)
float	4	β_0 ionospheric parameter (seconds)
float	4	β_1 ionospheric parameter (sec. per semicircle)
float	4	β_2 ionospheric parameter (sec. per semicircle)
float	4	β_3 ionospheric parameter (sec. per semicircle)
double	8	A_0 Constant term of GPS/UTC polynomial
double	8	A_1 Constant term of GPS/UTC polynomial
unsigned long	4	t_{ot} Reference time
short	2	W_{nt} reference week
short	2	Δt_{LS} Delta UTC-GPS time at reference time
short	2	WN_{LSF} Week of leap second correction
short	2	DN day of leap second correction
short	2	Δt_{LSF} Delta time between GPS and UTC
short	2	WN Current GPS week number
unsigned long	4	tow Current time of week
short	2	bulwn Current GPS week number when message was read
unsigned long	4	bultow Time of week when message was read
short	2	Checksum (word)
Total characters = 76 bytes		

The CP14 does not calculate ionospheric parameters on its own. The ionospheric data, listed in Table 5.23, are obtained from subframe 4 of the GPS navigation message.

KFP: Kalman Filter

$PASHS,KFP,s1

This command enables the Kalman filter where s1 is ON or OFF. If you issue this command again, it will reset the Kalman filter.

The Kalman filter supports a known point initialization.

Example

Enter the following command to enable the Kalman filter.

$PASHS,KFP,ON

DEFAULT SETTING
KFP—OFF

$PASHQ,KFP,[c1]

This command queries the Kalman filter parameter setting (ON or OFF) where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

The response is in the readable format below:

KFP SETUP:

MODE:OFF PRI:O10.0 FDE:99.0 PAR:001.00,001.00

where Table 5.24 defines the response parameters:

Table 5.24. KFP Message Structure

Parameter	Description	Range
KFP SETUP		
MODE	The currently set Kalman Filter mode.	ON, OFF
PRI	The current setting for the prediction interval.	0 to 100
FDE	The fault detection value for the Kalman filter.	95, 99, or 99.9
PAR	Reserved for internal use.	

KFP,FDE: Kalman Filter Fault Detection and Elimination

$PASHS,KFP,FDE,x1

This command sets the fault detection and elimination parameters for the Kalman filter where x is percent reliability of outliers and cycle slip detection in the Kalman filter at 95, 99, or 99.9.

Example

Enter the following command to set the reliability to 99 percent:

$PASHS,FKP,FDE,99

DEFAULT SETTINGS
KFP,FDE—99

KFP,PRI: Kalman Filter Prediction Interval

$PASHS,KFP,PRI,f1

This command sets the Kalman filter maximum prediction interval where f1 is the prediction interval from 0 to 100 seconds. The Kalman filter stops outputting the predicted position if the prediction interval is longer than f1 or if the position error mask (ERM) is exceeded. If f1 is set to zero, the prediction mode is disabled/

The predicted position is flagged in the $PASHR,POS message as 8.

Example

Enter the following command to set the Kalman filter maximum prediction interval to 45.

$PASHS,KFP,PRI,45

DEFAULT SETTING
KFP,PRI—10 seconds

KPI: Known Point Initialization

$PASHS,KPI,m1,c1,m2,c2,m3,s1,s2,s3

This command sets the known coordinates for an antenna phase center, where the parameters are as defined in Table 5.25.

Table 5.25. $PASHS,KPI Parameters

Parameter	Description	Format and Range
m1	WGS84 latitude in degrees and decimal minutes	ddmm.mmmmmmm 0 to 8959.9999999
c1	Direction of latitude	N=North, S=South
m2	WGS84 longitude in degrees and decimal minutes	dddmm.mmmmmmm 0 to 17959.9999999
c2	Direction of longitude	E=East, W=West
m3	WGS84 ellipsoidal height in meters	mmmm.mmm -9999.999 to +9999.999
s1, s2, s3	*a priori* expected sigmas of entered coordinates (meters)	

The receiver will not acknowledge the command if the entered and computed position differ by more than 500 meters.

Empty m fields are interpreted as having no a priori information for the direction (to cover 3D, 2D and 1D initializations).

Empty s fields are interpreted as taking value 0.01 > m.

If you set an s field to 100 m the receiver interprets this as having no a priori information for this direction.

This command is applied only to Kalman filtered positioning (KFP > ON). If the receiver is set to LMS positioning (KFP OFF), the KPI command has no effect. After you have issued this command, the Kalman filter resets and is initialized with specified coordinates and sigmas. The Kalman filter uses the KPI settings only once for initialization, so you can safely to move in a few seconds after issuing this command.

LGS: Grid to Grid Transformation

$PASHS,LGS,s1

This command selects the UG4 grid-to- grid transformation (UG4) or no grid to grid transformation (NON) where s1 is UG4 or NON.

Example

Enter the following command to set the grid to grid transformation to UG4.

$PASHS,LGS,UG4

DEFAULT SETTING
LGS—NON

LPS: Third-Order Loop Tracking Parameters

$PASHS,LPS,d1,d2,d3

This command sets third-order loop tracking parameters to optimize loop tracking performance for a specific application, where d1 is the ratio of the carrier loop, d2 is the carrier loop parameter, and d3 is the code loop parameter. The carrier and code loop parameters are set independently. The CP14 uses default loop tracking values until new parameters are set through this command. Loop tracking parameters set through this command are saved in battery-backed memory and used until new settings are selected, battery-backed memory is cleared, or the RST command is issued to the receiver.

The loop tracking parameters are applied to all GPS channels.-

IWe recommend that you use the $PASHS,DYN commane (see 70) instead of $PASHS,LPS. $PASHS,LPS is described in this manual for backward compatibility only.

Example

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

$PASHS,LPS,1,2,2

$PASHQ,LPS,[c1]

This command queries the current loop tracking parameter settings, where c1 is the optional port designator for the output of the response.If a port is not specified, the receiver sends the response to the current port.

$PASHR,LPS

The response message outputs in the format:

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

Table 5.26 defines the parameters.

Table 5.26. $PASHR,LPS Format

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

Typical LPS response message:

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

Table 5.27 defines the response message.

Table 5.27. Typical LPS Response Message

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

Table 5.27. Typical LPS Response Message

Item	Description
1	Code loop parameter setting (fast range availability, medium range noise)
14	Checksum

DEFAULT SETTING
LPS—10, 3, 1

LTZ: Local Time Zone

$PASHS,LTZ,d1,d2

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

Examples

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

$PASHS,LTZ,+7,0

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

$PASHS,LTZ,-4,25

DEFAULT SETTING
LTZ—00 hours, 00 minutes

OOP: Output Messages Order

$PASHS,OOP,s1,s2,s3...

This command sets the order of the output messages where s1, s2, and s3 are the messages. You can set the order for any number of messages.

Example

Enter the following command to set the message order to GGA, PBN, SAT.

$PASHS,OOP,GGA,PBN,SAT

$PASHQ,OOP,c1

This command lists all the ASCII and binary messages in the order the receiver outputs them.

$PASHR,OOP

The response is in the format:

$PASHR,OOP,s1,s2,s3...

where s1, s2, s3, ... are the message formats in the order the receiver outputs them.

PAR: Query General Receiver Parameters

$PASHQ,PAR,[c1]

This command queries the current settings of general receiver parameters, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

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

```
SPDA:5 SPDB:5 SPDC:5
GPS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
SYS:GPS DTM:W84 TDP:04
PMD:1 FIX:0 ALT:+00000.00 PDP:40 HDP:04 VDP:04 ERM:600,1200,30,60
PEM:05 SEM:OFF UNH:N ION:Y TRO:Y SAV:N
RTC:OFF PRT:A
SBA:OFF
NMEA: LTN POS GLL GXP GGA VTG GSN GSA GSV SAT GRS RRE ZDA GST GNS CRT GDC UTM
  UKO SUD DTM ALM
PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
  OFF OFF OFF OFF OFF OFF OFF OFF OFF
PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
  OFF OFF OFF OFF OFF OFF OFF OFF OFF
PER:001.00
```

Table 5.28 describes the items in the PAR response message:

Table 5.28. PAR Response Format

Item	Description	Range
SPDA:5	Serial port A baud rate. Default is 5 (9600).	0 to 9
SPDB:5	Serial port B baud rate. Default is 5 (9600).	0 to 9
SPDC:5	Serial port C baud rate. Default is 5 (9600).	0 to 9
GPS:Y...Y	Indicates which GPS satellites (1-32) will be used (Y) or ignored (N) in position computations. Default is Y for all satellites.	Y, N
SBAS:N...N	Not applicable to CP14.	
SYS	Indicates the satellite system used by the receiver.	GPS
DTM	Indicates whether the current geodetic reference datum is WGS-84 (W84) or a user-defined datum (USR). Default is W84.	W84, USR
TDP	Current TDOP (Time Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated TDOP value exceeds the TDOP mask value. The default setting is 40.	00.0 to 99.9
PMD:1	Current position mode setting for the minimum number of satellites required to compute a position. With default value 1, a minimum of 3 satellites are needed to compute a position. With 3 satellites, the altitude is fixed (2-D); with 4 or more, the altitude is computed (3-D).	0 to 3

Table 5.28. PAR Response Format (Continued)

Item	Description	Range
FIX	Current fixed altitude mode setting used when computing a 2-D position or when there are not enough visible satellites to compute a 3-D position. Mode 0 (default) Indicates that the altitude value is either the most recently entered antenna altitude ($PASHS,ALT) or the most recently computed altitude in which the VDOP value is lower than the VDOP mask.	0, 1
ALT	Current altitude of the antenna position (meters). Default is 00000.00 meters.	-99999.99 to +99999.99
PDP	Current PDOP (Position Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated PDOP value exceeds the PDOP mask value. The default setting is 40.	00.0 to 99.9
HDP	Current HDOP (Horizontal Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated HDOP value exceeds the HDOP mask value. Default is 04.	00.0 to 99.9
VDP	Current VDOP (Vertical Dilution Of Precision) mask setting. The receiver stops computing positions when the calculated VDOP value exceeds the VDOP mask value. Default is 04.	00.0 to 99.9
ERM	This setting indicates the mask values for horizontal and vertical error in relation to the different positioning modes. The default is OFF for both autonomous and differential modes which is represented by 6000,6000,6000,6000.	1 to 6000
PEM	Current position elevation mask setting (degrees). The receiver excludes any satellite from the position computation when its elevation falls below the elevation mask setting. Default is 05.	0° to 90°
SEM	This field indicates the secondary elevation mask angle value for a sector of the sky defined by two azimuth angles. The default is OFF.	ON, OFF
UNH	This setting indicates whether the receiver uses (Y) or ignores (N) unhealthy satellites. This setting is always N. The CP14 never uses unhealthy satellites in position computation.	N
ION	Indicates whether ionospheric modelling is enabled (Y) or disabled (N) in position computation. Default is always Y when the receiver is in differential mode and always Y in autonomous mode.	Y, N
TRO	Indicates whether tropospheric modelling is enabled (Y) or disabled (N) in position computation. The tropospheric setting is controlled by the ION setting. When ION is Y, then TRO is automatically set to Y	Y, N

Table 5.28. PAR Response Format (Continued)

Item	Description	Range
SAV	Indicates whether user-entered parameters are saved (Y) or not saved (N) in battery-backed memory. If user-entered parameters are not saved, the default parameter settings are restored at the next power cycle. Default is N.	Y, N
RTC	Not applicable to CP14.	
PRT	Port assignment for sending or receiving differential corrections.	A, B, C
SBA:OFF	Not applicable to CP14.	•
NMEA	Lists the NMEA and Ashtech NMEA-style messages supported by the CP14.	LTN, POS, GLL, GXP, GGA, VTG, GSN, GSA, GSV, SAT, GRS, RRE, ZDA, GST, GNS, CRT, GDC, UTM, UKO, SUD, DTM, ALM
PRTA	Indicates whether a given NMEA or Ashtech NMEA-style message is enabled (ON) or disabled (OFF) for output from Port A. Default is OFF.	ON, OFF
PRTB	Indicates whether a given NMEA or Ashtech NMEA-style message is enabled (ON) or disabled (OFF) for output from Port B. Default is OFF.	ON, OFF
PER	Output interval setting for NMEA and Ashtech NMEA-style messages. Default is 1 second.	1 to 999

PDP: PDOP Mask Value

$PASHS,PDP,d1

This command sets the value of the PDOP (Position Dilution of Precision) mask, where d1 is a number between 0 and 99. The receiver stops computing positions when the calculated PDOP value exceeds the PDOP mask value. You can view the current PDOP mask setting by entering the **$PASHQ,PAR** command and checking the PDP field.

Example

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

$PASHS,PDP,30

DEFAULT SETTING
PDP—40

PEM: Position Elevation Mask Value

$PASHS,PEM,d1

This command sets the elevation mask for position computation, where d1 is 0 to 90 degrees. Default is 5 degrees. A GPS satellite with an elevation less than the elevation mask setting is excluded from position computations. You can view the current elevation mask value by entering the query command $PASHQ,PAR and checking the PEM field.

Example

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

$PASHS,PEM,15

DEFAULT SETTING
PEM—5°

PMD: Position Mode

$PASHS,PMD,d1

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

- **Position Mode 0: Manual 3-D Mode**

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

- **Position Mode 1: Automatic 3-D Mode**

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

- **Position Mode 2: Manual 2-D Mode**

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

- **Position Mode 3: Automatic 3-D Mode**

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

Example

Enter the following command to select Position Mode 3:

$PASHS,PMD,3

DEFAULT SETTING
PMD—1

POW: Battery Parameters

$PASHS,POW,d1,d2,f1

This command sets the parameters associated with the external battery. The query and response uses the entered parameters to compute the approximate amount of remaining battery time. Table 5.29 defines the parameters.

Table 5.29. $PASHS,POW Parameters

Parameter	Description	Range
d1	Battery capacity in mAh	500 to 10000
d2	Battery capacity in percent (percent charged)	0 to 100
f1	Battery voltage	5.0 to 28.0

Example

Enter the following command to set the battery capacity to 1000 mAh, the battery capacity percent to 100%, and the battery voltage to 12.0 VDC.

$PASHS,POW,1000,100,12.0

The data for the external battery is estimated based on user-entered parameters and the power consumption of the CP14. Re-enter the battery parameters after clearing the CP14's internal memory, or connecting to a different battery. Using the CP14 to power external devices such as a radio can reduce the effectiveness of this command.

$PASHQ,POW,[c1]

The query command requests current available battery power data, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,POW,d1,d2,f3

The available battery power displayed in the response is computed from the battery parameters entered and the amount of time the receiver has been on.

$PASHR,POW,d1,d2,d3,f1*cc

where Table 5.30 defines the response format.

Table 5.30. POW Message Structure

Parameter	Description	Unit
d1	battery capacity (time)	minutes
d2	capacity remaining	minutes
d3	battery capacity (power)	mAh
f1	battery voltage	volts
*cc	checksum	n/a

PPO: Point Positioning

$PASHS,PPO,c

This command enables or disables the point positioning mode, where c is either Y (enable) or N (disable). Point positioning is an averaging algorithm that improves the stand alone accuracy of a static point after about 4 hours.

Example

Enter the following command to enable point positioning.

$PASHS,PPO,Y

$PASHQ,PPO

This command queries the point position mode.

$PASHR,PPO

The response is in the format:

$PASHR,PPO,c

where c is Y or N.

PPR: Position Parameters

$PASHQ,PPR

This command queries for the position computation parameters.

$PASHR,PPR

The response is in the format:

$PASHR,PPR,h1,h2,h3,h4,h5,h6,h7,h8,h9,h10

where Table 5.31 defines the parameters.

Table 5.31. $PASHR,PPR Response Format

Parameter	Description	Range
h1	Position Mode	0 to 3
h2	Altitude fix mode	0 to 1
h3	PDOP mask	0 to 99
h4	HDOP mask	0 to 99
h5	VDOP mask	0 to 99
h6	Position elevation mask	0 to 90
h7	Point position mode	N or Y
h8	Use unhealthy satellites for position computation	N or Y
h9	Use ionospheric model	N or Y
h10	Satellite System Used	GPS

PRT: Serial Port Baud Rate

$PASHQ,PRT,[c1]

This command queries the baud rate code of the CP14 serial port to which you are currently connected, where c1 is the optional serial port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port. Issue the query command **$PASHQ,PAR** to see the baud rate codes for both serial ports.

$PASHR,PRT

The response is output in the format:

$PASHR,PRT,c1,d2*hh

Table 5.32 defines the parameters.

Table 5.32. $PASHR,PRT Message Format

Parameter	Description	Range
c1	Identifier for the serial port to which you are currently connected	A, B, C (optional)
d2	Baud rate code (see Table 5.33)	0 to 9
hh	Checksum	2-character hex

Table 5.33 lists baud rate codes and the corresponding baud rates:

Table 5.33. CP14 Baud Rate Codes

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

DEFAULT SETTING
PRT— 5 (9600 baud)

PWR: Receiver Power

$PASHS,PWR,OFF

This command turns the receiver power off. Any activity from the serial port turns the receiver power on.

RID: Receiver Identification Parameters (Format 1)

$PASHQ,RID,[c1]

This command queries the various receiver identification parameters, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

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

$PASHR,RID

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

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

Table 5.34 defines the parameters.

Table 5.34. $PASHR,RID Fields

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

Three options are available for the CP14. Each option is represented by a letter or number in a definite order. The presence of a given option is indicated by the presence of the corresponding letter or number. A dash (“-”) indicates that a given option is not installed. An underscore (“_”) indicates a reserved option slot.

Table 5.35 lists the letters and numbers in conjunction with the options they represent.

Table 5.35. Available CP14 Options

Option	Description
[1 = 1 Hz]	Position/raw update rate
[O]	Raw data output
[P]	Carrier phase measurements

Typical RID response message:

$PASHR,RID,CP,#B27,1OP**$_{BBBBBBBBBBBBBBB}$*21**

Table 5.36 describes the typical RID response message.

Table 5.36. $PASHR,RID Fields

Field	Description
$PASHR	Header
RID	Message identifier
CP	CP14 receiver model identifier
#B27	Firmware version number
1OP$_{BBBBBBBBBBBBBBB}$	Options available: [1] 1 Hz position update rate [O] Raw data output [P] Carrier phase measurements
*21	Checksum

RIO: Receiver Identification Parameters (Format 2)

$PASHQ,RIO,[c1]

This command queries the receiver identification parameters, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

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

$PASHR,RIO

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

$PASHR,RIO,s1,s2,s3,s4,f5*hh

Table 5.37 defines the RIO message structure.

Table 5.37. RIO Message Structure

Field	Description
s1	Receiver model name (maximum 10 characters)
s2	Main processor firmware version number (maximum 10 characters)
s3	Channel firmware version number (maximum 10 characters). This field is empty for the CP14
s4	Option list (maximum 42 characters). ASCII characters represent options not available. For option definitions, see Table 5.35
s5	Receiver serial number (maximum 20 characters). Underscores represent blank fields
*hh	Checksum: XOR of all characters between the dollar sign ($) and the asterisk (*), but not including the dollar sign and asterisk

As with the RID query, the presence of a given option is indicated by the presence of the corresponding letter or number. A dash (“-”) indicates that a given option is not installed. An underscore (“_”) indicates a reserved option slot.

Typical RIO response message:

$PASHR,RIO,CP14,#B27,,1OPBBBBBBBBBBBBBBB,00000000000000000000*2F

Table 5.38 describes a typical RIO response message.

Table 5.38. $PASHR,RIO Fields

Field	Description
$PASHR	Header
RIO	Message identifier
CP14	Receiver model identifier
#B27	Firmware version number
,,	Empty field
1OPBBBBBBBBBBBBBBB	Options available: [1] 1 Hz position update rate [O] Raw data output [P] Carrier phase measurements
00000000........	Receiver serial number
*2F	Checksum

See Table 5.35 for more information on available options for the CP14.

