SCA-12 GPS RECEIVER
SCA-12S GPS SENSOR

INTERFACE GUIDE

and

OPERATING MANUAL

Firmware Version 1D00

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FCC USER'S MANUAL STATEMENT

Class B Verification Requirements

This equipment has been tested and found to comply with the limits of Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide a reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Shielded cables and I/O cords must be used for this equipment to comply with the relevant FCC regulations.

Changes or modifications not expressly approved in writing by Ashtech may void the user's authority to operate this equipment.

FOREWORD

This document describes the Ashtech SCA-12/12S hardware, support requirements, operation procedures, and requirements for establishing a communications interface with other components of the system.

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GENERAL INFORMATION

The Ashtech SCA-12 and SCA-12S receivers, figures 1 and 2, process signals from the Global Positioning System (GPS) satellite constellation. The receivers provide real-time position, velocity, heading, and time measurements using twelve dedicated separate and parallel channels for Coarse/Acquisition (C/A) code-phase and carrier-phase measurement on the L1 (1575 Mhz) band. The receivers receive satellite signals via an L-band antenna and low-noise amplifier (LNA). The modules are designed for stand-alone range and phase measurement applications, and also are suitable for use as a base (reference) station or remote (rover) station providing real-time differential GPS operation in RTCM 104 Version 2.0 format.

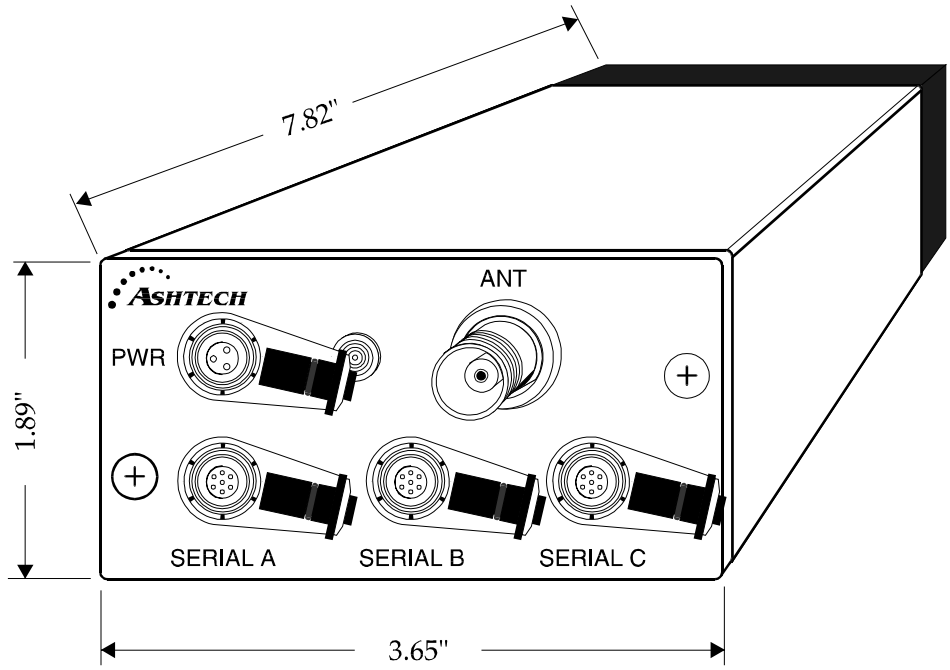


Figure 1. Ashtech SCA-12 GPS Receiver

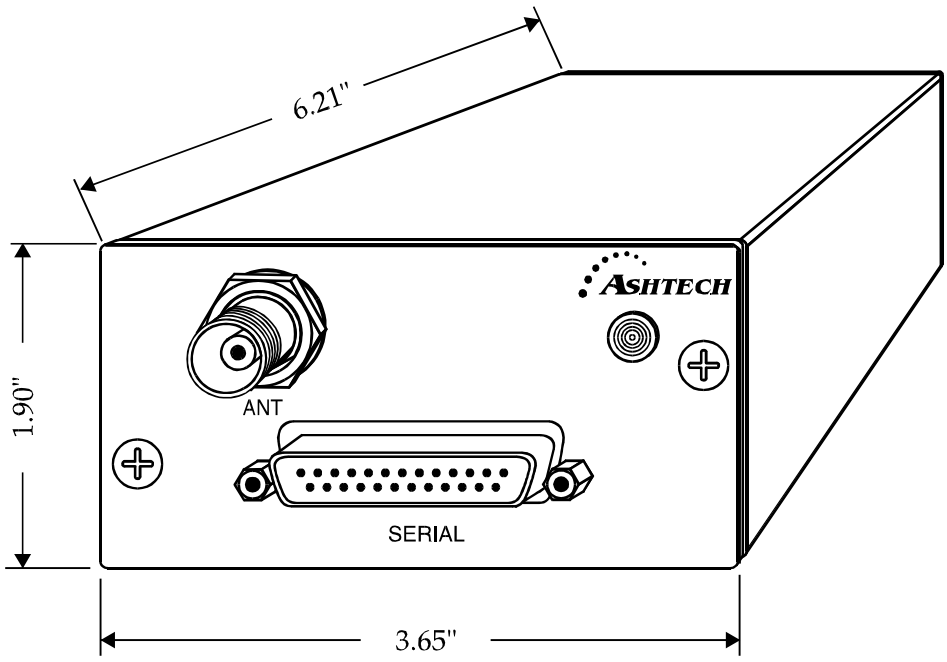


Figure 2. Ashtech SCA-12S GPS Sensor

FUNCTIONAL DESCRIPTION

This section comprises a functional and hardware description of the SCA-12/12S, and characterizes the RF and power/input/output connectors.

The SCA-12 receiver is activated when any character is sent through any of the serial ports while running a communications program. The SCA-12S sensor is activated when power is applied to the power input through the DB-25 connector. Upon application of power, the SCA-12/12S runs a built-in self test of its internal memory, and thereafter periodically self-tests various functions during normal operation. Test results are stored for commanded output. After self test, the SCA-12/12S initializes volatile RAM. If non-volatile RAM fails self test (due, for example, to a low battery backup condition), the SCA-12/12S clears and reports the loss of stored data, then initializes its 12 channels and begins searching for all satellites (SVs or Space Vehicles) within the field of view of the antenna.

The SCA-12/12S 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 coded inside the receiver/processor card. As the SCA-12/12S acquires (locks on to) each SV, it notes the time and then collects the ephemeris data about the orbit of that SV and almanac data about the orbits of all the SVs in the constellation.

When tracking three SVs, the SCA-12/12S can compute and time tag the two-dimensional position and velocity of its antenna; no initial estimate is necessary. When it receives an appropriate command message from controller equipment through one of its serial communications ports, the SCA-12/12S sends the results of its computations to the commanded port.

With four locked SVs, the SCA-12/12S can determine three-dimensional position and velocity. Position accuracy is 16 meters rms or less SEP (when Position Dilution of Precision - PDOP is less than 4), subject to the US governmental policy of Selective Availability; velocity accuracy is one centimeter per second.

One independent measurement is determined per half-second, with no interpolation or extrapolation from previous solutions. The position and velocity computations are performed using all the SVs in view

simultaneously. The SCA-12/12S uses a sophisticated technique for computing velocity which does not require computations to be dependent upon the last position, and uses instantaneous doppler values from four SVs to compute dynamic speed. All computations are accomplished relative to the World Geodetic System WGS-84 reference ellipsoid.

The SCA-12/12S features 12-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 SCA-12/12S automatically records this information in its non-volatile memory.

The SCA-12/12S has an L1-band radio frequency (RF) port and three RS-232 serial input/output (I/O) ports. All three serial ports are capable of two-way communication with external equipment.

With external power removed from the non-volatile part of the RAM, data storage is maintained using an internal lithium battery.

The RF circuitry receives satellite data from a GPS antenna and LNA via a coaxial cable, and can supply power to the antenna/LNA by means of that cable. No separate antenna power cable is required. Power consumption is approximately 4 watts even when powering an LNA.

The SCA-12/12S includes a two-color LED; red indicates the power status, and green flashes for the number of SVs locked.

POWER/INPUT/OUTPUT CONNECTIONS

Although the power, input, and output parameters are identical for the SCA-12 and SCA-12S, the physical connections are different. In the SCA-12, there are separate connectors for power and serial I/O data, as shown in Figures 3 and 4. In the SCA-12S, all power and serial I/O connections are embedded in a single DB25 connector, as shown in Figure 5.

SCA-12

Figure 4 shows the pin configurations for the power and serial data connectors.

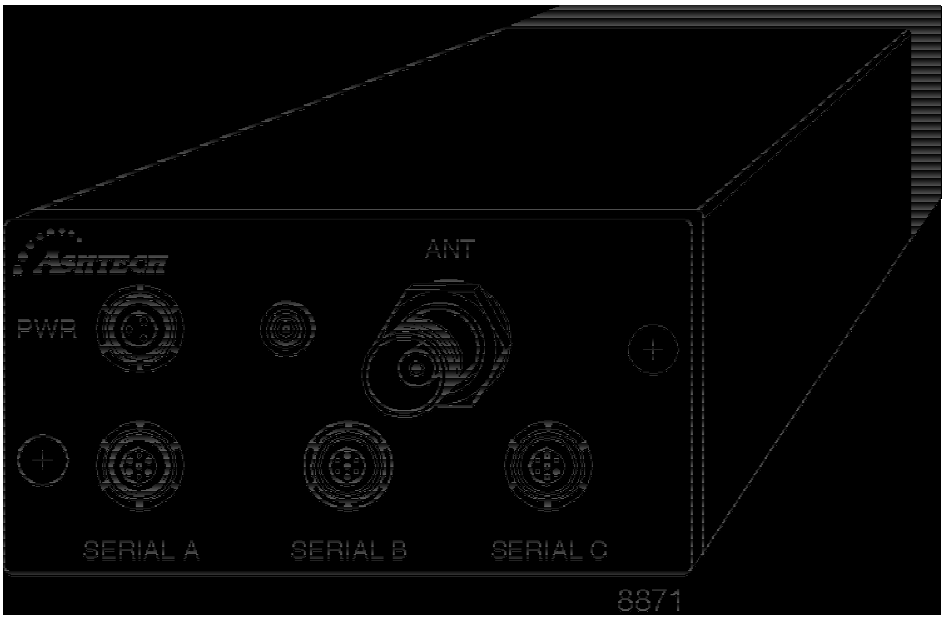


Figure 3. SCA-12 Power/Input/Output Connectors

SCA-12 signal designations are detailed in the following table.

Connector	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
Power	Ground	6-15 VDC in	Control*				
Serial A	No connection	Ground	CTS	RTS	RXD	TXD	Reserved. Do not use.
Serial B	No connection	Ground	CTS	RTS	RXD	TXD	Photogrammetry in
Serial C	No connection	Ground	CTS	RTS	RXD	TXD	1 PPS out

*On the power connector, the factory default configuration is ground on pin 1, 6-15 VDC on pin 2, open pin 3. In this configuration, sending any character through one of the serial ports turns the receiver on and sending the command $PASHS,PWR,OFF through serial port A turns the receiver off. If pin 3 is connected to pin 2, the receiver automatically turns on when power is applied.

Figure 4. SCA-12 Power and Serial Connector Pinouts

SCA-12S

The SCA-12S power input/output connector, Figure 5, is a DB25 female socket. It provides the input power connection, the one-pulse-per-second TTL output, the event marker (EVENT IN) input connector, three RS-232 I/O ports, and power for an external LED if required.

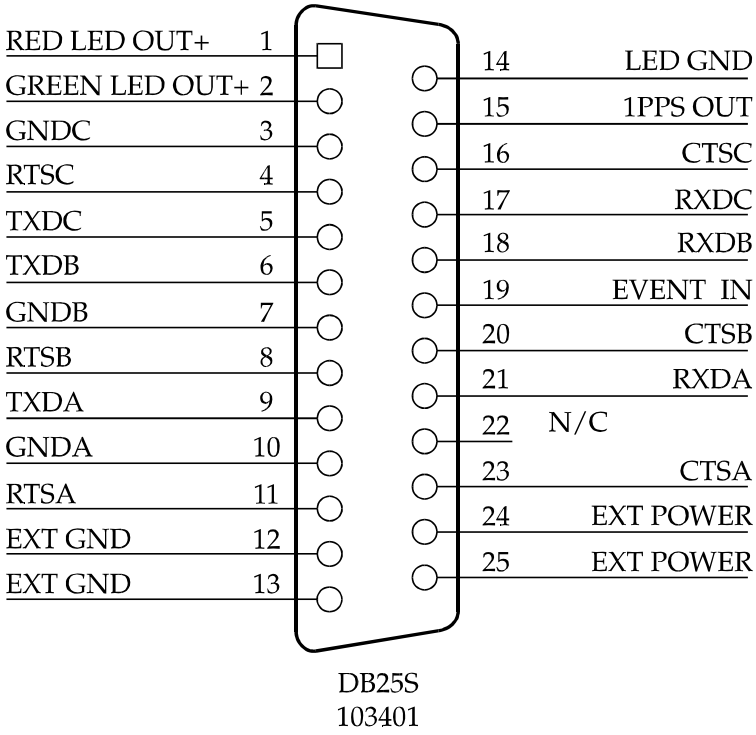


Figure 5. SCA-12S Power/Input/Output Connector

SCA-12S Power/Input/Output Connector Pin Assignments

Pin	Code	Description
01	Red LED Out+	Red LED + power out
02	Green LED Out+	Green LED + power out
03	GNDC	Serial port C ground
04	RTSC	RS-232 port C request to send
05	TXDC	RS-232 port C transmit data
06	TXDB	RS-232 port B transmit data
07	GNDB	RS-232 port B ground
08	RTSB	RS-232 port B request to send
09	TXDA	RS-232 port A transmit data
10	GNDA	RS-232 port A ground

11	RTSA	RS-232 port A request to send
12	EXT GND	External ground
13	EXT GND	External ground
14	LED GND	LED ground
15	1 PPS OUT	One pulse-per-second output
16	CTSC	RS-232 port C clear to send
17	RXDC	RS-232 port C receive data
18	RXDB	RS-232 port B receive data
19	EVENT IN	Event marker input
20	CTSB	RS-232 port B clear to send
21	RXDA	RS-232 port A receive data
22	--	No connection
23	CTSA	RS-232 port A clear to send
24	EXT POWER	External power (nominal 6 to 15V)
25	EXT POWER	External power (nominal 6 to 15V)

RF INTERFACE CONNECTOR

The RF connector is a standard TNC female receptacle wired for connection via 50-ohm coaxial cabling to a GPS antenna with integral LNA. The TNC connector shell is connected to the SCA-12/12S common ground. The TNC center pin provides +4.8 VDC (to power the LNA) and accepts 1575 MHz RF input from the antenna; the RF and DC signals share the same path.

CAUTION

The SCA-12/12S may be damaged if the TNC center pin is not isolated from DC ground. Provide a DC block between the center pin and ground with the following characteristics: VSWR 1.15 maximum at 1575 MHz, insertion loss 0.2 dB maximum, and main line maximum voltage 5 VDC.

