uZ-CGRS™ GPS Receiver *Operations & Reference Manual*

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Introduction

The Ashtech Micro Z Continuous Geodetic Reference Station (uZ-CGRS) System provides the world's most powerful GPS Reference Station technology at an affordable price. At the heart of the uZ-CGRS system is the new Ashtech uZ-CGRS GPS receiver, Figure 1.1. The uZ-CGRS is the latest and most advanced receiver in the Z family, and incorporates our patented Z-Tracking. Designed to support an expanding variety of Reference Station applications including crustal deformation, earthquake and seismic monitoring, volcanic studies, meteorological studies, high-accuracy scientific land survey, GIS, engineering applications, and others requiring a high level of accuracy, the uZ-CGRS system is ideal as a permanent GPS base station.

Figure 1.1. uZ-CGRS GPS Receiver

This manual is intended to inform the user of the receiver functionality and characteristics as well as instruct the user on how to set up their Reference Station receiver for their particular application(s). It details all commands supported thus allowing the user to utilize all the possibilities the uZ-CGRS has to offer, simply and efficiently.

In addition, the uZ-CGRS firmware may be loaded into the Z-Surveyor and Z-FX receivers. Thus, giving these receivers the robust functionality required by Reference Station networks of today. Minor differences exist between these receiver models and the uZ-CGRS receiver. These differences are detailed throughout this manual as well as summarized in Chapter 3, **Operation**.

We recommend that you read in detail all of Chapter 1, **Introduction**, Chapter 2, **Equipment Description**, and Chapter 3, **Operation** as well as the portions of Chapter 4, **Setup** that pertain to your application before you install your uZ-CGRS receiver (or firmware in Z-Surveyor or Z-FX) and power it on. For detailed information on commands accepted by the uZ-CGRS firmware see Chapter 5, **Command/Response Formats**.

Overview

The uZ-CGRS processes signals from the GPS satellite constellation, deriving real-time position, velocity, and time measurements. Twelve dedicated separate and parallel channels extract Coarse/Acquisition (C/A) code-phase, and carrier-phase measurement on the L1 (1575 MHz) band, and Precise (P) code phase and carrier phase measurement on the L1 and L2 (1227 MHz) bands.

The uZ-CGRS receives satellite signals via an L-band antenna and low-noise amplifier (LNA). The receiver operates as a stand-alone reference station providing raw measurements, and as a real-time differential base station broadcasting DGPS corrections based on codephase, and real-time kinematic (RTK) corrections based on carrier phase. The unit implements the RTCM SC104 V2.2 standard for differential DGPS and RTK operation. These features allow the uZ-CGRS to achieve centimeter accuracy while being compatible for differential DGPS and RTK operation with any other receiver that implements the RTCM standard.

With the proper post processing software and methodology, mm-level positioning repeatability with Ashtech receivers is claimed by such organizations as the Southern California Integrated GPS Network and the International GPS Service. For more information about these organizations refer to their websites:

- Southern California Integrated GPS Network—www.scign.org
- International GPS Service—igscb.jpl.nasa.gov

Functional Description

The receiver is activated when either power is initially supplied to the receiver through a power connector in the back of the unit, or when the power button is pressed (after the receiver has been turned off via the power button). After self-test, the receiver initializes its twelve channels and begins searching for all space vehicles (SVs) within the field of view of the antenna. The receiver can track all Block I and Block II GPS SVs. All 32 PRN numbers as specified in Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS-200, Revision B are internally coded. As the receiver acquires (locks onto) each SV, it notes the time and collects the ephemeris data about the orbit of that SV, and the almanac data about the orbits of all the SVs in the constellation.

The receiver features 12-parallel channel/12-SV all-in-view operation; each of up to 12 visible SVs can be assigned to a channel and then continuously tracked. Each SV broadcasts almanac and ephemeris information every 30 seconds, and the unit automatically records this information in its non-volatile memory. The unit has an L1/L2-band radio frequency (RF) port and four RS-232 serial input/output (I/O) ports. Ports A, B, C, and D are capable of two-way communication with external equipment. Ports A and B have expanded support for more advanced communication strategies (for more information on this see Chapter 2, Equipment Description.)

The RF circuitry receives satellite data from a GPS antenna and LNA via a coaxial cable, and can supply +5V to the antenna/LNA by means of that cable. No separate antenna power cable is required. Typical power consumption of the receiver is approximately 7.0 watts when powering an LNA.

The receiver incorporates three multi-colored LEDs. A satellite/power status LED blinks green for each satellite tracked, and blinks red between the satellites-tracked count to depict power-on status. A memory storage status LED blinks green when data is stored to the memory card. An event LED blinks green every time information is written to the D-file, including meteorological or tilt data. This allows the user to easily confirm that the receiver is performing to the setup requirements.

The receiver collects C/A code-phase (pseudo-range) and full wavelength carrier phase measurement on the L1 frequency and P code-phase and full wavelength carrier phase measurements on the L1 and L2 frequencies. All data can be stored in the internal memory and/or output in a real time data stream. The receiver permits uninterrupted use even when Anti-Spoofing (AS) is turned on. When AS is on, the receiver automatically activates our patented Z-tracking mode that mitigates the effects of AS.

Memory Options

The receiver also includes internal memory in the form of a compact flash card at a standard of 16MB. For more intensive memory requirements, additional memory is available, allowing up to a total of 80MB's internal memory within the receiver to be accessed. Memory sizes available are 16, 32, and 80MB's

The duration of data the uZ-CGRS can collect depends upon the memory size and the recording interval set within the receiver. At a 30-second data interval, tracking six satellites, a 16MB receiver can log 406 hours of data.

The receiver can be set to record data in conventional memory mode or Ring File Memory mode. In conventional memory mode, the receiver will log data until the memory card is full. Once full, the receiver will stop logging until some portion of memory has been cleared by deleting at least one file. In Ring File Memory mode, the receiver will log data continuously, almost filling up all the memory and then clearing a portion of the oldest data (by deleting the oldest file when approximately 250k of free memory is left). This allows the receiver to constantly log data without external intervention.

Technical Specifications

Table 1.1 lists the technical specifications of the uZ-CGRS.

Table 1.1. Technical Specifications

Characteristic	Specifications
Tracking	12 channels CA/P L1 and P L2
Size	2.5"H x 7"W x 9.6"D (6.33cm x 7.71cm x 24.3cm)
Weight	3.75 lb (1.7kg)
Operating temperature	-40° to +55°C
Storage temperature	-40° to +85°C
Humidity	100%
Environment	Meets MIL-STD-810E for wind-driven rain and dust
Power consumption (Operating at room temperature 25° C)	7.0 watts
Power input	10 - 28VDC
Data storage	16, 32, or 80MBs

Table 1.1. Technical Specifications (continued)

Characteristic	Specifications
Interface	• 1 advanced Power Button • 3 dual-color LED • 2 power input ports via 2 Fischer 103 connectors • 4 external RS-232 ports via 2 Fischer 104 connectors • 1 External Frequency Reference Port via BNC connector • 1 GPS Antenna port via N connector • 1 1PPS output via Fisher 104 connector
MEASUREMENT PRECISION	
C/A (>10° elevation) • Pseudo-range (raw/smooth) • Carrier Phase	 • 25cm/3.6cm • 0.9mm
P-Code AS off (>10° elevation) • L1 Pseudo-range (raw/smooth) • L1 Carrier Phase • L2 Pseudo-range (raw/smooth) • L2 Carrier Phase	 • 15cm/0.9cm • 0.9mm • 21cm/1.3cm • 0.9mm

Receiver Options

Table 1.2 lists the options available within the uZ-CGRS receiver.

Table 1.2. uZ-CGRS Options

Option	Description
B	RTCM Differential Codephase Base
X	External Frequency
M	Remote Monitor Option
F	Fast Data Output
3	Observables
K	RTK Base

Each option is represented by a letter or number presented in a certain order. You can verify the installed options within your uZ-CGRS receiver by issuing the **$PASHQ,RID** command using a PC and a communication interface package such as Ashtech's Micro-Manager, RCS, or any third party communication package.

The **$PASHQ,RID** command responds in the $PASHR response string format. For example:

$PASHR,RID,UZ,30,UH00,B—XM—3---,0A16*63

If the letter or number is displayed in the response message, the option is installed. If the letter/number is not displayed, the option is not installed. Standard package options are X, M, and 3.

Option B - RTCM Base

The receiver can be set as an RTCM differential code-phase base station outputting real-time differential corrections when this option is enabled. The output will be in RTCM-104, Version 2.2 format message types 1, 2, 3, 6, 9, and 16. For RTCM Carrier Phase Differential BASE (RTK) operations, see option K.

Option X - External Frequency Reference

The external frequency option X allows you to input an external frequency source so you can synchronize receiver data to an external clock. When enabled, the internal oscillator is phase-locked to the external frequency input.

Option M - Remote Monitoring

The Remote Monitoring option M allows you to remotely access the uZ-CGRS receiver and download GPS data sets via a modem or other data link while continuously recording data, performing uninterrupted data collection at the remote site while retrieving the data.

Option F - Fast Data Output

The Fast Data Output option F allows the receiver to be programmed to output raw position data, NMEA messages, or record data at user-selectable frequencies up to 10Hz. Without this option, frequencies up to 5Hz are available.

Option 3 - Observables

This option determines the observables available in the receiver where:

3—CA code and carrier on L1, P-code and carrier on L1/L2

Option K - RTK Base

The receiver can be set as an RTCM carrier phase differential (RTK) base station outputting real-time carrier phase differential corrections when this option is enabled. The output will be in RTCM 104, Version 2.2 format message types 18 and 19, or 20 and 21 messages as well as message type 22. This option requires the observable options 3 and the B option to be installed to function properly.

Other options may be available as well. Contact your Ashtech supplier for more information.

2

Equipment Description

This chapter provides a detailed description of the uZ-CGRS equipment. For the Z-Surveyor and Z-FX receivers, refer to their specific receiver manuals for the functionality of the 8 character LED, button functionality, and back panel descriptions.

uZ-CGRS Front Panel

The uZ-CGRS front panel, Figure 2.2, allows you to easily determine the basic working setup of the receiver without having to issue commands. Three LED's show the status of different activities within the receiver:

Figure 2.1. uZ-CGRS Front Panel

The LED's from left to right are the SV/Power LED, Data Log LED, and the Event LED. The Blue button on the left is the Power ON/OFF button which can also be used to reset the receiver to factory defaults.

SV/Power LED

At power up the SV/Power LED will continue to blink red approximately once every couple of seconds to indicate that the unit is powered on. This LED will additionally blink green once for each SV the unit is tracking in between each red blink. Additional functionality of this LED is described below in the "Advanced Power ON/OFF Button" section.

Data Log LED

The Data Log LED will blink green each time an epoch is recorded to memory. In addition, if the receiver memory fills up and is not able to log any more data to memory, the LED will go to constant red. Additional functionality of this LED is described in the "Advanced Power ON/OFF Button" section.

If Ring File memory is enabled, the receiver memory will never fill up, and the LED cannot go to constant red due to a memory full state.

CAUTION

If only one file exists in memory, the receiver will delete that file, erasing all recorded data in the receiver when Ring File memory is activated.

Event LED

Every time information (a data block) is written to the D-file, the Event LED will blink green. This includes such events as logging Meteorological or Tilt Data to the D-file. Additional functionality of this LED is described in the "Advanced Power ON/OFF Button" section.

Advanced Power ON/OFF Button

The power button functionality is enhanced as follows:

Power the Unit "ON"

When the unit is off and the user presses the power button until it "clicks" and then releases the button, the unit will power on normally. The SV/Power LED will take 1 to 2 seconds before a RED blink occurs indicating the unit is turned "ON". In addition, the uZ-CGRS unit is designed to automatically power on when power is initially sent to the receiver. This will occur when power is initially supplied through the back connectors or if power is lost (due to a power outage) and then comes back on.

Turn the Unit "OFF"

Whenever the user presses the power button when the unit is "ON" until it "clicks" and maintains holding the power button in, the following will happen:

1. after one second the 3 LED's will flash red.
2. after two seconds the 3 LED's will flash red again.
3. after three seconds the 3 LED's will flash red again.
4. after four seconds the unit will turn off.

If the user stops maintaining pressure on the power button at any time up until the unit shuts off, the unit will remain powered on and will not be interrupted in any way. There will not be data gaps for the period in which the power button was pressed.

Reset the Unit.

When the unit is off and the user presses the power button until it “clicks”, the unit will power “ON” as noted above. In addition, if the user maintains pressure on the power button, the following will happen:

5. after one second the 3 LED's will flash red.
6. after two seconds the 3 LED's will flash red.
7. after three seconds the 3 LED's will flash red.
8. after four seconds the 3 LED's will maintain red.
9. after five seconds the 3 LED’s will maintain red.
10. after six seconds, the 3 LED's will change to “rolling green” and the unit will “reboot” itself going back to factory defaults and erase the memory card within the unit. Note the 3 LED's will stay “rolling green” until the unit completely resets itself. You may release the power button anytime after the “rolling green” starts and the unit will complete it’s reset. After the unit resets itself, the unit will stay powered up.

This can only be done at power-up. If the user stops maintaining pressure on the power button at anytime up until the 3 LED's go to the “rolling green” state, the unit will power up normally.

CAUTION
Turning the unit “OFF” while in the “reset” or “rolling green” state can have adverse effects. If this occurs, repeat the Reset process immediately.

Rear Panel

The rear panel of the uZ-CGRS, Figure 2.2, contains all the connectors for connection to external equipment. The pinout of port A is wired to handle all modem support signals. The pinout of Port B is designed to connect to the PC. Port C and Port D are designed to work with Meteorological and Tilt sensors although any ports may be connected to these transducers. Large connectors have been used for backward compatibility to existing Z-12 CGRS cables. Table 2.1 describes the rear panel components.

Figure 2.2. uZ-CGRS Rear Panel

Table 2.1. uZ-CGRS Rear Panel Description

Component	Function
Power connector	Allows connection to external power equipment as well as 'boot' the receiver. These connectors are labeled "PWR"
Serial Ports	4 functional serial ports reside in 2 physical ports. Each Physical Port delivers a 12V output on pin 16 for external devices. The total power delivered by all connectors is 1A, at 50% duty cycle, 250ms duration. In case of a short circuit, the power is internally fused—the fuse will be tripped requiring the removal of the short-circuit prior to reactivation of this power. These connectors are labeled "A/C" and "B/D."
•A	A complete RS-232 port with full-handshaking. Port A may be used for transferring data from the receiver to a computer, receiver to receiver, and all other communication equipment. Port A is designed and recommended to fully support Modem communications equipment.

Table 2.1. uZ-CGRS Rear Panel Description (continued)

Component	Function
Serial Ports (continued) •B	A complete RS-232 port with full hand-shaking. Port B may be used for transferring data from the receiver to a computer, from a receiver to a receiver, and all other communication equipment. Port B is designed to be used for communication with an IBM-compatible PC.
•C	A RS-232 port. Port C may be used for transferring data from the receiver to a computer, from a receiver to a receiver, and all other communication equipment. Port C is specifically designed as the input for transducers such as Meteorological Stations and Tilt Sensors.
•D	A RS-232 port. Port D may be used for transferring data from the receiver to a computer, from a receiver to a receiver, and all other communication equipment. Port D is specifically designed as the input for transducers such as Meteorological Stations and Tilt Sensors.
External Frequency	The External Frequency connector is a standard BNC female receptacle wired for connection via a 50-ohm coaxial cabling to an external frequency source. The connector shell is connected to the uZ-CGRS common ground. It supports a 5 MHz, 10 MHz, and 20 MHz input signal. The External Frequency Port is labeled "EXT REF."
GPS Antenna Connector	The RF connector is a standard N female receptacle wired for connection via 50-ohm coaxial cabling to a GPS antenna with an integral LNA. The connector shell is connected to the uZ-CGRS common ground. The N connector center pin provides +5VDC (to power the LNA) and accepts 1227 MHz and 1575.42 MHz RF input from the antenna; the RF and DC signals share the same path. The GPS Antenna Connector port is labeled "GPS."
1 PPS	A 1 pulse-per-second signal is available on pin 10 of port A/C (See Table 2.3). A special cable is required to access this signal. Contact your Ashtech supplier for more information.

CAUTION

The current for the GPS antenna connector is limited to 150mA out of the RF center conductor. It is short-circuit protected. If using a splitter or other RF network, use an inner DC block suitable for 1-2 GHz, 50 ohms; maximum voltage back to the uZ-CGRS cannot exceed 15V.

Pinouts

Power and Boot

Two power connectors are used for the power input interface. The outside (left hand) power input can also be used to “reboot” the receiver. These connectors are 3-pin Fischer 103-series connectors, Figure 2.3, and are labeled “PWR.” The voltage input range is 10-28 VDC, with a power rating of 7 W. The pinout of these two connectors is shown in Table 2.2.

Figure 2.3. Power Connector Pin Layout

Table 2.2. Power Connector Pinouts

Pin	Signal	Description
1	EXT_INP	Power input 10-28 VDC
2	EXT_GND	External Ground
3	Boot Pin	Short pin to ground (pin 2) to put the unit into Boot Mode. The boot pin is supported on the outside (left hand) connector only.

Chassis ground and external ground are not the same for EMI purposes.

Serial Connectors

Two serial connectors are provided using 16-pin Fischer 104-series connectors, refer to Figure 2.4 for pin layout. Each Serial Port Connector can support up to two functional ports. The pinout of these two connectors is shown in Table 2.3 and Table 2.4. Table 2.3 denotes the pinout of the serial port connector labeled “A/C” and is used to access serial ports A and C within the receiver. Table 2.4 denotes the pinout of the serial port connector labeled “B/D” and is used to access serial ports B and D within the receiver. In addition, a 1PPS signal is available on pin 10 of Port A/C.

Figure 2.4. Serial Port Pin Layout

Table 2.3. Port A/C Connector Pinout

Pin	Signal	Description
1	NA	Not Connected
2	TXDA	Port A Transmit Data Output
3	RXDA	Port A Receive Data Input
4	RTSA	Port A Request To Send Output
5	CTSA	Port A Clear To Send Input

Table 2.3. Port A/C Connector Pinout (continued)

6	DSRA	Port A Data Set Ready Input
7	GND	Signal Ground
8	DCDA	Port A Data Carrier Detect Input
9	DTRA	Port A Data Terminal Ready Output
10	1PPS	One Pulse Per Second Output
11	GND	Signal Ground
12	TXDC	Port C Transmit Data Output
13	RXDC	Port C Receive Data Input
14		Pin 14 & 15 are tied together internally
15		to simulate RTS/CTS for port C
16	+12VDC	+12VDC Output Supply

Table 2.4. Port B/D Connector Pinout

Pin	Signal	Description
1	NA	Not Connected
2	TXDB	Port B Transmit Data Output
3	RXDB	Port B Receive Data Input
4	RTSB	Port B Request To Send Output
5	CTSB	Port B Clear To Send Input
6		See Pins 8 & 9
7	GND	Signal Ground
8		Pin 6, 8 & 9 are tied together internally
9		to simulate DTR/DCD/DSR for port B
10	PG-IN	Reserved
11	GND	Signal Ground
12	TXDD	Port D Transmit Data Output
13	RXDD	Port D Receive Data Input

Table 2.4. Port B/D Connector Pinout (continued)

14		Pin 14 & 15 are tied together internally
15		to simulate RTS/CTS for port D
16	+12VDC	+12VDC Output Supply

CAUTION

Do not connect or disconnect power or signal cables from the uZ-CGRS while power is applied. Possible injury and/or equipment damage may occur.

System Integration

This section shows possible setups of external equipment to the uZ-CGRS system.

Power Configuration

Figure 2.5 shows possible AC and DC setups which are supported by the uZ-CGRS receiver.

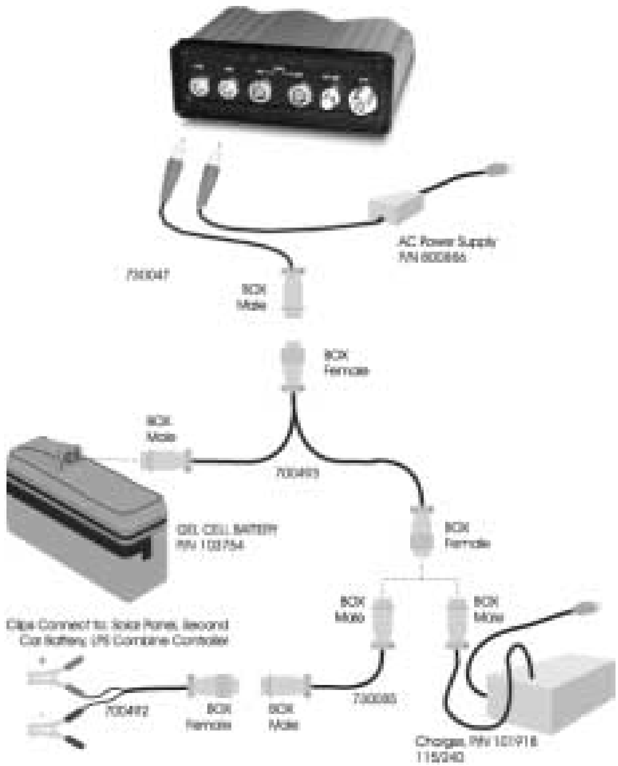

Figure 2.5. Examples of Powering the uZ-CGRS Receiver

Connect the back of the uZ-CGRS receiver at the power ports labelled “PWR” to the end of the power cables 800886 for AC power hookup and 730047 for DC power hookup.

The AC power module supplied is 24V and it is recommended to hook up a 12V DC battery for power backup. This allows the uZ-CGRS receiver to operate off of the AC power until such time that the AC power is no longer available (due to a power outage at the site). The uZ-CGRS receiver will then operate off of the DC power until AC power is again supplied.

Antenna and Serial Interface Connections

Figure 2.6 and Figure 2.7 show possible Antenna and Serial Interface connections.

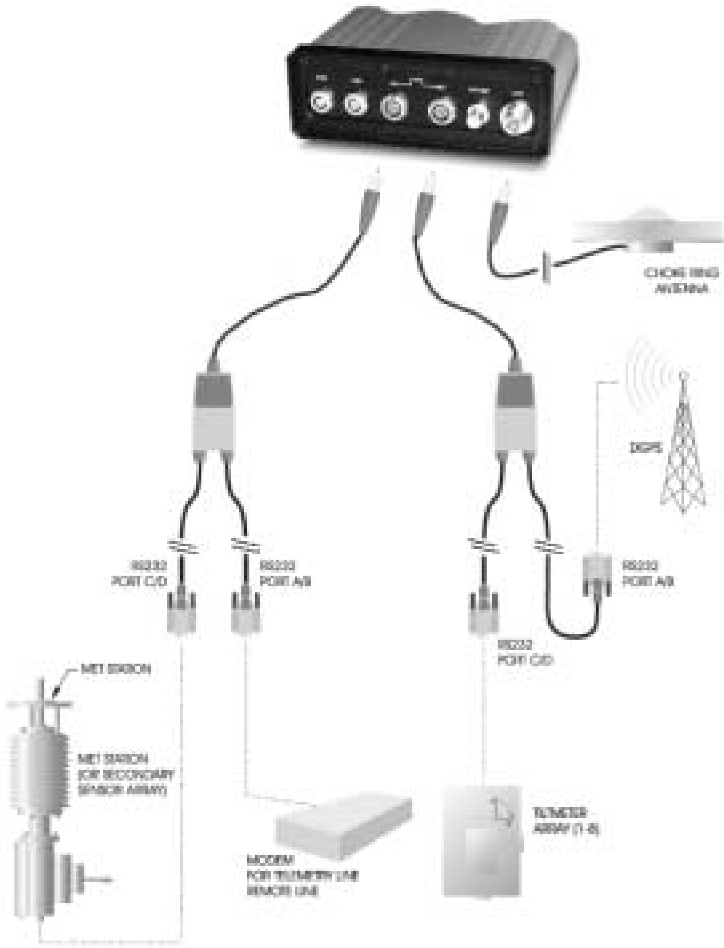

Figure 2.6. Example Antenna and Serial Interface Connections

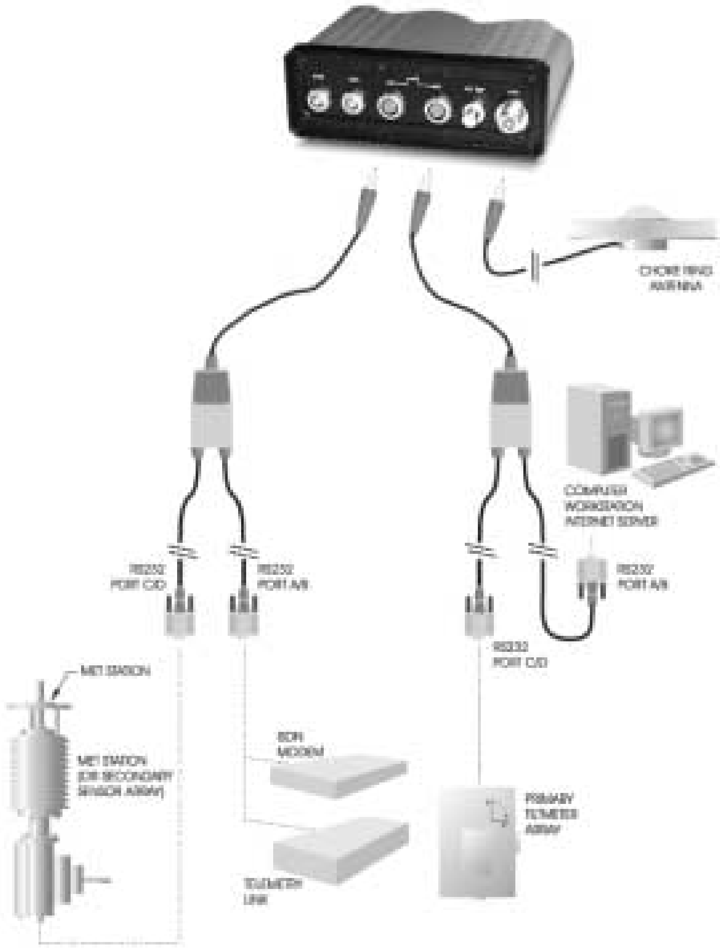

Figure 2.7. Additional Antenna and Serial Interface Connections

For additional information on antenna and serial interface cable configurations, contact your local ASHTECH Precision division supplier.