RST: Restore Default Parameters

$PASHS,RST

This command restores the CP14 parameters to their default values. After issuing the RST command, you can query PAR (general receiver parameters), RAW (raw data output parameters) to obtain CP14 default settings. This command does not clear the receiver almanac.

SAV: Save Parameter Settings

$PASHS,SAV,c1

This command enables or disables saving of user-entered parameters in battery-backed memory, where c1 is Y (save) or N (don't save). If c1 is set to Y, user-entered parameters are saved until external memory is cleared through the INI command or default settings are restored through the RST command. If c1 is set to N, default parameter settings will be restored at the next power cycle. You can see whether user-entered parameters have been saved by issuing the **$PASHQ,PAR** command and checking the SAV field.

User-enter parameters cannot be saved unless a back-up battery is wired to appropriate pins on the J301 connector. Without a back-up battery, user-entered parameters will be lost after each power cycle even if the SAV parameter is set to Y.

The CP14 has a watchdog timer. If the processor hangs up for any reason, the watchdog timer resets the receiver. On reset, the receiver parameters most recently saved using the set command $PASHS,SAV will be used at startup following the reset. If parameter settings were not saved, the default settings will be used at startup.

SCM: Smoothing Counter Mask

$PASHS,SCM,d1

This command sets the smoothing counter mask where d1 ranges from 0 to 100 seconds. If the smoothing counter mask is set to 30 seconds, and the CP14 acquires a new satellite, then the data from the new satellite is only used in positioning after 30 seconds.

DEFAULT SETTING
SCM— 0

$PASHQ,SCM,[c1]

This command queries the smoothing mask counter, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SCM

The response is in the format

$PASHR,SCM,d1

where d1 ranges from 0 to 100 seconds

SEM: Secondary Elevation Mask

$PASHS,SEM,d1,d2,d3

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

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

DEFAULT SETTING
SEM— OFF

Example

To set the mask zone shown in Figure 4.7, you would enter the following command:

$PASHS,PEM 10

$PASHS,SEM,20,300,60

—or—

$PASHS,PEM 20

$PASHS,SEM,10,60,300

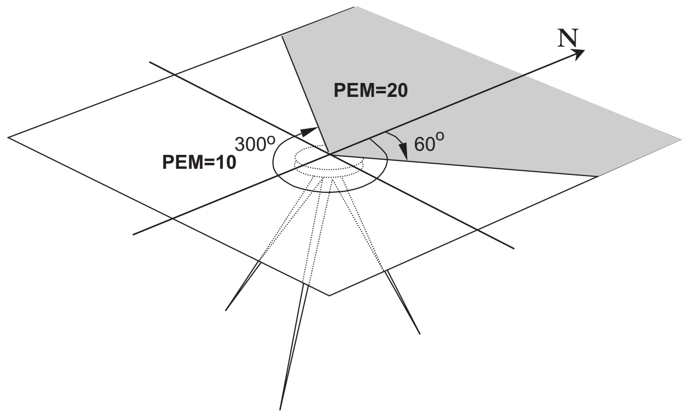


Figure 4.7. SEM Mask Zone

$PASHS,SEM,OFF

This command disables the SEM command.

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

SES,PAR: Session Programming Parameters

$PASHS,SES,PAR,c1,d1,d2

This command sets session programming parameters, where c1 sets the session mode and d2 and d3 set the reference day and daily offset. The reference day must be equal to or less than the current day for session programming to operate. Use the **$PASHS,SES,SET** command to program individual sessions.

Table 5.39. SES,PAR Message Structure

Setting Parameter	Description	Range
c1	Session in use Y = Yes N = No S = Sleep Mode	Y or N or S
d2	Session reference day	0 to 366
d3	Session offset (mm:ss)	0 to 59

Example

Enable session programming parameters with 4-minute daily offset to keep track of the daily change of the GPS satellite configuration:

$PASHS,SES,PAR,Y,121,0400

SES,SET: Individual Session Programing

$PASHS,SES,SET,c1,c2,d3,d4,f5,d6,d7,d8

This command sets the individual sessions for session programming. This command sets a single session. Up to 10 sessions may be programmed. You must use this command with the **$PASHS,SES,PAR** command.

Table 5.40. SES,SET Message Structure

Setting Parameter	Description	Range
c1	Session name	A to J
c2	Session flag	Y = Yes N = No
d3	Session start time (hhmmss)	hh = 0-23 mm = ss = 0-59
d4	Session end time (hhmmss)	hh = 0-23 mm = ss = 0-59
f5	Session record interval	0.1 to 999
d6	Session elevation mask	0 to 90
d7	Session min satellite	1 to 9
d8	Session data type	0, 2, or 4

Example

Set a session starting at 0100 that will run for 2 hours.

$PASHS,SES,SET,A,Y,010000,030000,10.0,10,3,0

If sleep mode is enabled, the receiver automatically powers on 2 minutes prior to session time to ensure all available satellites are tracked by the time recording starts.

$PASHQ,SES,[c1]

This command queries session programming parameters, where c1 is the optional output serial port.

Example

Query session programming parameters:

$PASHQ,SES

The response is in the format:

```
              START     END      INT      MASK    MIN   TYPE
A N      00:00:00 00:00:00 020.0    10       3       0
B N      00:00:00 00:00:00 020.0    10       3       0
C N      00:00:00 00:00:00 020.0    10       3       0
D N      00:00:00 00:00:00 020.0    10       3       0
E N      00:00:00 00:00:00 020.0    10       3       0
F N      00:00:00 00:00:00 020.0    10       3       0
G N      00:00:00 00:00:00 020.0    10       3       0
H N      00:00:00 00:00:00 020.0    10       3       0
I N      00:00:00 00:00:00 020.0    10       3       0
J N      00:00:00 00:00:00 020.0    10       3       0
INUSE:N      REF:000 OFFSET:00:00   TODAY:000
```

Table 5.41 lists the parameters in alphabetic order:

Table 5.41. SES Message Structure

Return Parameter	Description	Range
1st Column	Session Name	A to J
2nd Column	Session enabled flag	Y or N
3rd Column	Session start time (hours, minutes, seconds)	hh:mm:ss
4th Column	Session end time (hours, minutes, seconds)	hh:mm:ss
5th Column	Session recording interval (seconds)	0 to 1-999
6th Column	Session elevation mask	0 to 90
7th Column	Session minimum satellites	1 to 9
8th Column	Session data type	0, 2, or 4
INUSE	Session use	Y, N, or S
REF	Session reference day	0 to 366
OFFSET	Session time offset (minutes, seconds)	mm:ss
TODAY	Date of the year	0 to 366

SMI: Code Measurement Smoothing

$PASHS,SMI,d1,d2

Sets the interval in seconds of code measurements smoothing, reduceing the effect of noise, where d is the smoothing interval in seconds ranging from 0 to 1200, and d2 is the order of smoothing, 1 or 2. If d2 is omitted, the CP14 assumes first order of smoothing. This smoothing setting is independent of the internal receiver update interval.

If d2 = 1, the maximum value for d1 is 100. If d2 = 2, the maximum value for d1 is 1200.

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

Example

Set code measurement smoothing to 100 seconds:

$PASHS,SMI,100

DEFAULT SETTING		
SMI	Smoothing Interval	100 second
	Order of Smoothing	1

$PASHQ,SMI,[c1]

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

$PASHR,SMI

The response message is in the form:

$PASHR,SMI,d1,d2*cc

where d1 is the smoothing interval in seconds, and d2 is the order of smoothing (1 or 2).

SMV: Speed Filtering

$PASHS,SMV,d

This command sets the interval of speed filtering for the receiver velocity, reducing the noise effects on speed, where d is the interval ranging from 0 to 99 seconds. A filter interval of 0 seconds indicates no filtering.

$PASHQ,SMV,[c1]

This command queries the interval of speed filtering for the receiver velocity; c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SMV

The response is in the format:

$PASHR,SMV,d1

where d1 is the interval, which ranges from 0 to 99.

SNM: Signal-to-Noise Mask

$PASHS,SNM,d

This command sets the signal-to-noise mask for all satellites used in positioning, where d is the SNM mask value from 0 to 50. If the d is set to 35, then satellites with a signal to noise ratio less than 35 dB are not used in the position solution.

DEFAULT SETTING
SNM— 0

SPD: Serial Port Baud Rate

$PASHS,SPD,c1,d1

This command sets the baud rate for the CP14 serial ports, where c1 is port A, B, or C (optional port), and d1 is a code number between 0 and 9 corresponding to the baud rates listed in Table 5.42. The default baud rate is 9600. You can view the baud rate settings for ports A, B, and C by entering the **$PASHQ,PAR** command and checking the SPDA, SPDB, and SPDC fields.

Table 5.42. CP14 Baud Rate Codes

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

Example

Set baud rate of port A to 19200:

$PASHS,SPD,A,6

Set baud rate of port B to 4800:

$PASHS,SPD,B,4

If you change the baud rate of the CP14 serial port, be sure that the serial port of the device to which the CP14 port is connected is set to the same baud rate.

STA: Satellite Tracking Status

$PASHQ,STA,[c1]

This command queries the current satellite tracking status, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

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

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

Table 5.43 defines the parameters.

Table 5.43. STA Response Format

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

SUI: Satellite Usage Indicator

$PASHS,SUI, x

This command enables or disables the satellite usage indicator, where x is ON or OFF.

If **$PASHS,SUI, OFF** is sent, the usage indicator in the SAT message will be U for used or - for not used. If **$PASHS,SUI,ON** is sent, the usage indicator in the SAT message will be U for used or one of the letters listed in Table 5.44 in the SAT column.

Table 5.44. MCA Good/Bad Flags and SAT Messages When SUI is ON

MCA good/ bad Flag	SAT	Description
24	U	Used and position computed
23	U	Used and position not computed
22	-	RESERVED
21	M	Satellite NOT used because of low elevation
20	S	Satellite NOT used because the pseudo-range is not settled (transient is not over)
19	H	Satellite NOT used because marked 'unhealthy' in ephemeris
18	B	Satellite NOT used because of bad (URA or some accuracy problem indicated in navigational data)
17	Z	Satellite NOT used because marked 'unhealthy' in almanac
16	D	Satellite NOT used because differential corrections are old or invalid
15	J	Satellite NOT used because big code outlier was detected
14	R	Satellite NOT used because RAIM or some other algorithm detected a pseudo-range bias
13	I	Satellite NOT used because satellite disabled by external command SVP,USP)
12	L	Satellite NOT used because signal-to-noise ratio is less than mask
11	G	Satellite NOT used because it's possibly a ghost satellite
10	V	Satellite NOT used because computed satellite coordinates are suspicious
09	N	Satellite NOT used because satellite true number unknown (for modes, where we need the true satellite number
08	K	Satellite NOT used because it was disabled by RTK engine (N/A in CP14)
07	P	Satellite NOT used because no full range is available
02	O	Satellite NOT used because of some other cause
01	E	Satellite NOT used because no navigational data (ephemeris) is available

DEFAULT SETTING
SUI— 0

SVP: Include/Exclude Satellites for Position Computations

$PASHS,SVP,c1c2c3...c32

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

Examples

To exclude satellites 10 and 15 from the position computation, you could 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 32

$PASHQ,SVP,[c1]

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

$PASHR,SVP

The response message contains the current SVP settings for all 32 satellites. The format of the response message is nearly identical to the format used in the SVP set command:

$PASHR,SVP,c1c2c3…c32*hh

Table 5.45 defines the response message.

Table 5.45. $PASHR,SVP Message Format

Field	Description	Range
c1...c32	Indicates whether a satellites is included (Y) or excluded (N) for position computations	Y, N
*hh	Checksum	2-character hex

Typical SVP message:

$PASHR,SVP,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY*0D

Table 5.46 describes the SVP response message.

Table 5.46. $PASHR,SVP Message Format

Parameter	Description
$PASHR,SVP	Header
YYY…Y	Indicates that all 32 PRN numbers are included for position computations
*0D	Checksum

DEFAULT SETTING
SVP—Y (all satellites included)

SVS: Include/Exclude Satellites for Acquisition and Tracking

$PASHS,SVS,c1,c2,c3...c32

This command includes and 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 through 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. It is not necessary to enter a setting for all 32 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 32

$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 32 satellites. The format of the response message is nearly identical to the format used in the SVP set command:

$PASHR,SVS,c1c2c3…c32*hh

Table 5.47 defines the response message.

Table 5.47. $PASHR,SVS Message Format

Field	Description	Range
c1...c32	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,YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY*0E

Table 5.48 describes the SVS response message.

Table 5.48. $PASHR,SVS Message Format

Parameter	Description
$PASHR,SVP	Header
YYY…Y	Indicates that all 32 PRN numbers are included for acquisition and tracking
*0E	Checksum

DEFAULT SETTING
SVS—Y (all satellites included)

UCT,UDD,APT: Add point for 3-D Datum Transformation

$PASHS,UCT,UDD,APT,m1,c2,m3,c4,f5,m6,c7,m8,c9,f10,f11, f12,f13,f14,f15,f16

This command adds a point for the estimation of 3D datum transformation parameters where Table 5.49 defines the parameters. You must enter this command for each of the seven required data points to compute the 3-D datum transformation parameters.

Table 5.49. $PASHS,UCT,UDD,APT Parameters

Parameter	Description	Range
m1	Latitude of the position in WGS-84 (ddmm.mmmmm)	dd—0 to 90 mm.mmmmm—0 to 59.99999
c2	Latitude sector	N or S

Table 5.49. $PASHS,UCT,UDD,APT Parameters (Continued)

Parameter	Description	Range
m3	Longitude of the position in WGS-84 (dddmm.mmmmm)	dd—0 to 180 mm.mmmmm—0 to 59.99999
c4	Longitude sector	E or W
f5	Ellipsoidal height on WGS-84 (mm)	0 to 18000
m6	Latitude of the position in the local datum (ddmm.mmmmm)	dd—0 to 90 mm.mmmmm—0 to 59.99999
c7	Latitude sector	N or S
m8	Longitude of the position in the local datum (dddmm.mmmmm)	dd—0 to 180 mm.mmmmm—0 to 59.99999
c9	Longitude sector	E or W
f10	Ellipsoidal height on the local datum (mm)	0 to 18000
f11	Sigma latitude of WGS-84 point	0
f12	Sigma longitude of WGS-84 point	0
f13	Sigma altitude of WGS-84 point	0
f14	Sigma latitude of local datum	0
f15	Sigma longitude of local datum	0
f16	Sigma altitude of local datum	0

UCT,UDD,CAL: Calculate Datum Transformation Parameters

$PASHS,UCT,UDD,CAL

This command computes the estimated datum transformation parameters for the user-defined datum. In order to compute the estimated datum transformation parameters, you must have entered in at least seven data points with the **$PASHS,UCT,UDD,APT** command.

$PASHQ,UCT,UDD,CAL

This command queries the estimated datum transformation parameters of the user-defined datum.

$PASHR,UCT,UDD,CAL,f1,f2,f3,f4,f5,f6,f7,f8,f9,f10,f11,f12,f13,f14,f15

The response is in the format:

$PASHR,UCT,UDD,CAL,f1,f2,f3,f4,f5,f6,f7,f8,f9,f10,f11,f12,f13,f14,f15

Table 5.50 defines the UDD,CAL parameters.

Table 5.50. $PASHS,UTC,UDD,CAL Parameters

Parameter	Description	Range
f1	Semi-major axis of local datum (meters)	6300000 to 6400000
f2	Inverse flattening of local datum (meters)	290 to 310
f3	X shift origin of coordinates of ellipsoid (meters)	±1000.000
f4	Y shift origin of coordinates of ellipsoid (meters)	±1000.000
f5	Z shift origin of coordinates of ellipsoid (meters)	±1000.000
f6	Rotation in x axis (seconds) + rotation is counter clockwise - rotation is clockwise rotation	±10.000
f7	Rotation in y axis (seconds)	±10.000
f8	Rotation in z axis (seconds)	±10.000
f9	Delta Scale factor (scale factor - 1.0). (ppm)	±25.000
f10	Sigma latitude of WGS-84 point	0
f11	Sigma longitude of WGS-84 point	0
f12	Sigma altitude of WGS-84 point	0
f13	Sigma latitude of local datum	0
f14	Sigma longitude of local datum	0
f15	Sigma altitude of local datum	0

UCT,UDD,EST: Estimating a 3-D Datum Transformation

$PASHS,UCT,UDD,EST,f1,f2

This command indicates the start of a sequence of entering points for estimating 3D datum transformation parameters. Table 5.51 defines the UDD,EST parameters.

Table 5.51. $PASHS,UCT,UDD,EST Parameters

Parameter	Description	Range
f1	Semi-major axis of local datum	6300000 to 6400000
f2	Inverse flattening of local datum	290 to 310

UCT,UDH,APT: Add Point for Local Geoidal Surface Transformation

$PASHS,UCT,UDH,APT,f1,f2,f3,f4,f5,f6

This command adds a point for the estimation of local geoidal surface transformation parameters where the parameters are as defined in Table 5.52 . You must enter this command for each of the three required data points to compute the 3-D datum transformation parameters.

Table 5.52. $PASHS,UCT,UDH,APT Parameters

Parameter	Description	Range
f1	Easting based on user selected grid system (meters)	±9999999.99
f2	Northing based on user selected grid system (meters)	±9999999.99
f3	Ellipsoidal height	0 to 18000
f4	Orthometric height	0 to 18000
f5	Sigma ellipsoidal height	0
f6	Sigma orthometric height	0

UCT,UDH,CAL: Calculate Local Geoidal Surface

$PASHS,UCT,UDH,CAL

This command computes the estimated parameters for local geoidal surface. In order to compute the estimated grid transformation parameters, you must enter the four data points with the **$PASHS,UCT,UDH,APT** command.

$PASHQ,UCT,UDH,CAL

This command queries the estimated parameters of the local geoidal surface.

$PASHQ,UCT,UDH,CAL

The response is in the format

$PASHR,UCT,UDH,CAL,f1,f2,f3,f4,f5,f6

where the parameters are as defined in Table 5.53.

Table 5.53. $PASHQ,UCT,UDH,CAL Response Parameters

Parameter	Description	Range
f1	Rotation about x axis (seconds)	
f2	Rotation about y axis (seconds)	

Table 5.53. $PASHQ,UCT,UDH,CAL Response Parameters (Continued)

Parameter	Description	Range
f3	Vertical shift (meters)	
f4	Sigma rotation about x axis	0
f5	Sigma rotation about y axis	0
f6	Sigma vertical shift	0

UCT,UDH,EST: Estimating Local Geoidal Surface Transformation

$PASHS,UCT,UDH,EST

This command indicates the start of a sequence of entering points for estimating local geoidal surface transformation parameters.

UCT,UG4,APT: Add Point for Grid Transformation

$PASHS,UCT,UG4,APT,f1,f2,f3,f4,f5,f6,f7,f8

This command adds a point for the estimation of grid-to-grid transformation parameters where Table 5.54 defines the parameters. You must enter this command for each of the four required data points to compute the grid-to-grid transformation parameters.

Table 5.54. $PASHS,UCT,UG4,APT Parameters

Parameter	Description	Range
f1	Easting in known projection (meters)	±9999999.99
f2	Northing in known projection (meters)	±9999999.99
f3	Easting in local grid system (meters)	±9999999.99
f4	Northing in local grid system (meters)	±9999999.99
f5	Sigma easting in known projection	0
f6	Sigma northing in known projection	0
f7	Sigma easting in local grid system	0
f8	Sigma northing in local grid system	0

UCT,UG4,CAL: Calculate Grid Transformation Parameters

$PASHS,UCT,UG4,CAL

This command computes the estimated grid transformation parameters for the user-defined grid. In order to compute the estimated grid transformation parameters, you must have entered the four data points with the **$PASHS,UCT,UG4,APT** command.

$PASHQ,UCT,UG4,CAL

This command queries for the estimated grid-to-grid transformation parameters.