RADIO INTERFERENCE

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

RECEIVER SPECIFICATIONS

Receiver/Antenna

Tracking:	12 channels L1 Super C/A code (carrier optional)
Size:	3.65"W x 6.21"D x 1.9"H
Weight:	22 ounces
Operating temperature:	-20 to +60 °C
Storage temperature range:	-40 to +70 °C
Environment:	Wind-driven rain and dust to MIL-STD-810D
Case:	Aluminum
Power consumption:	4 watts
Power input:	5-16 VDC via DB25 or separate power connector
Data storage:	Optional 0.5 or 4MB memory board
Interface:	1 dual-color LED 3 RS-232 ports via DB25 or separate connectors 1 antenna port Remote LED via DB25 for SCA-12S Event marker via serial port connector or DB25 1 PPS via serial port connector or DB25
Battery:	Snaps onto rear panel of SCA-12
Mounting:	Attached plate with 4 holes

RECEIVER OPTIONS

The SCA-12/12S has a number of available options. The options that are set in the receiver will determine which commands and features you can use. For example, if the Event Marker option is not set, you will not be able to create a photogrammetry file of time tags in the receiver, or use the $PASHS,TTT command to output event time tags from the serial port.

To determine which options are in your receiver, use the $PASHQ,RID (receiver identification) command. The response from the receiver should be in the form:

$PASHR,RID,rr,vvvv,xxxxxxxxxxxxx*cc where

Item	Significance
1	rr = receiver type
2	vvvv = receiver version
3	xxxxxxxxxxxxx = options available
4	*cc = the checksum in hexadecimal

There are 13 available options. Each option is represented by a letter or number presented in a certain order. The availability of that option is indicated by a letter or number. If the letter or number is displayed, then the option is available. If the letter/number is not displayed, the option is not available.

The options in the slot order are:

Carrier Phase [P]

Differential - Base Station [B]
Event Marker (Photogrammetry) [E]
Pulse Per Second (1PPS) [L]
Session Programming/Sleep Mode [S]
Magnetic Variation [M]
Geoidal Height [G]
2 Hz Update Rate (Half-second Update) [2]
Point Positioning [T]
Raw Data Output [O]
NMEA Data Output [N]
Differential - Remote Station [U]
Data Recording [R]

Example:
Query: $PASHQ,RID<Enter>
Response: $PASHR,RID,SC,1D00,PB_LSM_2_ONUR*4D

where

Field	Significance
$PASHR,RID	Message header
SC	Receiver type: SCA
1D00	Receiver firmware version
PB_LSM_2_ONUR	Options available: [P] Carrier phase [B] Differential Base Station [L] Pulse Per Second [S] Session Programming [M] Magnetic Variation [2] 2Hz Update Rate [O] Real-Time Outputs [N] NMEA Data Outputs [U] Differential Remote Station [R] Data Recording
*4D	Checksum in hexadecimal

Details are given in the *Commands/Response Formats* chapter.

GETTING STARTED

This chapter is intended to help you learn to use the Ashtech SCA-12/12S. For details, please refer to the chapters on General Information, Operation, and Command/Response Formats.

Briefly discussed in Getting Started are:

- Power requirements for the SCA-12/12S.
- Procedure for connecting the SCA-12/12S to power, the antenna, and your control and data logging equipment.
- Important default parameters.
- Instructions for establishing communications with the SCA-12/12S using typical communications software with an IBM-compatible PC.
- Procedure for sending common commands to the SCA-12/12S.

CONNECTION PROCEDURES

Power

CAUTION

As a precaution to avoid possible damage to the SCA-12S, connect the interface cable to the DB25 connector before turning on the power supply, and turn off the power supply before disconnecting the interface cable from the DB25 connector.

1. Connect the interface cable(s) to the DB25 connector of the SCA-12S unit, and the power cable to the power connector of the SCA-12 unit, or the serial I/O connectors on the SCA-12/12S before applying power.

2. Connect the power cable to the power supply.

3. Applying power to the SCA-12/12S starts the unit. Once power is applied, the two-color LED on the SCA-12/12S card flashes red approximately every three seconds.

4. When you disconnect power, disconnect the interface cable from the power supply before disconnecting the interface cable from the connector on the SCA-12S.

Antenna

The SCA-12/12S is designed to work with an antenna/preamplifier that requires five volts and is isolated from DC ground. The gain of the antenna/preamplifier minus the loss of the cable should be between 20 and 30 dB.

Connect the antenna cable directly to the antenna TNC connector on the SCA-12/12S.

Once power is on and the antenna connected, the SCA-12/12S starts acquiring satellites (SVs or Space Vehicles) within the field of view of the antenna. As a channel in the SCA-12/12S locks on to an SV, the two-color led on the SCA-12/12S receiver/processor card flashes green between the red power flashes for every channel in use (i.e. SVs locked).

IMPORTANT DEFAULT PARAMETERS

Communication Port Setup

The default communication parameters of the SCA-12/12S are:

Baud	Data Bits	Parity	Stop Bits

9600	8	None	One

When you first establish communications with the SCA-12/12S, your communications interface must use this protocol.

Data Output Options

All the default data output commands are set to OFF. The SCA-12/12S will not output any data until you send a message commanding it to do so.

INITIAL OPERATING INSTRUCTIONS

After you have the SCA-12/12S powered and running, you must send it command messages in order to receive data (such as antenna position). The following procedure describes how to send directives to and receive information from the SCA-12/12S using an IBM-compatible PC. Many communications software packages are available.

Command the SCA-12/12S

After setting up the interface for establishing communications with the SCA-12/12S, you are now ready to send commands. The letters in your command must be typed in ALL UPPER CASE and completed with <Enter> or <CR><LF>. If you have typed in and sent the command correctly, you should get a response. To become familiar with the SCA-12/12S messages, send a few common commands to the SCA-12/12S and observe the responses. In the following steps command messages appear as COMMAND, and response messages appear as RESPONSE.

1. Type in capital letters: $PASHQ,PRT and press <Enter>. This command queries the communication setup of the port.

2. If interfacing through serial port A, the response message is

$PASHR,PRT,A,5. SCA-12/12S port A is using its default communications setup 5: 9600 baud, eight data bits, no parity, and one stop bit.

3. Type in capital letters: $PASHQ,STA and press <Enter>. This command queries which satellites are locked and their signal strength at the time the command is sent.

4. The response message typically might display:

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

5. If interfacing through port A, type in capital letters: $PASHS,NME,POS,A,ON and press <Enter>. This command tells the SCA-12/12S to return information through port A on the position of the antenna at a set rate. The default rate for NMEA commands is once per half-second if the 2HZ option is installed in the receiver; if not, it is once per second.

6. The response message displays once per half-second or once per second:

   $PASHR,POS,0,"....."

   where the "....." is your position information, if you have enough SVs locked to compute a position.

7. If interfacing through port A, type in capital letters: $PASHS,NME,SAT,A,ON and press <Enter>. This command tells the SCA-12/12S to return locked satellite information through port A at a set rate.

8. The response message displays once per half-second or once per second:

   $PASHR,SAT,"....."

   where the "....." is the number of SVs locked, and the elevation,

azimuth, and signal strength for each locked SV.

9. For details on these commands and responses, as well as the rest of the SCA-12/12S's command and response repertoire, consult the following chapters in this guide.

COMMAND/RESPONSE FORMATS

This chapter defines in detail the requirements for establishing a communications interface between the SCA-12/12S and external data equipment. Some commands are applicable only when the appropriate option installed.

The SCA-12/12S includes command/response messages enabling it to receive and to send data messages when so commanded through any of the three serial ports. The SCA-12/12S responds with messages indicating the acceptance or rejection of commands and providing data on its internal status, antenna position, and status for all SVs currently being tracked. The input messages to the SCA-12/12S consist of set command messages, query command messages, general command messages, and differential correction message capability. Output messages from the SCA-12/12S are composed of command acknowledged/not acknowledged messages, general status messages, RTCM, and NMEA-format data messages.

The SCA-12/12S serial port commands fall into four groups:

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

The following sections discuss each type of command.

OPERATION

This chapter discusses system setup, power-up, command format, serial port configuration, parameter settings and status, the satellite search algorithm, position modes, point positioning, altitude hold definition, the ionospheric/tropospheric model, antenna position setting, NMEA outputs, raw data outputs, differential operation, photogrammetry option, and pulse-per-second option.

SYSTEM SETUP

If other than Ashtech-supplied equipment is used, it must meet the hardware specifications described in *General Information.*

Applying power to the power input pins on the SCA-12S DB25 connector starts SCA-12S operation; applying power to the power connector on the SCA-12 and sending any character through one of the serial ports starts SCA-12 operation. Before applying power connect any controller devices or data logging equipment to the input/output ports of the SCA-12/12S.

CAUTION

As a precaution, to avoid possible damage to the SCA-12S, connect the interface cable(s) to the SCA-12S connector(s) before turning on the power supply.

Removing power from the power input pins on the SCA-12/12S connector stops SCA-12S operation. Issuing the command $PASHS,PWR,OFF through serial port A of the SCA-12 stops the SCA-12 operation.

CAUTION

As a precaution, to avoid possible damage to the SCA-12S, turn off the power supply before disconnecting the interface cable from the SCA-12S connector.

POWER-UP

Upon successful power-up of the "black box" configuration, the status LED lights red and then flashes briefly every three seconds (approximately). When the SCA-12/12S's automatic search results in an SV acquisition, the status LED flashes green between the red power status flashes. Every SV lock-on produces a green flash; for example, if the SCA-12/12S is tracking eight SVs, the LED flashes green eight times between red flashes.

MESSAGE FORMAT

The built-in command/response firmware allocates the three RS-232 ports to receiving command messages from and sending response messages to a single external control device (such as a PC), and to output data to a separate data logging device, as well as to transmit differential corrections to a remote station or to receive differential corrections from a reference (base) station.

Input Messages to the SCA-12/12S

These comprise set command messages, query command messages, and general command messages complying with the NMEA 0183 standard to the following extent:

- NMEA 0183 ASCII byte strings following $-character.
- Headers are Ashtech proprietary.
- Message IDs are Ashtech proprietary.
- Data items are separated by commas.
- Checksum character delimiter and NMEA checksum bytes are recognized by the SCA-12/12S but are optional. The hexadecimal checksum is computed by exclusive-ORing all of the bytes in the message between, but not including, the $ and the *.

- Message is ended with the standard NMEA message terminator characters, <CR> (ASCII carriage return 0DH) and <LF> (ASCII line feed 0AH).

All command messages (set, query or general) must be ALL UPPER CASE and completed by <Enter>. A valid set command causes the SCA-12/12S to return the $PASHR,ACK*3D, "acknowledged" response message. A set command containing a valid $PASHS set command header followed by character combinations unrecognized by the SCA-12/12S causes return of the $PASHR,NAK*30, "not-acknowledged" response message. All other invalid set commands are ignored. Valid query and general command messages are acknowledged by return of the requested information, and all invalid query and general commands are ignored.

Output Messages From the SCA-12/12S

These are messages the SCA-12/12S sends to the data logging device in response to a command message. They comprise the SCA-12/12S general status messages, command acknowledged/not acknowledged messages and GPS data messages. The SCA-12/12S general status messages have free-form Ashtech proprietary formats. The command acknowledged/not acknowledged messages and GPS data messages comply with NMEA 0183 as follows:

- NMEA ASCII byte strings following $-character.
- Headers are standard NMEA or Ashtech proprietary NMEA.
- Message IDs are standard NMEA or Ashtech proprietary NMEA.
- Standard NMEA format messages contain hexadecimal checksum.
- Data items are separated by commas; successive commas indicate invalid or missing data.
- Message is ended with <Enter>, the standard NMEA message terminator characters.

SERIAL PORT CONFIGURATION

The SCA-12/12S provides three RS-232 serial ports with two-way full-duplex communication. The default transmit/receive protocol is 9600 baud, eight data bits, no parity, and one stop bit (8N1). The baud rate of the SCA-12/12S ports is adjustable using the $PASHS,SPD speed set command; the

data bit, stop bit and parity protocol is always 8N1.

On initial power-up or after use of the $PASHS,RST (reset) command, the SCA-12/12S default is 9600 baud for all three RS-232 serial ports A, B, and C.

The baud rates between the SCA-12/12S and the interfacing equipment must be the same for the port and the device connected to the port.

To resume communication with the SCA-12/12S after changing the baud rate using the $PASHS,SPD set command, change the baud rate of the command device.

PARAMETER SETTINGS AND STATUS

On initial power-up or after use of the $PASHS,RST reset command, the SCA-12/12S reverts to its default parameter settings. To get the current status of these settings, there are four query commands available: $PASHQ,PAR (general parameters), $PASHQ,RAW (raw data parameters), $PASHQ,RTC (differential parameters), and $PASHQ,SES (session parameters).

$PASHQ,PAR Query Command

The response message for the default values of the query command $PASHQ,PAR (general parameters) is:

```
SVS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
PMD:1  FIX:0  PDP:40   HDP:04   VDP:04
PEM:05   PPO:N UNH:N   ION:N   SAV:N
DIF_RTCM MOD:OFF    PRT:A
DIF_ASH  MOD:OFF    PRT:A
LAT:00:00.00000N  LON:000:00.00000E  ALT:+00000.00
NMEA: POS GLL GXP GGA VTG GSN MSG GSS SAT GRS RRE TTT GSV GSA
PRTA: 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
PRTC: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PER: 000.5
```

Where:

SVS:Y Satellites which the SCA-12/12S will attempt to acquire, default is all Y

PMD:1 Position mode for the minimum number of satellites required to compute a position fix. With default value (1), a minimum of 3 SVs is needed to compute a position. With 3 SVs, the altitude is held fixed (2-D); with 4 or more SVs, the altitude is not held fixed (3-D).

FIX:0 Altitude hold fix mode to be used when computing a 2-D position (see PMD). With the default value (0), the most recent altitude computation is used.

PDP:40 Position Dilution Of Precision mask. Default is 40.

HDP:04 Horizontal Dilution Of Precision mask. Default is 04.

VDP:04 Vertical Dilution Of Precision mask. Default is 04.

PEM:05 Position elevation mask. Elevation below which the satellite will not be used to compute a position. Default is 05 degrees.

PPO:N Point positioning. An averaging technique to increase the accuracy of a stand-alone position. The default is N.

UNH:N Use unhealthy satellites for position computation. The default is N.

ION:N Include the ionospheric and the tropospheric model in the position fix computation. Default is N.

SAV:N Save parameters in the battery-backed-up memory. With default value (N), at the next power cycle, the default parameters are used.

DIF_RTCM RTCM differential

MOD:OFF Differential mode, OFF, BASE or REMOTE

PRT:A Port sending or receiving differential corrections

DIF_ASH Ashtech differential (not implemented in this release)

LAT:0 Latitude of the antenna position in degrees and decimal

minutes. Default is 0.

LON:0 Longitude of the antenna position in degrees and decimal minutes. Default is 0.

ALT:0 Height of antenna in meters. Default is 0.

For NMEA messages POS, GLL, GXP, GGA, VTG, GSN, MSG, GSS, SAT, GRS, RRE, TTT, GSV, and GSA, the default is OFF (disabled) for all ports. (PRTA, PRTB, PRTC).