Equipment Description

3

Operation

This chapter describes receiver operations for the uZ-CGRS, Z-Surveyor, and Z-FX receivers.

Receiver Initialization

It is good practice to reset your receiver prior to operating it for the first time or after a firmware upgrade. A reset of the internal memory clears the stored almanac data, emphemeris data, and receiver parameter settings and restores them to factory defaults. A reset of the external memory clears the memory of the data memory card and performs a reformat of the card. Send this command to execute the initialization of internal and external memory:

$PASHS,INI,5,5,5,5,3,0

To reset only the receiver parameters, use the $PASHS,RST command.

For more information about these commands, refer to Chapter 5, **Command/ Response Formats**.

Setting Receiver Parameters

All user parameters may be set or changed by sending commands to the receiver serial port. Refer to Chapter 5, **Command/Response Formats** for more information about these commands. In the Z-Surveyor and the Z-FX receivers, many parameters are accessible through the front panel LED display. Refer to your individual receiver operations manual for more information.

Default Parameters and Saving Parameter Settings

During the normal course of receiver operation, a typical user will often change one or more receiver parameters such as recording interval, port baud rate, or elevation mask. The uZ-CGRS receiver automatically saves each change within its internal battery-backed memory. To save new settings in the Z-Surveyor or Z-FX receivers, the user must save the current setting to memory or else all parameters (with a few exceptions) will be reset to the default values during a power cycle. The exceptions for the Z-Surveyor or Z-FX receivers are session programming parameters, modem setting parameters, MET (meteorological) and the TLT (tilt) parameters. Saving parameters to memory in the Z-Surveyor or Z-FX receivers can be done in two ways; either by enabling the SAVE option in the SETTINGS menu of the LED interface, or by issuing a $PASHS,SAV,Y command to the serial port. For the uZ-CGRS, Z-Surveyor, or Z-FX receivers when parameters are saved to the memory, they are maintained until a memory reset or a receiver initialization is performed which will reset all parameters back to their defaults.

For Z-Surveyor and Z-FX receivers, only the parameters modified prior to issuing the SAV command are saved in memory. Any parameter modified after SAV is issued reverts to default after power cycle.

The following table lists the default values of all user parameters.

Table 3.1: Default Values

Parameter	Description	Default
ANR	Antenna Noise Reduction	OFF
ANT horizontal azimuth	Azimuth measured from Reference Point to Antenna Phase Center	00000.00
ANT horizontal distance	Distance from Reference Point to Antenna Phase Center	00.0000
ANT offset	Distance from Antenna Phase Center to Antenna Edge	00.0000
ANT radius	Radius of the Antenna	0.0000
BEEP	LED display and warning beep	On (Z-Surveyor and Z-FX) Disabled (uZ-CGRS)
CTS	Clear to send port setting	On
ELM	Elevation Mask for Data Recording/ Output	10
EXT	External Frequency	Frequency 0.0 Autoswitch A

Table 3.1: Default Values (continued)

Parameter	Description	Default
ION	Enable Ionosphere Model	N
NMEA messages	NMEA Message Output Status	OFF in all ports
NMEA PER	NMEA Messages Output Rate	001.0
MDM	Modem Parameters	MODE=OFF TYPE = 0 (US Robotics) PORT = B BAUD RATE = 38400
MET	meteorological parameter setting	All ports off INIT-STR:No TRIG-CMD:*0100P9 INTVL:5
MSG	Text for RTCM type 16 message	empty
MSV	Minimum Number of Satellite's for Data Recording/Output	03
PEM	Position Elevation Mask	10
PDP	Position Dilution of Precision Mask	40
POS LAT	Antenna Latitude	00N
POS LON	Antenna Longitude	00W
POS ALT	Antenna Altitude	+00000.000
PPS	Pulse per Second Default Parameters	Period = 1 second Offset = 000.0000 Edge = R
RAW data	Raw Data Output Status	OFF in all ports
Raw data format	Raw Data Output Format	ASCII in all ports
RCI	Raw Data Output Rate/Recording Rate	020.0
REC	Record Data Flag	Y
RNG	Ranger Mode Selection	0
RTCM EOT	End of Character Selection for RTCM Corrections	CRLF
RTCM MODE	RTCM Differential Mode Selection	OFF
RTCM PORT	RTCM Differential Mode Port Selection	A
RTCM SPD	RTCM Differential BPS Speed Setting	0300
RTCM STH	RTCM Base Station Health Setting	0
RTCM STI	RTCM Base Station ID Setting	0000
RTCM TYPE	RTCM differential Messages Enabled and Output Frequency of the Enabled Messages	1 = 99, 6 = ON, remaining messages 00

Table 3.1: Default Values (continued)

Parameter	Description	Default
SAV	Save parameters in Battery Backup Memory	N (Z-Surveyor and Z-FX) Y (uZ-CGRS)
Serial Port Baud Rate	Serial Ports Baud Rate Selection	9600 in all ports
Session Programming	Session Programming Default Parameters	INUSE flag = N REF day = 000 OFFSET = 00:00 For all Sessions: Session Flag = N Start Time = 00:00:00 End Time = 00:00:00 RCI = 20 MSV = 3 ELM = 10 RNG = 0
SIT	Site ID Name	????
SVS	Satellite Tracking Selection	Y for all
TLT	Tilt Meter parameter setting	All ports OFF INIT-STR:No TRIG-CMD:*0100XY INTVL:1
UTS	Synchronization to GPS Time (clock steering)	Y

Synchronization to GPS Time (clock steering)

All GPS receivers contain internal clocks. These clocks are of varying quality, and for cost reasons, are not generally accurate enough to stay precisely synchronized to GPS system time (or “true GPS time”). The effect of receiver clock error shows up in two places. First, it affects the instant in time when measurement snapshots are taken, and second, it introduces errors in the values of the measurements themselves. This means that two receivers at the same location (zero-baseline), but with different clock errors, will, among other things, provide different position measurements.

Fortunately, if a receiver obtains measurements from four or more satellites it can determine its own internal clock error. In order to reduce the effects mentioned previously, most receivers use the computed clock error to periodically reset the internal receiver clock to remain close to GPS system time (within a millisecond). This method does not entirely remove the effects mentioned above and furthermore causes jumps in the raw measurements obtained by the receiver; all of which the user must account for when processing the data.

The Micro-Z receiver offers a GPS Time Sync Mode, which almost completely removes the effects of the receiver clock error. For example, the jumps in the raw measurements do not appear in GPS Time Sync Mode, and also in zero baseline tests, two Ashtech receivers in GPS Time Sync Mode will provide very closely matching pseudo-range measurements. It is recommended that when no external frequency source is being used, clock steering is enabled.

For more information see the $PASHS,UTS command in Chapter 5, **Command/ Response Formats**.

External Frequency

The uZ-CGRS receiver has an External Frequency option built into it which comes standard in most configurations. The External Frequency input is located on the back panel of the uZ-CGRS receiver and supports a 5 MHz, 10 MHz, or 20 MHz input signal. To utilize the External Frequency option, you must also activate it within the firmware. Use the $PASHS,EXT command detailed in Chapter 5, **Command/ Response Formats** to do this. When the External Frequency mode is turned on, the internal clock is phase locked to the external reference, so that the receiver is in effect running on the external reference input.

Two methods are supported when activating the External frequency mode, automatic and manual.

In automatic mode, the receiver will switch back to using the internal clock if the external frequency source is lost for more than 25 seconds. Thus allowing the receiver to then resume tracking SV’s and collecting data automatically. To resume using the External Frequency source, you must reissue the $PASHS,EXT command.

In manual mode, the receiver will continue to search for the external frequency source input if it is lost and will not track SV’s while no input source is present.

When running in the External Frequency mode, you should turn off the Synchronization to GPS time (Clock Steering) functionality in the receiver.

Data Recording

All data recording in the receiver is done on the memory data card also known as a PC card. The PC card is a compact and convenient way to store a lot of data. The amount of data that can be stored depends upon the size of the card. PC cards, available in sizes ranging from 2 to 85MB, are normally factory formatted, but they must be formatted by the receiver using the $PASHS,CLM command before using the card. This can also be done with the $PASH,INI command by issuing 2 or 3 for the “reset memory codes” variable.

Memory Data Card File Structure

The receiver stores files in the root directory and it creates a single file per session. Sessions are created after

- cycling the receiver power
- by selecting the NEW SESSION option in the SESSIONS menu of the front panel display in the Z-Surveyor or Z-FX receivers
- issuing the $PASHS,FIL,C command
- by selecting the STOP/START option in the SESSIONS menu of the front panel display in the Z-Surveyor or Z-FX receivers
- issuing the $PASHS,REC,S/R command
- setting up recording parameters with Micro-Manager

Although the receiver is capable of creating a number of different records that cover a wide variety of information, the session file, U-file, contains all available type of data records (almanac records, emphemeris records, raw data records, position records, site information records, site attribute records, event marker records). The U-file decodes into different files during the download process (see "Downloading the Data" on page 30 for more information).

The files are automatically named according to a naming convention that includes the site name, session, and day of the year. Figure 3.1 outlines the file naming convention. The one exception is almanac files that are named ALMyy.ddd where yy are the last two digits of the year and ddd is the day of the year.

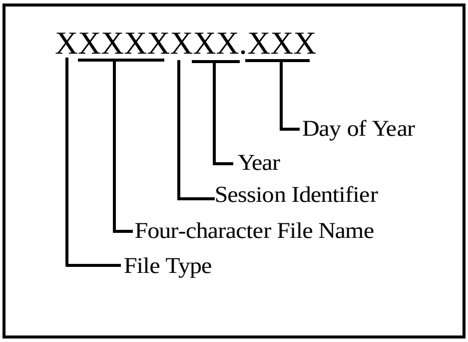

Figure 3.1: File Naming Convention

- The first letter is the file type (in this case always U).
- The next 4 characters indicate the SITE information. If the user has not entered a SITE, then these 4 characters are replaced by underscores("____"). If the user has not entered a SITE during the course of the session, the last SITE information entered in the previous session is used.

If the SITE has been entered several times during the course of the session, the last entered SITE information is used.

- The next character is the session identifier. This field automatically increments from A to Z, with each new session on a given day. After 26 sessions are created, the session identifier resets back to A and the first character of the year changes to A. Then, once again the session identifier increments from A to Z with each new session.
- The next two characters indicate the last two digits of the year when the session was terminated (e.g. 01).
- The file extension indicates the day of the year when the session was terminated (e.g. Jan. 1 is day 001; Dec. 31 is day 365).

Data Modes

The receiver can record data in three different modes, called data modes or data types. Each mode records different combination of data records and can only be changed using the serial port command $PASHS,RNG. Table 3.2 describes these modes. The default is mode 0.

Table 3.2: Recording Modes

Recording Mode	Typical Application	Records Created	File Type After Conversion
0	Raw data, full code and carrier phase	Raw data records Ephemeris records Session information records Event marker information Almanac records	B-file E-file S-file D-file ALMyy.ddd
2	Position data only	Position records Session records Almanac records	C-file S-file ALMyy.ddd
4	Raw data, full code and carrier phase, position data file	Raw data records Position records Ephemeris records Session Information records Event marker information Almanac records	B-file C-file E-file S-file D-file ALMyy.ddd

Downloading the Data

The data on the PC card is downloaded from the receiver via the serial port. Different options are available for downloading data. These include: Ashtech's Micro-Manager, RCS, or REMOTE33. Consult the specific application notes or manual for more information.

When transferring PC data from the receiver the download application reads the U-file records from the PC card and can convert them into different data files once transferred to the PC, creating one set of data files per session. Data files are named using the U-file name for that session, however the first letter corresponds to the file type. The one exception is almanac files which are named ALMyy.ddd where YY are the last two digits of the year and ddd is the day of the year. Table 3.3 lists the file types.

Table 3.3: File Types

File Type	Description	Format
B-file	Generated from raw data - generally code and carrier phase data, position data, and SITE	Binary
E-file	Generated from satellite ephemeris data	Binary
S-file	Generated from site information data	ASCII
C-file	Generated from position data	ASCII
D-file	Generated from event marker information	ASCII
ALMyy.ddd	Generated from Almanac data	Binary

Data Logging through Serial Port

An alternative way to record data is to record data directly onto your PC. This method is useful if your data card does not have enough space or if you wish to bypass the download process. To record data directly onto the PC, use the GBSS or REMOTE33 programs. GBSS or REMOTE33 will collect B and E-files in real time onto your computer.

Session Programming

The Session Programming feature allows you to pre-set up to 26 observation sessions in the receiver. The receiver can then run unattended and will collect data on the data card only during the times that have been preset. Once set, the sessions will collect data during the preset session times every day. Or if desired, a session time offset can be programmed in that will shift the session start and end times by a set 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 shut down which will conserve power when data is not being collected. Using the session start times that have been preset, the receiver will automatically wake up in time to collect data for the next session and go back to sleep when the session is over.

Session programming is enabled by using either a third party communication package or the Micro-Manager program. With Micro-Manager you can set up session programming through the graphical screen input, with Micro-Manager or a third party communication package you can set up session programming through the terminal window by sending the $PASHS,SES commands through the serial port. Regardless of which method is used, you will need to enable the individual sessions and set session parameters such as the desired start/stop time, the recording interval, elevation mask, minimum number of satellites, and the data type for each session to be recorded.

In addition, you will need to set the mode (session in use switch), the session reference day, and any desired session offset. The mode is either Yes, No, or Sleep. If the mode is NO, then session programming is not enabled, even if individual sessions are set. If the mode is Yes, then session programming is enabled, and any enabled individual sessions will be activated. If the mode is Sleep, then the receiver will go into sleep mode once an activated session is completed, and will wake up just prior to the next session.

The session reference day is a mandatory parameter that both determines 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 to 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 will 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 every day for 7 days observing the identical satellite window on each day. Since the GPS window moves backwards 4 minutes per day, you would 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 4 minutes earlier than the previous day. By the seventh day, the sessions will start and end 28 minutes earlier than on day 1.

Remote Monitoring

Remote monitoring allows a user to control a remotely located receiver through a PC and a modem link. You can then:

- monitor operational status
- configure receiver parameter settings
- download data while continuing to track and log data

This function is useful in situations where a receiver is operating in a difficult to access location.

The receiver must have the Remote Monitor [M] option enabled. Use the Micro-Manager or REMOTE33 software to perform remote monitoring.

Signal to Noise Ratio

The Signal to Noise ratio or C/No. as given by the receiver is the ratio of the total signal power to the noise power in a 1 Hz bandwidth otherwise known as the Carrier to Noise Ratio or C/No. The reference point of the reading is the antenna connector located on the receiver’s back-panel. It is expressed in units of dB.Hz.

It is important to realize that the receiver-displayed C/No. includes the degradation caused by many factors before reaching the receiver, including: antenna gain, antenna temperature, and LNA noise figure. The C/No. at the output of the antenna element will be degraded by the noise produced by the first amplifier, known as the low noise amplifier (LNA) which is built into most Ashtech antenna assemblies. When using different antennas with the receiver it should be noted that differences in C/No. can be seen as a result of the above mentioned factors.

If calibrating the C/No. reading of the receiver with a satellite constellation simulator at room temperature, realize that the noise figure of the LNA used will degrade the C/No reading by the amount equal to the noise figure of the LNA.

(C/No.)reading = (C/No)simulator - NF

where:

- NF is the preamplifier Noise Figure in dBs,
- (C/No.)reading is the carrier-to-noise ratio displayed by the receiver in dB.Hz,
- (C/No.)simulator is the carrier-to-noise ratio at the output of the GPS simulator in dBHz.

If you select to display C/No. for the C/A code (or C/No. for P1 code), the displayed figure relates to the ratio of the power of the C/A code only (or P1 code only) to the noise power in a 1Hz bandwidth.

1PPS Out

By default, the receiver generates a TTL-level pulse every second within one microsecond of the GPS time for synchronization of external equipment. Refer to Chapter 2, **Equipment Description** of this manual to determine signal location on the pinouts of the ports. This pulse can be offset using the $PASHS,PPS command (refer to “PPS: Pulse Per Second” on page 77). It can also synchronize either the rising edge (default) or the falling edge to the GPS time. The receiver can generate this signal with a different period (0.1 to 60 seconds). Setting the period to 0 disables the PPS pulse.

You may output the time tag of the pulse to a serial port via the $PASHS,NME,PTT,c,ON (where c is the output port). This message will be sent within 100ms of the pulse. It has been designed to minimize the latency when the offset is 0.0 (within 30ms of the pulse).

This output is driven by a 3.3 volt CMOS gate through a 150 ohm resistor, and is intended to drive a high-impedance TTL or CMOS input. The minimum allowable input resistance to guarantee TTL input levels is 250 ohms.

Antenna Reduction

Unless requested by the user, the position solution provided by a receiver is the one of the antenna phase center. The receiver provides a means of obtaining the position of the surveyed point rather than the antenna phase center through two commands: $PASHS,ANT and $PASHS,ANR.

The ANT command allows the user to specify the antenna parameters (such as the distance between the antenna phase center and the surveyed point). Since the antenna phase center cannot be accurately accessed, this distance can be entered as antenna radius (distance between phase center and the side of the ground plate) and antenna slant (distance between the side of the ground plate and the surveyed point). The receiver will compute antenna height based on these two parameters.

The antenna radius is usually provided by the antenna manufacturer while the antenna slant can be obtained with a measuring rod.

Once these parameters are entered, the user can select to use them through the $PASHS,ANR,*x* command with *x* indicating the following:

> **where x is N**—No antenna reduction is performed. The solution provided is the antenna phase center.
>
> **where x is Y**—Antenna reduction is performed. The solution provided is the surveyed point (if no antenna parameters were entered, the solution will be the antenna phase center)

NMEA Data Output

Real-time NMEA data output is available through the four RS-232 ports. There are two types of messages:

- NMEA

  NMEA is a standard data transfer format developed to permit ready and satisfactory data communication between communications equipment when interconnected via an appropriate system. This is data in printable ASCII form and may include information such as position, satellite locked status, etc. Typical messages might be 20 to a maximum of 79 characters in length and generally require transmission no more often than once per second.

- Proprietary

  When specific information was needed, and the NMEA standard did not contain a suitable message, Magellan created proprietary messages. These messages are available in ASCII also.

With the Fast Data output [F] option installed, the highest output rate supported is 10Hz. If the [F] option is not installed, the highest output rate supported is 5Hz. Refer to Chapter 5, **Command/Response Formats** for more details.

Daisy Chain Mode

The Daisy Chain mode establishes a communication link through the GPS receiver, between a PC and a peripheral device. When the GPS receiver is in Daisy Chain mode, all commands entered in one serial port are passed back out through another serial port. The commands are not interpreted by the GPS receiver. The command $PASHS,DSY enables the Daisy Chain mode and allows the user to assign which serial ports to be used. A typical example of the use of Daisy Chain mode is communicating with a meteorological device through a PC. The meteorological device and PC are not directly connected but are both connected to the GPS receiver via separate serial ports. By enabling the Daisy Chain mode between the two serial ports used by the PC and meteorological device, the PC can communicate with the meteorological device through the GPS receiver. Refer to “DSY: Daisy Chain” on page 84.

4

Setup

Differential, and RTK Operations

Real-time differential positioning involves a reference (base) station receiver computing the satellite range corrections and transmitting them to the remote stations. The reference station transmits the corrections in real time to the remote receivers via a telemetry link. Remote receivers apply the corrections to their measured ranges, using the corrected ranges to compute their position.

RTK (Real-time kinematic) positioning can be used in lieu of real-time differential positioning. RTK uses the carrier signal in addition to the code signal and is much more accurate. Although messages transmitted and calculations performed vary, RTK is essentially a special form of differential positioning.

As stand-alone, the receiver can compute a position to around 20 meters. Differential GPS achieves sub-meter precision at a remote receiver, and RTK positioning achieves centimeter accuracy at a remote receiver.

A communication link must exist between the base and remote receivers. The communication link can be a radio link, telephone line, cellular phone, communications satellite link, or any other medium that can transfer digital data.

Setting Up a Differential Base Station

You must have the Base option [**B**] installed on the receiver.

Send the commands listed in Table 4.1 to the receiver to generate RTCM differential corrections using message type 1.

Table 4.1: Differential Base Station Commands

Command	Description
$PASHS,RST	Reset the receiver to factory defaults
$PASHS,POS,ddmm.mmm,d,dddmm.mmm,d,saaaaa.aa	Enter the Actual Reference Point (ARP) of the antenna. ANR is OFF, or the ground mark if ANR is ON.
No command is necessary. Type 1 messages are set to ON by default.	Set Type 1 RTCM message to ON
$PASHS,RTC,TYP,3,1	Set Type 3 RTCM message to ON
$PASHS,PEM,9	Set the Base differential mask to nine degrees to broadcast differential corrections for Satellites 9 degrees and higher.
$PASHS,RTC,BAS,x	Turn on RTCM corrections on port x When this command is sent, a base station automatically sends RTCM message type 1 continuously.
$PASHS,RTC,SPD,9	Set internal bit-rate for corrections to burst mode.
$PASHS,SAV,Y	Save settings (only necessary for Z-Surveyor and Z-FX receivers)

Do not try to transmit corrections on the same receiver serial port you are using to set up the receiver from your PC or modem.

The receiver is set as a base station which transmits RTCM message type 1 continuously. Following a power cycle it automatically starts transmitting these corrections again (This is automatic for the uZ-CGRS because the SAV command is hardcoded to Y. For the Z-Surveyor and Z-FX receivers you have saved the settings with the $PASHS,SAV,Y command so a power cycle will keep the current setting in memory up to that point for those two receiver types). To change the message type or rate, use the $PASHS,RTC,TYP command.

Setting Up an RTK Base Station

An RTK base station supports two different types of messages:

- RTCM standard 18 & 19 (plus 3 & 22)
- RTCM standard 20 & 21 (plus 3 & 22)

RTCM 18 & 19

You must have both [**B**] and [**K**] options installed on the receiver.

Send the commands listed in Table 4.2 to the receiver to generate RTCM RTK message types 3,18,19 and 22.

Table 4.2: RTK Base Station Commands

Command	Description
$PASHS,RST	Reset the receiver to factory defaults
$PASHS,ELM,9	Set the RTK Base mask to nine degrees to broadcast SV information for Satellites 9 degrees and higher.
$PASHS,POS,ddmm.mmm,d,dddmm.mmm,d,saaaaa.aa	Enter the phase center of the antenna if ANR is OFF or the ground mark if ANR is ON.
$PASHS,RTC,BAS,B	Turn on RTCM corrections on port B When this command is sent, a base station automatically sends RTCM message type 1 continuously.
$PASHS,RTC,TYP,1,0	Turn off RTCM message type 1.
$PASHS,RTC,TYP,3,1	Turn on RTCM message type 3.
$PASHS,RTC,TYP,18,1	Turn on RTCM message type 18 & 19.
$PASHS,RTC,TYP,22,1	Turn on RTCM message type 22.
$PASHS,RTC,SPD,9	Set internal bit-rate for corrections to burst mode.
$PASHS,SAV,Y	Save settings (only necessary for Z-Surveyor and Z-FX receivers.)

The receiver is set as a base station which transmits RTCM messages types 18 and 19 every second, and types 3 and 22 every minute. Following a power cycle it will automatically start transmitting these messages again (This is automatic for the uZ-CGRS because the SAV command is hardcoded to Y. For the Z-Surveyor and Z-FX receivers you have saved the settings with the $PASHS,SAV,Y command). To change the message type or rate, use the $PASHS,RTC,TYP command.

RTCM 20 & 21

You must have both [**B**] and [**K**] options installed on the receiver.

Send the commands listed in Table 4.3 to the receiver to generate RTCM RTK message types 3,20, 21, and 22.

Table 4.3: RTK Base Station Commands

Command	Description
$PASHS,RST	Reset the receiver to factory defaults
$PASHS,ELM,9	Set the RTK Base mask to nine degrees to broadcast SV information for Satellites 9 degrees and higher.
$PASHS,POS,ddmm.mmm,d,dddmm.mmm,d,saaaaa.aa	Enter the phase center of the antenna if ANR is OFF or the ground mark if ANR is ON.
$PASHS,RTC,BAS,B	Turn on RTCM corrections on port B When this command is sent, a base station automatically sends RTCM message type 1 continuously.
$PASHS,RTC,TYP,1,0	Turn off RTCM message type 1.
$PASHS,RTC,TYP,3,1	Turn on RTCM message type 3.
$PASHS,RTC,TYP,20,1	Turn on RTCM message type 20 & 21.
$PASHS,RTC,TYP,22,1	Turn on RTCM message type 22.
$PASHS,RTC,SPD,9	Set internal bit-rate for corrections to burst mode.
$PASHS,SAV,Y	Save settings (only necessary for the Z-Surveyor and Z-FX receivers.)

The receiver is set as a base station which transmits RTCM messages types 20 and 21 every second, and types 3 and 22 every minute. Following a power cycle it will automatically start transmitting these messages again (This command is automatic for the uZ-CGRS because the SAV command in hardcoded to Y. For the Z-Surveyor and Z-FX receivers you must have saved the settings with the $PASHS,SAV,Y command). To change the message type or rate, use the $PASHS,RTC,TYP command.