$PASHR,UCT,UG4,CAL,f1,f2,f3,f4,f5,f6,f7,f8

The response is in the format

$PASHR,UCT,UG4,CAL,f1,f2,f3,f4,f5,f6,f7,f8

where the response parameters are as defined in Table 5.55.

Table 5.55. $PASHR,UCT,UG4,CAL Response Parameters

Parameter	Description	Range
f1	Displacement easting (meters)	±9999999.99
f2	Displacement northing (meters)	±9999999.99
f3	Rotation in z axis (seconds)	
f4	Delta Scale factor (scale factor - 1.0). (ppm)	
f5	Sigma easting in “known” projection	0
f6	Sigma northing in “known” projection	0
f7	Sigma easting in local grid system	0
f8	Sigma northing in local grid system	0

UCT,UG4,EST: Estimating a Grid Transformation

$PASHS,UCT,UG4,EST

This command indicates the start of a sequence of entering points for estimating parameters in a user-defined Grid transformation.

UD4: User-Defined Datum to Datum Parameters

$PASHS,UD4,d1,f1,f2,f3,f4

This command sets the parameters for a 2-D datum-to-datum transformation. Table 5.56 defines the parameters.

Table 5.56. $PASHS,UD4 Parameters

Parameter	Definition	Range
d1	Base System	0 = WGS-84 1 = PZ-90
f1	Translation 1	-1000 to 1000
f2	Translation 2	-1000 to 1000
f3	Datum rotation in seconds of arc	-10.00 to 10.00
f4	Datum scale value in parts per million	-10.0 to 10.0

Example

Enter the following command to set conversion parameters for a user-defined datum. You can use the **$PASHS,DTM** command to enable the conversion to the user-defined datum.

$PASHS,UD4,0,100.0,295.5,0.00001,9.5

DEFAULT SETTING
UD4 Base System—WGS-84

UDD: User-Defined Datum

$PASHS,UDD,d1,f2,f3,$\Delta$x,$\Delta$y,$\Delta$z,$\varepsilon_x$,$\varepsilon_y$,$\varepsilon_z$,f4

This command sets parameters for the user-defined datum and stores them in battery-backed memory. Use this command with the **$PASHS,DTM,UDD** command, described on page 66. Table 5.57 lists the parameters of the **$PASHS,DTM,UDD** command.

$PASHQ,UDD,[c1]

This is the associated query command, where c1 is the optional output port. If a port is not specified, the receiver sends the response to the current port.

The response message is in the format:

$PASHR,UDD,d1,f2,f3,$\Delta$x,$\Delta$y,$\Delta$z,$\varepsilon$x,$\varepsilon$y,$\varepsilon$z,f4

Table 5.57. User-defined Datum Parameters

Field	Description	Range	Units	Default
d1	Identifier for the geodetic reference datum; always zero	0	N/A	0
f2	Semi-major axis	6300000.000 to 6400000.000	meters	6378137.000
f3	Inverse flattening. 1/f3 = f2/(f2-b), where b is semi-minor axis	290.00000000 to 301.00000000	meters	298.257223563
$\Delta x, \Delta y, \Delta z$	Translation from the local datum to WGS-84	-1000.000 to +1000.000	meters	0.00
$\varepsilon_x, \varepsilon_y, \varepsilon_z$	Rotations from the local datum to WGS-84. Viewed from the positive end of the axis about which the rotation takes place, the positive rotation is counterclockwise; the negative rotation is clockwise	-10.0000 to +10.0000	seconds of arc	0.00
f4	Delta scale factor (scale factor = 1 + delta scale factor)	-25.000 to +25.000	ppm	0.00

Example

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

$PASHS,DTM,USR

After the user-defined datum is activated, the receiver internally transforms positions *from* the reference datum (WGS-84) *to* the user-defined datum. In standard text books, however, the datum transformations are given *from* local datums *to* WGS-84. To simplify the entering of the transformation parameters, the translation, rotation, and scale parameters are defined *from* the local datum *to* WGS-84.

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

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

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

To clarify the datum transformation process, create a user-defined datum using parameters from the WGS-72 datum. Table 5.58 lists ellipsoid parameters for the WGS-84 datum and the WGS-72 datum:

Table 5.58. Ellipsoid Parameters for WGS-72 and WGS-84

Datum	Reference Ellipsoid	f2[f4]	1/f3
WGS-72	WGS-72	6378135.0	298.26
WGS-84	WGS-84	6378137.0	298.257223563

1. Enter the following UDD command which lists parameters from the WGS-72 datum:

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

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

   $PASHS,DTM,USR

The following ellipsoid values are now in effect:

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

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

Taking these values, the following equation is used in calculating the transformation from WGS-84 coordinates to WGS-72 coordinates:

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

The CP14 performs an internal coordinate transformation *from* WGS-84 *to* WGS-72 so that geodetic position messages can be output in the desired coordinates as dictated by the parameters specified in the UDD command. Figure 4.8 illustrates the translation and rotation that occur in the WGS-84 to WGS-72 transformation.

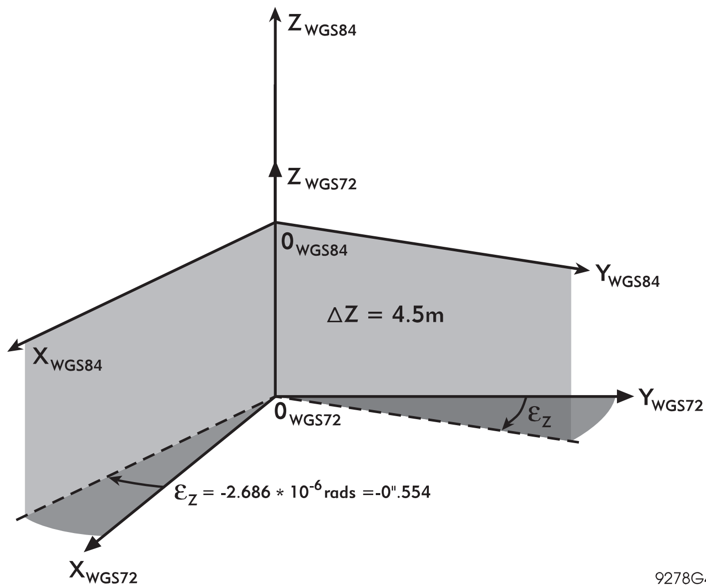


Figure 4.8. Rotation & Translation Between WGS-72 and WGS-84

UDG: User-Defined Datum-to-Grid Transformation

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

This command sets parameters to transform geodetic coordinates specified by the UDD command to grid coordinates. The CP14 performs the transformation internally. The number of UDG parameters required for the transformation depends on the type of map projection selected, and must be indicated by the user in the d2 parameter. The parameters for each map projection are listed in Table 5.59 through Table 5.66.

Table 5.59. UDG Structure for Equatorial Mercator

Field	Description	Range/Name	Units
s1	Map projection type	EMER	n/a
d2	Number of parameters for the selected projection	3	n/a

Table 5.59. UDG Structure for Equatorial Mercator (Continued)

Field	Description	Range/Name	Units
f3	Longitude for the central meridian	±1800000.0000	dddmmss.sss
f4	False northing	±10,000,000	meters
f5	False easting	±10,000,000	meters

Table 5.60. UDG Structure for Transverse Mercator

Field	Description	Range / Name	Units
s1	Map projection type	TM83	n/a
d2	Number of parameters for selected projection	5 or 7 (last 2 optional)	n/a
f3	Longitude for central meridian	±1800000.0000	dddmmss.ssss
f4	Scale factor at central meridian	0.5 to 1.5	n/a
f5	Latitude of grid origin of projection	±900000.0000	ddmmss.ssss
f6	False easting	±10000000	meters
f7	False northing	±10000000	meters
f8	Zone width (is 6°)	3 or 6	degrees
f9	Zone number at 0° longitude (default is 31°)	1 to 60	N/A

Table 5.61. UDG Structure for Oblique Mercator

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

Table 5.62. UDG Structure for Stereographic (Polar and Oblique)

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

Table 5.63. UDG Structure for Lambert CC SPC83 (2 Standard Parallels)

Field	Description	Range / Name	Units
s1	Map projection type	LC83	n/a
d2	Number of parameters for selected projection	6	n/a
f3	Latitude of southern standard parallel	±900000.0000	ddmmss.ssss
f4	Latitude of northern standard parallel	±900000.0000	ddmmss.ssss
f5	Longitude of grid origin of projection	±1800000.0000	ddmmss.ssss
f6	Latitude of grid origin of projection	±900000.0000	ddmmss.ssss
f7	False easting	±10,000,000	meters
f8	False northing	±10,000,000	meters

The SPC27 map projections presented in Table 5.64 must be used in conjunction with the Clarke 1866 ellipsoid: (a = 6378206.4 m and 1/f= 294.978698200) and the following datum (Tx = -8.0, Ty = 160.0, Tz = 176.0, rotation and scale = 0) which is included in the preset datum list as NAC.

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

Table 5.64. UDG Structure for Lambert CC SPC27

Field	Description	Range / Name
s1	Map projection type.	LC27
d2	Number of parameters for selected projection	11
f3	False easting or x coordinate of central meridian	L1

Table 5.64. UDG Structure for Lambert CC SPC27 (Continued)

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

f9: $\omega = \Phi - [1052.893882 - (4.483344 - 0.002352 * \cos^2\Phi) * \cos^2 \Phi] * \sin \Phi * \cos \Phi$

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

$No = a / (1-e^2 * \sin^2 \Phi o)^{1/2}$: radius of curvature in prime vertical at Φo

Table 5.65. UDG Structure for Transverse Mercator SPC27

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

Table 5.66. UDG Structure for Transverse Mercator SPC27 Alaska Zones 2-9

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

Examples

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

$PASHS,UDG,LC83,6,36000.0,371500.0,-1190000.0,352000.0,2000000,500000

Set datum-to-grid transformation parameters:

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

UDH: Geoidal Surface in a Local Area

$PASHS,UDH,f1,f2,f3

This command sets the parameters to determine a linear approximation of a geoidal surface in a local area where f1, f2, and f3 are the linear parameters that approximate a geoidal surface in a local area.

After you enter this command, and enter a UDH elevation model with the **$PASHS,HGT,UDH** command, the receiver computes the orthometric height based on the following equation:

Orthometric Height = f1 * X + f2 * Y + f3.

X and Y are the current grid coordinates.

$PASHQ,UDH

This command queries the linear parameters entered by the **$PASHS,UDH** command.

$PASHR,UDH

The response is in the format:

$PASHR,UDH,f1,f2,f3

where f1, f2, and f3 are the three parameters entered in by the **$PASHS,UDH** command.

USE: Satellites for Acquisition

$PASHS,USE,d1,c2

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

Example

Exclude satellite 13 from being tracked by the receiver:

$PASHS,USE,13,N

DEFAULT SETTING
USE—ALL

$PASHS,USE,ALL,c1

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

USP: Satellites Used in Position Computation

$PASHS,USP,d1,c2

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

Example

Exclude PRN 4 from being used in position computation:

$PASHS,USP,4,N

DEFAULT SETTING
USP—All satellites included for position computation

UTS: Synchronize with GPS Time

$PASHS,UTS,s

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

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

DEFAULT SETTING
UTS—OFF

$PASHQ,UTS,[c1]

The associated query command is **$PASHQ,UTS,[c1]**, where c1 is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHQ,UTS,

The response message is in the format:

$PASHR,UTS,x*cc

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

VDP: VDOP Mask

$PASHS,VDP,d1

This command sets the value of the VDOP mask, where d1 is a number between 0 and 99. If the VDOP value computed by the CP14 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,PAR and checking the VDP field.

Example

Set VDOP mask value to 6:

$PASHS,VDP,6

DEFAULT SETTING
VDP—4

VIS: Satellite Visibility

$PASHQ,VIS,[c1]

This command queries the satellites currently visible in the sky, where c1 is the optional output port. If a port is not specified, the receiver sends the response to the current port.

$PASHR,VIS

The response is in the format:

```
SATELLITES VISIBILITY:
GPS: FULLTIME:0690921841 TIME:18:44:01 NSV:06
 SV:   01  02 #03  04  05 #06 #07  08 #09 #10 #11 #12  13 #14 #15 #16
 EL:  *51 *27 -99 -02 -80 -99 -99 *32 -99 -99 -99 -99 *82 -99 -99 -99
 SV:  #17 #18 #19 #20 #21 #22 #23 #24 #25 #26  27  28 #29 #30 #31 #32
 EL:  -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 *58 *09 -99 -99 -99 -99
WAS: FULLTIME:0690921841 TIME:18:44:01 NSV:01
 SV:  #01 #02 #03 #04 #05 #06 #07 #08 #09 #10 #11 #12 #13 #14  15 #16
 EL:  -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 *15 -99
 SV:  #17 #18 #19 #20 #21 #22 #23 #24 #25 #26 #27 #28 #29 #30 #31 #32
 EL:  -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99 -99
```

where the parameters are as defined in Table 5.67.

Table 5.67. $PASHR,VIS Response Format

Parameter	Description
GPS	
FULLTIME	Number of seconds elapsed since the beginning of GPS evaluation (6 January 1980)
TIME	Current UTC time
NSV	Number of visible GPS satellites, based on the almanac. Since this is based on the almanac, NSV represents a theoretical visibility.
SV	GPS satellite PRN number
EL	GPS satellite elevation
WAS	Not applicable to CP14.

6

Raw Data Commands

Raw data commands allow you to set and query raw data parameters and raw data messages, including enabling or disabling the output of raw data messages, setting thresholds for the output of raw data messages, and setting an output interval for raw data messages. All raw data messages are disabled for output by default. Table 6.1 lists the raw data commands.

Table 6.1. Raw Data Commands

Command	Description	Default	Page
ALMANAC DATA			
$PASHS,RAW,SAL	Enable/disable raw almanac data.		158
$PASHQ,SAL	Query GPS raw almanac data.		158
RAW DATA OUTPUT			
$PASHS,RAW,ALL	Enable/disable raw data messages		109
EPHEMERIS DATA			
$PASHS,RAW,SNV	Enable/disable raw ephemeris message		160
$PASHQ,SNV	Query raw ephemeris data		160
MEASUREMENT DATA			
$PASHS,RAW,MBN	Enable/disable raw measurement data messages with Ashtech type 2 data structure		143
$PASHQ,MBN	Query raw measurement data messages with Ashtech type 2 data structure		143
$PASHS,RAW,MCA	Enable/disable raw measurements data (MCA)		145
$PASHQ,MCA	Query raw measurements data (MCA)		145
POSITION DATA			
$PASHS,RAW,GGB	Enable/disable position data (GGB)		142
$PASHQ,GGB	Query GGB position data		142
$PASHS,RAW,PBN	Enable/disable raw position data (PBEN)		155

Table 6.1. Raw Data Commands (Continued)

Command	Description	Default	Page
$PASHQ,PBN	Query raw position data (PBEN)		155
$PASHS,RAW,XYZ	Enable/disable 3-D satellite positions		162
$PASHQ,XYZ	Query 3-D satellite positions for tracked satellites		162
RAW DATA PARAMETERS			
$PASHS,RAW,CMB	Enable the channel measure block		134
$PASHQ,CMB	Query the channel measure block		134
$PASHS,ELM	Set raw data output elevation mask	5°	141
$PASHS,MSV	Set minimum number of satellites	3	154
$PASHS,RCI	Set recording interval	1	157
$PASHS,SIT	Set site name	????	159
COMBINED RAW DATA			
$PASHS,RAW,CT1	Enable/disable combined raw data in CT1 Format		136
$PASHQ,CT1	Query combined raw data in CT1 Format		136
$PASHS,RAW,CT2	Enable/disable combined raw data in CT2 Format		138
$PASHQ,CT2	Query combined raw data in CT2 Format		138
$PASHS,RAW,CT3	Enable/disable combined raw data in CT3 Format		140
$PASHQ,CT3	Query combined raw data in the CT3 Format data structure		140
MISCELLANEOUS DATA			
$PASHS,RAW,MIS	Enable/disable miscellaneous data structure message		151
$PASHQ,MIS	Query miscellaneous data structure message		151
MISSILE APPLICATION			
$PASHS,RAW,MCM	Enable/disable missile application condensed measurement message		148
$PASHQ,MCM	Query missile application condensed measurement message		149

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

If the output is set without a period, f1, and the period set by the $PASHS,RCI command is issued after individual RAW message output periods have been set, all individual message periods will be reset to the RCI output period setting.

Query commands prompt the receiver to output the corresponding response message once only. Message output prompted by a query command occurs independently of any related message output settings.

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

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

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

$PASHS,RAW,MBN,B,OFF

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

$PASHQ,MBN,B

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

Message Structure

Real-time messages are output in binary format:

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

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

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

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

Checksum

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

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

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

CMB: Channel Measure Block

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

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

$PASHQ,CMB,[c1]

This command queries the CMB message, where c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CMB

The message is output in the format:

$PASHR,CMB,<structure>

Table 6.3 defines the data string format.

Table 6.2. $PASHR,CMB Data String

Binary Type	Bytes	Content
unsigned int	2	The number of bytes remaining in the message. This value varies depending on the number of channels reported in the message.
char [2]	2	The version number for this message. For example 2.01. The first byte specifies the major part (2) and the second byte specifies the minor part (.01).
long	4	The time value for the internal receiver counter in milliseconds modulo one week.
int	2	Satellite PRN number associated with the data that follows. Values 1 to 32. 0 indicates that the channel is not used. This repeats for each channel.
int	2	• LBS bit0 = TRUE: the carrier loop locked at the instant the phase value was harvested. • LBS bit1 = TRUE: carrier phase lock indicator continuously locked since the last report. This repeats for each channel.
long	4	The raw doppler from the carrier loop (HZ*2^{12}/100). This repeats for each channel.
long	4	The raw accumulated carrier phase (cycles * 2^{16}). This phase reading shows jumps due to rollover of the long variable. This repeats for each channel.
long	4	Measured sub 1 ms code phase (chips*2^{16}). This repeats for each channel.
int	2	Measure of the quality of code phase (absolute value of tracking loop error). This repeats for each channel.
int	2	Signal-to-noise ratio from the carrier loop. This repeats for each channel.
int	2	Peak value of 10 ms sums of Q from the carrier loop since the last report. This repeats for each channel.
int	2	• LBS bit0 = TRUE: Preamble found: data count and sample count are good. • LBS bit1 = TRUE: TOW decoded for this PRN. This repeats for each channel.
int	2	Number of data bits since the beginnign of the preamble. This repeats for each channel.

Table 6.2. $PASHR,CMB Data String (Continued)

Binary Type	Bytes	Content
int	2	Number of epochs since the last bit edge. This repeats for each channel.
long	4	GPS time of week for the satellite PRN. This repeats for each channel.
short [checksum]	2	Checksum.
Total bytes = (32 * number of channel tracking satellites) + 10		

CT1: Combined Measurement/Position Data (Format 1)

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

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

$PASHQ,CT1,[c1]

This command queries for a combined raw data message in the CT1 data structure, which contains elements derived from the MCA and PBN messages; c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,CT1

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

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

Table 6.3 defines the data string format.

Table 6.3. $PASHR,CT1 Data String

Binary Type	Bytes	Content
Long [adj_rcvtime]	4	The time at which the data was received, based on the following formula using the rcvtime and navt values from the PBN message: adj_rcvtime = rcvtime - navt/speed of light
char [sv_no]	1	The number of satellites in the message (1...6).
char [remainder]	1	The number of satellites remaining for the current epoch; i.e., since the CT1 message can contain data for a maximum of six satellites, if the receiver is tracking eight satellites, two are remaining
char [chn1]	1	Channel (1...14)
char [prn1]	1	Satellite PRN number
double [smooth_rng1]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn2]	1	Channel (1...14)
char [prn2]	1	Satellite PRN number
double [smooth_rng2]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn3]	1	Channel (1...14)
char [prn3]	1	Satellite PRN number
double [smooth_rng3]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn4]	1	Channel (1...14)
char [prn4]	1	Satellite PRN number
double [smooth_rng4]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn5]	1	Channel (1...14)
char [prn5	1	Satellite PRN number
double [smooth_rng5]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn6]	1	Channel (1...14)
char [prn6]	1	Satellite PRN number
double [smooth_rng6]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message

Table 6.3. $PASHR,CT1 Data String (Continued)

Binary Type	Bytes	Content
short [checksum]	2	The checksum is calculated by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 10*number of satellites in the message + 8 (68 for 6 satellites)		

CT2: Combined Measurement/Position Data (Format 2)

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

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

$PASHQ,CT2,[c1]

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

$PASHR,CT2

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

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

Table 6.4 defines the data string format.