PER:000.5 Send interval of the NMEA response messages, with the exception of TTT, in half-seconds if the 2 HZ option is installed; if not installed, once per second. Default is once per half-second if 2 HZ option is installed; if not, once per second.

$PASHQ,RAW Query Command

This query is available only if Raw Data Outputs option (O) is installed in the receiver. The response message for the default values of the query command $PASHQ,RAW (raw data parameters) is:

```
RCI:020.0  MSV:3  ELM:05  REC:Y
ANH:0.0000 SIT:????   EPG:000  RNG:0
RAW:  MBN  PBN  SNV  SAL  MCA
PRTA: OFF  OFF  OFF  OFF  OFF
PRTB: OFF  OFF  OFF  OFF  OFF
PRTC: OFF  OFF  OFF  OFF  OFF
```

Where:

RCI:020.0 This is the send or record interval of the data in seconds. Default is once every 20 seconds.

MSV:3 Minimum number of SVs for the data to be sent or recorded. Default is 3.

ELM:05 Data elevation mask. The elevation below which data from that satellite will not be recorded.

REC:Y Data recording to internal memory.

ANH:0.0000 Antenna height.

SIT:???? Four-character site name.

EPG:000 Epochs to go. The counter used during kinematic surveys to specify the number of epochs to collect data at a site.

RNG:0 Data mode. Determines the data type to be stored:
0 = carrier phase, 2 = positions only

RAW: Shows ON/OFF status for each raw data type and each port. For all raw data outputs (MBN,PBN,SNV,SAL,MCA) default is OFF.

$PASHQ,RTC Query Command

This query is available only if one of the differential options (B or U) is installed in the receiver. The response message for the default values of the query command $PASHQ,RTC (differential parameters) is:

```
STATUS:
  SYNC:      TYPE:00  STID:0000  STHE:0
  AGE:+000  QA:100.0%  OFFSET:00
SETUP:
  MODE:OFF  AUT:N
  SPD:0300  STI:0000  STH:0
  MAX:0120  QAF:100   SEQ:N
  TYP:1   2   3  6   9  16
  FRQ:99  00  00 OFF 00 00
MSG:
```

Where:

STATUS Displays the status of the differential data when differential mode is enabled.

- SYNC: Indicates with an * that synchronization between base and remote has been established. Valid only for REMOTE mode.
- TYPE: Indicates type of message being sent (base) or received (remote).
- STID: Displays the station ID received from the base

station.

STHE: Displays the station health received from the base station.

AGE: In BASE mode, displays the elapsed time in seconds between the beginning of the transmission of Type 1 or 9 messages. In REMOTE mode, displays the age of the received messages in seconds.

QA: Displays the communication quality factor between base and remote. Defined as

$$\frac{\text{number of good measurements}}{\text{total number of messages}} \times 100$$

Valid for REMOTE mode only.

OFFSET: Displays the number of bits from the beginning of the RTCM byte (in case of a bit slippage).

SETUP: Displays the default value setting for the differential parameters.

MODE:OFF Set Differential Mode to base, remote, or disabled. Default is OFF.

AUT:N Enable Auto Differential Mode. Default is N. Used only in REMOTE mode.

SPD:0300 Sets the number of bits per second sent from the differential serial port. Default is 300. Used only in BASE mode.

STI:0000 Sets the station ID supplied by the user. Default is 0000.

STH:0 Sets the reference station health. Default is 0. Used only in BASE mode.

MAX:0060 Specifies the maximum age, in seconds, required for a message to be used. Default is 60. Used only in REMOTE mode.

QAF:100 Sets the criteria to be applied when evaluating the quality of communication between base and remote. Default is 100. Used only in REMOTE mode.

SEQ:N Check for sequential received message number for the message to be accepted. Default is N. Used only in REMOTE mode.

TYP: Indicates the type of messages the receiver can generate. Messages available are 1, 2, 3, 6, 9, and 16. Used only in BASE mode.

FRQ: Enables message type 6, and indicates the output period for message types 1, 2, 3, 9, and 16. A 0 indicates message disabled, a 99 indicates continuous output, and any other number specifies the number of seconds between transmissions for message types 1 and 9, and the number of minutes between transmissions for all other messages. Default for message type 1 is 99, for message type 6 is OFF, and for all other messages is 00.

MSG: For BASE mode, it contains the message, up to 90 characters, that is sent from the base to the remote when message type 16 is enabled. In REMOTE mode, it displays the message, up to 90 characters, that is received from the base.

If any of these parameters are changed by the corresponding set commands, send the corresponding query command to get the current status. If changed, parameter values are saved by the $PASHS,SAV,Y set command. After the next power-up, the response message to the corresponding query command will display the saved quantities instead of the defaults. $PASHS,RST always reinstates the defaults.

$PASHQ,SES Query Command

This query is available only if Session option (S) is installed in the receiver. The query command **$PASHQ,SES<Enter>** can be used to display session parameters. This query is available only if the session option is installed in the receiver.

The receiver response is:

```
       START    END       INT     MASK       MIN       TYPE
A  N   00:00:00 00:00:00 020.0     10         3           0
B  N   00:00:00 00:00:00 020.0     10         3           0
C  N   00:00:00 00:00:00 020.0     10         3           0
D  N   00:00:00 00:00:00 020.0     10         3           0
E  N   00:00:00 00:00:00 020.0     10         3           0
F  N   00:00:00 00:00:00 020.0     10         3           0
G  N   00:00:00 00:00:00 020.0     10         3           0
H  N   00:00:00 00:00:00 020.0     10         3           0
I  N   00:00:00 00:00:00 020.0     10         3           0
J  N   00:00:00 00:00:00 020.0     10         3           0
INUSE:N   REF:000 OFFSET:00:00 TODAY:327
```

SATELLITE SEARCH ALGORITHM

When the SCA-12/12S is operated for the first time after receipt from Ashtech, the non-volatile memory must be cleared of factory acceptance test position, almanac, and ephemeris data. This is done with the $PASHS,RST reset command. Initially, therefore, no almanac or ephemeris data is available. The SCA-12/12S always assigns the first 12 elements of a 32-element table of SV PRN numbers to its 12 channels. These first 12 SVs are chosen to be members of the current actual SV constellation. This reduces the SV acquisition time. Within six seconds after an SV is locked, the SCA-12/12S time is set. If no ephemeris data is available in the memory, or if the data is older than ten hours, 30 to 60 seconds may be needed to collect data. After three or four SVs are locked and the almanac/ephemeris data is collected, the SCA-12/12S attempts to compute its first position fix using an estimated position based on SV locations. The SCA-12/12S continuously collects in its non-volatile memory the almanac and ephemeris data as well

as the most recent position for calculations in the current session. The time to the first position fix, if no almanac/ephemeris data is available, is typically two minutes.

At the next power up, if the almanac/ephemeris data from non-volatile memory is available, the SCA-12/12S uses the almanac data to search only the visible SVs. The almanac data also allows the prediction of the doppler shift and the SCA-12/12S clock offset to reduce the lock time considerably.

POSITION MODES

The SCA-12/12S performs a position fix computation in four modes. The $PASHS,PMD command us used to select the mode.

In **mode 0** at least four SVs with elevation equal to or above the position elevation mask are needed to compute a position. All three polar coordinates are computed in this mode.

In **mode 1** at least three SVs with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and the longitude are computed if three SVs are locked and the altitude is held. If more than three SVs are locked, this mode is similar to mode 0.

In **mode 2** at least three SVs with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and the longitude are computed, and the altitude is always held.

In **mode 3** at least three SVs with elevation equal to or above the position elevation mask are needed to compute a position. Only the latitude and longitude are computed, and the altitude is held if only three SVs are locked. If more than three SVs are used and the HDOP is less than the specified HDOP mask, all three polar components are computed. If HDOP is higher than the specified HDOP mask, the SCA-12/12S automatically goes into the altitude hold mode.

POINT POSITIONING

The Point Positioning option improves the accuracy of a stand-alone absolute position from about 50 meters to less than 5 meters. Point positioning uses an averaging technique to reduce or eliminate the effects of Selective Availability (SA) and other fluctuating errors. This technique can be used only when the receiver is static, and takes a couple of hours for the accuracy to be achieved. The point positioning mode can be set using the $PASHS,PPO command. See the *Command/Response* chapter for details.

ALTITUDE HOLD DEFINITION

Two modes define what altitude is selected when the SCA-12/12S is in altitude hold mode. The $PASHS,FIX set command can be used to select between these modes.

In mode 0 the most recent altitude is used. This is either the one entered by using the $PASHS,ALT set command or the one computed when four or more SVs are used in the solution, whichever is most recent. If the last altitude is the one computed with four or more SVs, it is used only if VDOP is less than the VDOP mask.

In mode 1 only the last altitude entered is used in the position fix solution.

On initial power-up or after use of the $PASHS,RST set command, the most recent antenna altitude is zero.

IONOSPHERIC MODEL

The SCA-12/12S can be set to use an ionospheric model in its position fix computation. The ionospheric model is based on the model defined in ICD-GPS-200, Revision B.

ANTENNA POSITION SETTING

When in Differential Base Mode, the SCA-12/12S determines range correction by subtracting the measured range from the true range, computed by using an accurate antenna position entered previously in the receiver. Four commands are available to enter this known position:

$PASHS,POS (position setting including latitude, longitude, altitude)
$PASHS,LAT (latitude setting)
$PASHS,LON (longitude setting)
$PASHS,ALT (antenna height setting)

NMEA OUTPUTS

As an option, the SCA-12/12S allows you to output NMEA message format through serial ports A, B, and C. Ten different types of messages are available: GLL, GXP, GGA, VTG, GSN, MSG, GSS, GRS, GSV, and GSA. All the NMEA messages are a string of ASCII characters defined by commas and that comply with NMEA 0183 Standards Version 2.0. Transmission protocol is 8 data bits, 1 stop bit, and no parity bit. Any combination of these messages can be output through any of the serial ports, and the same messages can be output through different ports at the same time. The output rate is determined by the $PASHS,NME,PER command, and can be set to any value between 0.5 and 999.5 seconds if the 2HZ option is installed, or between 1 and 999 seconds if the 2HZ option is not installed. Additional details are presented in the discussion of NMEA message commands.

RAW DATA OUTPUTS

As an option, the SCA-12/12S has a feature that allows you to send real-time data out through serial ports A, B, and C. Five different types of messages are available:

MBN messages which contain measurement data output with Ashtech type 2 data structure
PBN messages which contain position data
SNV messages which contain ephemeris data
SAL messages which contain proprietary almanac data
MCA messages which contain measurement data (same as MBN) output with Ashtech type 3 data structure

All outputs are in binary format and the transmission protocol is 8 data bits, 1 stop bit, and no parity bit. Any combination of messages can be output through any of the serial ports, and the same messages can be output through different ports at the same time. The output rate is determined by the $PASHS,RCI setting. Information on the data structures for all the above messages can be found in the RAW DATA MESSAGES section.

DIFFERENTIAL OPERATION

This section discusses differential operation in general, sources of error, the SCA-12/12S messages for differential, and RTCM 104 format as it applies to a reference station and to a remote station. Differential remote and base operation are available as receiver options.

General

Real-time differential positioning involves a reference (base) station computing the SV range corrections and transmitting them to the remote (rover) stations. The reference station transmits these 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.

The base receiver determines range correction by subtracting the measured range from the true range, computed by using the accurate position entered in the receiver. This accurate position must have been previously surveyed using GPS or some other technique. The remote receivers subtract the received corrections from their measured ranges and use the corrected ranges for position computation.

As stand-alone, the SCA-12/12S can compute a position of around 25 meters with Selective Availability off and around 100 meters with SA on. Differential GPS can achieve sub-meter precision at the remote receivers even with SA on.

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.

Sources of Error

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

Receiver noise is not correlated between the base and the remote receiver and is not canceled by differential GPS. However, in the SCA-12/12S, integrated doppler is used to smooth the range measurements and reduce the receiver noise.

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

If the lock to a SV is lost, the noise goes back to one meter and smoothing starts from the one-meter level. The loss of lock to an SV is rare. It typically happens only when the direct path to the SV is blocked by an object.

Total position error (or error-in-position), is a function of the range errors (or errors-in-range) multiplied by the PDOP (three-coordinate position dilution of precision). The PDOP is a function of the geometry of the SVs.

RTCM Messages

The SCA-12/12S can accept RTCM 104 version 2.0 differential formats. The SCA-12/12S is set to differential mode in any of the three ports with the set command **$PASHS,RTC,str,c** where str is BAS or REM and c is the port. Of RTCM message types 1 through 64, the SCA-12/12S processes only: types 3 and 16 for station location and special information; types 1, 2 and 9 for RTCM differential corrections; and null frame type 6. The differential corrections are

automatically processed by the SCA-12/12S. RTCM message types 3 and 16 provide user information from the reference (base) station via the $PASHS,NME,MSG set command and the $PASHQ,MSG inquiry command. RTCM message types 1 and 9 provide differential correction information via the $PASHS,NME,MSG set command and $PASHQ,MSG query command. The reference station sends types 1, 2 and 9 continuously and may send either type 3 or type 16 individually.

On initial power-up or after use of the $PASHS,RST reset set command, the SCA-12/12S default automatic differential mode is OFF, and the default is 120 seconds for the maximum age of an RTCM differential correction above which it will not be used. If the automatic mode is not enabled by the $PASHS,DIF,AUT set command and the differential correction data is older than the maximum age specified by the $PASHS,RTC,MAX set command, the SCA-12/12S will not return antenna position data.

In automatic mode, if no differential correction data is received or the age of data is older than the specified maximum age, the SCA-12/12S will return the uncorrected raw position.

RTCM 104 Format, Version 2.0

When the SCA-12/12S is used as a reference station and the RTCM option is enabled, it computes differential corrections for up to 12 SVs, converts those corrections to RTCM format and transmits the converted messages via its serial ports. It can generate message types 1, 2, 3, 6, 9, and 16, as detailed in the following table.

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

The SCA-12/12S uses the six-of-eight format (data bits a1 through a6 of an eight-bit byte) for communication between the reference station and user equipment.

When the SCA-12/12S is used as remote equipment and the RTCM option is enabled, the SCA-12/12S can accept any type of RTCM message. However it decodes types 1, 2, 3, 6, 9, and 16 and uses only types 1, 2, and 9 for differential corrections. For radio communication, the SCA-12/12S in remote mode can recover bit slippage.

PHOTOGRAMMETRY (EVENT MARKING)

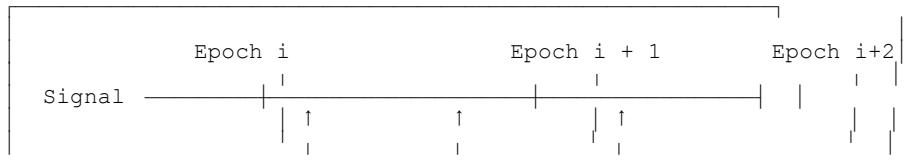
When the event [E] option is installed, the SCA-12/12S can measure and record event times with high accuracy. In order to store an event time in the receiver's memory, a trigger signal must be applied to the appropriate connector located on the back panel of the SCA-12/12S; in the SCA-12, this connector is serial port B; in the SCA-12S this connection is pin 19 of the DB25 connector. The photogrammetry feature allows the event time to be stored in memory and downloaded using the HOSE program, or output by using the $PASHS,NME,TTT command.