Setting Up a Combined Differential and RTK Base Station

You must have both the [**B**] and [**K**] installed in your receiver.

Send the commands listed in Table 4.4 to the receiver.

Table 4.4: Base Station Commands

Command	Description
$PASHS,RST	Reset the receiver to factory defaults
$PASHS,PEM,9	Set the Base differential mask to nine degrees to broadcast differential corrections for Satellites 9 degrees and higher
$PASHS,ELM,9	Set the RTK base elevation mask to nine degrees to broadcast SV information for Satellites 9 degrees and higher
$PASHS,POS,ddmm.mmm,d,dddmm.mmm,d,saaaaa.aa	Enter the phase center of the antenna if ANR is OFF or the ground mark if ANR is ON.
$PASHS,RTC,BAS,x	Turn on RTCM corrections on port x
$PASHS,RTC,SPD,9	Set internal bit-rate for corrections to burst mode
$PASHS,RTC,TYP,1,1 $PASHS,RTC,TYP,3,1 $PASHS,RTC,TYP,22,1	Turn on type 1 message differential correction message once per second Turn on base station position messages 3 & 22 once per minute
$PASHS,RTC,TYP,18,1	Turn on Code and Carrier phase messages (RTCM 18 and RTCM 19 messages), once per second
$PASHS,SAV,Y	Save settings (only necessary for Z-Surveyor and Z-FX receivers.)

Type 1 is on continuously by default.

The receiver is set as a base station which transmits RTCM Differential corrections (type 1) every second, RTCM messages types 18 and 19 every second, and types 3 and 22 every minute. Following a power cycle it automatically starts transmitting these messages again. You can also set up the Base Station to use messages 20 & 21 instead of 18 & 19.

Advanced Base Station Operation

Recommended Advanced Parameter Settings for Base Stations

There are many parameters that control the operation of the receiver. Most should be left at default values, except for the settings identified in Table 4.1 through Table 4.4.

Antenna

Locate the antenna with a clear view of the sky.

The antenna position, entered with the $PASHS,POS command, is the WGS84 phase center of the antenna if the antenna reduction mode (ANR) is OFF. It is the ground mark position if ANR is ON.

Message Rate

To improve Differential and RTK performance, minimize base station data latency by using the highest possible data rates that your data link supports. There are three different settings that affect data rates:

- RTCM message bit rate. $PASHS,RTC,SPD. This is the internal bit rate used to generate the RTCM messages. This should be as high as possible without exceeding the baud rate of the serial port. Recommended bit rate setting is burst mode (9), which automatically adjusts the bit rate to the fastest possible rate based on the serial port baud rate:

  $PASHS,RTC,SPD,9
- Serial port baud rate. This should be as high as possible.
- RTCM message rate. This is the rate at which messages are generated.
  - RTK messages (RTCM 18 & 19, RTCM 20 & 21) are the most important. They should be generated as fast as possible, ideally once per second. If they are generated slower then the effect on the remote receiver depends on the mode it is set to. The slowest allowable setting for type 18 and 19 is once per 5 seconds.
    - Fast RTK mode: when the remote is set to Fast RTK mode, accuracy will degrade by approximately 1cm for each second of latency (example: type 18 and 19 generated every 5 seconds, fast RTK accuracy of 5cm, horizontal 1s. Fast RTK update rate is unaffected.
    - Synchronized RTK mode: when the remote is set to Synchronized RTK mode, accuracy is unaffected. Update rate is limited to the update rate of messages 18 and 19.
  - Differential messages (1) are next most important, ideally once per second. With Selective Availability (SA) turned off now, this could be increased to 5 or 10 seconds with very little impact as long as a good telementry link exists between the remote and base station.
  - RTK base station position (RTCM 3 & 22) are least important. They affect the RTK initialization time following power on of the remote receiver, (the remote receiver cannot provide an RTK position until it has received messages 3 and 22 unless the rover equipment allows this information to

be entered), but the rate at which these messages are generated does not affect RTK accuracy.

Required Differential Update Rates

For RTK operation there is a minimum radio baud rate that is acceptable. The required radio rate depends on which messages are being generated at the base station, and the message period. The slowest rate at which one should send RTK data is once every 5 seconds. Ashtech remote receivers can fix integers with base station data arriving once every 5 seconds or faster.

Message size

Table 4.5 lists the message size for RTCM messages 18 & 19 or 20 & 21.

Table 4.5: Message Size for RTCM Messages 18 & 19 or 20 & 21

Number of Satellites	Number of RTCM Words in Message Type 18/20. (30 bits/word)	Number of RTCM Words in Message Type 19/21. (30 bits/word)
7	(2+1+7)*2 = 20	(2+1+7)*2 = 20
9	(2+1+9)*2 = 24	(2+1+9)*2 = 24
12	(2+1+12)*2 = 30	(2+1+12)*2 = 30

Required Radio Rate

For RS232 communications, 1 start bit and 1 stop bit is required for each byte. The required number of bits is 10/8 times the number of message bits.

For RTCM, the data is packed in 6/8 format. The required number of bits is 8/6 times the number of bits in the message.

For RTCM data on an RS232 link, the required number of bits is 8/6*10/8 times the number of bits in the message.

Table 4.6 lists the minimum baud rates, for a receiver sending RTCM 18 & 19 or 20 & 21 messages only.

Setup

Table 4.6: Minimum Baud Rates for RTCM Messages 18 & 19 or 20 & 21

Number of Satellites	Minimum baud rate (message period = T)	Minimum standard baud rate (T = 5 sec)	Minimum standard baud rate (T = 1 sec)
7	20*30*2*8/6*10/8*1/T	600 bps	2400 bps
9	24*30*2*8/6*10/8*1/T	600 bps	2400 bps

Table 4.6: Minimum Baud Rates for RTCM Messages 18 & 19 or 20 & 21 (continued)

Number of Satellites	Minimum baud rate (message period = T)	Minimum standard baud rate (T = 5 sec)	Minimum standard baud rate (T = 1 sec)
12	30*30*2*8/6*10/8*1/T	600 bps	4800 bps

Table 4.6 list the minimum baud rates, assuming no other data is sent on the data link. If other messages are transmitted, then the minimum standard baud rate may increase.

The recommended optimal setting is to transmit type 18 and 19 messages once every second on a high-speed link.

If a high speed data link is not available, you have *indirect* control over the number of satellites used, by setting elevation mask angles. The elevation angle for any particular satellite changes by 1° for every 100 km of baseline length. For baselines of less than 100 km, you should set the base station elevation mask at 1° less than the remote receiver elevations masks to guarantee that the base station sends data for all satellites the remote might use, while not sending data for low elevation satellites that the remote does not use.

Recommended mask angle settings for RTK:

Remote: 10° (Default)

Base: 9°

Mask Angle

The base station mask angle for RTK messages 18, 19, 20, & 21 is controlled by $PASHS,ELM. The base station mask angle for differential corrections (type 1 or 9) is controlled by $PASHS,PEM. If your data link bandwidth is large enough, then you can set both mask angles below 9 degrees for base stations.

If your bandwidth limits the number of satellites for which you can transmit base station data, then you may raise the mask angle. On baselines less than 100 km, the remote station sees satellites at approximately the same elevation angles as the base station sees them, the base station mask angle should be set one degree lower than the remote mask angle. On long baselines the elevation angle changes by approximately 1° for every 100 km. So for baselines of x*100 km the base station should not have a mask angle higher than the remote station mask minus x*1°.

The two different controls allow you, for a combined RTK/Differential base station, to set the mask angles higher for RTK (which typically operates on short baselines) than Differential (which often operates on longer baselines).

Base Station Position

The RTCM messages 3 and 22 broadcast the base station position to the rover. In some cases, the base station position may also be entered directly into the remote unit. This reduces bandwidth requirements by obviating the need for messages 3 and 22.

Base Station Antenna Offset

If you set up the base station antenna over a known, surveyed point, you may enter the position of the surveyed point and the offset from this point to the antenna phase center. Or you may enter the phase center directly.

If you are using 3 & 22:

- At the base station, enter the phase center of the antenna directly using $PASHS,POS and setting $PASHS,ANR,OFF, or
- At the base station, enter the surveyed reference point using $PASHS,POS and enter the antenna offset using $PASHS,ANT and $PASHS,ANR, ON.

Using Reference Station ID

You may monitor which reference or base station the remote receiver uses by setting a reference station ID at the base station. Set the reference station ID using the command $PASHS,RTC,STI.

Reference Station Health

You may set the reference station to “unhealthy”, which causes all remote receivers to ignore the messages they receive from that base station.

Other RTCM Messages

Message 2

These are automatically generated when the base station is transmitting differential corrections and a new ephemeris is downloaded from the satellites when using RTCM type 1 messages.

Filler: Message 6 Null Frame

This message is provided for datalinks that require continuous transmission of data, even if there are no corrections to send. As many Messages 6 are sent as required to fill in the gap between two correction messages. Messages 6 are not sent in the burst mode ($PASHS,RTC,SPD,9)

Special Message: Message 16

This message allows you to transmit an ASCII message from the base station.

Meteorological Station Operations

Meteorological (MET) Stations are increasingly being co-located with GPS receivers. MET data are often used in post processing of GPS data, and GPS receivers plus MET stations are often used to study the atmosphere for weather forecasting applications.

The uZ-CGRS is designed to integrate seamlessly with a Meteorological Station. The MET station is attached to one of the receiver's serial ports. Commands are then issued to the MET Station (through the receiver) to send the meteorological data to the receiver on a set interval. MET data can then be output from the receiver as a NMEA message and/or stored in the D-File. When using Ashtech Geodetic Base Station Software (GBSS) and the GBSS Meteorological Module, a RINEX MET file is made automatically.

The following section describes how to connect the Paroscientific MET station to the uZ-CGRS and how to verify that it is operating with the receiver. The procedure has you turn off all other types of data output so that you can easily verify that the receiver is outputting MET data. Please note that once this procedure is completed, you may need to issue other commands to configure the system for your specific application.

Basic MET Station Connection and Operation Verification

To connect the MET station and verify its operation follow these steps:

1. Connect the dual RS-232 I/O and MET Sensor cable (P/N 730417) to port 1 (A/C) of the powered and running uZ CGRS unit.
2. Connect the DB9 connector of cable 730417, labeled "Port A/B", to Com 1 or 2 of your PC.
3. Connect the other DB9 connector labeled "Port C/D" to the MET cable, P/N 2319.
4. Connect the MET cable to the MET station.
5. Using communication software such as the terminal in Micro-Manager or Procomm, issue the command "$PASHQ,RAW" to the receiver via port A.

Look at the data returned and ensure <u>EVERYTHING</u> is listed as OFF.

If everything is *not* off, issue command "$PASHS,OUT,PORT" to turn everything off.

6. Issue command "PASHQ,PAR" and ensure everything for the data returned is also listed as OFF.

If not, issue command "$PASHS,NME,ALL,PORT,OFF" to turn everything OFF.

7. Issue command "$PASHS,OUT,C,MET,ON" to connect the MET station via port C. The uZ-CGRS should now start logging MET information in the D-file if data recording is enabled.
8. Issue Command "$PASHS,NME,XDR,A,ON" to enable the NMEA XDR message with MET information and output the information through Port A.

9. At this point the PC will display the MET station outputs once every 5 seconds. The data received will look similar to the below string:

   $GPXDR,P,1.018719,B,DQ 75136,C,23.33,C,DQRHT212,H,34.7,P,DQ RHT212*7C

Which has the meaning:

$GPXDR,P,<Pres Value>,B,<SN>,C,<Temp Value>,C,<SN>,H,<Hum Value>,P,<SN>checksum

If the PC shows the “GPXDR…” string, then the MET station is on line and operating.

The uZ-CGRS is also creating a D-file with this data and a time tag preceding each line of data similar to the following example.

C 521092.997000,1108

XDR,P,1.008417,B,DQ 75136,C,22.88,C,DQRHT212,H,37.7,P,DQRHT212

The time tag has the format

C <GPS Seconds of week>,<GPS week>

The MET data has the format:

XDR,P,<Pres Value>,B,<SN>,C,<Temp Value>,C,<SN>,H,<Hum Value>,P,<SN>

The data between the “C”s is the temperature, in degrees Centigrade, that the MET station is measuring.

You can verify that the Met station data is being recording in the D-file by observing the EVENT LED on the front of the uZ-CGRS receiver.

5

Command/Response Formats

This chapter details the formats and content of the serial port commands through which the receiver is controlled and monitored. These serial port commands set receiver parameters and request data and receiver status information. You can use the Micro Manager, RCS, or any other standard serial communication software to send and receive messages. 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 data to be successfully transmitted and received. The receiver protocol is 8 data bits, 1 stop bit, and parity = none.

All commands sent by the user to the receiver are either **Set** commands or **Query** commands. **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, and all query commands begin with the $PASHQ string. $PASHS and $PASHQ are the message start character and message header and are required for all commands. All commands must end with <Enter> to transmit the command to the receiver. If desired, an optional checksum may precede <Enter>. All response messages end with <Enter>.

In this manual, the serial commands have been separated into 4 separate groups:

- Receiver commands—commands that relate to general receiver operations
- Raw data commands—commands that control the output of measurement, ephemeris, and almanac information.
- NMEA message commands—commands that control NMEA style data message output
- RTCM commands—commands that control RTCM differential operation

Within each section, the commands are listed alphabetically and described in detail. Information about the command including the syntax, a description, the range and default, and an example of how it is used are presented. The syntax includes the number and type of parameters that are used or required by the command. These parameters may be either characters or numbers depending upon the particular command. The parameter type is indicated by the symbol that is a part of the syntax. Parameter formats are as follows:

Table 5.1: Command Parameter Symbols

Symbol	Parameter Type	Example
d	Numeric integer	3
f	Numeric real	2.45
c	1 character ASCII	N
s	Character string	OFF
m	Mixed parameter (integer and real) for lat/lon or time	3729.12345
h	Hexadecimal digit	FD2C
*cc	Hexadecimal checksum which is always preceded by a *	*A5
<Enter>	Combination of <CR><LF> (carriage return, line feed, in that order)	

For example, for the receiver command:

$PASHS,RCI,f <Enter>

The parameter **f** indicates that the RCI command accepts a single parameter that is a real number such as 0.5 or 10.0. If a character is entered instead, the command will be rejected. Generally speaking, the parameter must be in the specified format to be accepted. However, most parameters that are real numbers (f) will also accept an integer. For example, in the case of the RCI command, both 10 and 10.0 are accepted by the receiver.

Receiver Commands

Receiver commands change or display various receiver operating parameters such as recording interval, antenna position, and PDOP mask. Commands may be sent through any available serial port.

Set Commands

The general structure of the set commands is:

$PASHS,s,c <Enter>

where s is a 3-character command identifier, and c is one or more data parameters that will be sent to the receiver. For example, the set command to change the recording interval to 5 seconds is:

$PASHS,RCI,5 <Enter>

If a set command is accepted, an acknowledgment message is returned in the form:

$PASHR,ACK*3D

If a set command is not accepted, a non-acknowledgment message is returned in the form $PASHR,NAK*30. If a command is not accepted, check that the command has been typed correctly, and that the number and format of the data parameters are correct.

Query Commands

The general structure of the query command is:

$PASHQ,s,c <Enter>

where s is a 3-character command identifier and c is the serial port where the response message will be sent. The serial port field is optional. If the serial port is not included in a query command, the response will be sent to the current port. For example, if you are communicating with the receiver on Port A and send the following query command:

$PASHQ,SES <Enter>

The response will be sent to port A. However, if from the same port, you send the query command:

$PASHQ,SES,B <Enter>

Then the response will be sent to port B.

The format of the response message may either be in a comma-delimited format or in a free-form table format, depending upon the query command. Note that not every set command has a corresponding query command. The most useful query command to check the general status of most receiver parameters is:

$PASHQ,PAR <Enter>

Table 5.2 lists the receiver commands alphabetically by function, and then alphabetically within each function. Each command is described in detail following the table in alphabetical order.

Table 5.2: Receiver Commands

Function	Command	Description	Page
Antenna Position	$PASHS,ANR $PASHS,ANT $PASHQ,ANT $PASHS,POS	Antenna Reduction Setting Set Antenna Offsets Query Antenna Offset Parameters Set position of antenna	52 53 54 77
Data Recording	$PASHS,DSC $PASHS,ELM $PASHS,MSV $PASHS,RCI $PASHS,REC $PASHS,RNG $PASHS,SIT	Store event or attribute string Set recording satellite elevation angle mask Sets minimum number of Svs for recording Set Data recording interval Enable/disable data recording Set Data Recording Type Enter Site Name	56 57 73 80 80 82 88
Data Recording/ Memory storage/ File Management	$PASHS,CLM $PASHS,FIL,C $PASHS,FIL,D $PASHQ,FLS $PASHS,FRM $PASHQ,FRM	Clear (reformat) memory storage card Close current file Delete data files Query data file information Set Ring File Memory Query Ring File Memory Status	55 59 60 60 62 62
External Frequency	$PASHS,EXT $PASHQ,EXT	Set External Frequency Query External Frequency Status	57 58
Ionosphere	$PASHS,ION $PASHQ,ION	Include/exclude ionospheric model Display ionosphere data information	66 67
Internal/External Memory	$PASHS,INI $PASHS,RST $PASHS,SAV $PASHQ,SAV	Clear internal memory and/or memory storage Card Reset receiver to default parameters Save parameters in battery-backed-up memory Query SAV command status	65 82 83 83
Meteorological Unit	$PASHQ,MET $PASHS,MET,CMD $PASHS,MET,INIT $PASHS,MET,INTVL $PASHS,OUT,c,MET	Query meteorological unit setup Set meteorological unit trigger string Set meteorological unit initialization string Set meteorological unit output interval Start/Stop output of meteorological unit data	71 72 72 73 73

Table 5.2: Receiver Commands (continued)

Function	Command	Description	Page
Miscellaneous Parameters	$PASHS,PWR $PASHQ,TMP $PASHS,WAK $PASHQ,WARN $PASHQ,WKN	Put receiver to sleep Query receiver temperature Acknowledge warning messages Query warning messages Query GPS week number	80 92 94 94 98
Modem	$PASHQ,MDM $PASHS,MDM $PASHS,MDM,INI	Query modem parameters Set modem parameters Initialize Modem Communication	70 68 71
Position Computation	$PASHS,PDP $PASHS,PEM	Set PDOP mask for position computation Set elevation mask for position computation	76 77
1PPS	$PASHS,PPS $PASHQ,PPS	Set period and offset of 1PPS signal Display 1PPS parameters	77 78
Receiver Configuration	$PASHS,BEEP $PASHQ,BEEP $PASHS,CTS $PASHQ,CTS $PASHS,DSY $PASHS,LTZ $PASHQ,PAR $PASHQ,PRT $PASHQ,RID $PASHQ,SID $PASHS,SPD $PASHS,UTS $PASHQ,UTS	Enable/Disable LED and warning beep Query LED and Warning beep setting Enable/disable hardware handshake Query hardware handshake status Configure serial ports as daisy chain Set Local Time Zone Request current settings of receiver parameters Request Port Baud Rate Request receiver identification Query receiver serial number Set baud rate of serial port Set Synchronization with GPS Time (Clock Steering) Query Clock Steering status	54 55 56 56 56 68 74 79 112 83 88 89 93 93
Satellites info	$PASHQ,ALH $PASHQ,STA $PASHS,SVS $PASHS,USE	Query the almanac messages received Request status of SVs currently locked Designate satellites to track Designate individual satellites to track	52 89 90 93
Session Parameters	$PASHS,INF $PASHQ,INF	Set session parameters Query session parameters	63 63
Session Programming	$PASHQ,SES $PASHS,SES,DEL $PASHS,SES,PAR $PASHS,SES,SET $PASHQ,SSN	Query session programming parameters Delete current session parameters Set session programming parameters Set individual sessions Query session programming parameters	84 85 85 86 88
Tiltmeter	$PASHQ,TLT $PASHS,TLT,CMD $PASHS,TLT,INIT $PASHS,TLT,INTVL $PASHS,OUT,c,TLT	Query tiltmeter set up Set tiltmeter trigger string Set tiltmeter initialization string Set tiltmeter ouput interval Start/stop output of tiltmeter data	90 91 91 92 74

ALH: Almanac Messages Received

$PASHQ,ALH,c

This command queries the receiver for the number of almanac messages that have been received since the last power cycle, where c is the optional output port. Using this query, a user can tell when all of the most recent almanac messages have been received.

Example: Query the current port for the number of received almanac messages.

$PASHQ,ALH <Enter>

$PASHR,ALH

The response message is in the form:

$PASHR,ALH,d1,s1*cc <Enter>

Table 5.3: ALH Parameter Table

Parameter	Significance	Range
d1	Number of almanac messages received since power up	0-32
s1	All almanac messages received NO = not all almanacs have been received OK = all almanacs received	 NO OK
*cc	checksum	

ANR: Set Antenna Reduction Mode

$PASHS,ANR,s

Sets the antenna reduction mode. The mode selection is used to translate between ground mark position and antenna phase center position.

When turned on, this mode applies the antenna parameters entered via $PASHS,ANT to the computed position to make it the ground mark position. This implies that the base position entered should also be the ground mark position of the base.

When turned off, the parameters entered via $PASHS,ANT are ignored and the position is the position of the phase center of the antenna. This implies that the base position entered should also be the one of the phase center of the base antenna.

Table 5.4: ANR Message Structure

Parameter	Description	Range
s	Reduction Mode	ON => Antenna Reduction on ALL position messages for Autonomous, Code Differential, and RTK. OFF => No Antenna Reduction in ANY position messages for Autonomous, Code Differential, and RTK.

Example: Set antenna reduction mode to OFF:

$PASHS,ANR,OFF <Enter>

Antenna Reduction, when performed, is applied to ALL position messages except for PBN and the position in the B-file.

ANT: Set Antenna Offsets

$PASHS,ANT,f1,f2,f3,m1,f4

Sets the antenna offsets from ground mark to antenna phase center via a reference point. Horizontally, the reference point is the physical center of the antenna housing. Vertically, the reference point is the point to which the antenna slant height was measured. The antenna phase center is the center of reception of the signal.

Table 5.5: Antenna Offsets Settings

Parameter	Description	Range	Unit
f1	Antenna slant height: height measured from the reference point to the antenna edge	0 -64.000	Meter
f2	Antenna radius: the distance from the reference point to the antenna edge	0.0 - 9.9999	Meter
f3	Antenna vertical offset: the offset from the antenna phase center to the reference point	0.0 - 99.9999	Meter
m1	Horizontal azimuth: measured from reference point to antenna phase center, with respect to the WGS84 north (dddmm.mm)	35959.99	Degrees decimal minutes
f4	Horizontal distance: measured from reference point to point below (above) antenna phase center.	999.9999	Meter

Example: Set antenna offsets.

$PASHS,ANT,1.678,0.1737,0.5,0,0 <Enter>

$PASHQ,ANT,c

Requests the current antenna offset parameters, where c is the output port and is not required to direct the response message to the current communication port.

Example: $PASHQ,ANT <Enter>

$PASHR,ANT,f1,f2,f3,m1,f4*cc

Returns the antenna parameters of the receiver, where Table 5.6 outlines the response format.

Table 5.6: ANT Message Structure

Parameter	Description	Unit
f1	Antenna height: height measured from the reference point to the antenna edge	meter
f2	Antenna radius: the distance from the antenna phase center to the antenna edge	meter
f3	Antenna offset: the offset set from the antenna phase center to the antenna ground plane edge	meter
m1	Horizontal azimuth: measured from reference point to antenna phase center, with respect to the WGS84 north (dddmm.mm)	degree and decimal minutes
f4	Horizontal distance: measured from reference point to point below (above) antenna phase center.	meter
*cc	checksum	n/a

BEEP: Beeper Set-up

$PASHS,BEEP,s

This command enables or disables the audible beeper, where s is ON or OFF. If the beeper is disabled, it will not sound when a warning is generated. The beeper is ON by default in Z-Surveyor and FX and is deactivated in the uZ-CGRS. The status is saved on battery-backed memory if $PASHS,SAV,Y has been issued afterwards.

Example: Disable the beeper.

$PASHS,BEEP,OFF <Enter>

$PASHQ,BEEP,c

Requests the current state of the beeper, where c is the optional output port and is not required to direct the response to the current port.

$PASHR,BEEP

The response message is in the form $PASHR,BEEP,s where s is the beeper status, ON or OFF.

CLM: Clear/Reformat Data Card

$PASHS,CLM

The CLM command deletes all files from the data card and reformats all tracks in the data card one by one. This includes the FAT table, directory structure, and data area.

Example: Clear the data files from the memory card.

$PASHS,CLM <Enter>

$PASHR,CLM

If the card passes the test, the response is in the form:

$PASHR,CLM,WAIT*cc <Enter>

$PASHR,CLM,SIZE,d1KB*cc <Enter>

$PASHR,CLM,PASSED*cc <Enter>

If the card fails the test, the response is in the form:

$PASHR,CLM,FAILED*cc <Enter>

Table 5.7 describes the parameters in the response message.

Table 5.7: CLM Message Structure

Parameter	Significance
d1	Size of the data card in kilobytes
*cc	checksum

The time to complete the CLM process depends on the data card size: approximately 5 seconds per MB of card memory.

CTS: Port Protocol Setting

$PASHS,CTS,c,s

This command enables or disables the RTS/CTS (handshaking) protocol for the specified port, where c is the port and s is ON or OFF. If the port is not specified (i.e., if c is not included in the command), the protocol is enabled or disabled for the port to which the command was sent.

Example: Disable the handshaking protocol for port A.

$PASHS,CTS,A,OFF <Enter>

$PASHQ,CTS,c

Query the RTS/CTS (handshaking) protocol status, where c is the optional output port and is not required to direct the response to the current port.

$PASHR,CTS,s

Response message where s is ON or OFF.