Table 6.4. $PASHR,CT2 Data String

Binary Type	Bytes	Content
Long [adj_rcvtime]	4	The time at which the data was received, based on the following formula using the rcvtime and navt values from the PBN message: adj_rcvtime = rcvtime - navt/speed of light
char [sv_no]	1	The number of satellites in the message (1...4)
char [remainder]	1	The number of satellites remaining for the current epoch; i.e., since the CT2 message can contain data for a maximum of four satellites, if the receiver is tracking eight satellites, four are remaining
char [chn1]	1	Channel (1...14)
char [prn1]	1	Satellite PRN number
double [full_phase1]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng1]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn2]	1	Channel (1...14)
char [prn2]	1	Satellite PRN number
double [full_phase2]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng2]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn3]	1	Channel (1...14)
char [prn3]	1	Satellite PRN number
double [full_phase3]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng3]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
char [chn4]	1	Channel (1...14)
char [prn4]	1	Satellite PRN number
double [full_phase4]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng4]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message

Table 6.4. $PASHR,CT2 Data String (Continued)

Binary Type	Bytes	Content
short [checksum]	2	The checksum is calculated by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 18*number of satellites in the message + 8 (80 for 4 satellites)		

CT3: Combined Measurement/Position Data (Format 3)

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

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

$PASHQ,CT3,[c1]

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

$PASHR,CT3

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

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

Table 6.5 defines the data string format.

Table 6.5. $PASHR,CT3 Data String

Binary Type	Bytes	Content
Long [adj_rcvtime]	4	The time at which the data was received, based on the following formula using the rcvtime and navt values from the PBN message: adj_rcvtime = rcvtime - navt/speed of light
char [sv_no]	1	The number of satellites in the message (1, 2, 3).

Table 6.5. $PASHR,CT3 Data String (Continued)

Binary Type	Bytes	Content
char [remainder]	1	The number of satellites remaining for the current epoch; i.e., since the CT3 message can contain data for a maximum of three satellites, if the receiver is tracking six satellites, three are remaining
char [chn1]	1	Channel (1...14)
char [prn1]	1	Satellite PRN number
double [full_phase1]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng1]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
long [doppler1]	4	Doppler measurement as defined in the MCA message
char [chn2]	1	Channel (1...14)
char [prn2]	1	Satellite PRN number
double [full_phase2]	8	Full carrier measurements in cycles as defined in the MCA message
double [smooth_rng2]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
long [doppler2]	4	Doppler measurement as defined in the MCA message
char [chn3]	1	Channel (1...14)
char [prn3]	1	Satellite PRN number
double [full_phase3]	8	Full carrier measurements in cycles (as defined in the MCA message)
double [smooth_rng3]	8	Smoothed pseudo-range measurement, derived from raw range data and smoothing as defined in the MCA message
long [doppler3]	4	Satellite doppler measurement (10^{-4} Hz) as defined in the MCA message
short [checksum]	2	The checksum is calculated by breaking the structure into shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 22*number of satellites in the message + 8 (74 for 3 satellites)		

Raw Data Commands

ELM: Elevation Mask for Raw Measurements Outputs

$PASHS,ELM,d1

This command sets the minimum elevation for the output of raw measurement data (CT1, MBN, MCA, etc.), where d1 is a number between 0 and 90. The receiver can be set to output raw measurement data for each satellite it is tracking that is above the elevation mask. It stops outputting raw measurement data for any satellite at or below the elevation mask. If the elevation mask is set to 10°, the receiver outputs raw measurement data for all tracked satellites with an elevation of 11° or higher, but does not output raw measurement data for any tracked satellites with an elevation of 10° or lower. You can view the current raw data elevation mask setting $PASHQ,RAW and checking the ELM field.

Examples

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

$PASHS,ELM,10

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

$PASHS,ELM,15

DEFAULT SETTING	
ELM	5°

GGB:GGB Position Data

$PASHS,RAW,GGB,c1,s2,f1

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

$PASHQ,GGB,[c1]

This command queries one GGB position data, where c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,RCI** command If the **$PASHS,RCI** command is issued after this message period has been set, the period resets to the RCI setting.

$PASHR,GGB

This message is not output unless the receiver is tracking at least one satellite. The GGB message contains some of the same measurement information as is contained in the GGA message: latitude, longitude, GPS position indicator, HDOP, UTC, time, etc. The structure of the message is in the format:

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

Table 6.6 defines the GGB data string format.

Table 6.6. $PASHR,GGB Data String Format

Binary Type	Name	Description
Char	cHour	UTC Hour
Char	cMin	UTC Minute
Float	fSec	UTC Second
Double	dLatitude	Latitude in radians
Double	dLongitude	Longitude in radians
Char	cQuality	GPS quality indicator: 0=no pos, 1=Raw pos
Char	cSatNum	Number of satellites used
Float	fHDOP	Horizontal dilution of precision (HDOP)
Float	fHeigh	Antenna height in meters above geoid
Float	fGeoInd	Geoidal undulation in meters. the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid), "-" = mean-sea-level below ellipsoid
Float	fDifAge	Age of differential data. Not applicable to CP14.
long	sId	Differential reference station ID 1 to 1023. Not applicable to CP14.
short	sCS	2 bytes sum from cHour to sCS (exclude sCS itself)

MBN: Raw Measurements (Ashtech Type 2 Data Structure)

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

This command enables or disables the measurement data (MBN) messages with Ashtech Type 2 data structure, where c1 is port A or B, s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending upon the measurement update rate option installed.

The CP14 outputs this message in binary format on every recording interval (RCI) for locked satellites with an elevation equal to or greater than the elevation mask (ELM), and only if the number of locked satellites is equal to or greater than the minimum satellite mask (MSV).

$PASHQ,MBN,[c1]

This command queries for raw satellite measurement data contained in the Ashtech Type 2 data structure.

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,RCI** command If the **$PASHS,RCI** command is issued after this message period has been set, the period resets to the RCI setting.

$PASHR,MBN

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

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

Table 6.7 defines the data string format.

Table 6.7. $PASHR,MBN Data String

Field	Bytes	Content
char [datatype]	1	Always = 1
char [count]	1	Number of measurement structures to follow after this one
char [svprn]	1	Satellite PRN number
char chnind	1	Channel (1 to 14) assigned to the satellite
long [lost_lock_ctr]	4	Continuous counts since satellite is locked. This number is incremented about 500 times per second
char [polarity]	1	This number is either 0 or 5. 0 indicates that satellite is just locked, and 5 indicates that the beginning of the first frame has been found
char [goodbad]	1	This number is either 22 or 24. Twenty-two indicates the satellite is not usable; twenty-four indicates the satellite is usable for position computation.
char [warning]	1	Always zero
char [ireg]	1	Satellite signal strength
double [codetxmt]	8	The fractional part of the satellite transmit time in seconds. The integer part of this number is ignored.
long [doppler]	4	Satellite doppler measurement (10^{-4} Hz)
double [intdoppler]	8	Total phase in cycles - available only if carrier phase option installed
short carphase1	2	Reserved
short carphase2	2	Reserved
short elevation	2	Satellite elevation in units of 0.01 degrees
short azimuth	2	Satellite azimuth in degrees

Table 6.7. $PASHR,MBN Data String (Continued)

Field	Bytes	Content
checksum	2	The checksum is computed by breaking the structure into 20 unsigned shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 42		

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

MCA: Raw Measurements (Ashtech Type 3 Data Structure)

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

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

The CP14 outputs this message in binary format on every recording interval (RCI) for locked satellites with an elevation equal to or greater than the elevation mask (ELM), and only if the number of locked satellites is equal to or greater than the minimum satellite mask (MSV).

$PASHQ,MCA,[c1]

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,RCI** command If the **$PASHS,RCI** command is issued after this message period has been set, the period resets to the RCI setting.

$PASHR,MCA

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

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

Table 6.8 defines the data string format.

Table 6.8. $PASHR,MCA Data String

Field	Bytes	Content
unsigned short [sequence tag]	2	Sequence ID number in units of 50 ms, modulo 30 minutes
unsigned char [left]	1	Number of remaining MCA messages to be sent for current epoch
unsigned char [svprn]	1	Satellite PRN number (1 to 32)
unsigned char [elev]	1	Satellite elevation angle in degrees
unsigned char [azim]	1	Satellite azimuth angle in increments of 2 degrees
unsigned char [chnind]	1	Channel (1 to 14) assigned to the satellite
unsigned char [warning]	1	Warning flag: • Bit 1 set - See note below • Bit 2 set - See note below • Bit 3 set - Carrier phase questionable • Bit 4 set - Code phase questionable • Bit 5 set - Code phase integration questionable • Bit 6 set - Not used • Bit 7 set - Possible loss of lock • Bit 8 set - Loss of lock; counter reset The interpretation of bits 1 and 2 is as follows: [Bit 1, Bit 2] • [0, 0] Same as 22 in good/bad flag (see next field) • [1, 0] Same as 23 in good/bad flag • [0, 1] Same as 24 in good/bad flag Note that more than one bit may be set at the same time, e.g., if bits 1, 3, and 6 are set at the same time, the warning flag is 37 (1 + 4 + 32)

Table 6.8. $PASHR,MCA Data String (Continued)

Field	Bytes	Content
unsigned char [goodbad]	1	Indicates the quality of the position measurement: • 24—Used and position computed. • 23—Used, position not computed • 22—RESERVED • 21—Satellite NOT used because of low elevation • 20—Satellite NOT used because the pseudo-range is not settled (transient is not over) • 19—Satellite NOT used because marked 'unhealthy' in ephemeris • 18—Satellite NOT used because of bad URA (or some accuracy problem indicated in navigational data) • 17—Satellite NOT used because marked 'unhealthy' in almanac • 16—Satellite NOT used because differential corrections are old or invalid. • 15—Satellite NOT used because big code outlier was detected • 14—Satellite NOT used because RAIM or some other algorithm detected a pseudo-range bias. • 13—Satellite NOT used because SV disabled by external command SVP,USP) • 12—Satellite NOT used because Signal To Noise Ratio is less than Mask • 11—Satellite NOT used because it's possibly a ghost satellite • 10—Satellite NOT used because computed satellite coordinates are suspicious • 09—Satellite NOT used because satellite true number unknown (for modes, where we need the true SV number • 08—Satellite NOT used because it was disabled by RTK engine (N/A in CP14) • 02—Satellite NOT used because of some other case • 01—Satellite NOT used because no navigational data (ephemeris) is available
unsigned char [polarity_known]	1	This number is either 0 or 5, 0 meaning satellite is just locked, and 5 meaning the beginning of the first frame has been found
unsigned char [ireg]	1	Signal-to-noise measurement for the satellite observation
unsigned char [qa_phase]	1	Not used; always zero
double [full phase]	8	Full carrier phase measurements in cycles. Not available unless carrier phase option is installed
double [raw_range]	8	Raw range to satellite in seconds, i.e., receive time - raw range = transmit time
long [doppler]	4	Doppler (10^{-4} Hz)

Table 6.8. $PASHR,MCA Data String (Continued)

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

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

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

MCM: Missile Application Condensed Measurement Record (MACM)

This message optimizes the data output and data transmission in high dynamic applications requiring high speed data output with communications bandwidth limitations.

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

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

Examples

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

$PASHS,RAW,MCM,A,ON

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

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

$PASHQ,MCM,c1

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

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

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

MACM Message Structure

This message is not output unless positions are being computed. MCM is a combined message containing elements from the MBN, MCA, and PBN messages. The MCM message was designed for high speed data output under the limited bandwidth conditions common to high dynamic telemetry. Satellite PRN number, receive time (the time at which the data was received), doppler measurements, pseudo-range measurements, and full carrier phase measurements are contained in this message. The MCM message is variable in length, defined by the count field in the header. The message begins with a 4-byte sync word [4D 41 43 4D] (ASCII “MACM”) and ends with a checksum byte. The **<CR><LF>** characters that terminate the majority of CP14 response messages are not used in this case. In addition, the usual response header, $PASHR, is not used here. If the receiver is set to output the MCM message at regular intervals, the MACM sync word appears only the first time the message is output and is excluded from the messages that follow; however, the sync word is output each time MCM is queried. The following is the output for one epoch. The syntax for each parameter is listed in brackets ads [parameter name:number of bytes for parameter]. At the right of each line is an identifier and byte count.

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

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

[CHECKSUM:1]                                                             Checksum: 1
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

The total message length for 8 satellite measurements is 207 bytes.

Table 6.9 defines the MACM data string format.

Table 6.9. MACM Data String

Byte #	Name	Type	Size	Content	Origin
1	MACM	char	4	Name of Message ("MACM")	sync_word (ASCII "MACM")
5	COUNT	char	2	Number of remaining structures to be sent for the current epoch.	MBN record, count
7	RCVTIME	long	4	Signal received in milliseconds of week GPS system time. This is the time tag for all measurements and position data.	PBN record, rcvtime
11	NAVT	float	4	Receiver clock offset in meters.	PBN record, navt
24*j-9	PRN	unsigned char	1	Satellite PRN number	MCA record, svprn
24*j-8	WRN	unsigned char	1	Warning flag, where: • Bit 1 set = see note below • Bit 2 set = see note below • Bit 3 set = carrier phase questionable • Bit 4 set = code phase questionable • Bit 5 set = code phase integration questionable • Bit 6 set = not used • Bit 7 set = possible loss of lock • Bit 8 set = loss of lock counter reset The interpretation of bits 1 and 2 is as follows: Bit 1 Bit 2 • 0 0 Same as 22 in goodbad flag (see next field) • 1 0 Same as 23 in goodbad flag • 0 1 Same as 24 in goodbad flag More than one bit may be set at the same time, e.g., if bits 1, 3, and 6 are set at the same time, the warning flag is 37 (1 + 4 + 32)	MCA record, warning
24*j-7	POL	unsigned char	1	This number is either 0 or 5, 0 meaning satellite is just locked, and 5 meaning the beginning of the first frame has been found.	MCA record, polarity_known
24*j-6	CN0	unsigned char	1	Signal-to-noise of satellite observation	MCA record, ireg

Table 6.9. MACM Data String (Continued)

Byte #	Name	Type	Size	Content	Origin
24*j-5	PHASE	double	8	Full carrier phase measurements in cycles. Not available unless carrier phase option is installed.	MCA record, full_phase
24*j+3	RANGE	unsigned long	4	Pseudo-range in seconds, sf=3.0e10	G-8 ITA record, raw_range
24*j+7	DPL	long	4	Doppler (10^{-4} Hz)	MCA record, doppler
24*j+11	LCK_TIME	unsigned long	4	Continuous counts since satellite is locked. This number increments about 500 times per second	MBN record, lost_lock_ctr
24*N+15	checksum	unsigned char	1		MCA record

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

MIS: Miscellaneous Data Structure

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

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

$PASHQ,MIS, [c1]

This command queries the miscellaneous data message, where c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,MIS,<struct>

The response is in the format $PASHR,MIS,<struct>*hh. The output varies depending upon the RTCM message type. Table 6.10 defines the $PASHR,MIS response structure for RTCM Type 1 message.

Table 6.10. $PASHR,MIS Response Format for Message Type 1

Field	Length (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 and 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 999us. Receive Time (us) = 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. Always 0.
unsigned short NumGpsSatsTrkd	1	Number of GPS satellites tracked.
unsigned short NumGloSatsTrkd	1	Number of GLONASS satellites tracked. Always 0.
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. Not applicable to CP14. • 1 0 —Differential corrections applied. Not applicable to CP14. • 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.

Table 6.10. $PASHR,MIS Response Format for Message Type 1 (Continued)

Field	Length (bytes)	Content
unsigned short VDOP	2	VDOP multiplied by 100.
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: • User Range Accuracy (URA) Flag (“accuracy alert”, bit 18 of the Hand-Over-Word (HOW)) is set (ref. paragraph 2.4.2.2 of GPS SPS Signal Specification); • Failure of parity on 3 successive words of the navigation data; • All data bits in subframe 1, 2 or 3 are 0’s; • Default navigation data (alternate 1’s and 0’s) is transmitted in words 3 through 10 of subframe 1, 2 or 3 for that satellite (ref. paragraph 2.4.1.3 of GPS SPS Signal Specification).
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.
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.

Table 6.10. $PASHR,MIS Response Format for Message Type 1 (Continued)

Field	Length (bytes)	Content
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: • User Range Accuracy (URA) Flag (“accuracy alert”, bit 18 of the Hand-Over-Word (HOW)) is set (ref. paragraph 2.4.2.2 of GPS SPS Signal Specification); • Failure of parity on 3 successive words of the navigation data; • All data bits in subframe 1, 2 or 3 are 0’s; • Default navigation data (alternate 1’s and 0’s) is being transmitted in words 3 through 10 of subframe 1, 2 or 3 for that satellite (ref. paragraph 2.4.1.3 of GPS SPS Signal Specification).
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: • 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 data bits in a string of any frame 1, 2, 3, 4 or 5 are 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	integer
Total Characters	42	

MSV: 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 stops outputting measurement data if the number of satellites it is tracking falls below this minimum. You can view the current setting for minimum satellites by entering the **$PASHQ,RAW** command and checking the MSV field.

Examples

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

$PASHS,MSV,4

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

$PASHS,MSV,1

DEFAULT SETTING	
MSV	3

PBN: Raw Position Data

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

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

$PASHQ,PBN,[c1]

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

$PASHR,PBN

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

$PASHR,PBN,<Raw Position Data + Checksum>

Table 6.11 defines the message format.

Table 6.11. PBN Raw Position Data String

Field	Bytes	Content
long rcvtime	4	Signal received time in milliseconds of week of GPS time. This is the time tag for all measurements and position data
char sitename	4	4 character string (user entered)

Table 6.11. PBN Raw Position Data String (Continued)

Field	Bytes	Content
double navx	8	X coordinate of the antenna position (ECEF) in meters
double navy	8	Antenna position ECEF y coordinate in meters
double navz	8	Antenna position ECEF z coordinate in meters
float navt	4	Receiver clock offset in meters
float navxdot	4	The antenna x velocity in meters per second
float navydot	4	The antenna y velocity in meters per second
float navzdot	4	The antenna z velocity in meters per second
float navtdot	4	Receiver clock drift in meters per second
unsigned short PDOP	2	PDOP multiplied by 100
checksum	2	The checksum is computed by breaking the structure into 27 unsigned shorts, adding them together, and taking the least significant 16 bits of the result
Total bytes: 56		

RAW: RAW Data Query Command

$PASHQ,RAW,x

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

The response is in the format:

RCI:020.00 MSV:3 ELM:05 SIT:????

RAW: MCA MBN PBN MIS XYZ DIF MSB GGB MCM CMB CT1 CT2 CT3 SNV SAL

PRTA: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF

PRTB: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF

Table 6.12 defines the response parameters:

Table 6.12. $PASHQ,RAW Response Parameters

Field	Description
RCI:001.00	This is the output interval of the data in seconds. This example has an output of 1 second. The default is once every 1 seconds.
MSV:3	Minimum number of satellites for the data to be output. Default is 3.
ELM:05	Data elevation mask. Elevation below which data from that satellite will not output.
SIT:????	Four-character site name.
EPG	Number of Kinematic epoch for a site.
RAW:	Raw data types: MCA, MBN, PBN, MIS, XYZ, DIF, MSB, CT1, CT2, CT3, SNV, SAL
PRTA PRTB	Communication Ports A and B
OFF/XX	OFF indicates that the RAW data message is not sent to the port. If the message is sent to the communication port, this field delivers the output rate (XX).