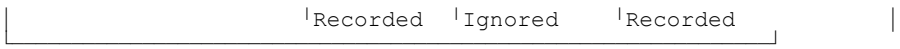
At the rising or falling edge (selectable) of the trigger signal, the time is recorded in the receiver's nonvolatile external memory. The recorded time can be read by the downloading (HOSE) program at a later time. The trigger signal can be set to the falling edge using the $PASHS,PHE command.

The measured time is accurate down to 1 microsecond. This is a GPS time (UTC + 10 seconds) and is recorded as the number of seconds since the start of the GPS week (00:00 a.m. Sunday). The HOSE program reads the time and converts it to day number, hours, minutes, seconds, and fractional seconds up to 6 digits. With each event time, the receiver also records the site name. One example of the record is:

TEXA 4 21:30:19:430964

The photogrammetry time measures the event time relative to the receiver's GPS time. It measures only the first event during the period between 2 GPS epochs. See figure below. This allows use of mechanical switches without concern for contact bounces.





The receiver stores only one event time per data collection period. If more than one event time is measured within a data collection period, the receiver records only the first one.

Therefore, setting the interval parameter to 1 second ($PASHS,RCI,1) yields the highest event time record rate.

Because the 1 PPS signal is being used to record the photogrammetry events, the period of the 1 PPS signal needs to be set to a value equal to or less than the period of the EVENT pulse.

The trigger pulse may be TTL-compatible or open collector. Minimum pulse duration is 100 nanoseconds when the signal is not terminated at the receiver input. The impedance is approximately 2K ohms.

Use a coaxial cable with BNC connectors to connect the camera trigger output to the photogrammetry input connector of the SCA-12/12S.

Time Tagging the Shutter Signal

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

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

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

Closed-Loop Technique

The closed-loop technique combines PPS synchronization and shutter timing as shown in Figure 6.

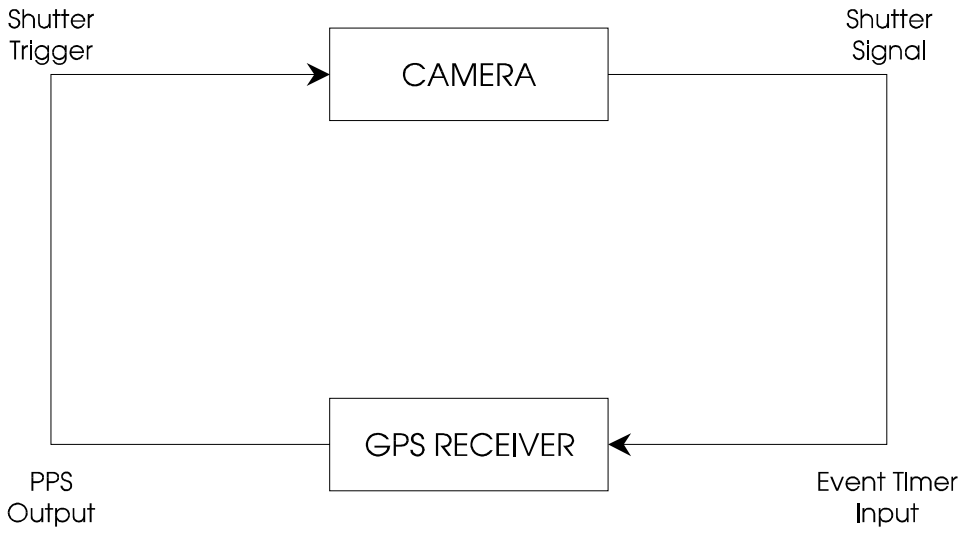


Figure 6. Closed-Loop Technique

In this technique, the 1PPS output of the SCA-12/12S triggers a camera shutter. The camera shutter generates a signal that is fed to the SCA-12/12S for accurate time tagging, better than one microsecond.

The delay between the camera receiving the pulse and triggering the EVENT IN port should be calculated. This may then be applied so as to advance the 1PPS from the SCA-12/12S so that the shutter time exactly matches the GPS time for the epoch. No interpolation between the shutter time and the GPS position time will be needed.

PULSE GENERATION (1PPS)

When the 1PPS [L] option is installed, the SCA-12/12S provides the capability of a 1 pulse-per-second (1PPS) signal syncronized with GPS time. The PPS signal is TTL-level into a 75-ohm impedance. 1PPS is generated by default once every second with its rising edge synchronized to GPS time. Using the $PASHS,PPS command, the period of the PPS may be changed fron one second up to 32 seconds, and may be offset from GPS time up to 500 milliseconds with a resolution of 100 nanoseconds.

In the SCA-12, PPS is output through Port C. In the SCA-12S, PPS is output on pin 15 of the DB25 connector.

Figure 7 shows the PPS characterisics. PPS occurs when the signal goes high. PPS is generated exactly on the GPS second as long as at least 4 SVs are locked. If fewer than 4 SVs are locked, position must be held fixed to ensure accuracy of the pulse. The pulse remains high for 1-2 milliseconds. Accuracy is ± 100 microseconds.

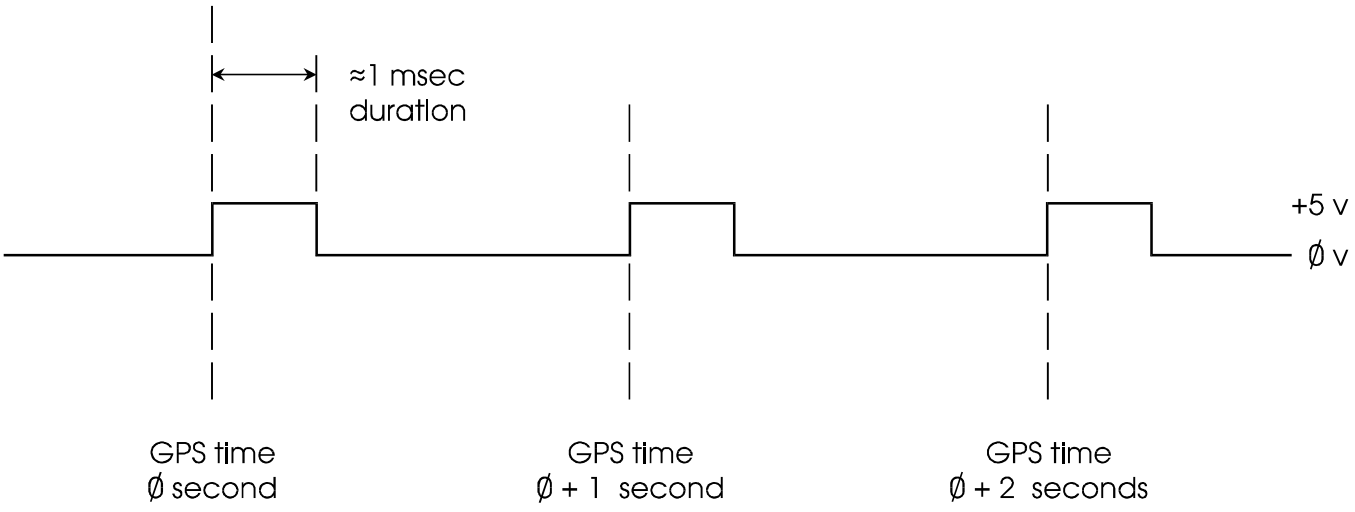


Figure 7. 1PPS Pulse

RECEIVER COMMANDS

Receiver commands are used to change various default operating parameters such as elevation mask, latitude of antenna, operating modes, etc. Receiver commands can be either SET commands or QUERY commands. SET commands are used to change the desired parameter. QUERY commands are used to display parameter and operating information stored in the receiver.

Set command messages are accepted by all serial ports. When the SCA-12/12S receives a set command message it returns an "acknowledged" message if it accepts the command; the SCA-12/12S returns a "not acknowledged" message if it rejects the command.

The set command message format is:

$PASHS,xxx,<data items>*cc<Enter>

Where:

$	Message start character
PASHS	proprietary Ashtech set message header
xxx	proprietary message ID for message command
<data items>	data field dependent upon message ID
*	Checksum character delimiter - optional
cc	Checksum bytes - optional

NOTE

All message items between the $ and the * including data items are separated by commas; if any of these message items is not available, it will be omitted.

The acknowledged message is: $PASHR,ACK*3D<Enter>.

The not-acknowledged message is: $PASHR,NAK*30<Enter>.
Examples:

1) Set message $PASHS,UNH,Y<Enter> instructs the SCA-12/12S to include unhealthy satellites in position fix computation; the SCA-12/12S returns $PASHR,ACK*3D<Enter>.

2) Set message $PASHS,UNH lacks the data (Y or N), therefore the SCA-12/12S returns $PASHR,NAK*30.

NOTE

To get the current status of parameters altered by the set commands, send the applicable query command

$PASHQ,PAR for paramters
$PASHQ,RAW for raw data
$PASHQ,RTC for real time, or
$PASHQ,SES for session.

The **query** commands are used to request current GPS information and receiver status information such as port baud rate setting, position information, and tracking information. Query command messages can be sent to the SCA-12/12S through RS-232 serial port A, B, or C, and in some cases, also directed so that the SCA-12/12S responds through either port A, B, or C. The SCA-12/12S acknowledges a valid query command message by sending , the requested response message through the specified port. The information requested is sent once each time the command is issued and is not repeated.

The query command message format is:

$PASHQ,xxx,<data items>*cc<Enter>

Where:

$	NMEA message start character
PASHQ	proprietary Ashtech query message header
xxx	proprietary message ID for message command
<data items>	data field dependent upon message ID
*	Checksum character delimiter - optional
cc	NMEA checksum bytes - optional.

NOTE

All message items between the $ and the * including data items are separated by commas; if any of these message items are omitted, the SCA-12/12S ignores the command.

Table 1 lists these receiver commands alphabetically by function, and then alphabetically within each function. The commands are described in detail in the pages following Table 1.

Table 1. Receiver Commands

FUNCTION	COMMAND	DESCRIPTION
Antenna position	$PASHS,ALT $PASHS,LAT $PASHS,LON $PASHS,POS	Set ellipsoidal height of antenna Set latitude of antenna Set longitude of antenna Set position of antenna
Antenna height	$PASHS,ANH	Set height of antenna
Data recording	$PASHS,EPG $PASHS,MSV $PASHS,REC $PASHS,RCI $PASHS,SIT	Set epochs to go Set minimum number of satellites Turn data recording on/off Set recording interval Set site name
Dilution of Precision (DOP)	$PASHS,HDP $PASHS,PDP $PASHS,VDP	Set HDOP mask for position computation Set PDOP mask for position computation Set VDOP mask for position computation
Elevation masks	$PASHS,ELM $PASHS,PEM	Set data collection elevation mask Set elevation mask for position computation
File generation/ data storage	$PASHS,DSC $PASHS,FIL $PASHS,RNG $PASHQ,DIR	Store string to current open file Close or delete current file Set data type Request receiver file directory information
Ionosphere	$PASHS,ION	Include/exclude ionospheric model
Memory	$PASHS,CLM $PASHS,RST $PASHS,SAV $PASHQ,MEM	Clear external memory Reset receiver and clear all memory Save parameters in battery-backed-up memory Request result of last memory test
Photogrammetry/ 1PPS	$PASHS,PHE $PASHS,PHO $PASHS,PPS $PASHQ,PPS	Set photogrammetry edge Delete photogrammetry file Set period and offset of 1PPS signal Display 1PPS parameters
Position computation	$PASHS,FIX $PASHS,PMD $PASHS,PPO $PASHS,UNH	Set altitude hold position fix mode Set position computation mode Set the point positioning mode Omit/include unhealthy satellites for position computation
Receiver configuration	$PASHS,DSY $PASHS,LPS $PASHS,POW $PASHS,PWR $PASHS,SPD $PASHQ,PAR $PASHQ,PRT $PASHQ,RID	Configure serial ports as daisy chain Set loop tracking parameters Set battery capacity, remaining power, voltage Turns the SCA-12 unit off Set baud rate of serial port Request current settings of sensor parameters Request port baud rate Request receiver identification

Satellites	$PASHS,SVS $PASHS,USE $PASHQ,SEL $PASHQ,STA	Designate SVs to acquire Designate satellites to use Request SVs being tracked or searched in each channel Request status of SVs currently locked
Session programming	$PASHS,SES,PAR $PASHS,SES,SET $PASHQ,SES	Set session programming parameters Set individual session programming parameters Request session program parameters

Antenna Position Commands

The antenna position commands let you set the altitude, latitude, and longitude of the antenna.

Altitude of Antenna, Altitude Hold Fix

$PASHS,ALT,sxxxxx.xx
Sets the ellipsoidal height of the antenna, where s = + or -, and x = 0 to 99999.99. The SCA-12/12S uses this data in the position calculation for 2-D position computation, and when the receiver is in differential base mode.

Examples:
$PASHS,ALT,+100.25<Enter>
$PASHS,ALT,-30.1<Enter>

Latitude of Antenna Position

$PASHS,LAT,ddmm.mmmmmmm,x
Sets the latitude of the antenna used in differential base mode, where ddmm.mmmm is latitude in degrees (dd) and decimal minutes (mm.mmmmmmm), and x is N (North) or S (South). The default is 0.

Example:
$PASHS,LAT,3722.3819219,N<Enter>

Longitude of Antenna Position

$PASHS,LON,dddmm.mmmmmmm,x
Sets the longitude of the antenna used in differential base mode, where dddmm.mmmm is longitude in degrees (ddd) and decimal minutes (mm.mmmmmmm), and x is E (East) or W (West). The default is 0.

Example:
$PASHS,LON,12159.8291219,W<Enter>

Position of the Antenna

$PASHS,POS,ddmm.mmmmmmm,x,dddmm.mmmmmmm,y,sxxxxx.xx
Sets the position of the antenna used in differential base mode, where ddmm.mmmmmmm is latitude in degrees (dd) and decimal minutes (mm.mmmmmmm), x is North (N) or South (S), dddmm.mmmmmmm is longitude in degrees (ddd) and decimal minutes (mm.mmmmmmm), y is East (E) or West (W), and sxxxxx is the ellipsoidal height in meters where s is the sign (+ or -) and xxxxx ranges from 0 to ±99999.99.

Example:
$PASHS,POS,3722.2912129,N,12159.7998265,W,+15.25<Enter>

Antenna Height Command

$PASHS,ANH,x.xxxx
Sets the antenna height, where x.xxxx is the height in meters. Maximum value is 6.4000.

Example:
$PASHS,ANH,2.0000<Enter>

Data Recording Commands

The data recording commands let you define parameters for recording data. epochs to go, record on/off, recording interval, and site name.

Epochs To Go

$PASHS,EPG,x
Set epochs to go (for kinematic use), where x (number of epochs to go) is a number between 0 and 999. Epochs to go is a counter used during kinematic surveys that specifies the number of data epochs to be collected at the current

site. When the counter reaches 0, the site name automatically changes to **????**, indicating that the antenna is about to move.