DSC: Store Event String

$PASHS,DSC,s

Store a string as event to current open session in receiver, where s is a character string of up to 80 characters in length. The string is stored on the D-file with a time tag.

Example: Send the string 'SITEOK' to the receiver:

$PASHS,DSC,SITEOK <Enter>

DSY: Daisy Chain

$PASHS,DSY,c1,c2 or $PASHS,DSY,OFF

Redirects all characters from one serial port to another without interpreting them, where c1 is the source port, and c2 is the destination port. Any combination may be chosen. This command is used primarily to initialize the radio from an external monitor (handheld or PC). When a port is in daisy chain mode, it can only interpret the OFF command; all other characters are redirected. The OFF command discontinues the daisy chain mode. Redirection can also be bi-directional (i.e. A to B and B to A at the same time), but a second command is necessary to set the other direction.

Table 5.8: DSY Parameter Table

Parameter	Description	Range
c1	Source Port	A...D
c2	Destination Port	A...D

Example: Redirects A to B. Can issue from any port.

$PASHS,DSY,A,B <Enter>

Redirects B to A. Can issue from any port, but it cannot be issued from port A if $PASH,DSY,A,B <Enter> has been sent.

$PASHS,DSY,B,A <Enter>

Turns off redirection from A. Can issue from any port.

$PASHS,DSY,A,OFF <Enter>

Turns off daisy chain on all ports. Can issue from any port.

$PASHS,DSY,OFF <Enter>

ELM: Recording Elevation Mask

$PASHS,ELM,d

Set the value of satellite elevation below which measurement data will not be output or recorded. d ranges from 0-90 degrees. The default is 10.

Example: Set the data elevation mask to 15 degrees.

$PASHS,ELM,15 <Enter>

EXT: External Frequency Settings

$PASHS,EXT,d1,c2

This command Sets the receiver to use either the internal clock built into the receiver or an External Frequency reference source. Default is to use the internal clock (d1=0).

It is recommended that when you use an external frequency source you also turn OFF Clock Steering Synchronization. When no external frequency source is used, it is recommended to turn Clock Steering Synchronization to ON. See command $PASHS,UTS,c for more information.

Table 5.9: External Frequency Message Structure

Parameter	Description	Range	Unit
d1	External Frequency value	0 (default), 5, 10, 20 0-use internal clock (Setting to 0 will force the receiver to use the internal clock regardless of the ‘c2’ parameter setting below).	MHz
c2	Frequency switching mode when loss of external reference	A- (default) automatically switches back to internal clock if external reference is not detected for more than 25 sec. Once the receiver has switched back to the Internal clock you must reissue the command or power cycle the receiver to return to External Frequency. N- stays in External Frequency mode. If the unit looses lock to the External Frequency source it will not track SV’s again until the External Frequency source is restored. Once the External Frequency source is restored, the unit will automatically detect it, at which time the unit will again be able to track SV’s.	N/A

Example:

$PASHS,EXT,10,A

Set external frequency mode with a reference of 10 MHz and automatic switching to internal clock if the external reference source is lost for more than 25 sec.

$PASHQ,EXT,c

Requests the current status of the external frequency setting, where c is the output port and is not required to direct the response message to the current communication port.

With the response:

$PASHR,EXT,f1,c2,c3*cc which is described in Table 5.10.

Table 5.10: External Frequency Parameters

Parameter	Description
f1	External Frequency value setting
c2	Frequency switching mode setting
c3	Status of the lock with external reference L – Locked to external reference U – Unlocked to external reference. If the setting of c2 is 'A', this state will last for approximately 25 seconds after loosing lock to the External Frequency Source at which time it will switch to the Internal clock or 'I'. I - Switched to Internal clock because either A) External frequency source is not detected or B) External Frequency was set to 0.0
*cc	Checksum

Example:

$PASHQ,EXT

Response :

$PASHR,EXT,05.00,A,U*2E

External Frequency mode is set to 5MHz and is in the 'A' or Automatic switch to Internal Frequency if no External Frequency can be found. In the particular example the unit is not detecting an External Frequency source of 5MHz and is in the process of the 25 second countdown sequence. If no External Frequency source is detected during the 25 seconds, the unit will begin to use the Internal clock source and thus would report 'I' in the last field of the message.

FIL,C: Close a File

$PASHS,FIL,C

Closes the current file in the receiver.

Example: Close the current file in the receiver:

$PASHS,FIL,C <Enter>

FIL,D: Delete a File

$PASHS,FIL,D,d

Delete data file(s) from the receiver, where d is the file index number, and ranges from 0 - 99. If d is 999 then all files are deleted and the PC card is reformatted.

If the deleted file is not the last file in the receiver, the receiver will reorder all files after the deleted file, thus changing the file index numbers for those files.

Example: Delete 6th file from receiver.

$PASHS,FIL,D,5 <Enter>

Command $PASHS,FIL,D,999 not only deletes all files, but also reformats the memory card by clearing the FAT table and directory structure.

FLS: Receiver File Information

$PASHQ,FLS,d

This command requests file information from the memory card, where d is the beginning file index number and can range from 0 - 99. The file index number is a sequence number where the first file has a file index = 0, the second file has a file index = 1, and continuing through to the 100th file which has a file index number of 99.

The output displays files in blocks of up to 10 files. If d is greater than the highest file index number, then the command will not be acknowledged (NAK is returned).

Example: Display file information for files 1-10.

$PASHQ,FLS,0 <Enter>

Display file information for files 6-15.

$PASHQ,FLS,5 <Enter>

$PASHR,FLS

The response returns file size, name, and available memory information.

Response:

$PASHR,FLS,d1,d2,d3,n(s4,m5,d6) *cc <Enter>

Table 5.11: FLS Message Structure

Parameter	Description
d1	Free memory in receiver memory card in Kbytes.
d2	Total number of files currently in the receiver.
d3	Number of files that match the query parameter and are displayed in the response.
s4	File 4 character site name.
m5	Time of last epoch recorded in the file, in the format wwwwdhhmm where: wwww = the GPS week number d = day in the week (1-7) hhmm = hours and minutes
d6	Size of the file in Kbytes
*cc	checksum

n = number of files displayed (f3)

Example:

$PASHR,FLS,000003,003,03,SIT1,095641850,001666,SIT2,095721707,000187,SIT3,095721803,000051*2A <Enter>

Table 5.12: Typical FLS Message

Item	Significance
000003 003 03	3 kb left on the memory card (i.e., memory card is full) 3 sessions total on the card 3 sessions listed in the message
SIT1 095641850 001666	Site name of 1st session listed GPS week 0956, day 4 (Wednesday) at 18:50 (6:50 pm) 1.666 MByte of data on that session
SIT2 095721707 000187	Site name of the 2nd session listed GPS week 0957, day 2 (Monday) at 17:07 (5:07 pm) 187 KByte of data on that session
SIT3 095721803 000051	Site name of 3rd session listed GPS week of 0957, day 2 (Monday) at 18:03 (6:03 pm) 51 KByte of data on that session
2A	checksum

FRM: Ring File Memory Setting

$PASHS,FRM,c

Enables or disables the Ring File Memory capability, where c is Y (Yes) or N (No). Once the Ring File memory is enabled, the receiver will delete the oldest file in memory when, a) there is 250K of free memory left or b), when the receiver opens the 100th file. This allows the receiver to be able to continuously record data indefinitely keeping the most current recorded data in the receiver memory with no user interaction required. The default is N (No).

CAUTION
If only one file exists in memory, the receiver will delete that file, erasing all recorded data within the receiver.

Example:

$PASHS,FRM,Y

Enable Ring File memory mode.

$PASHQ,FRM,c

Requests the current status of the Ring File memory option setting, where c is the output port. It is not required to direct the response message to the current communication port.

Example:

$PASHQ,FRM

Query the current status of the Ring File Memory Mode and direct the response to the Port of the receiver where the query was received from.

With the response:

$PASHR,FRM,N

Showing that File Ring Memory mode is disabled.

INF: Set Session Information

$PASHS,INF,c1,s2,s3,s4,s5,s6,f7,d8,d9,d10,d11

Sets a variety of session information parameters.

Table 5.13: INF Parameter Table

Parameter	Description	Range
c1	Session name	1 alphanumeric char
s2	Receiver serial number	3 alphanumeric char
s3	Antenna serial number	3 alphanumeric char
s4	Month and Day of the session (mmdd)	01-12 month 01-31 day
s5	Operator identification,	3 alphanumeric characters
s6	User comment	up to 9 alphanumeric characters
f7	Antenna height in meters	0.0000 - 64.0000
d8	Dry temperature in degrees Celsius	-99 - +99
d9	Wet temperature in degrees Celsius	-99 - + 99
d10	Relative humidity in percent	0 - 99
d11	Barometric pressure in millibars	0 - 9999

Example: Set session parameters

$PASHS,INF,A,325,401,0313,DWK,Test-Proj,1.456,65,60,65,1010 <Enter>

$PASHQ,INF,c

Query the survey session parameters, where c is the optional output port.

Example: Query session parameters to the current port.

$PASHQ,INF <Enter>

$PASHR,INF

The response message is in the form:

$PASHR,INF,f1,d2,d3,d4,c5,d6,d7,s8,c9,s10,s11,s12,s13,s14,f15,d16,
d17,d18,d19,f20,d21,d22,d23,d24 *cc <Enter>

Where Table 5.14 outlines the response format.

Table 5.14: INF Message Structure

Return Parameter	Description	Range
f1	Data recording interval in seconds	0.1 - 999
d2	Minimum number of SV for data recording	0 - 9
d3	Satellite elevation angle mask for data recording	0 - 90
d4	Data type recorded	0, 2, 4
c5	Recording data switch	Y or N
d6	Minimum number of SV for kinematic alarm	0, 4 - 9
d7	Number of epochs to go for kinematic survey	0 - 999
s8	Site name	4 alpha-numeric characters
c9	Session name	1 alpha-numeric character
s10	Receiver number	3 alpha-numeric character
s11	Antenna number	3 alpha-numeric character
s12	Month and Day of the session (mmdd)	1 - 12 month/1 - 31 day
s13	Operator identification	3 alpha-numeric character
s14	User comment	9 alpha-numeric character
f15	Antenna height **before** data collection	0.0000 - 64.0000
d16	Dry temperature **before** data collection (degrees celsius).	±99
d17	Wet temperature **before** data collection (degrees celsius)	±99
d18	Relative humidity **before** data collection (percent)	0 - 99
d19	Barometric pressure **before** data collection (millibars)	0 - 9999
f20	Antenna height **after** data collection (meters)	0.0000 - 64.0000
d21	Dry temperature **after** data collection (degrees celsius)	±99
d22	Wet temperature **after** data collection (degrees celsius)	±99

Table 5.14: INF Message Structure (continued)

Return Parameter	Description	Range
d23	Relative humidity **after** data collection (percent)	0 - 99
d24	Barometric pressure **after** data collection (millibars)	0 - 9999
*cc	Checksum	

INI: Receiver Initialization

$PASHS,INI,d1,d2,d3,d4,d5,c6

The INI command clears the stored almanac, emphemeris data, resets the receiver memory, sets the serial port baud rate to the specified rates, and/or sends the modem initialization string through the specified port.

If a port is specified for use with a modem through the MDM command, you must set the same baud rate through the INI command for that port. If the baud rates differ you will receive a “NAK” as the command response and the command itself will not be recognized.

Table 5.15: INI Parameter Description Table

Parameter	Description	Range*	Default
d1	Port A baud rate code	0-9	5
d2	Port B baud rate code	0-9	5
d3	Port C baud rate code	0-9	5
d4	Port D baud rate code	0-9	5
d5	Reset Memory Code	0-3	n/a
c6	Modem initialization Port, 0 = No initialization	A-D, 0	n/a

* Refer to Table 5.16 for baud rate and Table 5.17 for reset memory codes.

Table 5.16: Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
0	300	5	9600
1	600	6	19200
2	1200	7	38400
3	2400	8	57600
4	4800	9	115200

Table 5.17: Reset Memory Codes

Reset Memory Code	Action
0	No memory reset
1	Reset internal memory/battery back-up memory
2	Reset/reformat memory card
3	Reset internal memory and memory card

The Reset Memory Codes 0 and 2 behave like a power cycle. In that for the Z-Surveyor and Z-FX receivers any parameters not saved with the $PASHS,SAV command are lost. Code 1 and 3 reset all parameters to default as well as the ephemeris and almanac (i.e., creates a cold start). Code 2 and 3 reformat the memory card by clearing the FAT table and directory structure.

ION: Set Ionospheric Model

$PASHS,ION,c

Enable or disable the ionospheric model to compensate for ionospheric and tropospheric delay in the position computation, where c is either N (disable) or Y (enable). Default is N (disable).

Example: Enable ionospheric model:

$PASHS,ION,Y <Enter>

ION: Query Ionospheric Parameters

$PASHQ,ION,c

Query current ionosphere data information through port c, where c is the optional output port and is not required to direct the response message to the current communication port.

The ionosphere data is not computed by the receiver. It is obtained from the frame data transmitted by the satellites.

Example: Query the ionosphere parameters to port C.

$PASHQ,ION,C <Enter>

$PASHR,ION

Ionosphere and GPS-to-UTC data conversion parameters. See ICD-GPS-200 for the definition and the description of the model.

Format: $PASHR,ION,<ION Structure> <Enter>

where Table 5.18 outlines the response structure.

Table 5.18: ION Message Structure

Type	Size (Bytes)	Contents
float	4	α0. Ionspheric parameter(seconds)
float	4	α1. Ionspheric parameter (sec. per semicircle)
float	4	α2. Ionspheric parameter (sec. per semicircle)
float	4	α3. Ionspheric parameter (sec. per semicircle)
float	4	β0. Ionspheric parameter (seconds)
float	4	β1. Ionspheric parameter (sec. per semicircle)
float	4	β2. Ionspheric parameter (sec. per semicircle)
float	4	β3. Ionspheric parameter (sec. per semicircle)
double	8	A1.First order terms of polynomial
double	8	A0. Constant terms of polynomial
unsigned long	4	tot. Reference time for UTC data
short	2	Wnt. UTC reference week number
short	2	ΔtLS. GPS-UTC differences at reference time

Table 5.18: ION Message Structure (continued)

Type	Size (Bytes)	Contents
short	2	WNLSF. week number when leap second became effective
short	2	DN. day number when leap second became effective
short	2	∆tLSF. Delta time between GPS and UTC after correction
short	2	WN. GPS week number
unsigned long	4	tow. Time of the week (in seconds)
short	2	bulwn. GPS week number when message was read
unsigned long	4	bultow. Time of the week when message was read
short	2	Word checksum
total =	76	

LTZ: Set Local Time Zone

$PASHS,LTZ,d1,d2

Set local time zone value, where d1 is the number of hours that should be added to the local time to match GMT time and d2 is the number of minutes; minutes have the same sign as d1. The d1 value is negative for east longitude, and the range is 0 to 13. The setting is displayed by NMEA message ZDA.

Example: Set local time zone to East 7 hours, 20 minutes:

$PASHS,LTZ,-7,-20 <Enter>

MDM: Set Modem Parameters

$PASHS,MDM,s1,c2,d3,d4,CFG,s5,MOD,s6,NAM,s7,D2C,s8,C2D,s9,EOL,s10, HUP,s11

Table 5.19: MDM Setting Parameters and Descriptions

Setting Parameter	Description	Range	Default
s1	Switch to set modem-in-use flag on or off	“ON”/”OFF”	Off
c2	Serial port that modem connects to	‘A’- ‘D’	D

Table 5.19: MDM Setting Parameters and Descriptions (continued)

Setting Parameter	Description	Range	Default
d3	Modem type index: 0 - US Robotics 1 - Telebit WorldBlazer 2 - Telebit TrailBlazer 3 - Telebit CellBlazer 4 - User defined	0 - 4	0
d4 [optional]	Baud Rate Index Code	3 - 8	7
CFG,s5 [optional]	Modem configuration initialization string	96 bytes	
MOD,s6 [optional]	Modem Configuration mode used	16 bytes	
NAM,s7 [optional]	Modem name	40 bytes	
D2C,s8 [optional]	Data to command mode escape string	16 bytes	
C2D,s9 [optional]	Command to data mode string	16 bytes	
EOL,s10, [optional]	End of line characters	“CR” Carriage Return “LF” Line Feed “CRLF” Carriage Return and Line Feed	
HUP,s11 [optional]	Hang up string	e.g. AT0	

Table 5.20: Baud Rate Codes

Code	Baud Rate	Code	Baud Rate
0	300	5	9600
1	600	6	19200
2	1200	7	38400
3	2400	8	57600
4	4800	9	115200

All s-Parameter optional settings are user-defined modem settings and can be entered in any order and with any combination of these settings. If the baud rate index code in not entered, the default baud rate (7=38400) will be used.

Example: To send all parameters for user modem.

$PASHS,MDM,ON,B,4,6,CFG,ATS111=255S45=255S51=252S58=250=1&D2&C1X12E0Q0&W\r\n,MOD,AT&F1\r\n,NAM,US-ROBOTICS,D2C,+++AT, C2D,ATO\r\n <Enter>

To send only mode and data to command escape string and default baud rates.

$PASHS,MDM,ON,B,4,MOD,AT&F1\r\n,D2C,+++AT <Enter>

$PASHQ,MDM,c

Query current modem parameter settings, where c is the output port and is not required to direct the response message to the current communication port.

Example: Query modem setting to the current port.

$PASHQ,MDM <Enter>

$PASHR,MDM

The return message is in the form:

$PASHR,MDM,c1,d2,s3,d4,s5,s6,s7,s8*cc <Enter>

Where Table 5.21 outlines the response format.

Table 5.21: MDM Message Structure

Return Parameter	Description	Range
c1	Receiver port assigned for modem connection	‘A’ - ‘D’
d2	Baud Rate Code	3 - 8
s3	Modem Status	‘ON’/’OFF’/’INITOK’/’SYNC’/’ESCAPE’
d4	Modem type index	0-4
s5	User defined initialization string	
s6	User defined modem configuration mode	
s7	User defined data to command escape string	
s8	User defined command to data string	
*cc	Byte wise XOR checksum begin with ‘P’	2 byte in hex

MDM,INI: Initialize Modem Communication

$PASHS,MDM,INI

The $PASHS,MDM,INI command establishes communication between the modem and the receiver. This command must be run to initiate modem communication after modem parameters have been set using the $PASHS,MDM command.

Example: Initialize modem communication

$PASHS,MDM,INI <Enter>

$PASHR,MDM,INI

If the initialization is successful the response message is in the form:

$PASHR,MDM,INI,OK*cc <Enter>

If the initialization is not successful, the response message is in the form:

$PASHR,MDM,INI,FAIL*cc <Enter>

MET: Meteorological Unit Set-up

$PASHQ,MET,c

Query meteorological unit setup, where c is the optional output port and is not required to direct the response to the current port.

Response message:

```
MET PARAMETERS SETTINGS
PRTA:OFF INIT_STR:NO          TRIG_CMD:*0100P9      INTVL:0005
PRTB:OFF INIT_STR:NO          TRIG_CMD:*0100P9      INTVL:0005
PRTC:OFF INIT_STR:NO          TRIG_CMD:*0100P9      INTVL:0005
PRTD:OFF INIT_STR:NO          TRIG_CMD:*0100P9      INTVL:0005
```

MET,CMD: Meteorological Unit Trigger String

$PASHS,MET,CMD,c,s

Set meteorological unit trigger string, where c is the output port and s is the trigger string.

Table 5.22: MET,CMD Message Structure

Parameter	Description	Range
c	Serial port connected to the meteorological unit	A - D
s	Trigger string of meteorological unit excluding the starting '*' sign	Limited to 20 alphanumeric characters

Example: Set *9900XY to the MET CMD field:

$PASHS,MET,CMD,C,9900XY <Enter>

MET,INIT: Meteorological Unit Initialization

$PASHS,MET,INIT,*c,s*

Set meteorological unit initialization string.

Table 5.23: MET,INIT Message Structure

Parameter	Description	Range
c	Serial port connected to meteorological unit	A - D
s	Initialization string of meteorological unit excluding the starting '*' sign	limited to 20 alphanumeric characters

Example: Set *9900ID to the INIT STRING_MET field.

$PASHS,MET,INIT,A,9900ID <Enter>

MET,INTVL : Meteorological Unit Interval

$PASHS,MET,INTVL,*c,d*

Set the interval for the query of the meteorological unit.

Table 5.24: MET,INTVL Message Structure

Parameter	Description	Range
c	Serial port connected to meteorological unit	A - D
d	Sample interval for meteorological unit	5-9999 sec (default = 5)

Example: Set 10 to the MET SAMPLE field

$PASHS,MET,INTVL,D,10 <Enter>

MSV: Minimum SVs for Data Recording

$PASHS,MSV,d

Sets the minimum number of satellites required for measurement data to be output and/or recorded, where d is a number between 1 and 9. Default is 3.

Example: Set minimum satellites to 4:

$PASHS,MSV,4 <Enter>

OUT,MET: Start Meteorological Unit Process

$PASHS,OUT,c,MET,*s*

Start/stop the processing of the meteorological unit. It first initializes the meteorlogical unit and then regularly queries it at the interval requested, where c is the port the meteorological unit is connected to and s is ON or OFF.

Table 5.25: OUT,MET Message Structure

Parameter	Description	Range
c	Serial port connected to meteorological unit.	A - D
s	Enable /disable meteorological unit processing	ON / OFF

Example: Start meteorological unit on port B:

$PASHS,OUT,B,MET,ON <Enter>

OUT, TLT: Start Tiltmeter Process

$PASHS,OUT,c,TLT,*s*

Start/stop the processing of the tiltmeter. It first initializes the tiltmeter and then regularly queries it at the interval requested, where c is the port the tiltmeter is connected to and s are ON or OFF.

Table 5.26: OUT,TLT Message Structure

Parameter	Description	Range
c	Serial port connected to the tiltmeter	A - D
s	Enable /disable the tiltmeter processing	ON / OFF

Example: Start tiltmeter on port B:

$PASHS,OUT,B,TLT,ON <Enter>

PAR: Query Receiver Parameters

$PASHQ,PAR,c

Query general receiver parameters, where c is the optional output port and is not required to direct the response message to the current communication port. This query shows the status of most of the general receiver parameters.

Example: Query the receiver for parameters:

$PASHQ,PAR <Enter>

The response message is in a table format. A typical response message is:

```
SVS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
PMD:0  FIX:0 ION:N  UNH:N  PDP:40  HDP:04  VDP:04  FUM:N  FZN:01
DIF_RTCM MODE: OFF  PRT:A  NMEA_PER:001.0  PEM:10  PPO:N  SAV:N  ANR:CPD
LAT:00:00.0000000N LON:000:00.0000000W ALT:+00000.000
NMEA:GLL GXP GGA VTG GSN ALM MSG DAL GSA GSV TTT RRE GRS UTM POS SAT
PRTA:OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PRTB:OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PRTC:OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PRTD:OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
NMEA:XDR GDC RMC PTT ZDA
PRTA:OFF OFF OFF OFF OFF
PRTB:OFF OFF OFF OFF OFF
PRTC:OFF OFF OFF OFF OFF
PRTD:OFF OFF OFF OFF OFF
```

Table 5.27 lists all of the above fields in alphabetic order. The description of the field is given along with the set command to modify them.

Some parameters shown in this message are not supported as “user selectable parameters”. These are denoted as “Fixed Parameters” within Table 5.27.

Table 5.27: PAR Parameter Table

Return Parameter	Description/Related Command	Range	Unit
ALT	Altitude of antenna $PASHS,POS	±0-99999.999	meter
ANR	Antenna reduction mode $PASHS,ANR	ON/OFF	n/a
DIF_RTCM MODE	RTCM differential mode $PASHS,RTC	OFF BAS (Base)	n/a
FIX	Fixed Parameter	0	n/a
FUM	Fixed Parameter	N	n/a
FZN	Fixed Parameter	01	n/a
HDP	Fixed Parameter	04	n/a
ION	Enable ionospheric and tropospheric model. $PASHS,ION	Y/N	n/a
LAT	Latitude of the antenna position $PASHS,POS	0 - 90 N/S	degree - minute

Table 5.27: PAR Parameter Table (continued)

Return Parameter	Description/Related Command	Range	Unit
LON	Longitude of the antenna position $PASHS,POS	0 - 180 E/W	degree - minute
NMEA	NMEA message type for output. NMEA messages supported are: ALM, DAL, GGA, GLL, GRS, GSA, GSV, MSG, POS, PPT, SAT, XDR, and ZDA	0	n/a
PDP	Position Dilution of Precision mask $PASHS,PDP	0 -99	n/a
PEM	Position elevation mask. $PASHS,PEM	0 - 90	degree
NMEA_PER	NMEA message output period $PASHS,NME,PER	0.1 - 999	second
PMD	Fixed Parameter	0	n/a
PPO	Point Positioning $PASHS, PPO	Y/N	n/a
PRTA, PRTB, PRTC, PRTD	Output to port A/B/C/D $PASHS,NME	‘ON’, ‘OFF’	n/a
PRT	Port sending differential corrections $PASHS,RTC	A - D	n/a
SAV	Save parameters in the battery-backed-up memory. $PASHS,SAV	Y/N	n/a
SVS	Satellites which the receiver will attempt to acquire $PASHS,SVS	Y/N	n/a
UNH	Fixed Parameter	N	n/a
VDP	Fixed Parameter	04	n/a

PDP: PDOP Mask

$PASHS,PDP,d

Set the value of the PDOP mask to d, where d is a number between 0 and 99. Position is not computed if the PDOP exceeds the PDOP mask. The default is 40.

Example: Set PDOP mask to 20:

$PASHS,PDP,20 <Enter>

PEM: Position Elevation Mask

$PASHS,PEM,d

Set elevation mask for position computation where d is 0 to 90 degrees. Default is 10 degrees. Satellites with elevation less than the elevation mask will not be used for position computation.