RCI: Set Output Interval for Raw Messages

$PASHS,RCI,f1

This command sets a global output interval for all raw messages, where f1 is the value for the output interval. Use Table 6.13 to determine the value for f1. This command overrides individual settings for output interval. That is, if the CT1 message is enabled for output at intervals of two seconds and the MBN message is enabled for output at intervals of ten seconds, you can ese the RCI command to set an output interval of five seconds and reset the output interval of both messages to five seconds. You can view the current raw data output interval setting by entering the **$PASHQ,RAW** command and checking the RCI field.

Example

Set the global raw data output interval to 5 seconds:

$PASHS,RCI,5

Table 6.13. Raw Data Update Rate Option

Installed Option	Option Symbol	RCI Range (seconds)	Increment
1 Hz	1	1-999	1 second

DEFAULT SETTING	
RCI	1

The CP14 is designed to synchronize raw message output with the hour rollover, so that message output from multiple receivers can be synchronized regardless of when they were turned on.

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

SAL: Satellite Almanac Data

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

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

The CP14 output almanac data for all satellites once every hour, and outputs one satellite at each recording interval (RCI).

$PASHQ,SAL,[c1]

This command queries for satellite almanac data. c1 is the optional port designator for the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,SAL

This message is not output until the CP14 has completed downloading the current GPS almanac file. The receiver begins downloading the almanac file automatically almanac file can be obtained directly from the satellites, which happens automatically and takes about twelve minutes, or, with the aid of software, a current almanac file from another receiver can be manually downloaded into the CP14. A separate almanac message is output for each satellite being tracked. The SAL message contains information on satellite health, the almanac week number, and a variety of orbital measurements. The response is output in the format:

$PASHR,SAL,<Satellite almanac data string + checksum>

Table 6.14 defines the data string format.

Table 6.14. $PASHR,SAL Data String

Field	Bytes	Content
short prn	2	Satellite PRN number -1
short health	2	Satellite health
float e	4	Eccentricity
long toa	4	Reference time for orbit (sec)
float i0	4	Inclination angle (semicircles)
float omegadot	4	Rate of right ascension (semicircles/sec)
double roota	8	Square root of semi-major axis (meters 1/2)
double omega0	8	Longitude of ascending node (semicircles)
double omega	8	Argument of perigee (semicircles)
double m0	8	Mean anomaly at reference time (semicircles)
float af0	4	Clock correction (sec)
float af1	4	Clock correction (sec/sec)
short wna	2	Almanac week number
short wn	2	Week number
long tow	4	Seconds of GPS week
checksum	2	The checksum is computed by breaking the structure into 34 unsigned shorts, adding them together, and taking the least significant 16 bits of the result
Total Bytes: 70		

SIT: Site Name for Observation Session

$PASHS,SIT,s1

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

Examples

Enter the following command to set site name to 0001:

$PASHS,SIT,0001

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

$PASHS,SIT,SQR1

DEFAULT SETTING	
SIT	????

SNV: Satellite Ephemeris Data

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

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

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

$PASHQ,SNV,[c1]

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

$PASHR,SNV

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

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

Table 6.15 defines the data string format.

Table 6.15. $PASHQ,SNV Response Structure

Field	Bytes	Content
short wn	2	GPS week number
long tow	4	Seconds of GPS week
float tgd	4	Group delay (seconds)
long aodc	4	Clock data issue

Table 6.15. $PASHQ,SNV Response Structure (Continued)

Field	Bytes	Content
long toc	4	Clock data reference time in seconds
float af2	4	Clock correction (sec/sec2)
float af1	4	Clock correction (sec/sec)
float af0	4	Clock correction (sec)
long aode	4	Orbit data issue
float deltan	4	Mean anomaly correction (semicircles/sec)
double m0	8	Mean anomaly at reference time (semicircles)
double e	8	Eccentricity
double roota	8	Square root of semi-major axis (meters 1/2)
long toe	4	Reference time for orbit (sec)
float cic	4	Harmonic correction term (radians)
float crc	4	Harmonic correction term (meters)
float cis	4	Harmonic correction term (radians)
float crs	4	Harmonic correction term (meters)
float cuc	4	Harmonic correction term (radians)
float cus	4	Harmonic correction term (radians)
double omega0	8	Longitude of ascending node (semicircles)
double omega	8	Argument of perigee (semicircles)
double i0	8	Inclination angle (semicircles)
float omegadot	4	Rate of right ascension (semicircles/sec)
float idot	4	Rate of inclination (semicircles/sec)
short accuracy	2	User range accuracy
short health	2	Satellite health
short fit	2	Curve fit interval
char prnnum	1	Satellite PRN number minus 1 (0 to 31)
char res	1	Reserved character

Table 6.15. $PASHQ,SNV Response Structure (Continued)

Field	Bytes	Content
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		

XYZ: 3D Satellite Positions

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

This command enables or disables the 3-dimensional satellites position messages, where c1 is port A or B, s2 is ON or OFF, and f1 is the optional numeric output interval setting supporting a range of 0.05 to 999 seconds, depending on the measurement update rate option installed.

$PASHQ,XYZ,c1

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

$PASHR,XYZ

In addition to satellite positions, the XYZ message also contains the time at which the satellite signals were received and a pseudo-range value which has been corrected to eliminate atmospheric delays and uncertainties resulting from the differences in velocity between the CP14 and the satellites (relativistic errors).

The XYZ message is output in the format below:

$PASHR,XYZ<Satellite position data string + checksum>

Table 4.16 defines the response message.

Table 4.16. XYZ 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	The total number of satellites appearing in the message.

Table 4.16. XYZ Data String (Continued)

Field	Bytes	Content
short [sv_1]	2	The PRN number of the satellite (1 - 56) being tracked on channel 1 of the CP14.
double [satx_1]	8	The x coordinate of the satellite being tracking on channel 1 of the CP14; referenced to WGS-84.
double [saty_1]	8	The y coordinate of the satellite being tracking on channel 1 of the CP14; referenced to WGS-84.
double [satz_1]	8	The z coordinate of the satellite being tracking on channel 1 of the CP14; referenced to WGS-84.
double [range_1]	8	The corrected pseudo-range of the satellite referenced in [sv_1].
(These rows are repeated for each channel that is tracking a satellite. That is, if the CP14 is tracking seven satellites, these rows are repeated seven times; if the CP14 is tracking twelve satellites, these rows are repeated twelve times.)		
short [sv_n]	2	The PRN number of the satellite (1 - 56) being tracked on channel *n* of the CP14.
double [satx_n]	8	The x coordinate of the satellite being tracking on channel *n* of the CP14; referenced to WGS-84.
double [saty_n]	8	The y coordinate of the satellite being tracking on channel *n* of the CP14; referenced to WGS-84.
double [satz_n]	8	The z coordinate of the satellite being tracking on channel *n* of the CP14; referenced to WGS-84.
double [range_n]	8	The corrected pseudo-range of the satellite referenced in [sv_n].
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		

7

NMEA Commands

NMEA commands allow you to set parameters for outputting NMEA messages and Ashtech format NMEA-style messages. These commands can be sent to the CP14 through either serial port. Table 7.1 lists the set and query commands used in controlling NMEA message output. All NMEA messages and Ashtech format NMEA-style messages are disabled for output by default.

Table 7.1. NMEA Data Message Commands

Command	Description	Page
GENERAL COMMAND FOR CONTROLLING NMEA OUTPUT		
$PASHS,NME,ALL	Disable all messages	169
$PASHS,NME	Disable one or more NMEA message	167
LATENCY INFORMATION		
$PASHS,NME,LTN	Enable or disable the latency message	193
$PASHQ,LTN	Query position output latency	193
OUTPUT RATE PARAMETER		
$PASHS,NME,PER	Set send interval of NMEA response message	194
ALMANAC INFORMATION		
$PASHS,NME,ALM	Enable or disable almanac message	169
$PASHQ,ALM	Query almanac message	169
POSITION INFORMATION		
$PASHS,NME,GGA	Enable or disable 3-D position response message. Default is FUL.	175
$PASHQ,GGA	Query 3-D position message	176
$PASHS,GGA	Set the GGA message format	175
$PASHS,NME,GLL	Enable or disable latitude/longitude message	178
$PASHQ,GLL	Query latitude/longitude message	178
$PASHS,NME,GXP	Enable or disable horizontal position message	191

Table 7.1. NMEA Data Message Commands (Continued)

Command	Description	Page
$PASHQ,GXP	Query horizontal position message	191
$PASHS,NME,POS	Enable or disable NMEA position response message	194
$PASHQ,POS	Query NMEA position response message	194
$PASHS,NME,RMC	Enable or disable minimum position, course/speed message	197
$PASHQ,RMC	Query minimum position, course/speed message	197
RECEIVER CONFIGURATION		
$PASHS,NME,CRT	Enable or disable Cartesian coordinates message	171
$PASHQ,CRT	Query Cartesian coordinates message	171
$PASHS,NME,GDC	Enable or disable Grid coordinates message	172
$PASHQ,GDC	Query Grid coordinates message	173
$PASHS,NME,UTM	Enable or disable Universal Transverse Mercator (UTM) coordinates message	204
$PASHQ,UTM	Query Universal Transverse Mercator (UTM) coordinates message	205
TIME AND DATE		
$PASHS,NME,ZDA	Enable or disable time and date message	209
$PASHQ,ZDA	Query time and date information	210
COURSE AND SPEED		
$PASHS,NME,VTG	Enable or disable velocity/course message	207
$PASHQ,VTG	Query velocity and course information	207
RESIDUAL INFORMATION		
$PASHS,NME,RRE	Enable or disable satellite residual and position error	199
$PASHQ,RRE	Query satellite residual and position error information	199
$PASHS,NME,GRS	Enable or disable satellite range residual information message	181
$PASHQ,GRS	Query satellite range residual information message	181
$PASHS,NME,GST	Enable or disable pseudo-range error message	187
$PASHQ,GST	Query pseudo-range error message	187
SATELLITE INFORMATION		
$PASHQ,GNS	Query GNSS fix data	180
$PASHS,NME,GSA	Enable or disable satellites used message	183
$PASHQ,GSA	Query satellites used message	183

Table 7.1. NMEA Data Message Commands (Continued)

Command	Description	Page
$PASHS,NME,GSN	Enable or disable signal strength and satellite number message	185
$PASHQ,GSN	Query signal strength and satellite number message	185
$PASHS,NME,GSV	Enable or disable satellites in view message	189
$PASHQ,GSV	Query satellites in view message	189
$PASHS,NME,SAT	Enable or disable satellite status message	201
$PASHQ,SAT	Query satellite status message	201
UKOOA MESSAGE		
$PASHS,NME,UKO	Enable or disable UKOOA message	203
$PASHQ,UKO	Query UKOOA information	203
EXCEPTION MESSAGE		
$PASHS,NME,XMG	Enable or disable exception message	208
$PASHQ,XMG	Query exception message information	208

The general format for set commands used to control NMEA message output is:

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

In this context, set commands are used to enable the output of NMEA messages at regular intervals or to disable message output, where s1 is a three character message identifier (GGA, VTG, SAT, etc.). c1 is the port designator (A or B) for message output. s3 is ON or OFF. f4 is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Query commands prompt the receiver to output the corresponding response message once only. Message output prompted by a query command occurs independently of any related message output settings.

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

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

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

$PASHS,NME,GGA,B,OFF

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

$PASHQ,POS,B

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

Message Structure

Standard NMEA messages are output as a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards (version 3.0). Ashtech format NMEA-style messages are also output in a comma-delimited string of ASCII characters, but may deviate slightly from NMEA standards. For example, the maximum length of a standard NMEA message is eighty characters, but the length of some Ashtech format messages are variable (i.e., SAT) and may go beyond eighty characters. Both NMEA messages and Ashtech format NMEA-style messages begin with a dollar sign ($) and end with a Carriage Return/Line Feed **<CR><LF>** delimiter. Any combination of these messages can be output through different ports at the same time. The output rate can be set to any value between 0.05 and 999 seconds. The default output interval is one second.

Standard NMEA messages have the following structure:

HEADER,DATA*CHECKSUM<CR><LF>

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

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

The structure of non-standard NMEA messages:

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

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

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

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

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

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

NME: Disable All NMEA Messages

$PASHS,NME,ALL,x,OFF

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

Example

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

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

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

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

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

ALM: Almanac Message

$PASHS,NME,ALM,c,s

This command enables or disables the almanac message where c is the receiver serial port (A or B), and s is ON or OFF.

Example

Enable ALM message on port A:

$PASHS,NME,ALM,A,ON

$PASHQ,ALM,c

Query the almanac message, where c is the optional output port.

$GPALM

There is one response message for each satellite in the GPS constellation. The length of the message is calculated by the characters, in halves of bytes, not full bytes. The message in response to the set or query command is in the form:

$GPALM,d1,d2,d3,d4,h5,h6,h7,h8,h9,h10,h11,h12,h13,h14,h15*cc

where the field parameters are as defined in Table 7.2.

Table 7.2. ALM Response Message

Parameter	Description	Range
d1	Total number of messages	01 -32
d2	Number of this message	01 -32

Table 7.2. ALM Response Message (Continued)

Parameter	Description	Range
d3	Satellite PRN number	01 - 32
d4	GPS week	4 digits
h5	SV health (In ASCII Hex)	2 bytes
h6	e. Eccentricity (In ASCII Hex)	4 bytes
h7	toe. Almanac reference time (seconds. In ASCII Hex)	2 bytes
h8	Io. Inclination angle (semicircles. In ASCII Hex)	4 bytes
h9	OMEGADOT. Rate of ascension (semicircles/sec. In ASCII Hex)	4 bytes
h10	A½. Square Root of semi-major axis (Meters & ½ In ASCII Hex)	6 bytes
h11	ω. Argument of perigee (semicircle. In ASCII Hex)	6 bytes
h12	OMEGA0. Longitude of ascension mode (semicircle. In ASCII Hex)	6 bytes
h13	Mo. Mean anomaly (semicircle. In ASCII Hex)	6 bytes
h14	afo. Clock parameter (seconds. In ASCII Hex)	3 bytes
h15	af1. Clock parameter (sec/sec. In ASCII Hex)	3 bytes
*cc	Checksum	

Typical response message:

$GPALM,26,01,01,0899,00,1E8C,24,080B,FD49,A10D58,EB4562,BFEF85,227A5B,011,000*0B

Table 7.3 describes the items in the typical response message.

Table 7.3. Typical ALM Response Message

Item	Significance
$GPALM	Header
26	Total number of messages
01	Number of this message
01	Satellite PRN Number
0899	GPS week number
00	Satellite health
1E8C	Eccentricity
24	Almanac reference time
080B	Inclination angle

Table 7.3. Typical ALM Response Message (Continued)

Item	Significance
FD49	Rate of ascension
A10D58	Root of semi-major axis
EB4562	Argument of perigree
BFEF85	Longitude of ascension mode
227A5B	Mean anomaly
011	Clock parameter
000	Clock parameter
*0B	checksum

CRT: Cartesian Coordinates Message

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

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,CRT,x

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

$PASHR,CRT

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

$PASHR,CRT,d1,d2,m1,m2,m3,m4,f2,f3,f4,f5,f6,f7,f8,f9,f10,s*cc

Table 7.4 defines the message format.

Table 7.4. $PASHR,CRT Message Format

Parameter	Description	Range
d1	Position solution type: 0 = autonomous 1 = position differentially corrected with RTCM code. 2 = position differentially corrected with CPD float code. 3 = position is CPD fixed solution	Always 0
d2	Number of satellites used in position computation	3 to 12
m1	Current UTS time, (hhmmss), of position computation in hours, minutes, and seconds	00 to 235959.50
m2	Antenna position ECEF x coordinate in meters	
m3	Antenna position ECEF y coordinate in meters	
m4	Antenna position ECEF z coordinate in meters	
f2	Receiver clock offset in meters	
f3	X-component of velocity vector in m/s	
f4	Y-component of velocity vector in m/s	
f5	Z-component of velocity vector in m/s	
f6	Receiver clock drift in m/s	
f7	PDOP—position dilution of precision	0 to 99.9
f8	HDOP—horizontal dilution of precision	0 to 99.9
f9	VDOP—vertical dilution of precision	0 to 99.9
f10	TDOP—time dilution of precision	0 to 99.9
s*cc	Firmware version ID	4 character string

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

GDC: Grid Coordinates

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,GDC,[c1]

This command queries the current position according to the user-defined grid coordinate system selected through the UDG command, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port. The response message does not output unless the following three conditions are met:

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

$PASHR.GDC

The response is in the format:

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

Table 7.5 defines the message format:.

Table 7.5. GDC Message Structure

Parameter	Description	Range
m1	UTC of position in hours, minutes, and decimal seconds (hhmmss.ss)	000000.00 to 235959.90
s2	Map projection type	EMER, TM83, OM83, LC83, STER, LC27, Tm27, TA22
f3	Easting (x) of the user grid coordinate (meters)	-9999999.999 to +9999999.999
f4	Northing (y) of the user grid coordinate (meters)	-9999999.999 to +9999999.999
d5	Positioning mode Indicator • 1: Autonomous position • 2: RTCM differential or CPD float position. Not applicable to CP14. • 3: Carrier phase differential (CPD) fixed. Not applicable to CP14.	Always 1
d6	Number of GPS satellites being used	3 to 12
f7	Horizontal Dilution of Position (HDOP)	00.0 to 99.9
f8	Altitude (meters)	-9999999.999 to +9999999.999

Table 7.5. GDC Message Structure (Continued)

Parameter	Description	Range
M	Altitude units	M(eters)
f9	Geoidal separation in meters w.r.t. selected datum and Geoid Model	-999.999 to +999.999
M	Geoidal separation	M(eters)
d10	Age of differential corrections. Not applicable to CP14.	Null field
s11	Differential reference station ID. Not applicable to CP14.	Null field
s12	Datum type	W84, USR
*hh	Checksum	2-character hex

Typical GDC Message:

$PASHR,GDC,015454.00,EMER,588757.623,4136720.056,1,04,03.8, 00012.123,M,-031.711,M,,,W84*2A

Table 7.5 defines the message format:

Table 7.6. Typical GDC Message

Item	Description
015454.00	UTC time
EMER	Equatorial Mercator map projection
588757.623	User grid easting (X) coordinate
4136720.056	User grid northing (Y) coordinate
1	Autonomous position
04	Number of satellites used to compute position
03.8	HDOP
00012.123	Altitude
M	Altitude units (M = meters)
-031.711	Geoidal separation w.r.t. selected datum
M	Geoidal separation units (M = meters)
,	Null field
,	Null field
W84	Reference datum is WGS 84
2A	checksum

GGA: 3-D GPS Position

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHS,GGA,x,[f]

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

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

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

All fields are variable length fields.

DEFAULT SETTING
GGA—FULL

Example:

Enter the following command to enable GGA on port A.

$PASHS,NME,GGA,A,ON

Enter the following command to output the standard GGA message.

$PASHS,GGA,STD

$PASHQ,GGA,c1

This command queries the GGA position message, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$GPGGA

This message is not output unless positions are being computed. In addition to a 3-D position (latitude/longitude/altitude), the GGA message contains information on the type of position fix (i.e., autonomous ~~or differentially~~ corrected), HDOP, and current time. The CP14 can be set to output the GGA message at regular intervals by using the command $PASHS,NME. The message is output in the format:

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

Table 7.7 defines the message format.