Example: Set epochs to 27
$PASHS,EPG,27<Enter>

Set Minimum Satellites

$PASHS,MSV,x

Set the minimum number of satellites for data collection, where x is a number between 1 and 9. Default is 3.

Example: Set minimum satellites to 4
$PASHS,MSV,4<Enter>

Turn Data Recording On/Off

$PASHS,REC,x

Turn data recording on or off, where x is Y (yes) or N (no).

Example: Turn data recording on
$PASHS,REC,Y<Enter>

Recording Interval

$PASHS,RCI,x.x

Sets the value of the interval at which data will be output or recorded, where x is any ½-second or full-second number between 0.5 and 999.5 in seconds (½ second is not available if the 2HZ option is not installed). Default is 20.0.

Example: Set recording interval to 5.0 seconds
$PASHS,RCI,5.0<Enter>

Set Site Name

$PASHS,SIT,x

Set the site name, where x is user-defined string of four characters.

Example: Set site name to 0001
$PASHS,SIT,0001<Enter>

Dilution Of Precision Commands

The dilution of precision (DOP) commands let you set the horizontal, position, and vertical DOP masks for position computation.

$PASHS,HDP,x

Set the value of the HDOP mask (default = 4), where x is a number between 0 and 99.

Example:
$PASHS,HDP,6<Enter>

$PASHS,PDP,x

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

Example: Set PDOP to 30
$PASHS,PDP,30<Enter>

$PASHS,VDP,x

Set the value of the VDOP mask (default = 4), where x is 0 to 99.

Example: Set VDOP to 6
$PASHS,VDP,6<Enter>

Elevation Mask Commands

The elevation masks let you set masks for data collection and position computation.

$PASHS,ELM,x

Set the value of the SV elevation mask for data collection, where x is a number between 0 and 90 (default = 5 degrees)

Example: Set elevation mask to 10 degrees
$PASHS,ELM,10<Enter>

$PASHS,PEM,d

Set elevation mask for position computation where d is 0 to 90 degrees. Default is 5 degrees.

Example: Set position elevation position mask to 15 degrees
$PASHS,PEM,15<Enter>

File Generation//Data Storage Commands

The file generation/data storage commands let you control file operations and set data type.

Store String

$PASHS,DSC,s

Store a string as an event data to current open file in receiver, where s is an ASCII string, maximum 80 characters. The file is output as a D-file during data downloading.

Example: Store string "This is a test"
$PASHS,DSC,This is a test<Enter>

Close or Delete File

$PASHS,FIL,x,y

Closes the current file or deletes a designated file, where x is C for close or D for delete, and y is the file number. The receiver can store up to 10 files in mode 0 or 2.

NOTE
The first file is numbered 0, not 1.

Examples:

$PASHS,FIL,C<Enter>	Close the last file and open a new one.
$PASHS,FIL,D,y<Enter>	Delete file y

Type of Data

$PASHS,RNG,x

Set data type mode, where x is 0 or 2: 0 = geodetic data (B-file), 2 = position data (C-file).

File Directory

$PASHQ,DIR,x

This command requests receiver file directory information, where x is port A, B, or C.

The associated receiver response message is:

$PASHR,DIR,d1,d2,d3,d4,d5,d6,d7,d8,d9*CK

where

d1 = total number of files, range 1 to 10
d2 = file name, 4 characters
d3 = file size in Kwords, 4 digits
d4 = weeknumber(3 char), day (1 char), hours (2 char), min(2 char)
d5 - d7 for second file (if any)
d8 = free memory in external RAM in Kwords, 4 digits
d9 = percent of external RAM free in %

Ionospheric Model Commands

$PASHS,ION,x

Exclude or include the ionospheric model model from the position computation, where x = N (no) or Y (yes). Default is N (exclude).

Example: Include ionospheric model
$PASHS,ION,Y<Enter>

Memory Commands

The memory commands let you clear external memory, save parameters, and reset the receiver.

Clear External Memory

$PASHS,CLM

Clear and test the external memory where files are stored.

Example:
$PASHS,CLM<Enter>

This command deletes all the files and finds the size of the external memory and tests it. The response to this command is:

$PASHR,CLM,WAIT<Enter>
$PASHR,CLM,SIZE,xxxxKW<Enter> (xxxxKW is kilowords, 0 to 9999)
$PASHR,CLM,PASSED<Enter>
$PASHR,CLM,FAILED,d1,WRITE,d2,READ,d3<Enter>

where
d1 = address of the failed location
d2 = the pattern written to this location
d3 = the pattern read from this location

Save Parameters

$PASHS,SAV,x

Enables or disables the command to save user parameters in memory, where x is Y (yes) or N (no). Parameters are saved until the receiver is reset.

Example: Enable the save parameter command
$PASHS,SAV,Y<Enter>

Reset SCA-12/12S

$PASHS,RST<Enter>

Reset the SCA-12/12S and clear all memory. All parameters are reset to the defaults, and all almanac data is cleared.

Memory Test Status

$PASHQ,MEM

Show the result of the last memory test of the SCA-12/12S.

Example:

Query: $PASHQ,MEM<Enter>
Response: $PASHR,MEM,00000000,00000000,00000000

Photogrammetry (Event Marker) and 1 PPS Commands

$PASHS,PHO,D

This command allows you to delete the photogrammetry file from the receiver memory.

Example: Delete the photogrammetry file
$PASHS,PHO,D<Enter>

Set Photogrammetry Edge

$PASHS,PHE

The SCA-12/12S receiver allows you to set the edge (rising or falling) at which the trigger signal associated with the event marker will be recorded in memory. To set the edge of the trigger signal, use the following command:

$PASHS,PHE,x

where x = R (photo rising edge), or F (photo falling edge). Default is R.

$PASHQ,PHE,x

The associated query command is $PASHQ,PHE,x<Enter>, where x is port A, B, or C.

Example: Check photogrammetry edge on port B
Query: $PASHQ,PHE,B<Enter>
Response:$PASHR,PHE,R (or F)

1 PPS Pulse Output

$PASHS,PPS

The SCA-12/12S receiver can generate 1PPS pulse with programmable period and offset. 1 PPS is generated by default once every second with its rising edge synchronized to the GPS time. To change the period and the offset of the pulse use the following command:

$PASHS,PPS,xx,yyy.yyyy,a<Enter>

where

xx	1PPS period in seconds (max 60)
yyy.yyyy	offset from GPS time in milliseconds, with 10ns resolution
a	R or F. R means generate the PPS on the rising edge of the pulse. F means generate the PPS on the falling edge of the pulse.

$PASHQ,PPS

The associated query command is **$PASHQ,PPS,x<Enter>**, where x is port A, B, or C.

Example: Check PPS parameters on port A
$PASHQ,PPS,A<Enter>

The receiver response message is in the form:

$PASHR,PPS,xx,yyy.yyyy,a

The 1PPS parameters are saved automatically through a power cycle.

Position Computation Commands

The position computation commands let you set altitude hold, set position computation mode, and omit or include unhealthy satellites.

Fix, Altitude Hold Position

$PASHS,FIX,x

Set altitude hold position fix mode for the altitude used (for 2-D position determination), where x is 0 or 1.

x = 0 (default), the most recent antenna altitude is used in altitude hold position fix. The altitude is taken from either the altitude entered by the $PASHS,ALT command, or the last one computed when VDOP is less than VDOP mask.

x = 1, only the most recently entered altitude is used

Example:
$PASHS,FIX,0<Enter>

Position Mode

$PASHS,PMD,x

Set position mode for minimum number of SVs required to compute a position fix, where x = 0, 1, 2, or 3.

x = 0	minimum of 4 SVs needed (e.g., for 3-D)
x = 1	default, minimum of 3 SVs needed; with 3 SVs, altitude is held (2-D); with 4 or more, altitude is not held (3-D)
x = 2	minimum of 3 SVs needed; altitude always held (always 2-D)
x = 3	minimum of 3 SVs needed; with 3 SVs, altitude is always held; with 4 SVs, altitude is held only if HDOP is greater than HDOP mask (2-D), otherwise 3-D

Example: Set min SVs for 3-D computation

$PASHS,PMD,0<Enter>

Point Positioning Mode

$PASHS,PPO,x

Enables or disables the point positioning mode, where x is Y (yes) or N (no).

Example: Enable point positioning mode
$PASHS,PPO,Y<Enter>

Unhealthy SV Select Group

$PASHS,UNH,x

Omit unhealthy SVs from position computation computation, where x is Y (yes) or N (no).

Example: Include unhealthy SVs
$PASHS,UNH,Y<Enter>

Receiver Configuration Commands

The receiver configuration commands let you set and monitor various operating parameters in the receiver.

Daisy Chain

$PASHS,DSY,x,y

When the receiver is in daisy chain mode it redirects all characters from one serial port to the other without interpreting them, where x is the source port and y is the destination port. Any combination may be chosen (ex: A-> B, B->C etc.). When a port is in daisy chain mode it can only interpret the OFF command; all other characters are redirected. The OFF command gets the port out of daisy chain mode. Redirection can also be bi-directional, that is, (A-> B and B-> A at the same time. Following is a list of commands and their effects:

$PASHS,DSY,A,B<Enter>	Redirects A to B. Can be issued from any port.
$PASHS,DSY,B,A<Enter>	Redirects B to A. Can be issued from any port but it cannot be issued from port A if (1) has already been sent.
$PASHS,DSY,A,OFF<Enter>	Turns off redirection from A. Can be issued from any port.
$PASHS,DSY,OFF<Enter>	Turns off daisy chain on all ports. Can be issued from any port.

Loop Tracking

$PASHS,LPS,x,y

Set user-selectable third-order loop tracking parameters. Loop setting allows you to select the tracking loop parameters based on application. The carrier and code loop parameters are set independently. Firmware uses default values until you select another setting. The user settings are saved in battery-backed memory and are used until a new setting is selected, or the memory is cleared.

Example:
$PASHS,LPS,xx,y,z<Enter>
x = 0 - 10 (ratio)
y = 1, 2, or 3 (option number for selecting carrier loop)
z = 1, 2, or 3 (option number for selecting code loop)

Example:
$PASHS,LPS,2,1,1<Enter>

$PASHQ,LPS

The associated query command is **$PASHQ,LPS,x<Enter>,** where x = port = A, B, or C

$PASHR,LPS

The response is **$PASHR,LPS,x,y,z**

where
x = 0-10 (ratio)
y = 1, 2, or 3 (option number for selecting carrier loop)
z = 1, 2, or 3 (option number for selecting code loop)

Loop setting values:
1. Third-order ratio for carrier loop x (default = 1):
   x = 0 indicates ratio of 0, i.e., no third-order, the carrier loop is a regular second-order loop (with damping of 1 instead of 0.7 as in previous versions)
   x = 1 indicates ratio of 0.1, for low acceleration rate
   x = 10 indicates ratio of 1.0, for high acceleration rate
2. carrier loop parameter y (default = 2):
   y = 1 indicates noise bandwidth of 0 = 10;
   static, very low phase noise

y = 2 indicates noise bandwidth of 0 = 25;
low dynamics, low phase noise (< 2g)
y= 3 indicates noise bandwidth of 0 = 50;
high dynamics, medium phase noise (< 6g)

3. code loop parameter z (default = 1):
z = 1 indicates noise bandwidth of 0 = 1.0;
fast range availability (5 sec), medium range noise
z = 2 indicates noise bandwidth of 0 = 0.5;
medium range availability (10 sec), low range noise
z = 3 indicates noise bandwidth of 0 = 0.1;
slow range availability (50 sec), very low range noise

Power Consumption Set/Query Commands

$PASHS,POW,xxxxx,yyy,zz.z

Issue this command when the battery is fully or partially charged and inserted into the receiver,

where:

xxxxx battery capacity in mAh (500 - 10000)
yyy remaining power in percent (100 if fully charged)
zz.z battery voltage

$PASHQ,POW

To query the battery condition issue the command

$PASHQ,POW,x<Enter>

where x is the port ID, A, B, or C.

$PASHR,POW

The response message to the query command $PASHQ,POW is

$PASHR,POW,wwwww,xxxxx,yyyyy,zz.z
wwwww battery capacity in minutes
xxxxx capacity left in minutes
yyyyy battery capacity in mAh
zz.z battery voltage

NOTE

Indications are estimates based on the accuracy of the data entered with the $PASHS,POW command.

Power Off

$PASHS,PWR,OFF

The SCA-12 receiver can be turned off by issuing the following command:

$PASHS,PWR,OFF<Enter>

To turn on the receiver, send any character through serial port A.

Speed of Serial Port

$PASHS,SPD,x,s

Set the baud rate of the SCA-12/12S serial port x, where x is A, B, or C, and s is a number between 0 and 7 specifying the baud rate as shown in the table below. Default is 9600 baud.

Code	Baud Rate	Code	Baud Rate
0	300	4	4800
1	600	5	9600
2	1200	6	19200

3	2400	7	38400

To resume communication with the SCA-12/12S after changing the baud rate using this command, change the baud rate of the command device.

Example: Set port A to 19200 baud
$PASHS,SPD,A,6<Enter>

Request Current Receiver Parameters

$PASHQ,PAR

To request current settings of receiver parameters, issue the command $PASHQ,PAR<Enter>.

Example:
$PASHQ,PAR<Enter>

```
SVS:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYY
PMD:1  FIX:0  PDP:40   HDP:04   VDP:04
PEM:05  PPO:N  UNH:N   ION:N   SAV:N
DIF_RTCM  MOD:OFF      PRT:A
DIF_ASH   MOD:OFF      PRT:A
LAT:00:00.00000N  LON:000:00.00000E  ALT:+00000.00
NMEA: POS GLL GXP GGA VTG GSN MSG GSS SAT GRS RRE TTT GSV GSA
PRTA: 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
PRTC: OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
PER:000.5
```

For a description of the parameters, see the $PASHS,PAR section of the *Operations* chapter.

$PASHQ,RID

Show the receiver ID for the SCA-12/12S firmware version and installed options.

Example:
$PASHQ,RID<Enter>

$PASHR,RID

The response to the $PASHQ,RID command is a message in the form

$PASHR,RID,SC,vvvv,ooooooooooooo*cc<Enter>

where

SC =	SCA-12/12S
vvvv =	firmware version
ooooooooooooo =	installed options

For more information on the options, see the *Receiver Options* section of the *Operation* chapter.

Example:
Query: $PASHQ,RID<Enter>
Response: $PASHR,RID,SC,1D00,-*1A<CR><LF>

$PASHQ,PRT

Display baud rate in effect for the connected port.

Example:
$PASHQ,PRT<Enter>

$PASHR,PRT

The response is a message in the form

$PASHR,PRT,x,s<CR><LF>

where

x = communication port, A, B, or C
s = communication speed according to the code table below

Code	Baud Rate	Code	Baud Rate
0	300	4	4800
1	600	5	9600
2	1200	6	19200

3	2400	7	38400

Satellite Commands

The satellite commands let you acquire selected satellites and designate satellites to use.

Designate Satellites to Acquire

$PASHS,SVS,xxx...x
Select SVs that the SCA-12/12S will attempt to acquire, where x:

x = Y, SV is used (default).
x = N, SV is not used.