Example: Set position elevation mask to 15 degrees

$PASHS,PEM,15 <Enter>

POS: Set Antenna Position

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

Sets the position of the antenna used in differential base mode.

Table 5.28: POS Parameter Table

Parameter	Description	Range
m1	latitude in degrees, decimal minutes (ddmm.mmmmmmm)	0 - 90.0
c2	North (N) or South (S)	N, S
m3	longitude in degrees, decimal minutes (dddmm.mmmmmmm)	0 - 180.0
c4	East (E) or West (W)	E, W
f5	the ellipsoidal height in meters	±0-99999.999

Example: Set antenna position

$PASHS,POS,3722.2912135,N,12159.7998217,W,15.25 <Enter>

PPS: Pulse Per Second

$PASHS,PPS,d1,f2,c3

The receiver generates a PPS pulse with programmable period and offset with respect to GPS time. The PPS set command allows the user to change the period and the offset of the pulse, and to either synchronize the rising edge of the pulse with GPS time, or synchronize the falling edge of the pulse with GPS time. PPS is generated by default once every second with its rising edge synchronized to GPS time and no offset.

Table 5.29: PPS Message Structure

Parameter	Description	Range	Units
d1	period	0-60	Second
f2	offset	±999.9999	Milliseconds
c3	rising edge or falling edge	R / F	n/a

The period set to 0 will disable the PPS output. Between 0 and 1, the period can be set in increments of 0.1. Between 1 and 60, the period can be set in increments of 1.

Example: Set PPS to a period of 2 seconds, an offset of 500ms, and synchronize the rising edge of the pulse with GPS time.

$PASHS,PPS,2,+500,R <Enter>

$PASHQ,PPS,c

Query PPS parameter where c is the output port. Note that c is not required to direct the response message to the current communication port.

Example: Query PPS parameters to port A.

$PASHQ,PPS,A <Enter>

$PASHR,PPS

The response is in the form:

$PASHR,PPS,d1,f2,c3*cc <Enter>

where Table 5.30 outlines the structure:

Table 5.30: PPS Response Structure

Parameter	Description
d1	Period. Range from 0 to 60.0
f2	Offset, Range from -999.9999 to +999.9999
c3	Edge, R = rising edge or F = falling edge
cc	Checksum

PRT: Port Setting

$PASHQ,PRT,c

Display the baud rate setting for the connected communication port where c is the optional output port. Note that to direct the response message to the current communication port, the c is not required.

Example: Query the baud rate of the current port.

$PASHQ,PRT <Enter>

$PASHR,PRT

The response is a message in the format:

$PASHR,PRT,c1,d2*cc <Enter>

Table 5.31: PRT Response Structure

Parameter	Description	Range
c1	serial port	A - D
d2	baud rate code	0 - 9 (See Table)
*cc	checksum	n/a

Table 5.32: 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

PWR: Sleep Mode

$PASHS,PWR,off

Direct the receiver to immediately go into sleep mode. Once a receiver is in sleep mode, any character issued through any port will restore normal operation.

Example: Put receiver into sleep mode

$PASHS,PWR,OFF <Enter>

RCI: Recording Interval

$PASHS,RCI,f1

Set the value of the interval for data recording and raw data output, where f1 is any value between 0.1 and 999. Values between 0.1 and 1 can increment in 0.1 secs. Values between 1 and 999 can increment in 1 second. The default is 20.0.

Example: Set recording interval to 5 seconds

$PASHS,RCI,5 <Enter>

If the fast data option (F) is not installed, the setting 0.1 second is not available. All other settings (0.2 to 999) are available except 0.7, which is never available.

REC: Data Recording

$PASHS,REC,c

Data recording switch that turns data recording to either Yes, No, Stop, or Restart.

Yes and No are used to enable/disable data recording. The default is Yes. Stop is used prior to removing a memory card from the receiver while the receiver is recording data. This will prevent any corruption of the data files on the memory card. When the same or another memory card is inserted into the receiver, the receiver will automatically restart data recording. The Restart command is necessary to restart data recording only if the Stop command is used, but the memory card is not actually removed.

See $PASHQ,RAW command for a list of the various states this parameter can take internally.

Table 5.33: REC Message Structure

Setting Parameter	Description	Range
c	'Y' Record data 'N' Do not record data 'S' Stop data recording 'R' Restart data recording	'Y' / 'N' / 'S' / 'R'

Example: Disable recording data

$PASHS,REC,N <Enter>

REC,N will disable recording but will not close the session. Whenever REC,Y is issued, recording will resume in the same session. REC,S will close the session, and a new session will be created if REC,R is used or if the card is reinserted.

RID: Receiver ID

$PASHQ,RID,c

Request information about the receiver type, firmware and available options, where c is the optional output port.

Example: Query the current port for receiver identification

$PASHQ,RID <Enter>

$PASHR,RID

The return message is in the form:

$PASHR,RID,s1,d2,s3,s4,s5*cc <Enter>

Table 5.34: RID Message Structure

Return Parameter	Description	Range
s1	Receiver type	UZ
d2	Channel option Codeless option	3 (C/A, PL1, P L2) 0
s3	nav firmware version	4 char string
s4	Receiver options	Refer to Table 1.2.

Table 5.34: RID Message Structure (continued)

Return Parameter	Description	Range
s5	boot version	4 char string
*cc	checksum	in hex

Example:

Response: $PASHR,RID,UZ,30,UFB5,B--XM--3---,0A16*43 <Enter>

RNG: Data Type

$PASHS,RNG,d

Sets data recording mode where d is the desired data type.

Table 5.35: RNG Data Modes

Setting Parameter	Description	Range
d	Data recording mode 0 - creates B-file that includes carrier phase, code phase and position data 2 - creates a C-file with smoothed positions only 4 - creates both a B-file and a C-file	0,2,4

Example: Set data recording mode to 2

$PASHS,RNG,2 <Enter>

RST: Reset Receiver to default

$PASHS,RST

Reset the receiver parameters to their default values. The RST command resets all parameters except the MET, TLT, and MDM command parameters, including the baud rate of the modem port. For more information on default values, see the Operations Section.

Example: Reset receiver parameters

$PASHS,RST <Enter>

CAUTION
Ensure that 110 millisecond delay occurs before a new set command is issued.

RTR: Real-Time Error

$PASHR,RTR

This is an unsolicited response message that the receiver will send when a runtime error occurs. The response is an unsigned hex long word bitmap with the following bit assignments indicating the position computation didn’t converge.

The message is in the form:

$PASHR,RTR,h*cc <Enter>

Table 5.36: RTR Message Structure

Bit #	Description
13	Autonomous position did not converge.

SAV: Save User Parameters

$PASHS,SAV,c

Enables or disables saving user parameters in memory, where c is Y (Yes) or N (No). This command will save any parameters that have been modified from their default values prior to issuing the command. User parameters are saved until commands INI or RST are issued, or until SAV is set to N and a power cycle occurs. This value is hard coded to Y(Yes) in the uZ-CGRS receiver (Users cannot change this setting). In all other Z family receivers using uZ-CGRS firmware UFBA or later, the default is set to N (No).

MET, TLT and MDM command parameters are saved automatically every time the corresponding set command is issued.

Example: Save modified user parameters.

$PASHS,SAV,Y <Enter>

$PASHQ,SAV,c

Requests the current status of the Save User Parameters setting, where c is the output port. It is not required to direct the response message to the current communication port.

Example:

$PASHQ,SAV

Query the current status of the Save User Parameters setting and direct the response to the Port of the receiver where the query was received from.

With the response:

$PASHR,SAV,Y

Showing that User Parameters will be saved during a power cycle.

SES: Session Programming

$PASHQ,SES,c

Query session programming parameters, where c is the optional output serial port.

Example: Query session programming parameter

$PASHQ,SES <Enter>

Return message:

		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
K	N	00:00:00	00:00:00	020.0	10	3	0
L	N	00:00:00	00:00:00	020.0	10	3	0
M	N	00:00:00	00:00:00	020.0	10	3	0
N	N	00:00:00	00:00:00	020.0	10	3	0
O	N	00:00:00	00:00:00	020.0	10	3	0
P	N	00:00:00	00:00:00	020.0	10	3	0
Q	N	00:00:00	00:00:00	020.0	10	3	0
R	N	00:00:00	00:00:00	020.0	10	3	0
S	N	00:00:00	00:00:00	020.0	10	3	0
T	N	00:00:00	00:00:00	020.0	10	3	0
U	N	00:00:00	00:00:00	020.0	10	3	0
V	N	00:00:00	00:00:00	020.0	10	3	0
W	N	00:00:00	00:00:00	020.0	10	3	0
X	N	00:00:00	00:00:00	020.0	10	3	0

```
Y   N   00:00:00   00:00:00   020.0   10   3   0
Z   N   00:00:00   00:00:00   020.0   10   3   0
INUSE:N      REF:000  OFFSET:00:00   TODAY:000
An asterisk next to a session indicates that session is active.
```

Table 5.37 lists all of the above Parameters in alphabetic order:

Table 5.37: SES Message Structure

Return Parameter	Description	Range
1st Column	Session Name	A-Z
2nd Column	Session enabled flag	'Y' / '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)	0.1-999
6th Column	Session elevation mask	0-90
7th Column	Session minimum SVs	1-9
8th Column	Session data type	0, 2, or 4
INUSE	Session use	Y or N or S
REF	Session reference day	0-366
OFFSET	Session time offset (minutes, seconds)	mm:ss
TODAY	Date of the year	0-366

$PASHS,SES,DEL

This command deletes all session programming information that has been set in the receiver memory, returning the status back to the factory default.

Example: Delete all session programming information in the receiver.

$PASHS,SES,DEL

$PASHS,SES,PAR,c1,d2,d3

Set 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 to program individual sessions.

Table 5.38: 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	0-366
d3	Session offset (mm:ss)	0-59

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 <Enter>

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

Set the individual sessions for session programming. This command will set a single session. Up to 26 sessions may be programmed. This command must be used with $PASHS,SES,PAR to activate session programming.

Table 5.39: SES,SET Message Structure

Setting Parameter	Description	Range
c1	Session name	A-Z
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 recordinig interval	0.1-999
d6	Session Elevation Mask	0-90
d7	Session min SV	1-9
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 <Enter>

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

$PASHQ,SSN,c

This command queries session programming information for a given session, where the valid range is from A-Z.

With the response format:

$PASHR,c1,d1,d2:d3,d4,d5,c2,c3,d6:d7:d8,d9:d10:d11,f1,d12,d13,d14 <CR><LF>

Table 5.40: SSN Message Structure

Parameter	Description	Range	Unit
c1	Session programming in use flag.	‘Y’ or ‘N’	Coded
d1	Reference Day of all programmed sessions	0—365	Days
d2 d3	Offset Per Day of all programmed sessions	d2 = 0-60 minutes, d3 = 0-59 seconds	Minutes Seconds
d4	Total programmed sessions.	1-26	
d5	Session number of the session being reported by this message.	0-25	Session Number
c2	Session Name	‘A’ to ‘Z’	
c3	Session use flag.	‘Y’ or ‘N’	Coded
d6 d7 d8	Session Start Time (hh:mm:ss)	D6 = 0-23 D7 = 0-59 D8 = 0-59	Hours Minutes Seconds
d9 d10 d11	Session End Time (hh:mm:ss)	D9 = 0-23 D10 = 0-59 D11 = 0-59	Hours Minutes Seconds
f1	Epoch Interval.	0.1 to 999.5	Seconds
d12	Elevation Mask	0 to 89	Degrees
d13	Minimum Number of satellites for recording.	0 to 9	
d14	Ranger Mode	0 to 2	Coded

Example:

$PASHQ,SSN,C

Query the receiver for the session programming information for session C.

With an example response:

$PASHR,SSN,Y,121,04:00,26,2,C,Y,11:00:00,12:00:00,30.0,5,4,0

SID: Serial Number

$PASHQ,SID,c

Query receiver serial number and firmware timestamp, where c is the optional output port.

Example: Query receiver serial number

$PASHQ,SID <ENTER>

Return message:

DATE: / /

SER#:111122223333

The date field is there for backward compatibility.

SIT: Set Site Name

$PASHS,SIT,s

Sets site name where s is the 4 character site ID. Only characters that are DOS compatible are allowed (i.e., excludes "*", ".", "/", and "\". "?" will be converted to "_" in the file name).

Example: Set site name to ECC1

$PASHS,SIT,ECC1 <Enter>

SPD: Serial Port Baud Rate

$PASHS,SPD,c1,d2

Set the baud rate of the receiver serial port c1, where c1 is port A, B, C, or D and d2 is a number between 0 and 9 specifying the baud rate as shown in Table 5.41. Default is 9600 baud.

Table 5.41: SPD 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

To resume communication with the receiver after changing the baud rate using this command, be sure to change the baud rate of the command device.

Example:

Set port A to 19200 baud

$PASHS,SPD,A,6 <Enter>

STA: Satellite Status

$PASHQ,STA,c

Show the status of SVs currently locked, where c is the optional output serial port.

Example: Query satellite status to the current port

$PASHQ,STA <Enter>

The return message is in a free-form format. A typical response is:

TIME: 03:24:24 UTC

LOCKED: 23 22 17 06 30 10 26

CA S/N 50 46 54 53 43 43 44

P1 S/N 48 00 52 51 36 00 00

P2 S/N 44 00 48 47 38 00 00

Table 5.42: STA Message Structure

Return Parameter	Description	Range
TIME	Current UTC time in hours, minutes, & seconds (or GPS time if GPS is indicated instead of UTC)	hh:mm:ss
LOCKED	PRN number of all locked satellites	1-32
CA S/N	Signal-to-noise ratio of the C/A observable in dB Hz	30-60
P1 S/N	Signal to noise ratio of the L1 P-code observable in dB Hz	30-60
P2 S/N	Signal to noise ratio of the L2 P-code observable in dB Hz	30-60

After a cold start it can take the recevier up to 12.5 minutes to obtain UTC time; during this period, GPS time is displayed in the TIME field.

SVS: Satellite Selection

$PASHS,SVS,c1c2c3.....c32

Select SVs that the receiver attempts to acquire, where:

c = Y, SV is used (default).

c = N, SV is not used.

Up to 32 SVs may be selected. They are entered in order of PRN number. If fewer than 32 are specified the rest are set to N. Only the characters Y and N are accepted.

Example: Attempt to acquire SV 1-9; do not acquire 10,11; acquire 12, 13; do not acquire 14-32

$PASHS,SVS,YYYYYYYYYNNYYNNNNNNNNNNNNNNNNNNN <Enter>

TLT : Tiltmeter Set-up

$PASHQ, TLT,c

Query tiltmeter setup, where c is the optional output port and is not required to direct the response to the current port.

Response message:

```
TILTMETER PARAMETERS SETTINGS
PRTA:OFF INIT_STR:NO          TRIG_CMD:*0100XY        INTVL:0001
PRTB:OFF INIT_STR:NO          TRIG_CMD:*0100XY        INTVL:0001
PRTC:OFF INIT_STR:NO          TRIG_CMD:*0100XY        INTVL:0001
```

TLT,CMD: Tiltmeter Trigger String

$PASHS, TLT,CMD,c,s

Set tiltmeter trigger string, where c is the output port and s is the trigger string.

Table 5.43: TLT,CMD Message Structure

Parameter	Description	Range
c	Serial port connected to the tiltmeter	A - D
s	Trigger string of the tiltmeter excluding the starting '*' sign	Limited to 20 alphanumeric characters

Example: Set *9900XY to the TLT CMD field:

$PASHS,TLT,CMD,C,9900XY <Enter>

TLT,INIT : Tiltmeter Initialization

$PASHS, TLT,INIT,*c,s*

Set tiltmeter initialization string.

Table 5.44: TLT,INIT Message Structure

Parameter	Description	Range
c	Serial port connected to the tiltmeter	A - D
s	Initialization string of the tiltmeter excluding the starting '*' sign	Limited to 20 alphanumeric characters

Example: set *9900ID to the INIT STRING_ TLT field.

$PASHS,TLT,INIT,A,9900ID <Enter>

TLT,INTVL: Tiltmeter Interval

$PASHS, TLT,INTVL,c,d

Set the interval for the query of the tiltmeter.

Table 5.45: TLT,INTVL Message Structure

Parameter	Description	Range
c	Serial port connected to the tiltmeter	A - D
d	Sample interval for a tiltmeter	1-86400 sec (default = 1)

Example: set 10 to the TLT SAMPLE field

$PASHS, TLT,INTVL,D,10 <Enter>

TMP: Receiver Internal Temperature

$PASHQ,TMP,c

This command queries the receiver's internal temperature, where c is the optional output serial port.

If the internal temperature of the receiver reaches 80×C, an alarm is generated. When it reaches 82×C, the receiver will shut off.

Example: Query receiver for temperature

$PASHQ,TMP <Enter>

$PASHR,TMP

Return message:

$PASHR,TMP,f1,*cc <Enter>

Table 5.46: TMP Message Structure

Return Parameter	Description
f1	Receiver internal temperature in degrees Celsius
*cc	checksum

Example: $PASHR,TMP,+35.50*27 <Enter>

USE: Use Satellites

$PASHS,USE,d,c

Selects satellites to track or not track, where d is the PRN number of the satellite (range from 1 to 32) or ALL for all satellites and c is Y (enable) or N (disable).

Example: Do not track satellite 14

$PASHS,USE,14,N <Enter>

UTS: Clock Steering Synchronization

$PASHS,UTS,c

This command enables (Y=Yes) or disables (N=No) a mechanism that synchronizes measurements and coordinates with GPS system time rather than with local (receiver) clock. This means that 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 on.

It is recommended that when you use an external frequency source that you turn OFF (c=N) Clock Steering Synchronization. When no external frequency source is used, it is recommended to turn Clock Steering Synchronization to ON (c=Y). See command $PASHS,EXT,c for more information.

Example:Turn Clock Steering to YES.

$PASHS,UTS,Y

$PASHQ,UTS,c

Requests the current status of the Clock Steering Synchronization setting, where c is the output port. It is not required to direct the response message to the current communication port.

Example:

$PASHQ,UTS

Query the current status of the Clock Steering Synchronization setting and direct the response to the Port of the receiver where the query was received from.

With the response:

$PASHR,UTS,Y

Showing that Clock Steering Synchronization setting is enabled.

WAK: Warning Acknowledgment

$PASHS,WAK

This command acknowledges a warning condition (status displayed by WARN will go from CURRENT to PENDING) and will stop the receiver beep that accompanies a warning (if the beep is set to ON-See command $PASHS,BEEP,S for more information).

WARN: Warning Messages

$PASHQ,WARN,c

This queries the receiver for any warning messages, where c is the optional output port.

Example: Query receiver warning status:

$PASHQ,WARN <Enter>

$PASHR,WARN

The response is in the form:

$PASHR,WARN,s1,s2*cc <Enter>

Table 5.47: WARN Message Structure

Parameter	Significance	Range
s1	Warning Message - NONE = no warnings	For a list of all warning message, refer to Table 5.48.
s2	Status - Pending = has been acknowledged Current = has not been acknowledged Occurred = error condition has occurred but is no longer current.	'PENDING', 'CURRENT', 'OCCURED'

Table 5.48 lists the possible warnings the receiver may issue.

Table 5.48: Receiver Warning Messages

Warning	Definition	Action
Int. Battery Error : SMBus	The SMBus controller (for internal battery communication) is not working	Remove battery and reinsert it. If problem persists, insert a different battery. If problem still persists, contact customer support.

Table 5.48: Receiver Warning Messages (continued)

Warning	Definition	Action
Int. Battery Error : Access	Can not access the internal battery	Remove battery and reinsert it. If problem persists, insert a different battery. If problem still persists, contact customer support.
Battery Conditioning Required	Internal battery efficiency is down, it requires a conditioning cycle.	Perform battery reconditioning (depends on the battery, but typically means full charge, full discharge and full charge again)
Low Int. Battery : < 10 min	Internal battery remaining life is < 10 min, the battery needs to be changed	Replace battery with a charged one.
†Memory Test Error : RAM	RAM error	Perform a receiver initialization. If problem persists, contact customer support.
†Memory Test Error : BBRAM	Battery backed Ram	Perform a receiver initialization. If problem persists, contact customer support.
†Memory Test Error : ROM	ROM, i.e. Flash	Perform a receiver initialization. If problem persists, contact customer support.
†Memory Test Error : BOOT	Boot section of the flash	Perform a receiver initialization. If problem persists, contact customer support.
No Data Card Detected	There is no card in the PCMCIA drive or it cannot be detected; no recording	Insert or reinsert data card in slot.
Data Card Full	No space left on the PC card, therefore data recording is stopped	Replace current data card with a card containing available memory, or delete some older sessions.
Data Card Full <5 min	Not enough space on the PC card to record more than five minutes of data under current conditions (satellite number, recording period, output information).	Replace data card with one containing available memory, or delete older sessions.
†Data Card Error : Access	Can't read or write to the PC card	Power cycle the receiver. If problem persists, issue command $PASHS,CLM (card will be reformatted and all data erased, so download data prior to issuing the CLM command). If problem persists, replace the PC card.

Table 5.48: Receiver Warning Messages (continued)

Warning	Definition	Action
†Data Card Error : Update	Can't update the FAT (file allocation table)	Power cycle the receiver. If problem persists, issue command $PASHS,CLM (card will be reformatted and all data erased, so download data prior to issuing the CLM command). If problem persists, replace the PC card.
†Data Card Error : Create	Can't create the files for new session so we can't record data	Power cycle the receiver. If problem persists, issue command $PASHS,CLM (card will be reformatted and all data erased, so download data prior to issuing the CLM command). If problem persists, replace the PC card.
†Data Card Error : Rename	Can't rename the files of session	Power cycle the receiver. If problem persists, issue command $PASHS,CLM (card will be reformatted and all data erased, so download data prior to issuing the CLM command). If problem persists, replace the PC card.
†Data Card Error: Corrupted FAT	File Allocation Table on PCMCIA card has been corrupted and could not be recovered by the receiver.	Issue command $PASHS,CLM to reformat the card. If critical data is on the PC card, call Customer Support before issuing the CLM comnmand to recover data.
Bad RTCM Base Position	The position entered in the base receiver for RTCM code operation is not correct (too far from computed position)	Enter correct base position.
Low Backup Battery	The battery powering the non-volatile memory and the real-time clock is low and needs to be changed	Contact Customer Support. Back-up battery must be replaced.
Antenna Overload	Antenna installation problems, i.e. the set-up is drawing more than 150 milliamps (short on antenna cable or LNA drawing too much current)	Check antenna connection for bad cable or bad LNA.

Table 5.48: Receiver Warning Messages (continued)

Warning	Definition	Action
No Antenna Detected	Does not sense any antenna: WARNING, this will be the case if a DC block is installed somewhere between the receiver and the antenna	Check antenna connection for bad cable or bad LNA. There may be another receiver connected to the same antenna with no DC block, or this receiver is connected to the antenna via a DC block.
MODEM Communication Error	Cannot communicate with the modem	Check serial connection to the modem. Check power on modem. Check baud rate of modem-it should match baud rate of receiver. Reinitialize modem.
MODEM Initialization Error	Cannot initialize the modem	Check serial connection to the modem. Check power on modem. Check baud rate of modem-it should match baud rate of receiver. Reinitialize modem.
High Receiver Temperature	Inside receiver temperature > 80 deg Celsius: the receiver will turn off automatically at 82 deg Celsius (this message might be seen when the external ambient temperature is >55 degrees Celsius	Cover the receiver from the sun. Increase air flow around receiver. **NOTE:** If the receiver's temperature is still going up, it will automatically switch to the sleep mode, in reduced power consumption mode as a safety measure. To recover, cycle the Power, after having eliminated the source of overheating.
Download in Progress	Receiver is currently downloading data from the memory card to a PC. No front panel operations can be conducted at this time.	Wait for Download to complete operation before performing the command. If Download is not running, run Download again, perform proper shutdown routine. Do not disconnect serial link to PC before exiting Download.
No Ext. Freq. Source	The External Frequency mode has been turned on but no external reference signal is detected.	Check cable to the eternal reference clock
Ext. Freq Not Locked	The External Frequency mode has been turned on, a signal is received, but the internal clock can't lock to it (in normal operation this will only be shown for a very short time when turning the mode on).	Check the frequency of the external reference clock, make sure it is exactly the frequency entered with the EXT command

Table 5.48: Receiver Warning Messages (continued)

Warning	Definition	Action
Back To Int. Freq.	The external Frequency mode was turned on, with request for automatic switch to internal clock, but for more than 25 sec, either no signal was received or we could not lock to it. So the receiver reverted to internal clock.	Check that the cable was not inadvertently disconnected, check that the frequency of the reference is stable.
† Indicates warning is permanent (the warning will NOT go away if the condition disappears, but only if it is acknowledged). ‡ Indicates error will only display if antenna is present.		

WKN: GPS Week Number

$PASHQ,WKN,c

This command queries the current GPS week number, where c is the optional output serial port.

Example: Query receiver for GPS week number

$PASHQ,WKN <Enter>

$PASHR,WKN

Returns current GPS week number, where the message is in the form:

$PASHR,WKN,d1*cc <Enter>

Table 5.49: WKN Message Structure

Parameter	Description
d1	current GPS week number

Raw Data Commands

The raw data commands cover all query and set commands related to measurement, ephemeris, and almanac data.