Table 7.7. $GPGGA Message Format

Parameter	Description	Range
m1	UTC time (hhmmss.s) of the position fix	0 to 235959.99
m2	Latitude of the position fix (ddmm.mmmmm)	0 to 9000.00000
c3	Latitude sector	N or S
m4	Longitude of the position fix (dddmm.mmmmm)	0 to 18000.00000
c5	Longitude sector	E or W
d6	GPS quality indicator • 0—Invalid position or position not available • 1—GPS Standard Positioning Service (SPS) mode (C/A code), fix valid • 2—Differential GPS, SPS mode, fix valid; not applicable to CP14. • 3—GPS Precise Positioning Service (PPS) mode (P-code). N/A for CP14 • 4—Real Time Kinematic. System used in RTK mode with fixed integers. N/A for CP14 • 5—Float RTK. Satellite system used in RTK mode, floating integers. N/A for CP14 • 6—Estimated (dead reckoning) mode • 7—Manual input mode • 8—Simulator mode	0, 1
d7	Number of satellites used in position computation	3 to 14
d8	HDOP (horizontal dilution of precision)	00.0 to 99.9
f9	Altitude above mean sea level (geoidal height)	-1000.00 to 18000.00
c10	Altitude unit of measure (always M)	M

Table 7.7. $GPGGA Message Format (Continued)

Parameter	Description	Range
d11	Geoidal separation value	-999.99 to 999.99
c12	Geoidal separation unit of measure (always M)	M
d13	Age of differential corrections (seconds). Not applicable to CP14.	Always null
d14	Differential base station ID number. Not applicable to CP14.	Always null
hh	Checksum	2-character hex

Typical GGA message:

$GPGGA,183805.50,3722.36223,N,12159.82741,W,1,7,2.8, 16.12,M,-31.24,,,M*6F

Table 7.8 defines the response message.

Table 7.8. Typical GGA Message

Item	Description
$GPGGA	Header
183805.50	Time of position fix
3722.36223	Latitude
N	North
12159.82741	Longitude
W	West
1	Autonomous position fix valid
7	Number of satellites used in position computation
2.8	HDOP
+00016.12	Altitude
M	Altitude unit of measure (meters)
-31.24	Geoidal separation value
M	Geoidal separation unit of measure (meters)
6F	Checksum

GLL: 2-D Position

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,GLL,A,ON

$PASHQ,GLL,[c1]

This command queries the GLL position message, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$GPGLL

This message is not output unless position is computed. The GLL message contains a 2-D position (latitude/longitude only) and time of position fix. The CP14 can be set to output the GLL message at regular intervals by using the command $PASHS,NME. The message is output in the format:

$GPGLL,m1,c2,m3,c4,m5,c6,d7*hh

Table 7.9 defines the message format.

Table 7.9. $GPGLL Message Format

Parameter	Description	Range
m1	Latitude of the position fix (ddmm.mmmmm)	0° to 90°
c2	Latitude sector	N—North S—South
m3	Longitude of the position fix (dddmm.mmmmm)	0° to 180°
c4	Longitude sector	E—East W—West
m5	UTC time (hhmmss.ss) of the position fix	000000.00 to 235959.90

Table 7.9. $GPGLL Message Format

Parameter	Description	Range
c6	Status of the position fix (always A): • A—Valid • V—Invalid	A, V
d7	Positioning system mode indicator • A—Autonomous mode • D—Differential mode. Not applicable to CP14. • E—Estimated (dead reckoning) mode • M—Manual input mode • S—Simulator mode • N—Data not valid	A, E, M, S, or N
hh	Checksum	2-character hex

Typical GLL message:

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

Table 7.10 describes the response message.

Table 7.10. Typical GLL Message

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

GNS: GNSS Fix Data

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

Enable or disable fix data for single or combined satellite navigation systems (GNSS) response message to port x, where x is the output port, and s is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enable GNS message on port B:

$PASHS,NME,GNS,B,ON

$PASHQ,GNS,[c1]

This command queries the GNS 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.

$GPGNS

The response is in the format

GPGNS,m1,m2,c3,m4,c5,d6,d7,d8,f9,f10,f11,d12*cc

Table 7.11 defines the message format.

Table 7.11. $GPGNS Message Format

Parameter	Description	Range
m1	UTC (hhmmss.ss)	0 to 235959.99
m2	Latitude (ddmm.mmmmmm	0 to 9000.000000
c3	Latitude sector	N—North S—South
m4	Longitude (dddmm.mmmmmm)	0 to 18000.000000
c5	Longitude sector	E—East W—West
d6	Positioning system mode indicator (one character for GPS, one character for GLONASS) • A—Autonomous mode • D—Differential mode. Not applicable to CP14. • P—Precise. No SA and P-code • R—Fixed RTK (N/A) • F—Float RTK (N/A) • N—No fix	NN, AA, DD, RR, FF, PP
d7	Total number of satellites used in the computation	0 to 99
d8	HDOP	0.0 to 9.9
f9	Geoidal height (altitude above MSL) in meters	-1000.0 to 18000.0
f10	Geoidal separation in meters	-99.9 to 99.9

Table 7.11. $GPGNS Message Format (Continued)

Parameter	Description	Range
f11	Age of differential corrections.Not applicable to CP14.	Always null
d12	Base station ID. Not applicable to CP14.	Always null
*cc	Checksum	2-character hex

GRS: Satellite Range Residuals

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

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,GRS,B,ON

$PASHQ,GRS,[c1]

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

$GPGRS

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

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

Table 7.12 defines the message format.

Table 7.12. $GPGRS Message Format

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

Typical GRS message:

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

Table 7.13 defines the response message.

Table 7.13. Typical GRS Message

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

GSA: DOP and Active Satellites

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

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,GSA,B,ON

$PASHQ,GSA,[c1]

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

$GPGSA

The GSA message contains indicators for current position mode (see the **$PASHS,PMD** command on page 94), a list of the satellites being used to compute position, and the values for PDOP, HDOP, and VDOP. This message is not output until positions are being computed. The response is output in the format:

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

Table 7.14 defines the message format.

Table 7.14. $GPGSA Message Format

Parameter	Significance	
c1	Position mode indicator: • A—Automatic mode • M—Manual mode	A, M
d1	Position mode indicator: • 1— Position fix not available • 2—2D mode • 3—3D mode	1, 2, 3

NMEA Commands

Table 7.14. $GPGSA Message Format (Continued)

Parameter	Significance	
d3-d16	These 14 fields represent the receiver's 14 channels listed in ascending order. The number 17 appearing in field d5 indicates that CP14 channel 3 is locked on satellite 17. If a given channel is not locked on a satellite, the corresponding field will be empty.	1 to 64
d15	Current PDOP value	0 to 99.9
d16	Current HDOP value	0 to 99.9
d17	Current VDOP value	0 to 99.9
hh	Checksum	2-character hex

Typical GSA message:

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

Table 7.15 defines the typical response message.

Table 7.15. Typical $GPGSA Message

Field	Description
$GPGSA	Header
A	Indicates automatic 2-D/3-D switching mode
3	Indicates 3D position mode
31	CP14 channel 1 locked on satellite 31; satellite 31 used in position computations
29	CP14 channel 2 locked on satellite 29; satellite 29 used in position computations
23	CP14 channel 3 locked on satellite 23; satellite 23 used in position computations
26	CP14 channel 4 locked on satellite 26; satellite 26 used in position computations
empty field	Indicates that this channel (5) is not locked on a satellite or that the locked satellite is not being used in position computations
21	CP14 channel 6 locked on satellite 21; satellite 21 used in position computations
17	CP14 channel 7 locked on satellite 17; satellite 17 used in position computations
09	CP14 channel 8 locked on satellite 09; satellite 09 used in position computations
08	CP14 channel 9 locked on satellite 08; satellite 08 used in position computations
empty field	Indicates that this channel (10) is not locked on a satellite or that the locked satellite is not being used in position computations
03	CP14 channel 11 locked on satellite 03; satellite 03 used in position computations

Table 7.15. Typical $GPGSA Message (Continued)

Field	Description
empty field	Indicates that this channel (12) is not locked on a satellite or that the locked satellite is not being used in position computation
01.8	Current PDOP value
01.0	Current HDOP value
01.5	Current VDOP value
*0B	Checksum

GSN: Satellite PRN Number and Signal Strength

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

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,GSN,B,ON

$PASHQ,GSN,[c1]

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

$GPGSN

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

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

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

Table 7.16. $GPGSN Message Format

Parameter	Description	Range
d1	Number of satellites currently locked	0 to 14
d2	Satellite PRN number	01 to 32 for GPS
d3	Signal-to-noise ratio for the corresponding satellite	000 to 999
d4	Age of differential corrections. Not applicable to CP14.	Null field
*hh	Checksum	2-character hex

Typical GSN message:

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

Table 7.17 defines the typical response message.

Table 7.17. Typical GSN Message

Field	Description
$GPGSN	Header
07	Number of satellites currently locked
01	PRN number of the first satellite
048	Signal strength of the first satellite
29	PRN number of the second satellite
046	Signal strength of the second satellite
25	PRN number of the third satellite
048	Signal strength of the third satellite
08	PRN number of the fourth satellite
040	Signal strength of the fourth satellite
31	PRN number of the fifth satellite
037	Signal strength of the fifth satellite
15	PRN number of the sixth satellite
048	Signal strength of the sixth satellite
21	PRN number of the seventh satellite

Table 7.17. Typical GSN Message (Continued)

Field	Description
046	Signal strength of the seventh satellite
*4F	Checksum

GST: Pseudo-Range Error Statistics

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

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,GST,B,ON

$PASHQ,GST,[c1]

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

$GPGST

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

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

NMEA Commands

Table 7.18 defines the message format.

Table 7.18. $GPGST Message Format

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

Typical GST message:

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

Table 7.19 defines the typical response message.

Table 7.19. Typical GST Message

Field	Description
$GPGST	Header
130927.00	UTC time of the position fix
18.45	RMS value of the standard deviation of satellite range inputs (1-sigma position error)
empty field	This field is not implemented

Table 7.19. Typical GST Message (Continued)

Field	Description
empty field	This field is not implemented
empty field	This field is not implemented
17.78	Standard deviation of the latitude error (meters)
11.74	Standard deviation of the longitude error (meters)
28.68	Standard deviation of the altitude error (meters)
*71	Checksum

GSV: Satellites in View

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,GSV,[c1]

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

$GPGSV

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

The total number of messages transmitted and the number of messages transmitted are indicated in the first two fields of the first message.

The message is output in the format:

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

Table 7.20 defines the response message.

Table 7.20. $GPGSV Message Format

Parameter	Description	Range
d1	Total number of GSV messages to be output	1 to 9
d2	Message number	1 to 9
d3	Total number of satellites in view	1 to 14
d4	Satellite PRN number	1 to 32 for GPS
d5	Elevation (degrees)	0° to 90°
d6	Azimuth (degrees)	0° to 359°
f7	Signal-to-noise ratio (dbHz)	30 to 60
d8	Satellite PRN number	1 to 32 for GPS
d9	Elevation (degrees)	0° to 90°
d10	Azimuth (degrees)	0° to 359°
f11	Signal-to-noise ratio (dbHz)	30 to 60
d12	Satellite PRN number	1 to 32 for GPS
d13	Elevation (degrees)	0° to 90°
d14	Azimuth (degrees)	0° to 359°
f15	Signal-to-noise ratio (dbHz)	30 to 60
d16	Satellite PRN number	1 to 32 for GPS
d17	Elevation (degrees)	0° to 90°
d18	Azimuth (degrees)	0° to 359°
f19	Signal-to-noise ratio (dbHz)	30 to 60
*hh	Checksum	2-character hex

Typical GSV message:

$GPGSV,2,2,8,08,43,294,47,07,19,062,42,05,49,314,49,02,03,120,29 *45

Table 7.21 defines the typical response message.

Table 7.21. Typical GSV Message

Field	Description
$GPGSV	Header
2	Indicates that two GSV messages will output

Table 7.21. Typical GSV Message (Continued)

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

GXP: Horizontal Position Message

$PASHS,NME,GXP,c,s

This command enables/disables the horizontal position message where c is either A or B, and s is ON or OFF. If no position is computed, this message is output but the position-related fields will be empty.

Example

Enable the horizontal position message on port C:

$PASHS,NME,GXP,C,ON

$PASHQ,GXP,c

This command queries horizontal position where c is the optional output serial port.

$GPGXP

The response message is in the form:

$GPGXP,m1,m2,c3,m4,c5*cc

where Table 7.22 defines the response format.

Table 7.22. GXP Message Structure

Parameter	Description	Range
m1	UTC of fitx in hours, minutes and seconds (hhmmss.ss)	00-235959.90
m2	Latitude in degrees and decimal minutes (ddmm.mmmmmm)	0 - 90.00
c3	Direction of latitude	N = North S = South
m4	Longitude in degrees and decimal minutes (dddmm.mmmmmm)	0 - 180.00
c5	Direction of longitude	E = East W = West
cc	checksum	

Typical response message:

$GPGXP,212958.00,3722.396956,N,12159.849225,W*7A

Table 7.23 describes each item in a typical GXP message.

Table 7.23. Typical GXP Message

Item	Significance
$GPGXP	Header
212958.00	UTC time of position
3722.396956	Latitude
N	North latitude
12159.849225	Longitude
W	West longitude
*7A	checksum

LTN: Position Output Latency

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

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

Example

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

$PASHS,NME,LTN,B,ON

$PASHQ,LTN,[c1]

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

$PASHR,LTN

This single-field message is output even if a position is not computed. Latency is defined as the number of milliseconds it takes the receiver to compute a position (from the position fix tag time) and prepare data to be output through the serial port. The latency range is typically between 20 and 40 milliseconds, depending on the number of satellites tracked and the number of satellites used in the position solution. The response is output in the format:

$PASHR,LTN,d1*hh

Table 7.24 defines the message format.

Table 7.24. $PASHR,LTN Message Format

Parameter	Description	Range
d1	Latency value (milliseconds)	20 to 99
*hh	Checksum	2-character hex

Typical LTN message:

$PASHR,LTN,29*05

Table 7.25 describes the typical response message.

Table 7.25. $PASHQ,LTN Query Response

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

PER: Global Output Interval

$PASHS,NME,PER,f1

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

Example

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

$PASHS,NME,PER,5

POS: Position Message

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

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

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

Example

Enable position message on port B:

$PASHS,NME,POS,B,ON

$PASHQ,POS,x

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

$PASHR,POS

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

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

Table 7.26 defines the POS response structure.

Table 7.26. POS Response Structure

Field	Description	Range
d1	position type: 0 = autonomous 1 = position differentially corrected	Always 0
d2	Number of satellites used in position computation	3 to 14
m1	Current UTC time, (hhmmss), of position computation in hours, minutes and seconds	00 to 235959.50
m2	Latitude component of position in degrees, minutes, and fraction of minutes (ddmm.mmmm)	0 to 90.00000°
c1	Latitude sector: N = North, S = South	N or S
m3	Longitude component of position in degrees, minutes, and fraction of minutes	0 to 180.00000°
c2	Longitude sector: E = East, W = West	W or E
f1	Altitude in meters above WGS-84 reference ellipsoid. For 2-D position computation this item contains the altitude held fixed.	± 30000.00
f2	Site ID	4 character string
f3	True track/true course over ground in degrees (000.00 to 359.99 degrees)	0 to 359.9
f4	Speed over ground in knots	0 to 999.9
f5	Vertical velocity in meters per second	± 999.9
f6	PDOP—position dilution of precision	0 to 99.9
f7	HDOP—horizontal dilution of precision	0 to 99.9
f8	VDOP—vertical dilution of precision	0 to 99.9
f9	TDOP—time dilution of precision	0 to 99.9
s1	Firmware version ID	4 character string
*hh	checksum	2-character hex

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

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

Typical response:

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

Table 7.27 defines a typical POS response message.

Table 7.27. Typical POS Response Message

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

RMC: Recommended Minimum Course

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

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,RMC,C,ON

$PASHQ,RMC,[c1]

This command queries the RMC 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.

$GPRMC

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

$GPRMC,m1,c2,m3,c4,m5,c6,f7,f8,d9,f10,c11,d12*hh

Table 7.28 defines the message format.

Table 7.28. $GPRMC Message Format

Parameter	Description	Range
m1	UTC time of the position fix (hhmmss.ss)	000000.00 to 235959.95
c2	Status of the position fix (always A) • A—Autonomous, position data is valid • D—Differential, position data valid. Not applicable to CP14. • V—Invalid	A, V
m3	Latitude (ddmm.mmmmmm)	0000.000000° to 8959.999999°
c4	Latitude sector	N—North S—South
m5	Longitude (dddmm.mmmmmm)	00000.000000° to 17959.999999°

Table 7.28. $GPRMC Message Format (Continued)

Parameter	Description	Range
c6	Longitude sector	E—East W—West
f7	Speed over the ground (knots)	000.0 to 999.9
f8	Course over the ground (degrees); referenced to true north	000.0° to 359.9°
d9	Date (ddmmyy)	010100 to 123199
f10	Magnetic variation (degrees)	0.0° to 99.9°
c11	Direction of magnetic variation: • Easterly variation - subtract this value from true north course • Westerly variation - add this value to true north course	E—East W—West
d12	Positioning system mode indicator • A—Autonomous mode • D—Differential mode. Not applicable to CP14. • E—Estimated (dead reckoning) mode • M—Manual input mode • S—Simulator mode • N—Data not valid The positioning system mode indicator field supplements the positioning system for the Status field.	A, D, E, M, S, or N
*hh	The hexadecimal checksum is computed by exclusive -ORing all of the bytes in the message between, but not including, the $and the *. The result is *hh where h is a hex character.	0 to 9 and A through F

Typical RMC message:

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

Table 7.29 describes the typical response message.

Table 7.29. Typical RMC Message

Parameter	Description
213357.20	UTC time of the position fix (hhmmss.ss)
A	Valid position
3722.410857	Latitude
N	North latitude ddmm.mmmmmm
12159.773686	Longitude ddmm.mmmmmm
W	West longitude
000.3	Speed over ground, knots

Table 7.29. Typical RMC Message (Continued)

Parameter	Description
102.4	Course over ground, degrees True
290498	29 April 1998
15.4	Magnetic variation, degrees
W	Westerly variation (add to the True course)
A	Autonomous position
*43	Checksum

RRE: Satellite Range Residuals and Position Error

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

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

The CP14 does not output this message unless it computes a position.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,RRE,A,ON

$PASHQ,RRE,[c1]

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

$GPRRE

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

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

Table 7.30 defines the message format.

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

Table 7.30. $GPRRE Message Format

Parameter	Description	Range
d1	The number of satellites used to compute position	0 to 14
d2	PRN number for each of the satellites used in the position computation	1 to 32
f1	Magnitude of the residual range error (meters) for each satellite used in the position computation	-999.9 to +999.9
f2	RMS value for the horizontal position error (meters)	-9999.9 to +9999.9
f3	RMS value for the vertical position error (meters)	

Typical RRE message:

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

Table 7.31 describes the typical response message.

Table 7.31. Typical RRE Message

Field	Description
$GPRRE	Header
05	Number of satellites used to compute position
18	PRN of first satellite
000.2	Range residual for first satellite (meters)
29	PRN of second satellite
000.2	Range residual for second satellite (meters)
22	PRN of third satellite
-000.1	Range residual for third satellite (meters)
19	PRN of fourth satellite
-000.1	Range residual for fourth satellite (meters)
28	PRN of fifth satellite
000.5	Range residual for fifth satellite (meters)
0002.0	Horizontal position error (meters)

Table 7.31. Typical RRE Message (Continued)

Field	Description
0001.3	Vertical position error (meters)
*76	Checksum

SAT: Comprehensive Satellite Tracking Data

$PASHS,NME,SAT,x,y,[f]

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

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enable SAT message on port B.

$PASHS,NME,SAT,B,ON

$PASHQ,SAT,[c1]

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

$PASHR,SAT

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

$PASHR,SAT,d1,((d2,d3,d4,d5,c6)*d1)*hh

Table 7.32 defines the response message. The data fields for PRN number (d2), azimuth (d3), elevation (d4), signal-to-noise ratio (d5), and the used/not used flag (c6) are repeated for each satellite, using the value in the d1 field as a multiplier.