NOTE

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: Use 1-9; do not use 10,11; use 12, 13; do not use 14-32
$PASHS,SVS,YYYYYYYYYNNYYNNNNNNNNNNNNNNNNNN<Enter>

Designate Satellites to Use

$PASHS,USE,d,c
Selects satellites to track or not track.

d = PRN number of the satellite (range from 1 to 32)
c = Y to use, N to not use

Example: Use (track) satellite 15
$PASHS,USE,15,Y<Enter>

Request Status of Satellites Being Tracked

$PASHQ,SEL

Show what satellites are being tracked or searched for each channel. The information is displayed repeatedly from channel 1 to 12.

Example:
Query: $PASHQ,SEL<Enter>
Response: 01 28 31 06 21 22 23 27 29 26 17 09

Show Status of SVs

$PASHQ,STA

Show the status of SVs currently locked by the SCA-12/12S: present time, the PRN number, and the signal count.

Example:
Query: $PASHQ,STA<Enter>
Response:
TIME: 18:38:31 UTC
LOCKED: 03 23 16
COUNT : 54 26 17

Session Programming Commands

The session programming commands let you define **general** and **individual** session parameters.

To set **general** session parameters use the command:

$PASHS,SES,PAR,c1,d1,d2<Enter> where

c1 = mode, N = normal, Y = session, S = sleeping mode
d1 = reference day, 0 - 365,
d2 = offset, mmss, where mm and ss are minutes and seconds, respectively. Range : 00:00 to 59:59.

To set parameters for an **individual** session use the command:

$PASHS,SES,SET,c1,c2,d1,d2,f,d3,d4,d5<Enter>

c1 - session label, A to J
c2 - session flag, Y or N
d1 - session starting time, hhmmss, where hh, mm, and ss are hours, minutes, and seconds respectively.
d2 - session ending time, hhmmss
f - recording interval in seconds
d3 - elevation mask, degrees
d4 - minimum number of satellites
d5 - data type stored, 0 or 2
0 = geodetic data B files, 2 = position C files

Session Programming and Sleep Mode

$PASHS,SES,SET

The receiver provides the capability to set up sessions for recording. The maximum number of sessions is limited to ten. To conserve battery power, the receiver also provides an automatic power-on and power-off feature

according to the session schedule.

Serial commands can be used to provide and modify the input data. The input data goes through the validation process and is rejected if it fails to pass certain criteria. Sessions are re-arranged in the ascendant order of session starting times. Data is recorded if the following conditions are satisfied:

- record flag is set.
- receiver is in session mode.
- current time falls within the range of one of the sessions.

The receiver has two operation modes : **normal** mode or **session** mode. If a non-scheduled power-on event occurs the receiver is automatically set to the normal mode.

The associated query command **$PASHQ,SES<Enter>** can be used to display session parameters.

The receiver response is:

```
       START    END      INT     MASK      MIN       TYPE
A  N   00:00:00 00:00:00 020.0    10         3          0
B  N   00:00:00 00:00:00 020.0    10         3          0
C  N   00:00:00 00:00:00 020.0    10         3          0
D  N   00:00:00 00:00:00 020.0    10         3          0
E  N   00:00:00 00:00:00 020.0    10         3          0
F  N   00:00:00 00:00:00 020.0    10         3          0
G  N   00:00:00 00:00:00 020.0    10         3          0
H  N   00:00:00 00:00:00 020.0    10         3          0
I  N   00:00:00 00:00:00 020.0    10         3          0
J  N   00:00:00 00:00:00 020.0    10         3          0
INUSE:N   REF:000 OFFSET:00:00 TODAY:327
```

RAW DATA COMMANDS

The raw data commands let you enable or disable various raw data messages. Table 2 lists the raw data commands.

Table 2. Raw Data Commands

Command	Function
$PASHS,NME,MBN	Enable/disable raw measurement data message with Ashtech type 2 data structure
$PASHS,NME,MCA	Enable/disable raw measurement data message with Ashtech type 3 data structure
$PASHS,NME,PBN	Enable/disable raw position data message
$PASHS,NME,SNV	Enable/disable raw ephemeris data message
$PASHS,NME,SAL	Enable/disable raw almanac data messsage
$PASHQ,RAW	Show current settings of raw data parameters

The general format for raw data set commands is

$PASHS,NME,str,x,y

This command enables or disables raw data message type str on port x, where x is either A, B, or C, and str is one of the following character stamps: MBN, MCA, PBN, SNV, SAL, and y is ON or OFF. Raw data message is output in binary format.

Example:
$PASHS,NME,MBN,A,OFF<Enter>

NOTES

MBN and PBN messages are output at each recording interval (set with command $PASHS,RCI,x). SNV and SAL are output one satellite at each recording interval, once every hour, including when first requested. SNV is output once every hour.

All raw data query ($PASHQ) commands will output a single response. To get a later response, you will have to reissue the command.

Enable/Disable MBN Message

$PASHS,NME,MBN,x,y

Enable/disable measurement data (MBN) messages with Ashtech type 2 structure on port x, where x is A, B, or C, and y is ON or OFF.

NOTE

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

Example: Disable MBN message on port B
$PASHS,NME,MBN,B,OFF<Enter>

$PASHQ,MBN,x

The associated query command is **$PASHQ,MBN,x<Enter>**. This command outputs one MBN measurement data response message on port x, where x is A, B, or C.

$PASHR,MBN

The response is a binary message in the following form:

$PASHR,MBN,(measurement structure) checksum<CR><LF>

where the measurement structure is:

Field	Bytes	Content
char datatype	1	Always = 1
char count	1	Number of measurement structures to follow after this one.
char svprn	1	Satellite PRN number minus 1 (between 0 and 31)
char chnind	1	Channel number (between 1 and 12)
long lost_lock_ctr	4	Continuous counts since satellite is locked. This number is incremented about 500 times per second
char polarity	1	This number is either 4 or 5, 4 meaning satellite is just locked, and 5 meaning the beginning of the first frame has been found.

char goodbad	1	This number is either 22 or 24, 22 meaning the satellite is not usable, 24 meaning the satellite is usable for position computation.
char warning	1	Always 0
char ireg;	1	Satellite signal strength
double codetxmt	8	The fractional part of the satellite transmit time in seconds. The integer part of this number must be ignored.
long doppler	4	Satellite doppler in units of 0.00001 Hz.
double intdoppler	8	Total phase - available only if carrier phase option installed.
short carphase1	2	Fraction of total phase - available only if carrier phast option installed.
short carphase2	2	Smooth correction x 100 - available only if carrier phase option installed.
short elevation	2	Satellite elevation in units of 0.01 degrees.
short azimuth	2	Satellite azimuth in degrees.
checksum	2	The checksum is computed by breaking the structure into 20 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
total characters	42	

Enable/Disable MCA Message

$PASHS,NME,MCA,x,y

Enable/disable measurement data (MCA) messages with Ashtech type 3 structure on port x, where x is A, B, or C and y is ON or OFF.

NOTE

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

Example: Enable MCA message on port A
$PASHS,NME,MCA,A,ON<Enter>

$PASHQ,MCA,x

The associated query command is **$PASHQ,MCA,x<Enter>**. This command outputs one MCA measurement data response message on port x where x is A, B, or C.

$PASHR,MCA

The response is binary measurement data with Ashtech type 3 structure, The response message is in the following format:

$PASHR,MCA,(measurement structure) checksum <CR><LF>

where the measurement structure is:

Field	Bytes	Content
unsigned short sequence tag	2	Sequence ID number in units of 50 ms, modulo 30 minutes
unsigned char left	1	Number of remaining MBEN structures to be sent for current epoch.
unsigned char svprn	1	Satellite PRN number
unsigned char elev	1	Satellite elevation angle in degrees
unsigned char azim	1	Satellite azimuth angle in degrees/2
unsigned char chnind	1	Channel ID (1 to 12)
unsigned char warning	1	Warning flag, where: Bit 1 set = see note below Bit 2 set = see note below Bit 3 set = carrier phase questionable Bit 4 set = code phase questionable Bit 5 set = code phase integration questionable Bit 6 set = not used Bit 7 set = possible loss of lock Bit 8 set = loss of lock counter reset The interpretation of bits 1 and 2 is as follows: Bit 1 Bit 2 0 0 Same as 22 in goodbad flag (see next field) 1 0 Same as 23 in goodbad flag 0 1 Same as 24 in goodbad flag Note that more than one bit may be set at the same time, e.g., if bits 1, 3, and 6 are set at the same time, the warning flag is 37 (1 + 4 + 32)
unsigned char goodbad	1	Indicates quality of the position measurement, where: 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
unsigned char polarity_know	1	Indicates synchronization of receiver with NAV message

unsigned char ireg	1	Signal-to-noise of satellite observation
unsigned char qa_phase	1	Phase quality indicator. 0 to 5 and 95 to 100 are normal.
double full phase	8	Full carrier phase measurements in cycles. Not available unless carrier phase option is installed.
double raw_range	8	Raw range to SV in seconds, i.e., receive time - raw range = transmit time.
long doppler	4	Doppler (10^{-4} Hz)
long smoothing	4	32 bits where 31-24 are the smooth_count, unsigned, and normalized, representing the amount of smoothing where: 1 is least smoothed 200 is most smoothed 0 in unsmoothed Bits 23-0 are smooth_corr, where bit 23 (MSB) is the sign and the LSBs (22-0) are the magnitude of correction in centimeters.
checksum	1	Checksum, a bytewise exclusive OR (XOR) of all bytes from sequence_tag (just after header) to the byte before checksum.
total characters	37	

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

Enable/Disable PBN Message

$PASHS,NME,PBN,x,y

Enable/disable position data (PBN) messages on port x, where x is A, B, or C and y is ON or OFF.

Example: Enable PBN on port B
$PASHS,NME,PBN,B,ON<Enter>

$PASHQ,PBN,x

The associated query command is **$PASHQ,PBN,x <Enter>**. This command outputs one PBN position measurement data response message on port x, where x is A, B, or C. This message is output in binary format.

Example: Read PBN or port A
$PASHQ,PBN,A<Enter>

$PASHR,PBN

The response is a message giving binary position data output on every recording interval (RCI). The message is in the form:

$PASHR,PBN,(position structure) checksum<CR><LF>

Field	Bytes	Content
long rcvtime	4	Signal received time in milliseconds of week of GPS time. This is the time tag for all measurements and position data.
char sitename	4	Set to ????.
double navx	8	Antenna position ECEF x coordinate in meters.
double navy	8	Antenna position ECEF y coordinate in meters.
double navz	8	Antenna position ECEF z coordinate in meters.
float navt	4	Receiver clock offset in meters.
float navxdot	4	The antenna x velocity in meters per second.
float navydot	4	The antenna y velocity in meters per second.
float navzdot	4	The antenna z velocity in meters per second.
flost navtdot	4	Receiver clock drift in meters per second.
unsigned short PDOP	2	PDOP multiplied by 100.
checksum	2	The checksum is computed by breaking the structure into 27 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
total characters	56	

Enable/Disable SNV Message

$PASHS,NME,SNV,x,y

Enable/disable ephemeris data (SNV) messages on port x where x is A, B, or C, and y is ON or OFF.

Example: Enable SNV on port C
$PASHS,NME,SNV,C,ON<Enter>

NOTE

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

$PASHQ,SNV,x

The associated query command is **$PASHQ,SNV,x<Enter>**. This command calls the SNV ephemeris data response message on port x, where x is A, B, or C, and y is ON or OFF.

Example: Display SNV on port A
$PASHQ,SNV,A<Enter>

$PASHR,SNV

The response is a message that displays ephemeris data for all locked satellites The binary format is

$PASHR,SNV,(ephemeris structure) checksum<CR><LF>

and the data structure is as tabulated below.

Field	Bytes	Content
short wn	2	GPS week number.
long tow	4	Seconds of GPS week.
float tgd	4	Group delay (seconds).
long aodc	4	Clock data issue.
long toc	4	Clock data reference time in seconds.
float af2	4	Clock correction (sec/sec^2).
float af1	4	Clock correction (sec/sec).
float af0	4	Clock correction (sec).
long aode	4	Orbit data issue.
float deltan	4	Mean anomaly correction (semicircles/sec).
double m0	8	Mean anomaly at reference time (semicircles).
double e	8	Eccentricity.
double roota	8	Square root of semi-major axis (meters 1/2).
long toe	4	Reference time for orbit (sec).
float cic	4	Harmonic correction term (radians).
float crc	4	Harmonic correction term (meters).
float cis	4	Harmonic correction term (radians).
float crs	4	Harmonic correction term (meters).
float cuc	4	Harmonic correction term (radians).
float cus	4	Harmonic correction term (radians).
double omega0	8	Longitude of ascending node (semicircles).

double omega	8	Argument of perigee (semicircles).
double i0	8	Inclination angle (semicircles).
float omegadot	4	Rate of right ascension (semicircles/sec).
float idot	4	Rate of inclination (semicircles/sec).
short accuracy	2	User range accuracy.
short health	2	Satellite health.
short fit	2	Curve fit interval.
char prnnum	1	Satelite PRN number.
char res	1	Reserved character.
checksum	2	The checksum is computed by breaking the structure into 65 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
total characters	132	

Enable/Disable Satellite Almanac Message

$PASHS,NME,SAL,x,ON/OFF

Enable/disable almanac data (SAL) messages on port x; x is A, B, or C.

Example:
$PASHS,NME,SAL,A,OFF<Enter>

NOTE

Almanac data for all satellites is output once every hour, with one satellite output at each recording interval (RCI).

$PASHQ,SAL,x

The associated query command is **$PASHQ,SAL,x<Enter>**. This command gets the SAL almanac data response message on port x, where x is A, B, or C.

$PASHR,SAL

The response is a binary message in the form:

$PASHR,SAL,(almanac structure) checksum<CR><LF>

where the almanac structure is:

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

long tow	4	Seconds of GPS week.
checksum	2	The checksum is computed by breaking the structure into 34 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
total characters	70	

NMEA DATA MESSAGE COMMANDS

NMEA data message commands can be sent to the SCA-12/12S through serial port A, B, or C, and can also be directed so the message is output through port A, B, or C. Table 3 lists the available NMEA data message commands.

Table 3. NMEA Data Message Commands

Command	Function
$PASHS,NME,ALL	Disable all messages
$PASHS,NME,GGA	Enable/disable NMEA GPS position response message
$PASHS,NME,GLL	Enable/disable NMEA lat/lon message
$PASHS,NME,GRS	Enable/disable NMEA satellite range residual response
$PASHS,NME,GSA	Enable/disable NMEA DOP and active satellite information message
$PASHS,NME,GSN	Enable/disable NMEA signal strength/satellite number response message
$PASHS,NME,GSS	Enable/disable NMEA SVS USED message
$PASHS,NME,GSV	Enable/disable SATELLITE IN VIEW message
$PASHS,NME,GXP	Enable/disable NMEA position computation with time of fix message
$PASHS,NME,MSG	Enable/disable NMEA base station message
$PASHS,NME,PER	Set NMEA send interval (period)
$PASHS,NME,POS	Enable/disable position message
$PASHS,NME,RRE	Enable/disable NMEA satellite residual and position error message
$PASHS,NME,SAT	Enable/disable satellite status message
$PASHS,NME,TTT	Emable/disable event marker message
$PASHS,NME,VTG	Enable/disable NMEA velocity/course message

The general format for the NMEA message set commands is:

$PASHS,NME,str,x,y<Enter>

The command enables or disables NMEA message type str on port x, where

x is A, B, or C, str is one of the following three-character strings

POS, GLL, GXP, GGA, VTG, GSN, MSG, GSS, SAT, GRS, RRE, TTT, GSA, GSV

and y is ON or OFF.