Set Commands

There is only one set command that controls the continuous output of all raw data messages; the $PASHS,OUT command. The $PASHS,OUT command allows you to enable or disable the output of one or more raw data messages simultaneously as well as change the format (ASCII or Binary) of the message types where the format is an option. The general format of the $PASHS,OUT command is:

$PASHS,OUT,c,str(,str...),s

where c is the output serial port (A-D), str is one or more 3 character strings that denote the different raw data output types, and s is the optional format of the message and is either ASC (ASCII) or BIN (binary). For example, the command:

$PASHS,OUT,A,MBN,PBN,BIN <Enter>

will output MBEN and PBEN messages in binary format to serial port A. If the format field is not included, then the message will be sent in ASCII format which is the default. The ephemeris and almanac messages are available in binary format only. If a user attempts to output a raw data message type in ASCII format when only binary is available, the receiver will send the header only with no additional information or data. Also, be aware that a $PASHS,OUT command will override anything set in a previous $PASHS,OUT command.

If the $PASHS,OUT command is sent correctly, the receiver will respond with the $PASHR,ACK acknowledgment The messages will be output to the indicated serial port at the recording interval defined by the $PASHS,RCI command. The default output frequency is every 20 seconds.

Raw data messages are disabled by sending the $PASHS,OUT command with no data strings. For example the command:

$PASHS,OUT,A <Enter>

will disable the output of all raw data output from port A. See the $PASHS,OUT command in this section for more details. To see what raw data messages have been enabled, use the $PASHQ,RAW query.

In general, the parameters that affect raw data output are the same as those that control data recording, including: recording interval, elevation mask, and minimum number of SVs.   See the Raw Data Command table for more details about the commands that control these parameters.

Query Commands

The query commands will output a single raw data message type once. The general format of the query commands is:

$PASHQ,s,c

where s is the 3 character string that denotes the raw data message type, and c is the serial port to which the message will be output. The serial port field is optional. If the query is sent with the port field left empty, then the response will be sent to the current port. If the port field contains a valid port (A-D), then the response will be output to that port. For example, the query:

$PASHQ,PBN <Enter>

will output a single PBEN message to the current port. The command:

$PASHQ,MBN,C <Enter>

will output a single set of MBEN message to port C. It is not possible to change the format (ASCII or Binary) of the response with a query command. If the format of the port is ASCII, the response will be in ASCII, unless the ASCII format is not available for that message type. In this case, the receiver will send only the header of the raw data message.

There are no ACK command acknowledgments for queries. If the query has been enter properly, and the data is available (for example, MBEN is not available unless the receiver is tracking enough satellites above the elevation mask), then the acknowledgment will be the data response message.

Table 5.50 lists the available raw data available, the associated 3 character string used in the commands, and the format that is available for each data type.

Table 5.50: Raw Data Types and Formats

Raw Data Type	3-Character String	Description	Format Available
MBEN	MBN	measurement data	ASCII / Binary
PBEN	PBN	position data	ASCII / Binary
SNAV	SNV	ephemeris data	Binary only
SALM	SAL	almanac data	Binary only
EPB	EPB	raw ephemeris	Binary only
DBEN	DBN	CPD carrier phase	Binary only

Table 5.51 lists all the raw data commands. A complete description of each command can be found following the table.

Table 5.51: Raw Data Commands

Function	Command	Description	Page
Almanac data	$PASHQ,SAL	almanac query	114
Ephemeris data	$PASHQ,SNV $PASHQ,EPB	SNAV query raw ephemeris data query	115 104
Measurement data	$PASHQ,DBN $PASHQ,MBN	DBEN query MBEN query	101 105
Position data	$PASHQ,PBN	PBEN query	110
Raw Data Output	$PASHS,OUT	Enable/disable raw data output	110
Raw data parameters	$PASHQ,RAW $PASHS,SIT $PASHS,ELM $PASHS,RCI $PASHS,MSV	Query raw data parameters Set site name Set Elevation mask Set Recording Interval Set Minimum # of SVs	112 88 57 80 73

DBN: DBEN Message

$PASHQ,DBN,x

Query DBEN message for one epoch where x is the optional output port.

Example: $PASHQ,DBN <Enter>

$PASHR,RPC

DBEN is a packed message which contains one epoch of GPS pseudo-range and carrier phase measurements. It is an essential message that can be used for CPD operation.

This message only exists in binary format. If ASCII format is requested (default) only the header will be sent ($PASHR,RPC)

Structure:

$PASHR,RPC,<data length><packed data><ChkSum>

Table 5.52: RPC Message Structure

Parameter	Type	Number of bytes	Description
data length	unsigned short	2	Number of bytes in <packed data> part
packed data	unsigned char[]	data length	See below
ChkSum	unsigned short	2	Cumulative unsigned short summation of the <packed data>, after <data length> before <ChkSum>

<packed data> parameter:

Table 5.53: RPC Packed Parameter Descriptions

Data Type	Symbol	Range	Resolution	Compress Num. Bits	Description
double	rcvtime	0 - 604800000	1 msec	30	Receiver time in GPS milliseconds of week
char[4]	site ID			32	Receiver's four character's site ID
long	PRN			32	SVPRN for the satellites which have data in this message. It is a bitwise indication. Starting from least significant bit, bit 1 corresponds toSVPRN #1, bit 2 corresponds to SVPRN #2, and so on. Bit value of 1 means that SVPRN has data in this message, 0 otherwise.
For each satellite whose corresponding bit in PRN is '1, the following data will be repeated, i.e., sent once for PL1 data and a second time for PL2 data.					
double	PL1 or PL2		1.0e-10 seconds	31	Pseudorange in units of 1.0e-10 seconds (or 0.1 nanoseconds). Multiply this value by 1.0e-10 to get pseudo-range in seconds. A zero value indicates bad pseudo-range

Table 5.53: RPC Packed Parameter Descriptions (continued)

Data Type	Symbol	Range	Resolution	Compress Num. Bits	Description
char	WN			1	Warning bit 1- bad carrier phase and has possible cycle-slips 0 - good carrier phase
	Sign		1	1	Carrier phase sign bit 1 - negative carrier phase value 0 - positive carrier phase value
long	PH_I		1	28	Integer part of the carrier phase measurement in cycles
double	PH_F		15.0e-4	11	Fractional part of the carrier phase measurement in units of 5e-4 cycles. Multiply this number by 5e-4 to get fractional carrier phase in cycles. Whole carrier phase measurement = PH_I + PH_F*5.0e-4

Zeros will be padded so that all of <packed data> part will be a module of 16 bits. Total number of bits in <packed data>: ceil ((94 + 72*2*Nsvs)/16) * 16 and <data length> = ceil ((94 + 72*2*Nsvs)/16) * 2 in which, ceil (a) means truncates to +Inf, e.g., ceil (3.1) = 4, ceil (3.5) = 4, ceil (3.95) = 4. Nsvs is number of SVs.

DBEN message size:

Table 5.54: DBEN Message Sizes

Num of SVs	Bits	Bytes
4	808	101
5	952	119
6	1096	137
7	1240	155
8	1384	173
9	1528	191
10	1672	209
11	1816	227
12	1960	240

EPB: Raw Ephemeris

$PASHQ,EPB,d

Query for raw ephemeris data output, where d is the PRN number. If no PRN number is specified, data for all available SVs will be output.

Example: Query for raw ephemeris for all available satellites.

$PASHQ,EPB <Enter>

Query ephemeris data for PRN 25.

$PASHQ,EPB,25 <ENTER>

$PASHR,EPB

The response is the broadcast ephemeris data. See the ICD-GPS-200 for definition of the Parameters. Each subframe word is right-justified in a 32-bit long integer.

The response is in the form:

$PASHR,EPB,d,<ephemeris structure> <Enter>

This message only exists in a binary format, if ASCII format is requested (default) only the header will be sent ($PASHR,EPB).

Table 5.55 outlines the response format.

Table 5.55: EPB Response Format

Type	Size	Contents
d	2	PRN number
struct		
long	4	Subframe 1, word 1
long	4	Subframe 1, word 2
long	4	Subframe 1, word 3
long	4	Subframe 1, word 4
long	4	Subframe 1, word 5
long	4	Subframe 1, word 6
long	4	Subframe 1, word 7
long	4	Subframe 1, word 8
long	4	Subframe 1, word 9
long	4	Subframe 1, word 10

Table 5.55: EPB Response Format (continued)

Type	Size	Contents
long	4	Subframe 2, word 1
long	4	Subframe 2, word 2
long	4	Subframe 2, word 3
long	4	Subframe 2, word 4
long	4	Subframe 2, word 5
long	4	Subframe 2, word 6
long	4	Subframe 2, word 7
long	4	Subframe 2, word 8
long	4	Subframe 2, word 9
long	4	Subframe 2, word 10
long	4	Subframe 3, word 1
long	4	Subframe 3, word 2
long	4	Subframe 3, word 3
long	4	Subframe 3, word 4
long	4	Subframe 3, word 5
long	4	Subframe 3, word 6
long	4	Subframe 3, word 7
long	4	Subframe 3, word 8
long	4	Subframe 3, word 9
long	4	Subframe 3, word 10
short	2	Word checksum begin with header ‘P’.
total =	122	struct size

MBN: MBN Message

$PASHQ,MBN,c

Requests one epoch of MBN data, where c is the optional output port.

Example: Query MBN message to the current port.

$PASHQ,MBN <Enter>

$PASHR,MPC

The response can be in either ASCII or binary format. There will be a return message for each tracked satellite above the elevation mask.

The MBN response message in binary format is in the form:

$PASHR,MPC,<structure> <Enter>

Where Table 5.56 outlines the measurement structure. The checksum is computed after the MPC header, and includes the last comma.

Table 5.56: MPC Measurement Structure (Binary Format)

Type	Size	Contents
unsigned short	2	sequence tag (unit: 50 ms) modulo 30 minutes
unsigned char	1	number of remaining struct to be sent for current epoch.
unsigned char	1	satellite PRN number.
unsigned char	1	satellite elevation angle (degree).
unsigned char	1	satellite azimuth angle (two degree increments).
unsigned char	1	channel ID (1 - 12).
		C/A code data block 29 bytes
unsigned char	1	Warning flag
unsigned char	1	Indicates quality of the position measurement. (good/bad)
char	1	(set to 5 for backward compatibility)
unsigned char	1	Signal to noise of satellite observation (db.Hz)
unsigned char	1	Spare
double	8	Full carrier phase measurements in cycles.
double	8	Raw range to SV (in seconds), i.e., receive time - raw range = transmit time
long	4	Doppler (10^{-4} Hz).
long	4	bits: 0 - 23 Smooth correction (bit 0-22 = magnitude of correction in cms, bit 23 = sign) bits:24-31 Smooth count, unsigned. as follows: 0 = unsmoothed, 1=least smoothed, 200 = most smoothed
	(29)	**P code on L1 block**, same format as C/A code data block

Table 5.56: MPC Measurement Structure (Binary Format) (continued)

Type	Size	Contents
	(29)	**P code on L2 block**, same format as the C/A code data block.
unsigned char	1	Checksum, a bytewise exclusive OR (XOR)
total bytes	95	

For details on warning flag and good/bad flag, see ***MBN data struct in ASCII.***

The MBN response message in ASCII is in the form:

$PASHR,MPC,d1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,f12,f13,f14,f15,
d16,d17,d18,d19,d20,d21,f22,f23,f24,f25,d26,d27,d28,d29,d30,
d31,f32,f33,f34,f35,d36,ccc <Enter>

Table 5.57 provides details on the individual Parameters:

Table 5.57: MPC Message Structure (ASCII Format)

Parameter	Significance	Units	Range
d1	Sequence tag. This is the time tag used to associate all structures with one epoch. It is in units of 50 ms and modulo 30 minutes.	50 ms	0-36000
d2	Number of remaining structures		0-11
d3	SV PRN number		1-32
d4	Satellite elevation	degrees	0-90
d5	Satellite azimuth	degrees	0-360
d6	Channel index		1-12
C/A Code Data Block			
d7	Warning flag (see Table 5.58)		0-255
d8	Good/bad flag (see Table 5.59)		22-24
d9	5 for backwards compatibility		5
d10	signal to noise indicator	dB Hz	30-60
d11	spare		0
f12	Full carrier phase	cycles	±999999999.9
f13	Code transmit time	ms	0-999999999.9

Table 5.57: MPC Message Structure (ASCII Format) (continued)

Parameter	Significance	Units	Range
f14	Doppler measurement	10 (-4) Hz	±99999.99999
f15	Range smoothing correction. Raw range minus smoothed range.	meters	0-99.99
d16	Range smoothing quality		0-200
PL1 Code Data Block			
d17	Warning flag (see Table 5.58)		0-255
d18	Good/bad flag (see Table 5.59)		22-24
d19	5 for backward compatibility		5
d20	Signal to noise indicator	dB Hz	30-60
d21	spare		
f22	Full carrier phase	cycles	0-999999999.999
f23	Code transmit time	ms	0-99.9999999
f24	Doppler measurement	10 (-4) Hz	±99999.99999
f25	Range smoothing correction. Raw range minus smoothed range	meters	0-99.99
d26	Range smoothing quality		0-200
PL2 Code Data Block			
d27	Warning flag (seeTable 5.58)		0-255
d28	Good/bad flag (see Table 5.59)		22-24
d29	5 for backward compatibility		5
d30	Signal to noise indicator	dB Hz	30-60
d31	spare		
f32	Full carrier phase	cycles	0-999999999.999
f33	Code transmit time	ms	0-99.9999999
f34	Doppler measurement	10 (-4) Hz	±99999.99999
f35	Range smoothing correction. Raw range minus smoothed range	meters	0-99.99

Table 5.57: MPC Message Structure (ASCII Format) (continued)

Parameter	Significance	Units	Range
d36	Range smoothing quality		0-200
cc	Checksum Displayed in decimal. A bytwise exlusive OR (XOR) on all bytes from the sequence tag to the checksum (starts after MPC, and includes the last comma before the checksum).		

Table 5.58: Warning Flag Settings

Bits Index		Description of Parameter d_7
1	2	Combination of bit 1 and bit 2
0 0 1	0 1 0	same as 22 in good/bad flag same as 24 in good/bad flag same as 23 in good/bad flag
3		carrier phase questionable
4		code phase (range) questionable
5		range not precise (code phase loop not settled)
6		Z tracking mode
7		possible cycle slip
8		loss of lock since last epoch

Table 5.59: Measurement Quality (Good/Bad Flag)

Value of d_8	Description
0	Measurement not available and no additional data will be sent
22	Code and/or carrier phase measured
23	Code and/or carrier phase measured, and navigation message was obtained but measurement was not used to compute position
24	Code and/or carrier phase measured, navigation message was obtained, and measurement was used to compute position

Only C/A is used for position computation, so this flag will never be more than 22 on Pcode measurements.

OUT: Enable/Disable Raw Data Output

$PASHS,OUT,c1,(s2,s3,...)s4

The OUT command enables and disables continuous raw data output. The serial port c is mandatory, but the raw data type string and the format are optional. If the command is sent without a format field, the data will be output in the format of current setting of the port, if that format is available for that data type. Sending a $PASHS,OUT command will override any previously sent $PASHS,OUT commands.

To disable raw data output, send the $PASHS,OUT, command without any data format strings.

Table 5.60: OUT Message Structure

Parameter	Description	Range
c1	Serial port	A- D
s2, s3	Raw data type string, may have one or more delimited by commas	MBN, PBN, SNV, DBN, EPB, SAL
f4	ASCII or binary format	ASC or BIN

Examples: Enable MBN, PBN, and SNV message in binary format on port C:

$PASHS,OUT,C,MBN,PBN,SNV,BIN <Enter>

Disable all raw data messages on port A:

$PASHS,OUT,A <Enter>

PBN: Position Data

$PASHQ,PBN,c

Request PBEN data for one epoch, where c is the output port and is not required to direct the response message to the current communication port.

Example: Request PBN message to the current port:

$PASHQ,PBN <Enter>

$PASHR,PBN

The response message may be in either ASCII or binary format. Position data in ASCII format is in the form:

$PASHR,PBN,f1,f2,f3,f4,m5,m6,f7,f8,f9,f10,d11,s12,d13,d14,d15,d16 *cc <Enter>

Table 5.61: PBN Message Structure (ASCII Format)

Parameter	Description	Range
f1	Receiver time with seconds of the week when code is received	0 - 604800.00
f2	Station position: ECEF-X (meters)	±9999999.9
f3	Station position: ECEF-Y (meters)	±9999999.9
f4	Station position: ECEF-Z (meters)	±9999999.9
m5	Latitude in degrees and decimal minutes (ddmm.mmmmmm) Positive north.	±90
m6	Longitude in degrees and decimal minutes (dddmm.mmmmmm) Positive east.	±180
f7	Altitude (meters)	-1000.000 to 18000.000
f8	Velocity in ECEF-X (m/sec).	500.00
f9	Velocity in ECEF-Y (m/sec).	500.00
f10	Velocity in ECEF-Z (m/sec).	500.00
d11	Number of satellites used for position computation.	3 -12
s12	Site name	4 char string
d13	PDOP	0 - 99
d14	HDOP	0 - 99
d15	VDOP	0 - 99
d16	TDOP	0 - 99
*cc	Checksum	

The response message in the binary format is in the form:

$PASHR,PBN,<PBN structure> <Enter>

Table 5.62 describes the binary structure of the PBEN message.

Table 5.62: PBN Message Structure (Binary Format)

Parameter	Bytes	Significance	Units
long pbentime	4	GPS time when data was received.	10^{-3} seconds of week
char sitename	4	Site name	4 character
double navx	8	Station position: ECEF-X	meters
double navy	8	Station position: ECEF-Y	meters
double navz	8	Station position: ECEF-Z	meters
float navt	4	Clock offset	meters
float navxdot	4	Velocity in ECEF-X	m/sec
float navydot	4	Velocity in ECEF-Y	m/sec
float navzdot	4	Velocity in ECEF-Z	m/sec
float navtdot	4	Clock drift	m/sec
unsigned short pdop	2	PDOP	
unsigned short chksum	2	Checksum	
Total bytes	56		

RAW: Query Raw Data Parameter

$PASHQ,RAW

This query will display the settings of all parameters related to raw data.

Example: $PASHQ,RAW <Enter>

Some parameters shown in this message are not supported as “user-selectable parameters”. These are denoted as “Fixed Parameters” in Table 5.63.

Return Message:

RCI:020.0 MSV:03 ELM:10 REC:Y MST:0

ANH:00.0000 ANA:00.0000 SIT:???? EPG:000 RNG:0

RAW: MBN PBN CBN SNV EPB SAL DBN FORMAT BAUD

PRTA: OFF OFF OFF OFF OFF OFF OFF ASCII 5

PRTB: OFF OFF OFF OFF OFF OFF OFF ASCII 5

PRTC: OFF OFF OFF OFF OFF OFF OFF ASCII 5

PRTD: OFF OFF OFF OFF OFF OFF OFF ASCII 5

Table 5.63: RAW Message Structure

Return Parameter	Description	Range	Unit	Default
RCI	Recording interval	0.1 - 999	secon d	20.0
MSV	Minimum number of SVS for the data to be sent or recorded	1 - 9		3
ELM	Data elevation mask. The elevation below which measurement data from that satellite will not be output or recorded.	0 - 90	degree	10
REC	Data recording to memory card	'Y' = Yes 'N' = No (does not close file) 'E' = Error (recording is Y but can't write to PC card at this point) 'S' = Stop recording (closes file) 'F' = Bad FAT 'D' = Download in progress		Y
MST	Fixed Parameter	0	N/A	0
ANH	Antenna height	0.0000 to 64.0000	meter	0.0
ANA	Fixed Parameter	0.0000	meter	0.0000
SIT	Site id	(4 character alphanumeric)	n/a	????
EPG	Fixed Parameter	000		000
RNG	Data mode which controls what data type is stored 0 = B-files 2 = C-files 4 = B and C files	0, 2, 4		0

Table 5.63: RAW Message Structure (continued)

Return Parameter	Description	Range	Unit	Default
RAW	Raw data type	MBN, PBN, SNV, EPB, SAL, DBN	-	-
PRTA/ PRTB/ PRTC/ PRTD	Serial port	'ON', 'OFF'		OFF
BAUD	Baud Rate index at each port	0-9 (see Table 5.32)		5
Format	Format setting of each port	ASCII, Binary		ASCII

CBN format is not supported in this firmware.

SAL: Almanac Data

$PASHQ,SAL,c

Request for almanac data in Ashtech format, where c is the optional serial port.

Example: Query receiver for almanac data on current port.

$PASHQ,SAL <Enter>

$PASHR,ALM

The response is a binary message in the form:.

$PASHR,ALM,(almanac structure) <Enter>

This message only exists in binary format. If ASCII format is requested (default), only the header will be sent ($PASHR, ALM).

The almanac structure is defined in Table 5.64.

Table 5.64: ALM Message Structure

Type	Size	Contents
short	2	(Satellite PRN -1)
short	2	Health. see ICD-200 for description
float	4	e. Eccentricity
long	4	toe. Reference time for orbit (sec)
float	4	I0. Inclination angle at reference time (semi-circles).

Table 5.64: ALM Message Structure (continued)

Type	Size	Contents
float	4	OMEGADOT. Rate of right Asc. (semi-circles per sec).
double	8	(A)1/2. Square root of semi-major axis (meters 1/2).
double	8	(OMEGA)0. Lon of Asc. node (semi-circles).
double	8	ω. Argument of Perigee (semi-circles)
double	8	M0. Mean anomaly at reference time (semi-circle).
float	4	af0. sec
float	4	af1. sec/sec.
short	2	almanac week number
short	2	GPS week number
long	4	Seconds of GPS week
unsigned short	2	Word checksum
Total bytes	70	

SNV: Ephemeris Data

$PASHQ,SNV,c

Request ephemeris data from receiver, where c is either the optional output serial or the specific PRN number. If either the port is specified, or if this field is left blank, the ephemeris structures for all available SVs will be output.

Example: Send out SNAV data for all available SVs to the current port.

$PASHQ,SNV <Enter>

Send out SNAV data for PRN 10

$PASHQ,SNV,10 <Enter>

$PASHR,SNV

The response is in the form:

$PASHR,SNV,<ephemeris structure> <Enter>

This message only exists in binary format. If ASCII format is requested (default), only the header will be sent ($PASHR,SNV).

Table 5.65 describes the binary structure of the SNAV message.

Table 5.65: SNV Message Structure

Type	Size	Contents
short	2	Wn. GPS week number
long	4	Seconds of GPS week
float	4	Tgd. Group delay (sec)
long	4	Iodc. Clock data issue
long	4	toc. second
float	4	af2. sec/sec2
float	4	af1. sec/sec
float	4	af0. sec
long	4	IODE Orbit data issue
float	4	Δn. Mean anomaly correction (semi-circle/sec)
double	8	M0. Mean anomaly at reference time (semi-circle).
double	8	e. Eccentricity
double	8	(A)1/2. Square root of semi-major axis (meters 1/ 2).
long	4	toe. Reference time for orbit (sec).
float	4	Cic. Harmonic correction term (radians).
float	4	Crc. Harmonic correction term (meters).
float	4	Cis. Harmonic correction term (radians).
float	4	Crs. Harmonic correction term (meters).
float	4	Cuc. Harmonic correction term (radians).
float	4	Cus. Harmonic correction term (radians).
double	8	(OMEGA)0. Lon of Asc. node (semi-circles).
double	8	ω. Argument of Perigee (semi-circles)
double	8	I0. Inclination angle at reference time (semi-circles).
float	4	OMEGADOT. Rate of right Asc. (semi-circles per sec).

Table 5.65: SNV Message Structure (continued)

Type	Size	Contents
float	4	IDOT. Rate of inclination (semi-circles per sec).
short	2	Accuracy
short	2	Health
short	2	Curve fit interval (coded).
char	1	(SV PRN number -1)
char	1	Reserved byte.
unsigned short	2	Word checksum
Total =	132 bytes	

NMEA Message Commands

The NMEA message commands control all query and set commands related to NMEA format messages and miscellaneous messages in a NMEA-style format. All standard NMEA message are a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards version 2.1. All non-standard messages are a string of ASCII characters delimited by commas in the Ashtech proprietary format. Any combination of these messages can be output through different ports at the same time. The output rate is determined by the $PASHS,NME,PER command and can be set to any value between 0.1 and 999 seconds.

For each NMEA message type there is a set command, a query command and a response message. The set command is used to continuously output the NMEA response message at the period defined by the $PASHS,NME,PER command. The query outputs a NMEA response message only once.

Set Commands

The general structure of the NMEA set commands is:

$PASHS,NME,str,c,s <Enter>

where c is the serial port to which response message should be sent (A, B, C or D), and s is either ON or OFF. ON will enable the message and OFF will disable the message. The str is a 3-character string that depicts the NMEA message to be output. The available strings are:

ALM, DAL, GGA, GLL, GRS, GSA, GSV, MSG, POS, PTT, SAT, XDR and ZDA

When a set command is sent correctly, the receiver will send a $PASHR,ACK (command acknowledge) message. If the command is sent incorrectly or the syntax is wrong, the receiver will send a $PASHS,NAK (command not acknowledged) message. Once acknowledged, the receiver will output the corresponding NMEA data message at the interval defined by the $PASHS,NME,PER command, unless a necessary condition for the message to be output is not present.

To disable all set NMEA message, use the $PASHS,NME,ALL command.

To see what NMEA messages have been enabled, use the $PASHQ,PAR command.

Example: Enable GGA message on port A

$PASHS,NME,GGA,A,ON <Enter>

Output enabled NMEA messages every 5 seconds

$PASHS,NME,PER,5 <Enter>

Query Commands

The general structure of the NMEA query commands is:

$PASHQ,s,c <Enter>

where s is one of the 3-character NMEA strings and c is the serial port to which response message should be sent (A, B, C or D). The serial port field is optional. If a port is not included, the receiver will send the response to the current port. Unlike the set commands, the query command will initiate a single response message.

Example: Query POS message and send the response to port D

$PASHQ,POS,D <Enter>

Query GSA message and send the response to the current port.