Table 7.32. $PASHR,SAT Message Format

Field	Description	Range
d1	The number of satellites locked by the receiver	1 to 14
d2	Satellite PRN number	1 to 32 for GPS

NMEA Commands

Table 7.32. $PASHR,SAT Message Format (Continued)

Field	Description	Range
d3	Satellite azimuth angle	0° to 359°
d4	Satellite elevation angle	0° to 90°
d5	Satellite signal-to-noise ratio (dbHz)	0 to 99
c6	Indicates whether the locked satellite is used in position computations: • U—Used • A dash (-) indicates that the satellite is not being used in position computations • M—Satellite NOT used because of low elevation • S—Satellite NOT used because the pseudo-range is not settled (transient is not over) • H—Satellite NOT used because marked 'unhealthy' in ephemeris • B—Satellite NOT used because of bad URA (or some accuracy problem indicated in navigational data) • Z—Satellite NOT used because marked 'unhealthy' in almanac • D—Satellite NOT used because differential corrections are old or invalid. Not applicable to CP14. • J—Satellite NOT used because big code outlier was detected • R—Satellite NOT used because RAIM or some other algorithm detected a pseudo-range bias. • I—Satellite NOT used because SV disabled by external command SVP,USP) • L—Satellite NOT used because signal-to-noise ratio is less than Mask • G—Satellite NOT used because it's possibly a ghost satellite • V—Satellite NOT used because computed satellite coordinates are suspicious • N—Satellite NOT used because satellite true number unknown (for modes, where we need the true SV number • K—Satellite NOT used because it was disabled by RTK engine (N/A in CP14) • O—Satellite NOT used because of some other case • E—Satellite NOT used because no navigational data (ephemeris) is available • p—Satellite NOT used because no full range is available	
*hh	Checksum	2-character hex

The SAT message displays more information on unused satellites. Used satellites are indicated with a U and unused satellites, by default, are indicated with a -. If you enable the satellite usage indicator, SUI, switch, a variety of flags display instead of a - to indicate the reason why the respective satellite is not used in the solution.

Typical SAT message:

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

Table 7.33 describes the typical response message.

Table 7.33. Typical SAT Message

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

UKO: UKOOA Message

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

This command enables or disables the UKOOA message on port x, where x is the output port, and y is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

$PASHQ,UKO,[c1]

This command queries the UKOOA 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.

$GPUKO

The response is in the format:

$GPUKO,d1,d2,d3,f1,n(d4,d5,d6,d7,d8,d9)

where the parameters are as defined in Table 7.34.

Table 7.34. $GPUKO Response message format

Parameter	Description	Range
d1	GPS week number	0 to 1023
d2	TOW (seconds)	0 to 604800
d3	Number of satellites used in the solution	0 to 14
f1	Scale factor	0 to 1
n	**Fields d4 through d9 are repeated "n" times; n = the number of satellites used in the solution**	0 to 14
d4	PRN number	0 to 64
d5	Post-fit residuals, m	-999.9 to +999.9
d6	Line of sight, latitude sensitivity, sf = 7/100 (m/rad)	-99999999 to +99999999
d7	Line of sight, longitude sensitivity, sf = 7/100 (m/rad)	-99999999 to +99999999
d8	Line of sight, altitude sensitivity, sf = 1.0 * e^{-8}	-99999999 to +99999999
d9	Weight of satellite	0 to 9999

UTM: Universal Transverse Mercator (UTM) Coordinates

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

This command enables or disables the UTM message on port x, where x is the output port, y is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The CP14 does not output this message unless it computes a position.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

$PASHQ,UTM,[c1]

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

$PASHR,UTM

This message is not output unless positions are being computed. The UTM message contains position rendered in UTM coordinates, plus UTC time, the number of satellites used to compute the position, the mode of the position fix (i.e., autonomous or corrected), and more. The message is output in the format:

$PASHR,UTM,m1,m2,f3,f4,d5,d6,f7,f8,m,f9,m,d10,s11*hh

Table 7.35 defines the message format.

Table 7.35. $PASHR,UTM Message Format

Parameter	Description	Range
m1	UTC of position in hours, minutes, and decimal seconds (hhmmss.ss)	0 to 235959.90
m2	Zone number for the coordinates	1 to 60, 99 N—North S—South
f3	East UTM coordinate (meters)	-9999999.999 to +9999999.999
f4	North UTM coordinate (meters)	-9999999.999 to +9999999.999
d5	Position fix mode indicator. • 1—Raw position • 2—RTCM differential or CPD float. Not applicable to CP14. • 3—Carrier phase differential (CDP) fixed. Not applicable to CP14.	Always 1
d6	Number of GPS satellites being used to compute positions	3 to 14
f7	Horizontal dilution of precision (HDOP)	0.00 to 999.9
f8	Antenna height (meters)	-99999.999 to +99999.999
m	Antenna height units	M = meters
f9	Geoidal separation in meters	±999.999
m	Geoidal separation units (meters)	M
d10	Age of differential corrections. Not applicable to CP14.	Always empty
s11	Differential reference station ID. Not applicable to CP14.	Always empty
*hh	Checksum	

The antenna altitude is either ellipsoidal (default) or geoidal (mean-sea-level) depending on the selection made with $PASHS,HGT (see UCT section). The geoidal altitude can be also derived by subtracting the geoidal separation from the ellipsoidal altitude.

Typical UTM message:

$PASHR,UTM,015454.00,10S,588757.623,4136720.056,1,04,03.8, 00012.123,M,-031.711,M,,,*3A

Table 7.36 defines the response message.

Table 7.36. Typical UTM Message

Item	Description
015454.00	UTC time
10S	UTM zone 10; southern hemisphere
588757.623	UTM easting coordinate
4136720.056	UTM northing coordinate
1	Raw position
04	Number of satellites used to compute position
03.8	HDOP
00012.123	altitude
M	Altitude units (meters)
-031.711	Geoidal separation
M	Geoidal separation units (meters)
,	Empty field
,	Empty field
*3A	Checksum

VTG: Course and Speed Over the Ground

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

This command enables or disables the velocity/course message on port x, where x is the output port, c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The CP14 does not output this message unless it computes a position.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,VTG,B,ON

$PASHQ,VTG,[c1]

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

$GPVTG

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

$GPVTG,f1,c2,f3,c4,f5,c6,f7,c8,d9*hh

Table 7.37 defines the message format.

Table 7.37. $GPVTG Response Structure

Field	Description	Range
f1	Course over ground; referenced to true north	000.00° to 359.99°
c2	North reference indicator (always T; true north)	T
f3	Course over the ground; referenced to magnetic north	000.00° to 359.99°
c4	North reference indicator (always M; magnetic north)	M
f5	Speed over ground (knots)	000.00 to 999.99
c6	Speed unit of measure (always N; nautical miles per hour)	N
f7	Speed over ground (kilometers per hour)	000.00 to 999.99
c8	Speed unit of measure (always K; KPH)	K
d9	Positioning system mode indicator • A—Autonomous mode • D—Differential mode. Not applicable to CP14. • E—Estimated (dead reckoning) mode • M—Manual input mode • S—Simulator mode • N—Data not valid	A, E, M, S, or N
*hh	Checksum	2-character hex

Typical VTG message:

$GPVTG,179.00,T,193.00,M,000.11,N,000.20,K*3E

Table 7.38 describes the typical response message.

Table 7.38. 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

XMG: Exception Messages

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

This command enables or disables the exception messages or port x, where x is the output port, c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The CP14 does not output this message unless it computes a position.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

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

$PASHS,NME,XMG,B,ON

$PASHQ,XMG,[c1]

This command queries the exception messages, where c1 is the optional port designator for the output of the response. If a port is not specified, the receiver sends the response to the current port.

$PASHR,XMG, d1,d2

The response is in the format `$PASHR,XMG, d1,d2` where d1 is the exception number and d2 is a description of the exception message. Table 7.39 describes the exception numbers.

Table 7.39. $PASHR,XMG Exception Number Descriptions

Exception Number (d1)	Description	Meaning
01	SRAM corrupted	The CP14 enters Set Defaults state due to lost data.
02	Real Time Clock Corrupted	The CP14 initiates a cold start due to loss of time information.
03	No Position or Almanac	The CP14 initiates a cold start due to lack of position or almanac data.
04	BIT completed	End of built-in-test routines.
05	Cannot converge with 4 or more satellites	No navigation solution in auto mode with 4 satellites.
06	Cannot converge with 3 satellites	No navigation solution in auto mode with 3 satellites.
07	Too few satellites for 3D solution	No navigation solution in 3D mode with 3 or fewer satellites.
08	No 3D solution - PDOP mask exceeded	No navigation solution possible in 3D mode because of bad PDOP.
09	Too few satellites for 2D solution	No navigation solution in 2D mode with 2 or fewer satellites.
10	No 2D solution - PDOP mask exceeded	No navigation solution possible in 2D mode because of bad PDOP.
11	Time only - No Solution	No satellites above mask angle.
12	Solution valid.	A valid solution is now being generated.

ZDA: Time and Date

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

This command enables or disables the time and date message or port x, where x is the output port, c is ON or OFF, and f is the optional message output rate ranging from 0.05 to 999 seconds depending on the measurement update rate option installed.

The CP14 does not output this message unless it computes a position.

If the command is set without a period, the CP14 uses the period set by the **$PASHS,NME,PER** command If the **$PASHS,NME,PER** command is issued after this message period has been set, the period resets to the PER setting.

Example

Enter the following command to disable ZDA message on port A.

$PASHS,NME,ZDA,A,OFF

$PASHQ,ZDA,[c1]

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

$GPZDA

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

$GPZDA,m1,d2,d3,d4,d5,d6*hh

Table 7.40 defines the message format.

Table 7.40. $GPZDA Message Format

Field	Description	Range
m1	UTC time	000000.00 to 235959.90
d2	Current day	01 to 31
d3	Current month	01 to 12
d4	Current year	0000 to 9999
d5	Local time zone offset from UTC time (hours)	-13 to +13
d6	Local time zone offset from UTC time (minutes). This value has the same sign [+\-] as d5, but the sign is not displayed for this field	00 to 59
*hh	Checksum	2-character hex

Typical ZDA message:

$GPZDA,222835.10,21,07,1999,-07,00*4D

Table 7.41 describes the typical response message.

Table 7.41. Typical ZDA Message

Field	Description
$GPZDA	Message header
222835.10	Current UTC time

Table 7.41. Typical ZDA Message (Continued)

Field	Description
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

A

Floating Point Data Representation

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

Sign Bit Field

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

Exponent Field

The exponent of a number is multiplied by the fractional value of the number to get a value. The exponent field of the number contains a biased form of the exponent. The bias is subtracted from the exponent field to get the actual exponent. This allows both positive and negative exponents.

Fraction Field

The IEEE floating point format stores the fractional part of a number in a normalized form. This form assumes that all non-zero numbers are of the form:

1.xxxxxx (binary)

The character ‘x’ represents either a 0 or 1 (binary).

Because all floating point binary numbers begin with 1, the 1 becomes the implicit normalized bit and is omitted. It is the most significant bit of the fraction, and the binary point is located immediately to its right. All bits after the binary point represent values less than 1 (binary). For example, the number 1.625 (decimal) can be represented as:

1.101 (binary) which is equal to:

$2^0 + 2^{-1} + 2^{-3}$ (decimal) which is equal to:

1 + 0.5 + 0.125 (decimal) which is equal to:

1.625 (decimal).

The Represented Value

The value of the number being represented is equal to the exponent multiplied by the fractional value, with the sign specified by the sign bit field.

If both the exponent field and the fraction field are equal to zero, the number being represented will also be zero.

Note that in some systems (Intel-based PCs in particular) the order of the bytes will be reversed.

Single-Precision Float

The single precision format uses four consecutive bytes, with the 32 bits containing a sign bit field, an 8-bit biased exponent field, and a 23-bit fraction field. The exponent has a bias of 7F (hexadecimal). The fraction field is precise to 7 decimal digits. The single-precision format can represent values in the range $1.18*10^{-38}$ to $3.4*10^{38}$ (decimal), 1.

Table B.1. Single-Precision Format

31-28	27-24	23-20	19-16	15-12	11-8	7-4	3-0	
S EXPONENT FRACTION								VALUE
0000	0000	0000	0000	0000	0000	0000	0000	0.0
0011	1111	1000	0000	0000	0000	0000	0000	1.0
1111	1111	1111	1111	1111	1111	1111	1111	NAN (not a number)
0011	1111	0100	0000	0000	0000	0000	0000	0.75

In 1, the value 1.0 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 7F (hexadecimal). The exponent is calculated by subtracting the bias value (7F) from the exponent field value. The result is 0.

   7F - 7F = 0

   The exponent multiplier is equal to 2^0, which is equal to 1 (decimal).

3. The fraction field is equal to .0. After adding the implicit normalized bit, the fraction is equal to 1.0 (binary). The fraction value is equal to 2^0 (decimal), which is equal to 1 (decimal).
4. The value of the number is positive 1*1= 1.0 (decimal).

In 1, the value 0.75 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 7E (hexadecimal). The exponent is calculated by subtracting the bias value (7F) from the exponent field value. The result is -1 (decimal).

   7E - 7F = -1

   The exponent multiplier is equal to 2^{-1}, which is equal to 0.5 (decimal).
3. The fraction field is equal to .1 (binary). After adding the implicit normalized bit, the fraction is equal to 1.1 (binary). The fraction value is equal to $2^0 + 2^{-1}$ (decimal), which is equal to 1 + 0.5 (decimal), which is equal to 1.5 (decimal).
4. The value of the number is positive 0.5*1.5 = 0.75 (decimal).

Double-Precision Float

The double-precision format uses eight consecutive bytes, with the 64 bits containing a sign bit field, an 11-bit biased exponent field, and a 52-bit fraction field. The exponent has a bias of 3FF (hexadecimal). The fraction field is precise to 15 decimal digits. The double-precision format can represent values in the range $9.46*10^{-308}$ to $1.79*10^{308}$ (decimal), 2.

Table B.2 Double-Precision Format

63-60	59-56	55-62	51-48	47-44	43-40	...	15-12	11-8	7-4	3-0	
S EXPONENT FRACTION											VALUE
0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0.0
0011	1111	1111	0000	0000	0000	...	0000	0000	0000	0000	1.0
1111	1111	1111	1111	1111	1111	...	1111	1111	1111	1111	NAN (not a number)
0011	1111	1110	1000	0000	0000	...	0000	0000	0000	0000	0.75

In 2, the value 1 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 3FF (hexadecimal). The exponent is calculated by subtracting the bias value (3FF) from the exponent field value. The result is 0 (decimal).

3FF - 3FF = 0

The exponent multiplier is equal to 2^0, which is equal to 1 (decimal).

3. The fraction field is equal to .0 (binary). After adding the implicit normalized bit, the fraction is equal to 1.0 (binary). The fraction value is equal to 2^0 (decimal), which is equal to 1 (decimal).
4. The value of the number is positive 1*1 = 1.0 (decimal).

In 2, the value 0.75 is calculated by the following method:

1. The sign of the value is positive because the sign bit field is equal to 0.
2. The exponent field is equal to 3FE (hexadecimal). The exponent is calculated by subtracting the bias value (3FF) from the exponent field value. The result is -1 (decimal).

   3FE - 3FF = -1
3. The fraction field is equal to .1 (binary). After adding the implicit normalized bit, the fraction is equal to 1.1 (binary). The fraction value is equal to $2^0 + 2^{-1}$ (decimal), which is equal to 1 + 0.5 (decimal), which is equal to 1.5 (decimal).
4. The value of the number is positive 0.5*1.5 = 0.75 (decimal).

B

Global Product Support

If you have any problems or require further assistance, you can contact Customer Support by telephone, email, or Internet.

Please refer to the documentation before contacting Customer Support. Many common problems are identified within the documentation and suggestions are offered for solving them.

Ashtech Precision Products Customer Support, Santa Clara CA USA:

800 number 800-229-2400

Direct dial: (408) 615-3980

Switchboard (408) 615-5100

Fax Line: (408) 615-5200

e-mail: support@thalesnavigation.com

Nantes, France:

Direct dial: 33 2 2809 3934

Switchboard: 33 2 2809 3800

e-mail: technical@thalesnavigation.com

Ashtech South America:

Tel: +56 2 234 56 43

Fax: +56 2 234 56 47

When contacting Customer Support, please have the following information on hand:

Receiver serial number

Software version number

Software key serial number

Firmware version number

A clear, concise description of the problem

Solutions for Common Problems

- Check cables and power supplies. Many hardware problems are related to these components.
- If the problem seems to be with your computer, re-boot it to clear the system's RAM memory.
- If you are experiencing receiver problems, reset the receiver as documented in the set commands section of this manual. Note that the reset command clears receiver memory and resets operating parameters to factory default values.
- Verify that batteries, including the backup battery for RAM memory, have adequate charge.
- Verify that the antenna is oriented skyward and is unobstructed by trees, buildings, or other objects overhead.

If these suggestions don't solve the problem, contact the Customer Support team. To assist the Customer Support team, please have the following information in hand:

Table C.1. GPS Product Information

Product Information	Your actual numbers
Receiver model	
Receiver serial #	
Software version #	
Firmware version #	
Options*	

Table C.1. GPS Product Information

Product Information	Your actual numbers
A brief description of the problem	
* The firmware version # and options can be obtained using the $PASHQ,RID (receiver identification) command.	

Corporate Web Page

You can obtain data sheets, GPS information, application notes, and a variety of useful information from Thales Navigation's Internet web page. In addition, you can locate additional support areas such as frequently asked questions (FAQs). Use the internet addresses below:

http://www.thalesnavigation.com

Repair Centers

In addition to repair centers in California and England, authorized distributors in 27 countries can assist you with your service needs.

Thales Navigation
471 El Camino Real
Santa Clara, California 95050-4300 USA
Voice: (408) 615-3980
or (800) 229-2400
Fax: (408) 615-5200
E-mail: support@ashtech.com

Thales Navigation
First Base, Beacontree Plaza
Gillette Way
Reading RG2 OBP
United Kingdom
TEL: 44 118 931 9600
FAX: 44 118 931 9601

Glossary

A

Aerotriangulation (phototriangulation)
A complex process vital to aerial **Photogrammetry** that involves extending vertical and/or horizontal control so that the measurements of angles and/or distances on overlapping photographs are related to a spatial solution using the perspective principles of the photographs. Aerotriangulation consists of mathematically extending the vectors/ angles of the triangular pattern of known reference points on or near the designated photo-block terrain upward through a rectangle representing the area of the photo-block (as seen by the camera's optical center) in such a way that the tree-point terrain triangle and the camera's eye three-point triangle (within the photographic frame) are analogous.

AFT
After

AGE
Age of Data

ALM
See **Almanac**

Almanac
A set of parameters used by a GPS receiver to predict the approximate locations of all GPS satellites and the expected satellite clock offsets. Each GPS satellite contains and transmits the almanac data for all GPS satellites (See **Ellipsoid**).

ALT
Altitude

Ambiguity
The initial bias in a carrier-phase observation of an arbitrary number of carrier cycles; the uncertainty of the number of carrier cycles a receiver is attempting to count. If wavelength is known, the distance to a satellite can be computed once the number of cycles is established via carrier-phase processing.

AMI
ATM Management Interface

ANT
Antenna

Antenna
A variety of GPS antennas ranging from simpler microstrip devices to complex choke ring antennas that mitigate the effects of multipath scattering.

Anti-Spoofing (AS)
The process of encrypting the P-Code modulation sequence so the code cannot be replicated by hostile forces. When encrypted, the P-Code is referred to as the Y-Code.

ASCII
American Standard Code for Information Interchange. A set of characters (letters, numbers, symbols) used to display and transfer digital data in human-readable format.

Atomic clock
A clock whose frequency is maintained using electromagnetic waves that are emitted or absorbed in the transition of atomic particles between energy states. The frequency of an atomic transition is very precise, resulting in very stable clocks. A cesium clock has an error of about one second in one million years. For redundancy purposes, GPS satellites carry multiple atomic clocks. GPS satellites have used rubidium clocks as well as cesium clocks. The GPS Master Control Station uses cesium clocks and a hydrogen master clock.