Example: Enable NMEA POS (position) message on port A
$PASHS,NME,POS,A,ON<Enter>

Example: Disable NMEA position message on port A
$PASHS,NME,POS,A,OFF<Enter>

After one of the NMEA set commands enables the corresponding NMEA response message type, the SCA-12/12S will output the message at the frequency selected by the PASHS,NME,PER set command (default is once per second or once every half-second if the 2HZ option is available).

The general format of the NMEA message query is:

$PASHS,NME,str,x

where str is one of the NMEA three-character strings, and x is port A, B, or C. Unlike the set commands that output the corresponding message at the frequency selected by the $PASHS,NME,PER command, the query command outputs the message one time.

Disable All NMEA Messages

$PASHS,NME,ALL,x,OFF

Disable ALL NMEA message types on port x, where x is A, B, or C.

Example: Disable all NMEA messages on port A
$PASHS,NME,ALL,A,OFF<Enter>

GGA (GPS Position) Message

$PASHS,NME,GGA,x,y

Enable/disable NMEA GPS position response message on port x, where x is either A, B, or C, and Y is ON or OFF. This message is not output unless position is computed.

Example: Enable GGA on port A
$PASHS,NME,GGA,A,ON<Enter>

$PASHQ,GGA,x

The associated query command is $PASHQ,GGA,x<Enter>. This command outputs the GGA response message on port x, where x is A, B, or C. This message is not output unless position is computed.

Example: Output GGA message on port B
$PASHQ,GGA,B<Enter>

$GPGGA

The response message is in the form:

$GPGGA,hhmmss.ss,ddmm.mmmmm,s,dddmm.mmmmm,s,n,qq,pp.p, saaaaa.aa,u,±xxxx.x, M,sss,aaaa *cc<CR><LF>

Field	Significance
1	Current UTC time, hhmmss, of position fix in hours, minutes and seconds.
2	Latitude component of position, ddmm.mmmmm, in degrees, minutes and fraction of minutes.
3	Latitude sector, s = N - North, s = S - South.
4	Longitude component of position, dddmm.mmmmm, in degrees, minutes and fraction of minutes.
5	Longitude sector, s = E - East, s = W - West.
6	Raw/differential position, n n = 1 - Raw; position is not differentially corrected n = 2 - position is differentially corrected.
7	qq = number of SVs used in position computation.
8	HDOP - horizontal dilution of precision, pp.p = 00.0 to 99.9.
9	GPS Sensor-computed altitude, saaaaa s = "+" or "-" aaaaa = Altitude 00000 to 30000 meters above WGS-84 reference ellipsoid. For 2-D position computation this item contains the altitude used to compute the position computation.
10	Altitude units, u = M - meters.
11	Geoidal separation (value output only if Geoidal Height option (G) is installed in the receiver).
12	Geoidal separation units, u = M - meters.
13	Age of the differential corrections, sss, in seconds.
14	Base stid, aaaa.

Example:

Query: $PASHQ,GGA,C<Enter> or
Set: $PASHS,NME,GGA,A,ON<Enter>
Response:
$GPGGA,183805.50,3722.36223,N,12159.82741,W,2,03,02.8,
+00016.12,M,31,M,005,0001*6F<CR><LF>

Item	Significance
$GPGGA	Header
183805.50	Time of position fix
3722.36223	Latitude
N	North
12159.82741	Longitude
W	West
2	Differential mode
03	Number of SVs used in position computation
02.8	HDOP
+00016.12	Altitude
M	Meters. Units of altitude
31	Geoidal separation
M	Meters. Units of the geoidal separation
005	Age of differential corrections
0001	Base station ID
6F	Message checksum in hexadecimal

GLL (Latitude,Longitude) Message

$PASHS,NME,GLL,x,y

Enable/disable NMEA latitude/longitude response message on port x, where x is either A, B, or C and y is ON or OFF. This message is not output unless position is computed.

Example: Enable GLL message on port A
$PASHS,NME,GLL,A,ON<Enter>

$PASHQ,GLL,x

The associated query command is **$PASHQ,GLL,x<Enter>**. This command outputs the GLL message on port x, where x is A, B, or C. This message is not output unless position is computed.

Example: Output GLL message on port B
$PASHQ,GLL,B<Enter>

$GPGLL

The response message is in the form:

$GPGLL,ddmm.mmmmm,s,dddmm.mmmmm,s,hhmmss.ss,s*cc<CR><LF>

Field	Significance
1	Latitude component of position, ddmm.mmmmm, in degrees, minutes and fraction of minutes
2	Latitude sector, s = N - North, s = S - South
3	Longitude component of position, dddmm.mmmmm, in degrees, minutes and fraction of minutes.
4	Longitude sector, s = E - East, s = W - West
5	UTC of position (hours, minutes, seconds)
6	Status, A= valid, V=invalid

Example:

Query: $PASHQ,GLL,B<Enter> [or]
Set: $PASHS,NME,GLL,C,ON<Enter>
Response: $GPGLL,3722.36223,N,12159.82741,W,170003,A*7F

Item	Significance
$GPGLL	Header
3722.36223	Latitude
N	North
12159.82741	Longitude
W	West
170003	UTC of position

Item	Significance
A	Valid
7F	Message checksum in hexadecimal

GRS (Satellite Range Residual) Message

$PASHS,NME,GRS,x,y

Enable/disable NMEA satellite range residual response message to port x, where x is A, B, or C, and y is ON or OFF. This message is not output unless a position is computed.

Example: Enable GRS message on port C
$PASHS,NME,GRS,C,ON<Enter>

$PASHQ,GRS,x

The associated query command is **$PASHQ,GRS,x<Enter>**. This command outputs the GRS message on port x, where x is A, B, or C. This message is not output unless a position is computed.

Example: Output GRS message on port B
$PASHQ,GRS,B<Enter>

$GPGRS

The response message is in the form

$GPGRS,hhmmss.ss,m,sxx.x,sxx.x,sxx.x,....*cc<CR><LF>

NOTE

Range residuals are recomputed after the GGA position is computed. Therefore the mode m is always 1. There will be a range residual sxx.x for each satellite used in position computation, and the order of the residuals matches the order of the satellites in the GSS message.

Field	Significance
1	Current UTC time, hhmmss.ss, of GGA position fix in hours, minutes, and seconds hh = Hours (00 to 23) mm = Minutes (00 to 59) ss.ss = Seconds (00.00 to 59.99)
2	Mode, m, used to compute range residuals 0 - Residuals were used to calculate the position given in the matching GGA line 1 - residuals were recomputed after the GGA position was computed
3	Range residuals (sign s = + or -, and magnitude xx.x) for each satellite used in position computation. The order of the residuals matches the order of the satellites in the GSS message.

Example:
Query: $PASHQ,GRS,A<Enter> or
Set: $PASHS,NME,GSN,A,ON<Enter>
Response:
$GPGRS,180257.50,1,+00.3,-00.4,+00.2,+00.5,+00.7,-00.8*64

Item	Significance
$GPGRS	Header
180257.50	Time of position fix
1	Mode
+00.3	Range residual for first SV in GSS message
-00.4	Range residual for second SV in GSS message
+00.2	Range residual for third SV in GSS message
+00.5	Range residual for fourth SV in GSS message
+00.7	Range residual for fifth SV in GSS message
-00.8	Range residual for sixth SV in GSS message
64	Message checksum in hexadecimal

GSA (DOP and Active Satellites) Message

$PASHS,NME,GSA,x,y

Enable/disable DOP and active satellite message to be sent out to the serial port, where x is port A, B or C and y is ON or OFF.

Example: Enable GSA message on port B
$PASHS,NME,GSA,B,ON<Enter>

$PASHQ,GSA,x

The associated query command is **$PASHQ,GSA,x<Enter>**. This command gets the GSA message on port x, where x is A, B, or C.

Example: Output GSA message on port B
$PASHQ,GSA,B<Enter>

$GPGSA

The response is a message in the form

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

where

Field	Significance
c1	Mode M: manual A:automatic
d1	Mode 2: 2D 3:3D
d2-d13	Satellites used in position computation (range 1 to 32)
f1	PDOP (range 0 - 9.9)
f2	HDOP (range 0 - 9.9)
f3	VDOP (range 0 - 9.9)
CC	Checksum

Example:
$GPGSA,A,2,1,4,6,7,9,11,3,2,5, <CR><LF>

GSN (Signal Strength/Satellite Number) Message

$PASHS,NME,GSN,x,y

Enable/disable the signal strength/satellite number response message on port x, where x is either A, B, or C, and y is ON or OFF.

Example: Enable GSN message on port C
$PASHS,NME,GSN,C,ON<Enter>

$PASHQ,GSN,x

The associated query command is **$PASHQ,GSN,x<Enter>**, where x is port

A, B, or C.

Example: Output GSN message on port C
$PASHQ,GSN,C<Enter>

$GPGSN

The response is a message in the form:

$GPGSN,qq,pp,ss,ss,.....ttt*cc<CR><LF>

NOTE

For each SV locked, a PRN number item and a signal strength item follow; qq indicates the number of SVs displayed in the message.

Field	Significance
qq	Number of SVs locked, number of SVs in message
pp	SV PRN number, pp = 1 to 32
ss	SV signal strength/signal-to-noise ratio, ss = 00 to 99
ttt	999 ends the message if no RTCM age is reported or age of differential corrections in seconds if in RTCM mode

Example:
Query: $PASHQ,GSN,A<Enter> or
Set: $PASHS,,NME,GSN,A,ON<Enter>
Response: $GPGSN,03,03,060,23,039,16,021,999*7D<CR><LF>

Item	Significance
$GPGSN	Header
03	Number of SVs locked
03	PRN number of the first SV
060	Signal strength of the first SV
23	PRN number of the second SV
039	Signal strength of the second SV
16	PRN number of the third SV
021	Signal strength of the third SV
999	Termination when no RTCM information
7D	Message checksum in hexadecimal

GSS (SVs Used) Message

$PASHS,NME,GSS,x,y

Enable/disable NMEA SVs-used response message on port x, where x is either A, B, or C, and y is ON or OFF. This message is output regardless of whether a position is computed.

Example: Enable GSS message on port A
$PASHS,NME,GSS,A,ON<Enter>

$PASHQ,GSS

The associated query command is **$PASHQ,GSS,x<Enter>**, where x is port A, B, or C.

$GPGSS

The response message is in the form

$GPGSS,0,s,qq,ss,ss,ss,.....,pp.p,*cc<CR><LF>

Field	Significance
1	Always zero
2	Position solution, s s = 2, altitude held fixed (2-D) solution s = 3, altitude not held fixed (3-D) solution
3	Number of SVs used to compute position
4	First SV PRN number, ss = 1 to 32
5	Second SV PRN number, ss = 1 to 32
6	Third SV PRN number, ss = 1 to 32
7	PDOP position dilution of precision to nearest tenth; pp.p = 00.0 to 99.9

Example: Output GSS message on port B
Query: $PASHQ,GSS,B<Enter> or
Set: $PASHS,NME,GSS,B,ON<Enter>
Response: $GPGSS,0,2,04,03,23,16,31,02.8*5C<CR><LF>

Item	Significance
$GPGSS	Header
0	Always 0
2	Altitude held fixed in position solution
04	Number of SVs used in position solution
03	PRN number of the first satellite
23	PRN number of the second satellite
16	PRN number of the third satellite
31	PRN number of the fourth satellite
02.8	PDOP
5C	Message checksum in hexadecimal

GSV (Satellites-In-View) Message

$PASHS,NME,GSV,x,y

Enable/disable satellites-in-view message to send out of serial port, where x is port A, B or C, and y is ON or OFF.

Example: Output GSV message on port A
$PASHS,S,NME,GSV,A,ON<Enter>

$PASHQ,GSV,x

The associated query command is **$PASHQ,GSV,x<Enter>**, where x is port A, B, or C.

$GPGSV

The response message is in the form:

$GPGSV,d1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,d14,d15,
d16,d17,d18,d19*CC<CR><LF> where:

Field	Significance
d1	Total number of messages (1 to 3)
d2	Message number(1 to 3)
d3	Total number of satellites in view(1 to 12)
d4	Satellite PRN (1 to 32)
d5	Elevation (degrees from 0 to 90)
d6	Azimuth (degrees from 0 to 359)

d7	SNR (0 to 99 dB)
d8 - d11	Same as d4-d7 but for second satellite
d12 - d15	Same as d4-d7 but for third satellite
d16 - d19	Same as d4-d7 but for fourth satellite

Example:
Query: $PASHQ,GSV,c<Enter> or
Set:$PASHS,NME,GSV,c,ON<Enter>

Response:
$GPGSV,2,1,08,16,23,293,29,19,63,050,59,28,11,038,21,29,14,
145,16*78<CR><LF>

Field	Significance
$GPGSV	Header
2	total number of messages
1	message number
8	number of SVs in view
16	PRN of first satellite
23	elevation of first satellite
293	azimuth of first satellite
29	signal-to-noise of first satellite
19	PRN of second satellite
63	elevation of second satellite
050	azimuth of second satellite
59	signal-to-noise of second satellite
28	PRN of third satellite
11	elevation of third satellite
038	azimuth of third satellite
21	signal-to-noise of third satellite
29	PRN of fourth satellite
14	elevation of fourth satellite
145	azimuth of fourth satellite
16	signal-to-noise of fourth satellite
7	message checksum in hexadecimal

GXP (Position Horizontal) Message

$PASHS,NME,GXP,x,y

Enable/disable position horizontal message on port x, where x is either A, B, or C, and y is ON or OFF. This message is not output unless position is computed.

Example: Output GXP message on port C
$PASHS,NME,GXP,C,ON<Enter>

$PASHQ,GXP

The associated query command is **$PASHQ,GXP,x<Enter>** where x is port A, B, or C. This message is not output unless position is computed.

$GPGXP

The response message is in the following form:

$GPGXP,hhmmss:ss,ddmm.mmmmm,s,dddmm.mmmmm,s*cc<CR><LF>

where

Field	Significance
1	Current UTC time, hhmmss:ss,of position fix in hours, minutes and seconds
2	Latitude component of position, ddmm.mmmmm, in degrees, minutes and fraction of minutes
3	Latitude sector, s = N - North, s = S - South
4	Longitude component of position, dddmm.mmmmm, in degrees, minutes and fraction of minutes
5	Longitude sector, s = E - East, s = W - West

Example:

Query: $PASHQ,GXP,B<Enter> or
Set: $PASHS,NME,GXP,A,ON<Enter>
Response:
$GPGXP,183805.00,3722.36221,N,12159.82742,W*5C<CR><LF>

Item	Significance
$GPGXP	Header
183805.00	Time of position fix
3722.36221	Latitude
N	North
12159.82742	Longitude

Item	Significance
W	West
5C	Message checksum in HEX

MSG (RTCM) Message

$PASHS,NME,MSG,x,y

Enable/disable message containing RTCM reference (base) station message types 01, 03, 06, 09, and 16 on port x, where x is A, B, or C, and y is ON or OFF.