$PASHQ,GSA <Enter>

Table 5.66 lists the NMEA data message commands. Only the set command for each NMEA message type is listed in the table, as the description for the set, query, and response message for each NMEA message are grouped together.

A detailed description of each NMEA command will follow Table 5.66.

Table 5.66: NMEA Data Message Commands

Function	Command	Description	Page
Check NMEA Output Settings	$PASHQ,PAR	Query receiver parameters	74
Differential information	$PASHS,NME,MSG	Enable/disable base station messages	133
Disable Output	$PASHS,NME,ALL	Disable all messages	120
External Sensors	$PASHS, NME,XDR	Enable/disable external sensor information	145
Output rate parameter	$PASHS,NME,PER	Set output interval of NMEA response messages	139
PPS	$PASHS,NME,PTT	Enable/disable PPS pulse time tag message	141
Position information	$PASHS,NME,GGA $PASHS,NME,GLL $PASHS,NME,POS	Enable/disable GPS position response message Enable/disable lat/lon message Enable/disable position computation with time of fix	124 124 126
Residual information	$PASHS,NME,GRS	Enable/disable satellite range residual information	128

Table 5.66: NMEA Data Message Commands (continued)

Function	Command	Description	Page
Satellite information	$PASHS,NME,ALM $PASHS,NME,DAL $PASHS,NME,GSA $PASHS,NME,GSV $PASHS,NME,SAT	Enable/disable almanac data Enable/disable decimal almanac data Enable/disable SVs used message Enable/disable satellites in view message Enable/disable satellite status message	120 122 130 131 142
Time Synch	$PASHS,NME,ZDA	Enable/disable time synchronization message	147

ALL: Disable All NMEA Messages

$PASHS,NME,ALL,c,OFF

Turn off all enabled NMEA messages, where c is the specified serial port.

Example: Turn off all NMEA message currently sent out through port B

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

ALM: Almanac Message

$PASHS,NME,ALM,c,s

Enable/disable the almanac message where c is the receiver serial port and s is ON or OFF.

Example: Enable ALM message on port C

$PASHS,NME,ALM,C,ON <Enter>

$PASHQ,ALM,c

Query the almanac message, where c is the optional output port.

Example: Query almanac data message to receiver port D

$PASHQ,ALM,D <Enter>

$GPALM

There will be one response message for each satellite in the GPS constellation. The 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 <Enter>

Table 5.67: ALM Response Message

Parameter	Description	Range
d1	Total number of messages	01 -32
d2	Number of this message	01 -32
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	

Example:

Query: $PASHQ,ALM <Enter>

Response:

$GPALM,26,01,01,0899,00,1E8C,24,080B,FD49,A10D58,EB4562,BFEF85,227A5B,011,000*0B <Enter>

Table 5.68: 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
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

DAL: DAL Format Almanac Message

$PASHS,NME,DAL,c,s

This message displays the NMEA almanac message in decimal format, where c is the port and s is ON or OFF.

Example: Enable DAL message on port A:

$PASHS,NME,DAL,A,ON <Enter>

$PASHQ,DAL,c

Query almanac where c is the optional output serial port or specific SV almanac desired:

Example: $PASHQ,DAL <Enter>

$PASHR,DAL

There will be one response message for each satellite in the GPS constellation unless a specific SV is designated. The response message is in the form:

$GPDAL,d1,d2,f3,d4,f5,f6,f7,f8,f9,f10,f11,f12,d13*cc <Enter>

Table 5.69: DAL Message Structure

Parameters	Description	Range
d1	Satellite PRN number	1 - 32
d2	Satellite health	0 - 255
f3	e. Eccentricity	±9.9999999E±99
d4	toe, reference time for orbit (in seconds)	0 - 999999
f5	i0, inclination angle at reference time (semicircles)	0 - 9.9999999E±99
f6	omegadot, the rate of right ascension (semicircles/sec)	±9.9999999E±99
f7	roota, the square root of semi-major axis (meters 1/2)	0 - 9.9999999E±99
f8	omega0, the longitude of the ascension node (semicircle)	±9.9999999E±99
f9	ω, the argument of perigee (semicircle)	±9.9999999E±99
f10	M0, the mean anomaly at reference time (semicircle)	±9.9999999E±99
f11	af0, clock parameter (in seconds)	±9.9999999E±99
f12	af1, clock parameter (sec/sec)	0 - 9.9999999E±99
d13	wn, GPS almanac week number	4 digits
*cc	checksum in hex	hex

Example:

Query: $PASHQ,DAL,1 <Enter>

Response:

$PASHR,DAL,01,00,3.7240982E03,061440,3.0392534E-01,-2.5465852E-09,5.1536646E03,1.6172159E-01,-5.0029719E-01,2.7568674E-01,1.6212463E-05,0.0000000E00,0899*51 <Enter>

Table 5.70: Typical DAL Message

Item	Significance
$PASHR,DAL	Header
01	Satellite PRN Number
00	Satellite Health
3.7240982E03	Eccentricity
061440	Reference Time for orbit
3.0392534E-01	Inclination angle
-2.5465852E-09	Rate of right ascension
5.1536646E03	Square root of semi-major axis
-1.6172159E-01	Argument of perigree
-5.0029719E-01	Longitude of ascension mode
2.7568674E-01	Mean anomaly
1.6212463E-05	Clock Parameter
0.0000000E00	Clock Parameter
0899	GPS week number
*51	checksum

GGA: GPS Position Message

$PASHS,NME,GGA,c,s

This command enables/disables the GPS position message on port c, where c is either A, B, C, or D and s is ON or OFF. If no position is computed, the message will be output but the position related fields will be empty.

Example: Enable GGA on port A:

$PASHS,NME,GGA,A,ON <Enter>

$PASHQ,GGA,c

Query the GPS position message where c is the receiver port where the message will be output. If no position is computed, the message will be output but the position related fields will be empty.

Example: $PASHQ,GGA <Enter>

$GPGGA

The response message is in the form:

$GPGGA,m1,m2,c3,m4,c5,d6,d7,f8,f9,M,f10,M,f11,d12*cc <Enter>

Table 5.71: GGA Message Structure

Parameter	Description	Range
m1	Current UTC time of position fix in hours, minutes, and seconds (hhmmss.ss)	00-235959.90
m2	Latitude component of position in degrees and decimal minutes (ddmm.mmmmmm)	0-90
c3	Direction of latitude N= North, S= South	N/S
m4	Longitudinal component of position in degrees and decimal minutes (dddmm.mmmmmm)	0-180
c5	Direction of longitude E = East, W= West	E/W
d6	Position type 0. Position not available or invalid 1. Autonomous position	0, 1
d7	Number of GPS satellites being used in the position computation	3 - 12
f8	Horizontal dilution of precision (HDOP)	0 - 99.9
f9	Geoidal Height (Altitude above mean sea level)	-1000.000 to 18000.000
M	Altitude units M = meters	‘M’
f10	Geoidal separation in meters	±999.999
M	Geoidal separation units M = meters	‘M’
f11	Age of differential corrections (seconds)	0
d12	Base station ID (RTCM only)	0-1023
*cc	checksum	

Example: Query: $PASHQ,GGA <Enter>

Response:

$GPGGA,015454.00,3723.285132,N,12202.238512,W,2,04,03.8,00012.123,M,-032.121,M,014,0000*75 <Enter>

Table 5.72: Typical GGA Message

Item	Significance
$GPGGA	Header
015454.00	UTC time
3723.285132	Latitude (ddmm.mmmmmm)
N	North Latitude
12202.238512	Longitude (dddmm.mmmmmm)
W	West longitude
2	RTCM differential position
04	Number of satellites used in position
03.8	HDOP
00012.123	Geoided height (altitude above mean-sea-level)
M	Units of altitude (M = meters)
-032.121	Geoidal separation
M	Units of geoidal separation (M=meters)
014	Age of correction
0000	Base station ID
*75	checksum

GLL: Latitude/Longitude Message

$PASHS,NME,GLL,c,s

This command enables/disables the latitude/longitude response message, where c is port A, B, C, or D, and s is ON or OFF. If no position is computed, the message will be output with the position related fields empty.

Example: Enable GLL message on port A

$PASHS,NME,GLL,A,ON <Enter>

$PASHQ,GLL,c

Query where c is the optional output serial port.

Example: $PASHQ,GLL <Enter>

$GPGLL

The response message is in the form:

$GPGLL,m1,c2,m3,c4,m5,c6*cc <Enter>

Table 5.73: GLL Message Structure

Parameters	Description	Range
m1	Position latitude in degrees and decimal minutes (ddmm.mmmmmm)	0 - 90°
c2	Direction of latitude N = North, S = South	N/S
m3	Position longitude in degrees and decimal minutes (dddmm.mmmmmm)	0 - 180°
c4	Direction of longitude W = West, E = East	W/E
m5	UTC Time of position in hours, minutes, and seconds (hhmmss.ss)	00-235959.90
c6	Status, A: valid, V: invalid	A/V
*cc	Checksum	

Example: Query: $PASHQ,GLL <Enter>

Response:

$GPGLL,3722.414292,N,12159.852825,W,202556.00,A*12 <Enter>

Table 5.74 describes each item in a typical GLL message.

Table 5.74: Typical GLL Message

Item	Significance
$GPGLL	Header
3722.414292	Latitude
N	North Latitude
12159.852825	Longitude
W	West Longitude
202556.00	UTC time of position

Table 5.74: Typical GLL Message (continued)

Item	Significance
A	Status valid
*12	checksum

GRS: Satellite Range Residuals

$PASHS,NME,GRS,c,s

This command enables/disables the NMEA satellite range residual response message to port c, where c is A, B, C, or D, and s is ON or OFF. If only four SVs are used in the position solution, residuals are not computed and GRS outputs zeroes in the residual fields. With 3 or less SVs, the message is not output.

Example: Enable GRS message on port C

$PASHS,NME,GRS,C,ON <Enter>

$PASHQ,GRS,c

Query satellite range residual where c is the optional output serial port. The message is not output unless position is being computed.

Example: $PASHQ,GRS <Enter>

$GPGRS

The response message is in the form:

$GPGRS,m1,d2,n(f3)*cc <Enter>

Where n is equal to the number of satellites used in the position solution.

Table 5.75: GRS Message Structure

Parameter	Description	Range
m1	Current UTC time of GGA position in hours, minutes and seconds (hhmmss.ss)	00-235959.90
d2	Mode used to compute range residuals 0: Residuals were used to calculate the position given in the matching GGA line 1: Residuals were re-computed after the GGA position was computed or post-fit residuals	0, 1

Table 5.75: GRS Message Structure (continued)

Parameter	Description	Range
f3	Range residuals for satellite used in position computation. The order of the residuals matches the order of the satellites in the GSV message.	±999.999
*cc	checksum	

The range residuals are re-computed after the GGA position is computed, therefore the mode is always 1.

Example:

Query: $PASHQ,GRS <Enter>

Response:

$GPGRS,203227.50,1,-007.916,051.921,-048.804,-026.612,
-002.717,021.150*63 <Enter>

Table 5.76 describes each item in a typical GRS message.

Table 5.76: Typical GRS Message

Item	Significance
$GPGRS	Header
203227.50	UTC time of GGA position
1	Residuals computed after GGA position was computed
-007.916	Range residuals of the first satellite
051.921	Range residuals of the second satellite
-048.804	Range residuals of the third satellite
-026.612	Range residuals of the fourth satellite
-002.717	Range residuals of the fifth satellite
021.150	Range residuals of the sixth satellite
*63	checksum

GSA: DOP and Active Satellite Messages

$PASHS,NME,GSA,c,s

This command enables/disables the DOP and active satellite message to be sent out to serial port c, where c is port A, B, C, or D, and s is ON or OFF.

Example: Enable GSA message on port B:

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

$PASHQ,GSA,c

Query DOP and active satellites where c is the optional output serial port.

Example: Query GSA message to the current ports:

$PASHQ,GSA <Enter>

$GPGSA

The response message is in the form:

$GPGSA,c1,d1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,f1,
f2,f3*cc <Enter>

Table 5.77: GSA Message Structure

Parameter	Description	Range
c1	Mode: M: manual, A: automatic	'M' / 'A'
d1	Mode: 1: fix not available, 2: 2D, 3: 3D	1 -3
d2 - d13	Satellites used in solution (null for unused channel)	1 -32
f1	PDOP	0 - 9.9
f2	HDOP	0 - 9.9
f3	VDOP	0 - 9.9
*cc	Checksum	

Example:

Query: $PASHQ,GSA <Enter>

Response:

$GPGSA,M,3,,02,,04,27,26,07,,,,,09,3.2,1.4,2.9*39 <Enter>

Table 5.78: Typical GSA Message

Item	Significance
$GPGSA	Header
M	Manual mode
3	3D mode
empty field	Satellite in channel 1
02	Satellite in channel 2
empty field	Satellite in channel 3
04	Satellite in channel 4
27	Satellite in channel 5
26	Satellite in channel 6
07	Satellite in channel 7
empty field	Satellite in channel 8
empty field	Satellite in channel 9
empty field	Satellite in channel 10
empty field	Satellite in channel 11
09	Satellite in channel 12
3.2	PDOP
1.4	HDOP
2.9	VDOP
*38	checksum

GSV: Satellites in View Message

$PASHS,NME,GSV,c,s

This command enables/disables the satellites-in-view message to send out of serial port, where c is port A, B, C, or D, and s is ON or OFF.

Example: Output GSV message on port A:

$PASHS,NME,GSV,A,ON <Enter>

$PASHQ,GSV,c

Query satellites in view where c is the optional output serial port.

Example: Query the GSV message on port A:

$PASHQ,GSV,A <Enter>

$GPGSV

The response message is in the form:

$GPGSV,d1,d2,d3,n(d4,d5,d6,f7)*cc <Enter>

Where n is maximum 4. If more than 4 satellites are tracked, a second message is sent, then a 3rd if more than 8 SVs are tracked. Each item is described in Table 5.79.

Table 5.79: GSV Message Structure

Field	Description	Range
d1	Total number of messages	1-3
d2	Message number	1-3
d3	Total number of satellites in view	1-12
d4	Satellite PRN	1-32
d5	Elevation in degrees	0-90
d6	Azimuth in degrees	0-359
f7	SNR in DB-Hz	30.0-60.0
*cc	checksum	

Example:

Query: $PASHQ,GSV <Enter>

Response:

$GPGSV,2,1,08,16,23,293,50.3,19,63,050,52.1,28,11,038,51.5,
29,14,145,50.9*78 <Enter>

where each item is as described in Table 5.80.

Table 5.80: Typical GSV Message

Item	Significance
2	Total number of messages 1..3
1	Message number 1..3
8	Number of SVs in view 1..12
16	PRN of first satellite 1..32
23	Elevation of first satellite 0..90

Table 5.80: Typical GSV Message (continued)

Item	Significance
293	Azimuth of first satellite 0...359
50.3	Signal-to-noise of first satellite
19	PRN of second satellite
63	Elevation of second satellite
050	Azimuth of second satellite
52.1	Signal-to-noise of second satellite
28	PRN of third satellite
11	Elevation of third satellite
038	Azimuth of third satellite
51.5	Signal-to-noise of third satellite
29	PRN of fourth satellite
14	Elevation of fourth satellite
145	Azimuth of fourth satellite
50.9	Signal-to-noise of fourth satellite
*78	Message checksum in hexadecimal

MSG: Base Station Message

$PASHS,NME,MSG,c,s

This command enables/disables the message containing RTCM reference (base) station message types 1, 2, 3, 6, 9, 16, 18, 19, 20, 21, and 22 where c is the output port, A, B, C, or D, and s is ON or OFF.

Unless the unit is sending differential corrections, this command is ignored.

Example: Enable MSG on port A:

$PASHS,NME,MSG,A,ON <Enter>

$PASHQ,MSG,c

Query base station message where c is the optional output serial port. The message is not output unless differential corrections are being sent.

Example: $PASHQ,MSG,C <Enter>

$GPMSG

The response message will differ depending upon the RTCM message being used.

RTCM Message

Message type 1 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,f10,f11,d12)*cc <Enter>

Message type 2 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,f10,f11,d12)*cc <Enter>

Message type 3 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,f8,f9,f10*cc <Enter>

Message type 6 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7*cc <Enter>

Message type 9 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,f10,f11,d12)*cc <Enter>

Message type 16 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,s8*cc <Enter>

Message type 18 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,d10,d11,d12,d13,d14,d15)*cc <Enter>

Message type 19 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,d10,d11,d12,d13,d14,f15)*cc <Enter>

Message type 20 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,d10,d11,d12,d13,d14,d15)*cc <Enter>

Message type 21 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,n(d8,d9,d10,d11,d12,d13,d14,f15)*cc <Enter>

Message type 22 format:

$GPMSG,d1,d2,f3,d4,d5,d6,m7,f8,f9,f10*cc <Enter>

Common part of message 1, 2, 3, 6, 9, 16, 18, 19, 20, 21, and 22.

Table 5.81: Common Fields of Type 1, 2, 3, 6, 9, 16, 18, 19, 20, 21, and 22

Parameter	Description	Range
d1	RTCM message type	1,2,3,6,16,18, 19,20,21
d2	Station Identifier	0 - 1023
f3	Z count	0 - 9999.9
d4	Sequence number	0 - 9
d5	Station health	0 - 7
d6	Total number of characters after the time item (include the comma and <Enter>)	0 - 999
m7	Current GPS time of position fix (hhmmss.ss)	00-235959.90

Remaining message for type 1 and 9:

Table 5.82: Remainder of Type 1 Message

Parameter	Description	Range
d8	User differential range error (URDE)	0-9
d9	Satellite PRN number	1-32
f10	Pseudorange correction (PRC) in meters	±9999.99
f11	Range rate correction (RRC) in meters/sec	±9.999
d12	Issue of data ephemeris (IODE)	0-999
*cc	checksum	

Remaining message for type 2

Table 5.83: Remainder of Type 2 Message

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

Table 5.83: Remainder of Type 2 Message (continued)

Parameter	Description	Range
d12	Issue of data ephemeris (IODE)	0-999
*cc	checksum	

Remaining message for type 3

Table 5.84: Remainder of Type 3 Message

Parameter	Description	Range
f8	Station X component	±9999999.99
f9	Station Y component	±9999999.99
f10	Station Z component	±9999999.99
*cc	checksum	

Remaining message for type 16

Table 5.85: Remainder of Type 16 Message

Parameter	Description	Range
s8	Text message send from base receiver	Up to 80 alpha-numeric characters
*cc	checksum	

Remaining for Message type 18/20 (RTK carrier phase corrections)

size for type 18/20:

Total number of svs for L1 and L2 frequency +2*(10 byte freq+GNSS) + 3 byte chksum + 2 byte <Enter>

Table 5.86: Remainder of Type 18 and 20 Messages

Parameter	Description	Range
d8	L1 or L2 frequency	00...01
d9	GPS time of measurement	0..599999 [usec]
d10	Half/full L2 wavelength indicator	0 - full, 1 - half
d11	CA code /P code indicator	0 - CA, 1 -P
d12	SV PRN	1..32

Table 5.86: Remainder of Type 18 and 20 Messages (continued)

Parameter	Description	Range
d13	Data quality	0..7 refer to RTCM spec. for table of phase error
d14	Cumulative loss of continuity indicator	0..31
d15	Type 18 - carrier phase	+/- 8388608 full cycles with resolution of 1/256 full cycle +/- 16777216 half cycles with resolution of 1/128 half cycle
	Type 20 - carrier phase correction	+/- 32768 full wavelengths with resolution 1/256 full wavelength +/- 65536 half wavelengths with resolution of 1/128 half wavelength

Remaining message for type 19 (uncorrected pseudorange measurements) and 21 (RTK pseudorange correction).

size for type 19 /21:

Total number of svs for L1 and L2 frequency + 2*(13 byte Freq+sm+GNSS) + 3 byte chksum + 2 byte <Enter>

Table 5.87: Remainder of Type 19 and 21 Messages

Parameter	Description	Range
d8	L1 or L2 frequency	00...01
d9	Smoothing interval	00 - 0..1 min 01 - 1..5 min 10 - 5..15 min 11 - indefinite
d10	GPS time of measurement	0..599999 [usec]
d11	CA code /P code indicator	0 - CA, 1 -P
d12	SV PRN	1..32
d13	data quality	0..7 refer to RTCM spec. for table of pseudorange error

Table 5.87: Remainder of Type 19 and 21 Messages (continued)

Parameter	Description	Range
d14	Multipath error	0..15 refer to RTCM spec. for table of multipath error
f15	Type 19 - pseudorange Type 21 - pseudorange correction	0..85899345.90 meters +/-655.34 [0.02 meter] when pseudorange scale factor is 0 +/-10485.44 [0.32 meter] when pseudorange scale factor is 1 (default)

Examples:

$GPMSG,01,0000,2220.0,1,0,127,003702.00,2,12,-0081.30, 0.026,235,2,13,0022.86,0.006, 106,2,26,-0053.42,-0.070, 155,2,02,0003.56,+0.040,120,2,27,.0047.42,-0.004,145*cc <Enter>

$GPMSG,03,0000,1200.0,7,0,038,231958.00,-2691561.37,-4301271.02, 3851650.89*cc <Enter>

$GPMSG,16,0000,1209.6,5,0,036,23200.008,THIS IS A MESSAGE SENT FROM BASE*cc <Enter>

Table 5.88: Remainder of Type 22 Messages

Parameter	Description	Units
f8	L1 Delta station X component from RTCM 3 message	meters
f9	L1 Delta station Y component from RTCM 3 message	meters
f10	L1 Delta station Z component from RTCM 3 message	meters
f11	Antenna L1 phase center height	meters
f12	L2 Delta station X component from RTCM 3 message	meters
f13	L2 Delta station Y component from RTCM 3 message	meters
f14	L2 Delta station Z component from RTCM 3 message	meters

The L2 Delta components are hardcoded to 0.0 but included in message to assure future compatability.

PER: Set NMEA Send Interval

$PASHS,NME,PER,f

Set send interval of the NMEA response messages in seconds, where f is a value between 0.1 and 999. Values between 0.1 and 1 can be set at 0.1 second increments. Values between 1 and 999 can be set at 1 second intervals. Value 0.7 is not available.

Example: Output NMEA messages every 5 seconds:

$PASHS,NME,PER,5 <Enter>

If the fast data option (F) is installed, then PER can be set to 0.1 (10 Hz). If the fast data option is not installed, then PER can be set to 0.2 (5Hz) minimum.

POS: Position Message

$PASHS,NME,POS,c,s

Enable/disable NMEA position response message on port c where c is port A, B, C or D and s is ON or OFF. If no position is being computed, a message will still be output but the corresponding position fields will be empty.

Example: Enable position message on port B:

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

$PASHQ,POS,c

Query position message where c is the optional output serial port.

Example: Send POS message to current port:

$PASHQ,POS <Enter>

$PASHR,POS

The response message is in the form:

$PASHR,POS,d1,d2,m3,m4,c5,m6,c7,f8,f9,f10,f11,f12,f13,f14,f15,f16,
s17*cc <Enter>

Table 5.89: POS Message Structure

Parameter	Description	Range
d1	Raw/differential position 0: Raw; position is not differentially corrected	0
d2	Number of SVs used in position fix	3 -12
m3	Current UTC time of position fix (hhmmss.ss)	00-235959.90

Table 5.89: POS Message Structure (continued)

Parameter	Description	Range
m4	Latitude component of position in degrees and decimal minutes (ddmm.mmmmmm)	0 - 90
c5	Latitude sector, N = North, S = South	N/S
m6	Longitude component of position in degrees and decimal minutes (dddmm.mmmmmm)	0 - 180
c7	Longitude sector E = East, W = West	W/E
f8	Altitude above whatever datum has been selected in meters. For 2-D position computation this item contains the altitude held fixed.	-1000.000 to 18000.000
f9	reserved	
f10	True track/course over ground in degrees	0 - 359.9
f11	Speed over ground in knots	0 - 999.9
f12	Vertical velocity in decimeters per second	±999.9
f13	PDOP - position dilution of precision,	0 - 99.9
f14	HDOP - horizontal dilution of precision.	0 - 99.9
f15	VDOP - vertical dilution of precision.	0 - 99.9
f16	TDOP - time dilution of precision.	0 - 99.9
s17	Firmware version ID	4 char string
*cc	checksum	

Example:

Query: $PASHQ,POS <Enter>

Response:

$PASHR,POS,0,06,214619.50,3722.385158,N,12159.833768,W,00043.11 0,,331.0,000.7,000.0,02.7,01.2,02.4,01.6,UC00*6C <Enter>

Table 5.90 describes each item in a typical POS message.

Table 5.90: Typical POS Message

Item	Significance
$PASHR,POS	Header
0	Raw Position
06	Number of SVs used in position fix

Table 5.90: Typical POS Message (continued)

Item	Significance
214619.50	UTC time of position fix
3722.385158	Latitude
N	North Latitude
121159.833768	Longitude
W	West Longitude
00043.110	Altitude (meters)
empty field	reserved
331.0	Course over ground (degrees)
000.7	Speed over ground (knots)
000.0	Vertical velocity (dm/sec)
02.7	PDOP
01.2	HDOP
02.4	VDOP
01.6	TDOP
UC00	Firmware version ID
*6C	checksum

PTT: Pulse Time Tag Message

$PASHS,NME,PTT,c,s

Enable/disable output of PPS pulse time tag message, where c is the output port, and s is ON or OFF. The reponse message is output as soon as possible after the PPS pulse is generated (with minimum latency, < 50 ms if PPS offset is 0, otherwise < 150 ms), and contains the GPS time at which the latest PPS was sent, including the offset if an offset was set when the PPS pulse was enabled.

The period of the PTT message is independent of the NMEA period. It is only linked to the PPS period.