Argument of latitude
The sum of the true anomaly and the argument of perigee.

Argument of perigee
The angle or arc from the ascending node to the closest approach of the orbiting body to the focus or perigee, as measured at the focus of an elliptical orbit, in the orbital plane in the direction of motion of the orbiting body.

Ascending node
The point at which an object's orbit crosses the reference plane (e.g., equatorial plane) from south to north.

Azimuth
A horizontal direction expressed as the angular distance between a fixed direction and the direction of the object.

AZM
See Azimuth

B

Bandwidth
A measure of the information-carrying capacity of a signal expressed as the width of the spectrum of that signal (frequency domain representation) in Hertz.

Baseline
The measured distance between two receivers or two antennas

Bias
See **Integer bias terms**

BIN
Binary Index (file)

C

C/A
Coarse Acquisition

C/A code
A sequence of 1023 bits (0 or 1) that repeats every millisecond. Each satellite broadcasts a unique 1023-bit sequence that allows a receiver to distinguish between various satellites. The C/A-Code modulates only the L1 carrier frequency on GPS satellites. The C/A-Code allows a receiver to Carrier frequency
The basic frequency of an unmodulated radio signal. GPS satellite navigation signals are broadcast on two L-band frequencies, L1 and L2 is at 1575.42 Mhz, and L2 is at 1227.6 Mhz.

Carrier phase
The phase of either the L1 or L2 carrier of a GPS signal, measured by a receiver while locked-on to the signal (also known as integrated Doppler).

CEP
See Circular error probable.

Channel
Refers to the hardware in a receiver that

allows the receiver to detect, lock-on and continuously track the signal from a single satellite. The more receiver channels available, the greater number of satellite signals a receiver can simultaneously lock-on and track.

Chip
The length of time to transmit either a zero or a one in a binary pulse code.

Chip rate
Number of chips per second (e.g., C/A code = 1.023 MHz).

Circular Error Probable

A circle's radius, centered at the true antenna position, containing 50% of the points in the horizontal scatter plot.

Clock offset
The difference in time between GPS time and a satellite clock or a sensor clock (less accurate).

COG
Course Over Ground

Constellation
Refers to the collection of orbiting GPS satellites. The GPS constellation consists of 24 satellites in 12-hour circular orbits at an altitude of 20,200 kilometers. In the nominal constellation, four satellites are spaced in each of six orbital planes. The constellation was selected to provoke a very high probability of satellite coverage even in the event of satellite outages.

CTD
Course To Destination

Cycle slip
A loss of count of carrier cycles as they are being measured by a GPS receiver. Loss of signal, ionospheric interference and other forms of interference cause cycle slips to occur.

D

DGPS
See Differential GPS

Differential GPS (DGPS)
A technique whereby data from a receiver at a known location is used to correct the data from a receiver at an unknown location. Differential corrections can be applied in real-time or by post-processing. Since most of the errors in GPS are common to users in a wide area, the DGPS-corrected solution is significantly more accurate than a normal SPS solution.

Differential processing
GPS measurements can be differenced between receivers, satellites, and epochs. Although many combinations are possible, the present convention for differential processing of GPS measurements is to take differences between receivers (single difference), then between satellites (double difference), then between measurement epochs (triple difference). A single-difference measurement between receivers is the instantaneous difference in phase of the signal from the same satellite, measured by two receivers simultaneously. A double-difference measurement is the difference for a chosen reference satellite. A triple-difference measurement is the difference between a double difference at one epoch and the same double difference at the previous epoch.

Differential (relative) positioning

Determination of relative coordinates of two or more receivers which are simultaneously tracking the same satellites. Dynamic differential positioning is a real-time calibration technique achieved by sending corrections to the roving user from one or more reference stations. Static differential GPS involves determining baseline vectors between pairs of receivers.

Dilution of Precision (DOP)

A measure of the receiver-satellite(s) geometry. DOP relates the statistical accuracy of the GPS measurements to the statistical accuracy of the solution. Geometric Dilution of Precision (GDOP) is composed of Time Dilution of Precision (TDOP); and Position Dilution of Precision (PDOP), which are composed of Horizontal Dilution of Precision (HDOP); and Vertical Dilution of Precision (VDOP).

DOP

Dilution of Precision

Doppler aiding

The use of Doppler carrier-phase measurements to smooth code-phase position measurements.

Doppler shift

An apparent change in signal frequency which occurs as the transmitter and receiver move toward or away from one another.

Double difference

The arithmetic differencing of carrier phases measured simultaneously by a pair of receivers tracking the same pair of satellites. Single differences are obtained by each receiver from each satellite; these differences are then differenced in turn, which essentially deletes all satellite and receiver clock errors.

DTD

Distance to Destination

Dynamic positioning

Determination of a timed series of sets of coordinates for a moving receiver, each set of coordinates being determined from a single data sample, and usually computed in real-time.

E

Earth Centered, Earth Fixed (ECEF)

A cartesian coordinate system centered at the earth's center of mass. The Z-axis is aligned with the earth's mean spin axis. The X-axis is aligned with the zero meridian. The Y-axis is 90 degrees west of the X-axis, forming a right-handed coordinate system.

EDOP

Elevation Dilution of Precision

ELEV

Elevation

Elevation

Height above mean sea level. Vertical distance above the geoid.

Elevation mask

An adjustable feature of GPS receivers that specifies that a satellite must be at least a specified number of degrees above the horizon before the signals from the satellite are to be used. Satellites at low elevation angles (five degrees or less) have lower signal strengths and are more prone to loss of lock thus causing noisy solutions.

Elevation mask angle
That angle below which it is not advisable to track satellites. Typically the elevation mask is set to 5° to avoid interference problems caused by buildings and trees and multipath reflections.

Ellipsoid
In geodesy, unless otherwise specified, a mathematical figure formed by revolving an ellipse about its minor axis. It is often used interchangeably with spheroid. Two quantities define an ellipsoid; the length of the semimajor axis, a, and the flattening, f =- (a - b)/a, where b is the length of the semiminor axis. Prolate and triaxial ellipsoids are invariably described as such.

Ellipsoid height
The measure of vertical distance above the ellipsoid. Not the same as elevation above sea level. GPS receiver output position fix height in the WGS-84 datum.

Ephemeris
A set of parameters used by a GPS receiver to predict the location of a single GPS satellite and its clock behavior. Each GPS satellite contains and transmits ephemeris data for its own orbit and clock. Ephemeris data is more accurate than the almanac data but is applicable over a short time frame (four to six hours). Ephemeris data is transmitted by the satellite every 30 seconds.

Epoch
Measurement interval or data frequency, as in making observations every 15 seconds. Loading data using 30-second epochs means loading every other measurement.

F

FCC
Federal Communications Commission

Firmware
The coded instructions relating to receiver function, and (sometimes) data processing algorithms, embedded as integral portions of the internal circuitry.

Flattening
$f = (a- b)/a = 1 - (1 - e^2)^{1/2}$ where
a = semimajor axis
b = semiminor axis
e = Eccentricity

G

GDOP
Geometric Dilution of Precision. The relationship between errors in user position and time and in satellite range. $GDOP^2 = PDOP^2 + TDOP^2$. See Position Dilution of Precision.
.

Geodetic datum (horizontal datum)
A specifically oriented ellipsoid typically defined by eight parameters which establish its dimensions, define its center with respect to Earth's center of mass and specify its orientation in relation to the Earth's average spin axis and Greenwich reference meridian.

Geodetic height (ellipsoidal height)
The height of a point above an ellipsoidal surface. The difference between a point's geodetic height and its orthometric height equals the geoidal height.

Geoid
The equipotential surface of the Earth's gravity field which best fits mean sea level. Geoids currently in use are GEOID84 and GEOID90.

Geoidal height (geoidal separation; undulation)
The height of a point on the geoid above the ellipsoid measured along a perpendicular to the ellipsoid.

GLL
Position Latitude/Longitude

GMST
Greenwich Mean Sidereal Time

GPS DIFF
Differential

GPS ICD-200
The GPS Interface Control Document is a government document that contains the full technical description of the interface between the satellites and the user. GPS receiver must comply with this specification if it is to receive and process GPS signals properly.

GPS week
GPS time started at Saturday/Sunday midnight, January 6, 1980. The GPS week is the number of whole weeks since GPS time zero.

Greenwich mean time (GMT)
See universal time. In this text, they are often used interchangeably.

H

HDOP
Horizontal Dilution of Precision. See Dilution of Precision.

HI
Height of Instrument

HTDOP
Horizontal/Time Dilution of Precision. See Dilution of Precision.

I

ID
Identification or Integrated Doppler

Integer bias terms
The receiver counts the carrier waves from the satellite, as they pass the antenna, to a high degree of accuracy. However, it has no information number of waves to the satellite at the time it started counting. This unknown number of wavelengths between the satellite and the antenna is the integer bias term.

Integrated Doppler
A measurement of Doppler shift frequency or phase over time.

Ionosphere
Refers to the layers of ionized air in the atmosphere extending from 70 kilometers to 700 kilometers and higher. Depending on frequency, the ionosphere can either block radio signals completely or change the propagation speed. GPS signals penetrate the ionosphere but are delayed. The ionospheric delays can be predicted using models, though with relatively poor accuracy, or measured using two receivers.

Ionospheric delay
A wave propagating through the ionosphere [which is a nonhomogeneous (in space and time) and dispersive medium] experiences delay. Phase delay depends on electron content and affects carrier signals.

Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.

J

Julian date
The number of days that have elapsed since 1 January 4713 B.C. in the Julian calendar. GPS time zero is defined to be midnight UTC, Saturday/Sunday, 6 January 1980 at Greenwich. The Julian date for GPS time zero is 2,444,244.5.

K

Kinematic surveying
A method which initially solves wavelength ambiguities and retains the resulting measurements by maintaining a lock on a specific number of satellites throughout the entire surveying period.

L

L1
The primary L-band signal radiated by each NAVSTAR satellite at 1575.42 MHz. The LI beacon is modulated with the C/A and P codes, and with the NAV message. L2 is centered at 1227.60 MHz and is modulated with the P code and the NAV message.

L-band
A nominal portion of the microwave electro-magnetic spectrum ranging from 390 MHz to 1.55 GHz.

LNA
Low-Noise Amplifier

M

MSG
RTCM Message

MSL
Mean Sea Level

Multichannel receiver
A receiver containing many independent channels. Such a receiver offers highest SNR because each channel tracks one satellite continuously.

Multipath
The reception of a signal both along a direct path and along one or more reflected paths. The resulting signal results in an incorrect pseudo-range measurement. The classical example of multipath is the "ghosting" that appears on television when an airplane passes overhead.

Multipath error
A positioning error resulting from interference between radio waves which have traveled between the transmitter and the receiver by two paths of different electrical lengths.

Multiplexing
A technique used in some GPS receivers to sequence the signals of two or more satellites through a single hardware channel. Multiplexing allows a receiver to track more satellites than the number of hardware channels at the cost of lower effective signal strength.

Multiplexing channel
A receiver channel which is sequenced through several satellite signals (each from a specific satellite at a specific frequency) at a rate which is

synchronous with the satellite message bit-rate (50 bits per second, or 20 milliseconds per bit). Thus, one complete sequence is completed in a multiple of 20 milliseconds.

N

NMEA
National Marine Electronics Association

NV
Non-Volatile. Usually refers to a memory device that retains data after power is removed.

O

Outage
The occurrence in time and space of a GPS dilution of precision value exceeding a specified maximum.

P

Position Dilution of Precision (PDOP)
A unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Geometrically, POP is proportional to 1 divided by the volume of the pyramid formed by lines running from the receiver to four satellites observed. Values considered 'good' for positioning are small, say 3. Values greater than 7 are considered poor. Thus, small PDOP is associated with widely separated satellites. PDOP is related to horizontal and vertical DOP by $PDOP^2 = HDOP^2 + VDOP^2$. Small PDOP is important in positioning, but much less so in surveying.

Photogrammetry
An aerial remote sensing technique whose latest innovations employ a high-resolution aerial camera with forward motion compensation and uses GPS technology for pilot guidance over the designated photo block(s). Photogrammetry forms the baseline of many Geographic Information Systems (GIS) and Land Information System (LIS) studies.

Point positioning
A geographic position produced from one receiver in a stand-alone mode. At best, position accuracy obtained from a stand-alone receiver is 5 meters to less than 1 meter, depending on the geometry of the satellites.

POS
Position

Post-processing
The reduction and processing of GPS data after the data was collected in the field. Post-processing is usually accomplished on a computer in an office environment where appropriate software is employed to achieve optimum position solutions.

Precise Positioning System (PPS)
The more accurate GPS capability that is restricted to authorized, typically military, users.

Pseudo-kinematic surveying
A variation of the kinematic method where roughly five-minute site occupations are repeated at a minimum of once each hour.

Pseudorandom noise (PRN)
The P(Y) and C/A codes are pseudo-random noise sequences which

modulate the navigation signals. The modulation appears to be random noise but is, in fact, predictable hence the term "pseudo" random. Use of this technique allows the use of a single frequency by all GPS satellites and also permits the satellites to broadcast a low power signal.

Pseudo-range
The measured distance between the GPS receiver antenna and the GPS satellite. The pseudo-range is approximately the geometric range biased by the offset of the receiver clock from the satellite clock. The receiver actually measures a time difference which is related to distance (range) by the speed of propagation.

R

RAM
Random-Access Memory. A memory device whose data can be accessed at random, as approved to sequential access. RAM data is lost when power is removed.

Range rate
The rate of change of range between the satellite and receiver. The range to a satellite changes due to satellite and observer motions. Range rate is determined by measuring the doppler shift of the satellite beacon carrier.

RDOP
Relative Dilution of Precision. See Dilution of Precision.

Reconstructed carrier phase
The difference between the phase of the incoming Doppler-shifted GPS carrier and the phase of a nominally constant reference frequency generated in the receiver. For static positioning, the reconstructed carrier phase is sampled at epochs determined by a clock in the receiver. The reconstructed carrier phase changes according to the continuously integrated Doppler shift of the incoming signal biased by the integral of the frequency offset between the satellite and receiver reference oscillators.

Real-time
Refers to immediate, GPS data collection, processing and position determination (usually) within a receiver's firmware after the fact with a computer in an office environment.

Reference Network
A series of monuments or reference points with accurately measured vectors/ distances that is used as a reference basis for cadastral and other types of survey.

Reference station
A point (site) where crustal stability, or tidal current constants, have been determined through accurate observations, and which is then used as a standard for the comparison of simultaneous observations at one or more subordinate stations. Certain of these are known as Continuous Operating Reference Stations (CORS), and transmit reference data on a 24-hour basis.

Relative positioning
The process of determining the relative difference in position between two points with greater precision than that to which

the position of a single point can be determined. Here, a receiver (antenna) is placed over each point and measurements are made by observing the same satellite at the same time. This technique allows cancellation (during computations) of all errors which are common to both observers, such as satellite clock errors, propagation delays, etc. See also Translocation and Differential Navigation.

RF
Radio Frequency

RFI
Radio Frequency Interference

RINEX
The Receiver-INdependent EXchange format for GPS data, which includes provisions for pseudo-range, carrier-phase, and Doppler observations.

RMS
Root Mean Square. A statistical measure of the scatter of computed positions about a "best fit" position solution. RMS can be applied to any random variable.

RTCM
Radio Technical Commission for Maritime Services
P.O. Box 19087
Washington, DC. 20036-9087

RTCM SC-104 Format
A standard format used in the transmission of differential corrections.

S

Selective Availability (SA)
The process whereby DOD dithers the satellite clock and/or broadcasts erroneous orbital ephemeris data to create a pseudo-range error

SEP
See Spherical Error Probable

Sidereal day
Time between two successive upper transits of the vernal equinox.

Sidereal time
The hour angle of the vernal equinox. Taking the mean equinox as the reference yields true or apparent Sidereal Time. Neither Solar nor Sidereal Time are constant, since angular velocity varies due to fluctuations caused by the Earth's polar moment of inertia as exerted through tidal deformation and other mass transports.

Single difference
The arithmetic differencing of carrier phases simultaneously measured by a pair of receivers tracking the same satellite (between receivers and satellite), or by a single receiver tracking two satellites (between-satellite and receivers); the former essentially deletes all satellite clock errors, while the latter essentially deletes all receiver errors.

Spherical Error Probable (SEP)
A statistical measure of precision defined as the 50th percentile value of the three-dimensional position error statistics. Thus, half of the results are within a 3D SEP value.

Spoofing
The process of replicating the GPS code in such a way that the user computes incorrect position solutions.

SPS
See Standard Positioning Service

Standard Positioning Service (SPS)
Uses the C/A code to provide a minimum level of dynamic- or static-positioning capability. The accuracy of this service is set at a level consistent with national security.

Static observations
A GPS survey technique requiring roughly one hour of observation, with two or more receivers observing simultaneously, and results in high accuracies and vector measurements.

Static positioning
Positioning applications in which the positions of static or near static points are determined.

SV
Satellite Vehicle, Satellite Visibility or Space Vehicle.

Switching channel
A receiver channel which is sequenced through a number of satellite signals (each from a specific satellite and at a specific frequency) at a rate which is slower than, and asynchronous with, the message data rate.

T

TDOP
Time Dilution of Precision. See Dilution of Precision.

TOW
Time of week, in seconds, from midnight Sunday GPS.

Translocation
A version of relative positioning which makes use of a known position, such as a USGS survey mark, to aid in the accurate positioning of a desired point. Here, the position of the mark, determined using GPS, is compared with the accepted value. The three-dimensional differences are then used in the calculations for the second point.

Tropospheric correction.
The correction applied to the measurement to account for tropospheric delay. This value is obtained from the modified Hopfield model.

True anomaly
The angular distance, measured in the orbital plane from the earth's center (occupied focus) from the perigee to the current location of the satellite (orbital body).

U

Universal Time Coordinated (UTC)
Time as maintained by the U.S. Naval Observatory. Because of variations in the Earth's rotation, UTC is sometimes adjusted by an integer second. The accumulation of these adjustments compared to GPS time, which runs continuously, has resulted in an 11 second offset between GPS time and UTC at the start of 1996. After accounting for leap seconds and using adjustments contained in the navigation message, GPS time can be related to UTC within 20 nanoseconds or better.

User Range Accuracy (URA)
The contribution to the range-measurement error from an individual error source (apparent clock and

ephemeris prediction accuracies), converted into range units, assuming that the error source is uncorrelated with all other error sources. Values less than 10 are preferred.

UT
Universal Time

UTM
Universal Transverse Mercator Map Projection. A special case of the Transverse Mercator projection. Abbreviated as the UTM Grid, it consists of 60 north-south zones, each 6 degrees wide in longitude.

V

VDC
Volts Direct Current

VDOP
Vertical Dilution of Precision. See Dilution of Precision and Position Dilution of Precision.

W

WGS
World Geodetic System

World Geodetic System 1984 (WGS-84)
A set of U.S. Defense Mapping Agency parameters for determining global geometric and physical geodetic relationships. Parameters include a geocentric reference ellipsoid; a coordinate system; and a gravity field model. GPS satellite orbital information in the navigation message is referenced to WGS-84.

World Geodetic System (WGS-72)
The mathematical reference ellipsoid previously used by GPS, having a semimajor axis of 6378.135 km and a flattening of 1/298.26.

Y

Y-Code
The designation for the end result of P-Code during Anti-Spoofing (AS) activation by DoD.

Y-code tracking, civilian
Signal squaring (now obsolete) multiplies the signal by itself, thus deleting the carrier's code information and making distance measurement (ranging) impossible. Carrier phase measurements can still be accomplished, although doubling the carrier frequency halves the wavelength.

Index

Symbols

Numerics

A

B

C

D

E

Index

N

O

P

Q

R

S

X

Y

Z