Example: Enable PTT message on port A:

$PASHS,NME,PTT,A,ON <Enter>

$PASHQ,PTT,c

Query the time tag of the next PPS pulse, where c is the optional output port. If c is not specified, the reply is sent to the port on which the query was made.

The response will be sent out once, right after the next PPS pulse is generated, and contains the GPS time at which the PPS pulse was sent, including the offset if an offset was set when the PPS pulse was enabled. Thus the response may be delayed by one PPS period plus the time tag latency indicated above.

$PASHR,PTT

The response message is in the form:

$PASHR,PTT,d1,m2*cc <Enter>

Table 5.91: PTT Message Structure

Parameters	Description	Range
d1	Day of GPS week,	1 to 7, Sunday = 1
m2	GPS time in hours, minutes, seconds of the PPS pulse hh:mm:ss.sssssss	0 - 23:59:59.9999999

Typical response:

$PASHR,PTT,6,20:41:02.0000000*OD <Enter>

Table 5.92: Typical PTT Response Message

Item	Description
6	Day of week (Friday)
20:41:02.0000000	GPS Time (8:41:02 PM)
*OD	Message checksum in hexadecimal

SAT: Satellite Status

$PASHS,NME,SAT,c,s

This command enables/disables the satellite status message to port c, where c is A, B, C, or D, and s is ON or OFF.

Example: Enable SAT message on port B:

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

$PASHQ,SAT,c

Query satellite status where c is the optional output serial port.

Example: Send SAT message to port D:

$PASHQ,SAT,D <Enter>

$PASHR,SAT

The response message is in the form:

$PASHR,SAT,d1,n(d2,d3,d4,f5,c)*cc <Enter>

where n = the number of SVs tracked.

Table 5.93: SAT Message Structure

Parameter	Description	Range
d1	Number of SVs locked	1 - 12
d2	SV PRN number,	1 - 32
d3	SV azimuth angle in degrees	0 - 359
d4	SV elevation angle in degrees	0 - 90
f5	SV signal/noise ratio in dB Hz	30.0-60.0
c	SV used in position computation 'U': used, ' -' : not used	'U' / '-'
*cc	checksum	

The elevation/azimuth prior to the first computed position may be erroneous if the last position stored in battery back memory is very far from the current point.

Example:

Query: $PASHQ,SAT <Enter>

Response:

$PASHR,SAT,04,03,103,56,50.5,U,23,225,61,52.4,U,16,045,02,
51.4,U,04,160,46,53.6,U*6E <Enter>

Table 5.94 describes each item in a typical SAT response message.

Table 5.94: Typical SAT Message

Item	Significance
$PASHR,SAT	Header
04	Number of SVs locked
03	PRN number of the first SV
103	Azimuth of the first SV in degrees
56	Elevation of the first SV in degrees
50.5	Signal strength of the first SV
U	SV used in position computation
23	PRN number of the second SV
225	Azimuth of the second SV in degrees
61	Elevation of the second SV in degrees
52.4	Signal strength of the second SV
U	SV used in position computation
16	PRN number of the third SV
045	Azimuth of the third SV in degrees
02	Elevation of the third SV in degrees
51.4	Signal Strength of the third SV
U	SV used in position computation
04	PRN number of fourth SV
160	Azimuth of fourth SV in degrees
46	Elevation of fourth SV in degrees
53.6	Signal strength of fourth SV
U	SV used in position computation
*6E	Message checksum in hexadecimal

XDR: Transducer Measurements

$PASHS,NME,XDR,c,s

Enable/disable the transducer measurements message, where c is the output port, and s is ON or OFF.

This message simply transfers the XDR message received from external transducers (through $WIXDR and $YXXDR NMEA message or Ashtech format $PASHS,XDR) for use by the control station, so that the control station can have access to all measurements, GPS data and transducer data through a single communication link.

Example: Enable XDR message on port A::

$PASHS,NME,XDR,A,ON <Enter>

$PASHQ,XDR,c

Query Transducer measurements, where c is the optional output port and is not required to direct the response to the current port.

Example: Send query of XDR message on port A:

$PASHQ,XDR,A <Enter>

$GPXDR

As indicated above, the format of the response is the same as the format of the input from the transducer ($WIXDR and $YXXDR). The messages are in the form:

$GPXDR,c1,f2,c3,s4, c5,f6,c7,s8,..., c n,f n+1,c n+2,s n+3*cc <Enter>

Each data set from the transducers has the form c1,f2,c3,s4, and several transducer's data can be sent in the same message as long as the entire string is not longer than 180 characters.

Table 5.95: XDR Message Structure

Parameter	Description	Range
c1	Transducer type	A - Angular deplacement C - Temperature D - Linear displacement F - Frequency G - Generic H - Humidity I - current N - Force P - Pressure R - flow rate S - Switch or valve T - Tachometer U - Voltage V - Volume
f2	Transducer value	+/- x.x (variable < 30 char)
c3	Transducer units	type A : D - Degress type C : C - Celsius type D : M - Meters type F : H - Hertz type G : null - none type H : P - Percent type I : A - Amperes type N : N - Newton type P : B - Bars type R : L - Liters type S : null - none type T : R - RPM type U : V - Volts type V : M - Cubic meters
s4	Transducer ID	variable length (< 80 char)
*cc	Checksum	

ZDA: Time and Date

$PASHS,NME,ZDA,c,s

Enable/disable the time and date message, where c is the output port, and s is ON or OFF. This message is output even if a position is not computed.

Example: Disable ZDA message on port A:

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

$PASHQ,ZDA,c

Query time and date, where c is the optional output port and is not required to direct the response to the current port.

Example: Send query of ZDA message on port A:

$PASHQ,ZDA,A <Enter>

$GPZDA

The response message is in the form:

$GPZDA,m1,d2,d3,d4,d5,d6*cc <Enter>

Table 5.96: ZDA Message Structure

Parameter	Description
m1	UTC time (hhmmss.ss) (hours, minutes, seconds)
d2	Current day 01 - 31
d3	Current month 01 - 12
d4	Current year 0000-9999
d5	Local zone offset from UTC time where s = sign and hh = hours Range 00 - ±13
d6	Local zone offset from UTC time where mm = minutes with same sign as hh
*cc	Checksum

Example:

$GPZDA,132123.00,10,03,1998,-07,-20*22 <Enter>

Table 5.97: Typical ZDA Response Message

Parameter	Description
$GPZDA	Message header
123123.00	UTC time
10	Current day
03	Current month
1998	Current year
-07	Local zone offset (hours)
-20	Local zone offset (min)
*22	Checksum in hexadecimal

RTCM Response Message Commands

The RTCM commands allow you to control and monitor RTCM Base real-time differential operations. The RTCM commands are only available if the differential options are installed in the receiver. If the Base Station option (B) is installed, then only the base parameter and general commands are accessible for RTCM messages 1, 2, 3, 6, 9, and 16. If the (K) option is installed as well then RTCM messages 18, 19, 20, 21, and 22 are accessible within the commands. For a more detailed discussion of RTCM differential, refer to the RTCM differential section of the Operations chapter.

Set Commands

All RTCM commands but one are set commands. Through the set commands you can modify and enable a variety of differential parameters. If the set command is sent correctly, the receiver will respond with the $PASHR,ACK acknowledgment. If a parameter is out of range or the syntax is incorrect, then the receiver will respond with a $PASHR,NAK to indicate that the command was not accepted.

Query Commands

There is only one query command: $PASHQ,RTC. Use this command to monitor the parameters and status of RTCM differential operations. The query command has an optional port field. If the query is sent with the port field left empty, then the response will be sent to the current port. If the port field contains a valid port (A-D), then the response will be output to that port. For example, the query:

$PASHQ,RTC <Enter>

will output an RTCM status message to the current port. The command:

$PASHQ,RTC,C <Enter>

will output an RTCM status message to port C.

Table 5.98 lists the RTCM commands.

Table 5.98: RTCM Response Message Commands

Function	Command	Description	Page
Base	$PASHS,RTC,BAS	Sets receiver to operate as differential base station	152
	$PASHS,RTC,EOT	Controls end of message characters	153
	$PASHS,RTC,MSG	Defines RTCM type 16 message	153
	$PASHS,RTC,SPD	Sets bit rate of base station	154
	$PASHS,RTC,STH	Sets health of base station	155
	$PASHS,RTC,TYP	Sets message type and message period	152
General	$PASHS,RTC,INI	Resets RTCM internal operation	153
	$PASHS,RTC,OFF	Disables differential mode	153
	$PASHS,RTC,STI	Sets station identification of base or remote	154
	$PASHQ,RTC	Requests differential mode parameters and status	150

Query: RTCM Status

$PASHQ,RTC,c

Query RTCM differential status, where c is the optional serial port.

Example: Query receiver for RTCM status:

$PASHQ,RTC, <Enter>

The return message is a free-form format response. A typical response looks like:

STATUS:

```
SYNC:*       TYPE:00        STID:0000        STHE:0
AGE:+0000 QA:100.00%        OFFSET:00
SETUP:
MODE:BASE  PORT:A           AUT:N            CODE: C/A
SPD:0300    STI:0000        STH:0
MAX:0060    QAF:100         SEQ:N
TYP:        1   2  3 22  6  9 16 18/19 20/21 EOT
FRQ:        99 00 00 00 ON 00 00   00   00   CRLF
MSG:
```

Some parameters shown in this message are not supported as “user-selectable parameters”. These are denoted as “Fixed Parameters” within Table 5.99.

Table 5.99 describes the parameters.

Table 5.99: RTC Response Parameters

Return Parameter	Description	Range	Default
STATUS			
SYNC	Fixed Parameter	n/a	
TYPE	RTCM message type being sent.	1,2,3,6,9,16,18,19, 20,21,22	
STID	Station ID	0 (any station) to 1023	
STHE	Fixed Parameter	0	
AGE	Fixed Parameter	0 - 999	
QA	Fixed Parameter	100%	
OFFSET	Fixed Parameter	00	
SETUP			
MODE	RTCM mode	BAS, OFF	OFF
PORT	Communication port	‘A’ , ‘B’ , ‘C’ or ‘D’	A
AUT	Automatic differential mode	N	N
CODE	Indicated the code type used in differential	Always C/A	C/A
SPD	RTCM bit rate. Indicate the speed at which differential collection are transmitted to the serial port.	25,50,100,110,150 , 200, 250,300,1500,0 (burst mode)	300
STI	Station ID.	0 (any station) to 1023	0
STH	Station health	0-7	0
MAX	Fixed Parameter	0060	60
QAF	Fixed Parameter	100	100
SEQ	Fixed Parameter	N	N
TYP	RTCM message type that receiver will generate.	1,2,3,6,16,18/19, 20/21, 22	type 1
EOT	End of transmission character	CRLF, CR,NONE	CRLF

Table 5.99: RTC Response Parameters (continued)

Return Parameter	Description	Range	Default
FRQ	RTCM message send frequency. The period is in seconds for type 1, 9, 18/19, 20/21 and minutes for all other types. Type 6 is either ON or OFF.	99 - continuous 00 - disabled	Type 1 = 99 Type 6 = ON
MSG	Contains the message, up to 90 characters, that is sent from the base to the remote when message type 16 is enabled.		

BAS: Enable Base Station

$PASHS,RTC,BAS,c

Set the receiver to operate as an RTCM differential base station, where c is the differential port and can be set to port A, B, C or D.

Example: Set to differential base mode using port B:

$PASHS,RTC,BAS,B <Enter>

EOT: End of Transmission

$PASHS,RTC,EOT,s

Control which characters to transmit at the end of each RTCM message, where s is the end of message parameter. Default is 'CRLF'.

Table 5.100: EOT Parameters

Setting Parameter	Description	Range
s	nothing carriage return carriage return and line feed (default)	'NONE' 'CR' 'CRLF'

Example: Receiver transmits only carriage return at the end of every RTCM message

$PASHS,RTC,EOT,CR <Enter>

INI: Initialize RTCM

$PASHS,RTC,INI

Initialize RTCM internal operation.

Example: Initialize RTCM internal operation:

$PASHS,RTC,INI <Enter>

MSG: Define Message

$PASHS,RTC,MSG,s

Define RTCM type 16 message up to 90 characters long that will be sent from the base to the remote. **$PASHS,RTC,MSG,s** is used only at the base station and only if message type 16 is enabled.

Example: Define RTCM message “This is a test message”

$PASHS,RTC,MSG,This is a test message <Enter>

OFF: Disable RTCM

$PASHS,RTC,OFF

Disables base differential mode.

Example: Turn RTCM off:

$PASHS,RTC,OFF <Enter>

SPD: Base Bit Rate

$PASHS,RTC,SPD,d

Set the number of bits per second that are being generated to the serial port of the base station, where d is the code for the output rate in bits per second. The available speeds and corresponding codes are listed in Table 5.101. Default is 300 bits per second.

Table 5.101: Available Bit Rate Codes

Code	0	1	2	3	4	5	6	7	8	9
Rate	25	50	100	110	150	200	250	300	1500	0 (burst mode)

Example: Set bit rate to 110 bits/sec:

$PASHS,RTC,SPD,3 <Enter>

STH: Station Health

$PASHS,RTC,STH,d

Set the health of the base station, where d is any value between 0 and 7. Default is 0. Table 5.102 defines the codes for the station health:

Table 5.102: RTC,STH Health of Base Station

Code	Health Indication
7	Base station not working.
6	Base station transmission not monitored.
5	Specified by service provider/UDRE scale factor = 0.1
4	Specified by service provider/UDRE scale factor = 0.2
3	Specified by service provider/UDRE scale factor = 0.3
2	Specified by service provider/UDRE scale factor = 0.5
1	Specified by service provider/UDRE scale factor = 0.75
0	Specified by service provider/UDRE scale factor = 1

Example: Set health to “Base station not working”:

$PASHS,RTC,STH,7 <Enter>

The station health is simply transmitted by the base, code 1 to 5 are not valid since the base and rover are using UDRE scale factor of 1 always.

STI: Station ID

$PASHS,RTC,STI,d

This command sets the user station identification (user STID), where d is any integer value between 0000 and 1023. The STID is used to restrict the use of differential corrections to a particular base station.

Example: Set site identification to 0001:

$PASHS,RTC,STI,0001 <Enter>

TYP: Message Type

$PASHS,RTC,TYP,d1,d2

Enables the type of message to be sent by the base station and the period at which it will be sent, where d1 is the type and d2 is the period. Table 5.103 lists the message types available and the period range setting. The default is type 9 set to 99, and type 6 is ON.

Table 5.103: RTC,TYP Message Types

Type	Range
01	0-99 seconds, where 0 is disabled and 99 is generated continuously
02	0-99 minutes, where 0 is disabled and 99 is generated continuously
03	0-99 minutes, where 0 is disabled and 99 is generated continuously
06	1 = ON, 0 = OFF (ON and OFF are also accepted)
09	Same as type 1
16	Same as type 3
18/19	Same as type 1
20/21	Same as type 1
22	Same as type 3

All messages can be enabled simultaneously with any output period setting, with the exception of period 99; with simultaneous message, only one can be set at 99,

Example: Enable type 1, sent out every second:

$PASHS,RTC,TYP,1,1 <Enter>

A

Data Formats

Stored Formats

B-files

B-files contain raw measurement data downloaded from GPS receivers. Each record corresponds to one epoch. The file structure consists of a header (the structure RAWHEADER) followed by epoch data. Each epoch of data consists of a RAWNAV structure and a variable number of RAWDATA structures. The number of RAWDATA structures is defined by RAWNAV.NUM_SATS. For example, if RAWNAV.NUM_SATS = 6, then 6 RAWDATA structures will follow.

In turn, each RAWDATA structure contains several CHAN_OBS (channel observations) structures. RAWHEADER.NUM_OBS_TYPES defines the number of CHAN_OBS structures per RAWDATA structure for the entire file. For example, if RAWHEADER.NUM_OBS_TYPES = 2, then each RAWDATA structure in the file will contain 2 CHAN-OBS structures.

Although integrated Doppler and fractional phase were stored in previous releases, this is no longer so. Instead, the full carrier phase observable information is stored in CARPHASE.

Satellite transmit time (CODETXMT) has been replaced by RAWRANGE (RECEIVE_TIME-RAW_RANGE=transmit time).

Code smoothing values are also supplied in this release. SMTH_CORR is the code smoothing value (subtracted from RAWRANGE) used by the receiver. SMTH_COUNT is a measure of the smoothness of SMTH-CORR. SMTH-COUNT will always be normalized to 200; that is, 1 will represent the least smoothed and 200 will represent the most.

QA-PHASE provides a measure of receiver performance; its value should generally be between 0 and 5 or 95 and 100.

Note also that the B-file format, version 4.1, is the same as defined here with the exception of the header capability. The capabilities L1CP and L1C_L2P have also been added to version 4.2. The version 5.0 B-file has the following structure.

Each B-file starts with a rawheader struct. The size of a rawstruct header = 90 bytes.

```
struct rawheader {
char        version[101];
unsigned    char raw_version;
char        rcvr_type[101];
char        chan_ver[101];
char        nav_ver[101];
int         capability;
long        reserved;
char        num_obs types;
char        spare[42];
}
```

The size of rawnav struct=67 bytes.

```
struct rawnav {
char        sitename[4];
double      rcv_time;
double      navx;
double      navy;
double      navz;
float       navxdot;
float       navydot;
float       navzdot;
double      navt;
double      navtdot;
unsigned    int pdop;
char        num_sats;

};
```

Each epoch has a rawdata struct per SV

The size of L1 rawdata struct = (35 * nav.num_sats) bytes
The size of L2C rawdata struct = (66 * nav.num_sats) bytes
The size of L2P rawdata struct = (97 * nav.num_sats) bytes

```
struct rawdata {
unsigned char svprn;
unsigned char elevation;
unsigned char azimuth;
unsigned char chnind;
struct chan_obs obs[3]; /* This variable is indexed by 3 (currently)  */
            /* to support receivers measuring C/A code */
            /* L1 independently of P-Code L1.  Thus the */
            /* indexing is as follows:*/
            /*A) For L1 only receivers, L1 is in*/
```

```
                /*slot 0*/
                /*B) For L2 codeless receivers, L1 is in*/
                /*slot ) and L2 is in slot 1*/
                /*C) For our P-code receiver L1 C/A is*/
                /*in slot 0, L1 P-code is in slot 1,*/
                /*and L2 P-Code is in slot 2.

};

The size of struct chan_ob s= (31) bytes
The size of struct chan_obs = (31) bytes

struct chan_obs {
double          rawrange;/* SV raw range: raw transmit time is the*/
                /* value subtracted from receive time*/
                /* (receive time rounded to nearest*/
                /* millisecond)
float           smth_corr;/* Smoothing correction for ranges (meters)*/
unsigned int    smth_count;/*Number of data points in smoothing.*/
char            polarty_known/* Tracking status: 0 to 3 not usable for*/
                /* carrier phase.*/
unsigned char warning;/* Warning flag (BIT flags):*/
                /* 0 ==> All O.K.*/
                /* Bit 1 ==>Sv txmt approaching 1ms offset*/
                /* Bit 2 ==> Sv txmt approaching 1ms offset*/
                /* but different direction from*/
                /* Bit 3 ==> Carrier phase questionable*/
                /* Bit 8 => Lost_lock_counter reset.*/
unsigned char goodbad;/* Another health indicator:*/
                /* 22 ==> Code and carrier measured.*/
                /* 23 ==> Same as 22 but additionally, nav*/
                /* message obtained but measurement*/
                /* was not used in position computation*/
                /* 24 ==> Same as 23 but codephase was used*/
                /* in position computation.*/
unsigned hcar ireg;/* Signal to noise.*/
char            qa_phase;/* QA phase check (0.001 cycles).*/
long            doppler;/* SV raw doppler.*/
double          carphase;/* Full carrier phase (cycles).*/
```

E-files

The E-file contains the ephemeris information transmitted from each satellite. Each record consists of a byte identifying the SVPRN, followed by a NAVSTRCT. The data is recorded at hourly intervals and may consist of several records for a single satellite. If a satellite were not tracked during a given hour, there will be no entry for that satellite for that hour.

The NAVSTRCT consists of 32 records per SVPRN. The record definitions and the units of the orbit data conform to GPS-ICD-200. Each file record has the following structure.

char	svprn;	struct navstruct
int	wn;	GPS week number.
long	tow;	Seconds of GPS week.
float	tgd;	Group delay (sec).
long	aodc;	Clock data issue.
long	toc;	(sec).
float	af2;	Clock parameters: (sec/sec2)
float	af1;	(sec/sec)
float	af0;	(sec).
long	aode;	Orbit data issue.
float	deltan;	Mean anomaly correction (semi-circle/sec).
double	m0;	Mean anomaly at reference time (semi-circle).
double	e;	Eccentricity
double	roots;	Square root of semi-major axis (meters 1/2)
long	toe;	Reference time for orbit (sec).
float	cic;	Harmonic correction term (radians).
float	crc;	Harmonic correction term (meters).
float	cis;	Harmonic correction term (radians).
float	crs;	Harmonic correction term (meters).
float	cuc;	Harmonic correction term (radians).
float	cus;	Harmonic correction term (radians).
double	omega0;	Lon af Asc. node (semi-circles).
double	omega;	Arg. of Perigee (semi-circles).
double	i0;	Inclination angle at reference time (semi-circles).
float	omegadot;	Rate of right Asc. (semi-circles/sec).
float	idot;	Rate of inclination (semi-circles/sec).
int	accuracy;	(coded).
int	health;	(coded).
int	fit;	Curve fit interval (coded).

S-files

The S-file (site file) is an ASCII text file containing the information entered by the user using terminal commands through a receiver control software package such as Micro-Manager. An example of the data is shown below:

```
*************************************SITE INFORMATION***************************
NAME      BYTES    WEEK     TIME     SES      RCR    ANT    MMDD     OPR CODE  TYPE
RICK      147272   522      211478   A        164    016    0109     RS_______ 30F _XXIV

                            HI       T-DRY    T-WET         HUMIDITY           PRESSURE
BEFORE             2.0900   0        0        0      0.0
AFTER              2.0900   0        0        0      0.0

RECEIVER Type:  L-XII  Nav: 5A  Channel: 2H  Options: COO
**********************************************************************
```

D-File

Meteorological information is written into D-file in the following format:

XDR,P,X.X,B,ID,C,X.X,C,ID,H,X.X,P,ID [CR] [LF]

Table A.1: D-File Field Information

Field	Significance
1	Message type indicator, XDR
2	Pressure Transducer type, P
3	Pressure measurement data, float value in variable length
4	Unit of measure for pressure, B (bars)
5	Transducer ID, string of variable length
6	Temperature Transducer type, C
7	Temperature measurement data, float value in variable length
8	Unit of measure for temperature, C (Celsius)
9	Transducer ID, string of variable length
11	Humidity Transducer type, H
12	Humidity measurement data, float value in variable length
13	Unit of measure for humidity, P 9 percent
14	Transducer ID, string of variable length

Tilt meter information is written into D-file in the following format

XDR,Z,S.S,D,ID,A,S.S,D,ID,C,S.S,C,ID [CR] [LF]

Table A.2: D-File Tilt Meter Data Field Descriptions

Field	Description
1	Message type indicator, XDR
2	Angular Transducer type, A
3	N title value, float value in variable length
4	Unit of measure for N tilt value, D (degrees)
5	Transducer ID, string of variable length
7	E tilt value, float value in variable length
8	Unit of measure for E tilt value, D (degrees)
9	Transducer ID, string of variable length
11	Temperature Transducer type, C
12	Temperature measurement data, float value in variable length

Table A.2: D-File Tilt Meter Data Field Descriptions (continued)

Field	Description
13	Unit of measure for temperature, C (Celsius)
14	Transducer ID, string of variable length

Tilt meter data can follow MET3 data in one XDR string.
XDR,P,X.X,B,ID,C,X.X,C,ID,H,X.X,P,ID, A,X.X,D,ID,A,X.X,D,ID,C,S.S,C,ID [CR] [LF]

There are combinations of tilt data up to three meters in one XDR string
XDR,A,X.X,D,ID,A,X.X,D,ID,C,X.X,C,ID,A,X.X,D,ID,A,X.X,D,ID,C,X.X,C,ID,A,X.X,D,ID,A,X.X,D,ID,C,X.X ,C,ID [CR] [LF]

B

Global Product Support

If you have any problems or require further assistance, the Customer Support team can be reached through the following:

- telephone
- FAX
- email
- Internet

Please refer to the documentation before contacting Customer Support. Many common problems are identified within the documentation and suggestions are offered for solving them.

Ashtech customer support:

Santa Clara, California, USA

800 Number: 1-800-229-2400

Local Voice Line: (408) 615-5100

FAX : (408) 615-5200

International: 1-408-615-3980

Email: support@ashtech.com

Internet: http://www.ashtech.com

http://www.magellangps.com

Europe Ltd. Oxfordshire UK

TEL: 44-0118-931-9600

FAX: 44-0118-931-9601

Solutions for Common Problems

- Check cables and power supplies. Many hardware problems are related to these simple problems.
- 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 the batteries are charged.
- Verify that the antenna views skyward are unobstructed by trees, buildings, or other canopy.
- If none of these suggestions solves the problem, contact the Customer Support team. To assist the Customer Support team, please ensure the following information is available:

Table B.1: GPS/GIS Product Information

Information Category	Your actual numbers
Receiver model	
Receiver serial #	
Software version #	
Software key serial #	
Firmware version #	
Options*	

Table B.1: GPS/GIS Product Information (continued)

Information Category	Your actual numbers
A clear, concise description of the problem.	
* The firmware version # and options can be obtained using the $PASHQ,RID (receiver identification) command.	

Corporate Web Page

You can obtain data sheets, GPS information, application notes, and a variety of useful information from Ashtech's Internet web page at:

http://www.ashtech.com

Repair Centers

In addition to repair centers in California and England, authorized distributors in 27 countries can assist you with your service needs.

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