NOTE

Unless the SCA-12/12S is sending or receiving differential corrections, this command is ignored.

Example: Enable MSG on port A
$PASHS,NME,MSG,A,ON<Enter>

$PASHQ,MSG,x

The associated query command is $PASHQ,MSG,x<Enter>, where x is port A, B, or C.

$GPMSG

The response message format depends upon the RTCM message type enabled: type 1 is enabled by default; types 3, 6, 9, and 16 must be enabled by the $PASHS,RTC,TYP set command.

The format for RTCM message types 1 and 9 is:

$GPMSG,rr,ssss,zzzz.z,s,h,ccc,hhmmss:ss,
e,vv,spppp.pp,sr.rrr,iii*cc

Field	Significance
1	$GPMSG = header
2	rr = RTCM type, 01 or 09
3	ssss = station identifier, 0000 to 1023
4	zzzz.z = Z count in seconds and tenths, 0000.0 to 3600.0
5	s = sequence number, 0 to 7
6	h = Station health, 0 to 7
7	ccc = total number of characters after the time item, 000 to 999
8	hhmmss:ss = current UTC time of position computation in hours, minutes and seconds
9	e = user differential range error (UDRE)
10	vv = satellite PRN number
11	spppp.pp = pseudo-range correction (PRC) in meters
12	sr.rrr = range rate correction (RRC) in meters/sec
13	iii = issue of data (IODE)
14	*cc = checksum in hexadecimal

NOTE

Message types 1 and 9 are identical except for the fact that message type 1 has correction information (fields 9, 10, 11, 12, 13) for all satellites, and each message type 9 has correction information for up to 3 satellites per transmission.

Example 1:

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

Item	Significance
$GPMSG	Header
01	RTCM message
0000	Station ID
2220.0	Z count in seconds and tenths
1	Sequence number
0	Station health
127	Total number of characters of the time item
003702:00	Current time in hours, minutes, and seconds
2	UDRE for SV 12
12	Satellite PRN number
-0081.30	PRC for SV 12
+0.026	RRC for SV 12
235	IODE for SV 12
2	UDRE for SV 13
13	Satellite PRN number
+0022.86	PRC for SV 13
+0.006	RRC for SV 13
106	IODE for SV 13
2	UDRE for SV 26
26	Satellite PRN number
-0053.42	PRC for SV 26
-0.070	RRC for SV 26
155	IODE for SV 26
2	UDRE for SV 26
02	Satellite PRN number
+0003.56	PRC for SV 02
+0.040	RRC for SV 02
120	IODE for SV 02
2	UDRE for SV 02
27	Satellite PRN number
+0047.42	PRC for SV 27
-0.005	RRC for SV 27
145	IODE for SV 27
7A	Message checksum in hexadecimal

The format for RTCM message type 3 is:

$GPMSG,rr,sss,zzz.z,s,h,ccc,hhmmss:ss,sxxxxxxx.xx,syyyyyyy.yy,
szzzzzzz.zz<CR><LF>

Field	Significance
1	$GPMSG = header
2	rr = RTCM type, 01 or 09
2	sss = station identifier, 0000 to 1023
3	zzz.z = Z count in seconds and tenths, 0000.0 to 3600.0
4	s = sequence number, 0 to 7
5	h = station health, 0 to 7
6	ccc = total number of characters after the time item, 000 to 999
7	hhmmss:ss = current GPS time of position computation in hours, minutes and seconds
8	sxxxxxxx.xx = metric x - distance from geocenter (x component of station)
9	syyyyyyy.yy = metric y - distance from geocenter (y component of station)
10	szzzzzzz.zz = metric z - distance from geocenter (z component of station)
11	*cc = checksum

Example 2:

Response:
$GPMSG,03,0000,1200.0,7,0,038,231958:00,-2691561.37,-4301271.
02,+3851650.89*6C<CR><LF> where

Item	Significance
$GPMSG	Header
03	RTCM type
0000	Station ID
1200.0	Z count in seconds and tenths
7	Sequence number
0	Station health
038	Total number of characters after the time item

Item	Significance
231958:00	Current time in hours, minutes and seconds
-2691561.37	Station X component
-4301271.02	Station Y component
+3851650.89	Station Z component
6C	Message checksum in hexadecimal

The format for RTCM message types 6 and 16 is shown below, except that type 6 does not contain text:

$GPMSG,rr,sss,zzz,z,s,h,ccc,hhmmss:ss,text*cc<CR><LF>

where

Field	Significance
1	$GPMSG = header
2	rr = RTCM type 6 or 16
2	sss = station identifier, 0000 to 1023
3	zzz.z = Z count in seconds and tenths, 0000.0 to 3600.0
4	s = sequence number, 0 to 7
5	h = station health, 0 to 7
6	ccc = total number of characters after the time item, 000 to 999
7	hhmmss:ss = current GPS time of position computation in hours, minutes and seconds

Field	Significance
8	text = text message, type 16 only
8	*cc checksum, type 6 only
9	*cc = checksum, type 16 only

Example 3:
$GPMSG,16,0000,1209.6,5,0,038,232008:00,THIS IS A MESSAGE SENT FROM BASE*5C<CR><LF>

Item	Significance
$GPMSG	Header
16	RTCM type
0000	Station ID
1209.6	Z count in seconds and tenths
5	Sequence number
0	Station health
038	Total number of characters after the time item
232008:00	Current time in hours, minutes and seconds
TEXT	Message content
5C	Message checksum in hexadecimal

Set NMEA Send Interval

$PASHS,NME,PER,x

Set the send interval of the NMEA response messages in seconds, where x is a any half-second or full-second value between 0.5 and 999.5 (default once per half-second if the 2HZ option is installed, once per second if not installed).

Example:
$PASHS,NME,PER,10.0<Enter>

POS (Position) Message

$PASHS,NME,POS,x,y

Enable/disable NMEA position response message on port x where x is A, B, or C, and y is ON or OFF.

Example: Enable position message on port B
$PASHS,NME,POS,B,ON<Enter>

$PASHQ,POS,x

The associated query command is **$PASHQ,POS,x<Enter>** where x is port A, B, or C.

$PASHR,POS

The response is a message containing information on the most recently computed position, output at the rate defined by the $PASHS,NME,PER set command. The SCA-12/12S always returns the position message, whether it is currently computing a position or not. This response message is in the form:

$PASHR,POS,n,qq,hhmmss:ss,ddmm.mmmmm,s,dddmm.mmmmm,
s,saaaaa.aa,seeeee,ttt,ggg,svvv,pp,hh,vv,tt,vvvv*cc<CR><LF>

Field	Significance
1	n = raw/differential position: 0 = raw, position is not differentially corrected 1 = position is differentially corrected with RTCM format
2	qq = number of SVs used in position computation
3	hhmmss:ss = current UTC time, hhmmss, of position computation in hours, minutes and seconds
4	ddmm.mmmmm = latitude component of position, ddmm.mmmm, in degrees, minutes and fraction of minutes
5	s = latitude sector: N = North, S = South
6	dddmm.mmmmm = longitude component of position in degrees, minutes and fraction of minutes
7	s = longitude sector: E = East, W = West
8	saaaaa.aa = sensor-computed altitude s = "+" or "-" aaaaa.aa = altitude 00000 to 30000 meters above WGS-84 reference ellipsoid For 2-D position computation this item contains the altitude held fixed.
9	Reserved
10	True track/true course over ground in degrees, ttt = 000 to 359 degrees
11	Speed over ground, ggg ggg = 000 to 999 knots
12	Vertical velocity, Svvv s = "+" or "-" vvv = 000 to 999 decimeters per second
13	PDOP - position dilution of precision, pp = 00 to 99
14	HDOP - horizontal dilution of precision, hh = 00 to 99
15	VDOP - vertical dilution of precision, vv = 00 to 99
16	TDOP - time dilution of precision, tt = 00 to 99
17	SCA-12/12S firmware version ID in ASC vvvv.

Example 1:
Query: $PASHQ,POS,A<Enter> or
Set: $PASHS,NME,POS,B,ON<Enter>
Response:

$PASHR,POS,0,03,183805:00,3722.36221,N,12159.82742,W,
+00016.06,,179,021,+039,06,04,03,01,1D00*45
<CR><LF>

Item	Significance
$PASHR,POS	Header
0	Position is not differentially corrected
03	Number of SVs used in position computation

Item	Significance
183805.00	Time of position computation
3722.36221	Latitude
N	North
12159.82742	Longitude
W	West
+00016.06	Altitude in meters
empty field	Reserved
179	Course over ground in degrees (True)
021	Speed over ground in knots
+039	Vertical velocity in meters per second
06	PDOP
04	HDOP
03	VDOP
01	TDOP
1D00	Version number
45	Message checksum in hexadecimal

Example 2:

If no position is computed, the SCA-12/12S will return:

Response: $PASHR,POS,0,,,,,,,,,,,,,,,,1D00*1A<CR><LF>

RRE (Satellite Residual and Position Error) Message

$PASHS,NME,RRE,x,y

Enable/disable satellite residual and position error message to port x, where x is A, B, or C and y is ON or OFF. This message is not output unless a position is computed.

Example: Enable RRE message on port A
$PASHS,NME,RRE,A,ON<Enter>

$PASHQ,RRE,x

The associated query command is **$PASHQ,RRE,x<Enter>**, where x is port A, B, or C.

Example:

$PASHQ,RRE,C<Enter>

$GPRRE

The response is a message in the form

$GPRRE,qq,ss,sxxx.x,...hhhh.h,vvvv.v*cc<CR><LF>

There will be a range residual (xxx.x) computed for each satellite (ss) used in position computation. Residuals and position errors will not be computed unless at least 5 satellites are used in position computation.

Field	Significance
1	qq = number of satellites used to compute position
2	ss = PRN number for each of the satellites used in position computation
3	s = + or - and xxx.x = range residuals magnitude in meters for each satellite used in position computation
Last 2 fields	hhhh.h = horizontal RMS position error in meters vvvv.v = vertical RMS position error in meters

Example:
Query: $PASHQ,RRE,A<Enter> or
Set: $PASHS,NME,RRE,A,ON<Enter>
Response:
$GPRRE,05,18,+000.2,29,+000.2,22,-000.1,19,-000.1,28,
+000.5,0002.0,0001.3*76<CR><LF>

Item	Significance
$GPRRE	Header
05	Number of SVs used to compute position
18	PRN of first SV
+000.2	Range residual for first SV in meters
29	PRN of second SV
+000.2	Range residual for second SV in meters
22	PRN of third SV
-000.1	Range residual for third SV in meters
19	PRN of fourth SV
-000.1	Range residual for fourth SV in meters
28	PRN of fifth SV
+000.5	Range residual for fifth SV in meters
0002.0	Horizontal position error in meters
0001.3	Vertical position error in meters
76	Message checksum in hexadecimal

SAT (Satellite Status) Message

$PASHS,NME,SAT,x,y

Enable/disable satellite status message on port x, where x is A, B, or C, and y is ON or OFF.

Example: Enable SAT message on port B
$PASHS,NME,SAT,B,ON<Enter>

$PASHQ,SAT,x

The associated query command is **$PASHQ,SAT,x<Enter>**, where x is port A, B, or C.

Example:

$PASHQ,SAT,B<Enter>

$PASHR,SAT

The response is a satellite status response message in the form:

$PASHR,SAT,qq,pp,aaa,ee,ss,h*cc<CR><LF>

NOTE

The SV-locked item is followed by as many groups of the following items as there are SVs currently being tracked: PRN number, azimuth, elevation, signal strength, and whether SV is used in position fix solution; qq indicates the total number of SVs in the message.

Field	Significance
1	qq = number of SVS locked, number of SVs in message, range 0-12
2	pp = SV PRN number, range 1 to 32
3	aaa = SV azimuth angle, 000 to 359 degrees
4	ee = SV elevation angle, 00 to 90 degrees
5	ss = SV signal strength/signal-to-noise ratio, 00 to 99
6	h = SV used/not used if position computation U = SV used in position computation - = SV not used in position computation

Example 1:

Query: $PASHQ,SAT,B<Enter> or
Set: $PASHS,NME,SAT,B,ON<Enter>
Response:
$PASHR,SAT,03,03,103,56,60,U,23,225,61,39,U,16,045,02,21,
U*6E<CR><LF>

Item	Significance
$PASHR,SAT	Header
03	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
60	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
39	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
21	Signal strength of the third SV
U	SV used in position computation
6E	Message checksum in hexadecimal

TTT (Event Marker) Message

$PASHS,NME,TTT,x,y

Enable/disable event marker message on port x, where x is A, B, or C, and y is ON or OFF. This message is not output unless an event pulse is being input through the serial port and the event marker option (E) is available in the receiver.

Example: Enable TTT message on port A
$PASHS,NME,TTT,A,ON<Enter>

There is no query command for TTT.

$PASHR,TTT

The response is a message in the form:

$PASHR,TTT,x,hh:mm:ss.sssssss*cc<CR><LF>

Item	Significance
1	x = day of GPS week, 1 to 7, where Sunday = 1
2	hh:mm:ss.sssssss = time in hours, minutes, seconds

Example: Enable TTT event marker on port A
Set: $PASHS,NME,TTT,A,ON<Enter>

Response:
$PASHR,TTT,6,20:41:02.0000000*OD

Field	Significance
$PASHR,TTT	Header
6	Day of week (Friday)
20:41:02.0000000	Time
OD	Message checksum in hexadecimal

VTG (Velocity/Course) Message

$PASHS,NME,VTG,x,y

Enable/disable velocity/course message on port x, where x is A, B, or C and y is ON or OFF. This message is not output unless position is computed.

Example: Enable VTG message or port B
$PASHS,NME,VTG,B,ON<Enter>

$PASHQ,VTG,x

The associated query command is **$PASHQ,VTG,x<Enter>** where x is port A, B, or C. This message is not output unless position is computed.

$GPVTG

The response is a message in the form:

$GPVTG,ttt,c,ttt,c,ggg.gg,u,ggg.gg,u*cc<CR><LF>

Field	Significance
1	True track/true course over ground, ttt = 000 to 359 degrees
2	True course over ground marker, c = always T (true course)
3	Magnetic track/magnetic course over ground, ttt = 000 to 359 degrees (output only if magnetic variation option (M) is installed in receiver)
4	Magnetic course over ground marker, c = always M (magnetic course)
5	Speed over ground, ggg.gg = 000 to 999.99 knots
6	Speed over ground units, u = N (nautical miles per hour)
7	Speed over ground, ggg.gg = 000 to 999.99 kilometers per hour
8	Speed over ground units, u = K (kilometers per hour)

Example:

Query: $PASHQ,VTG,B<Enter> or
Set: $PASHS,NME,VTG,A,ON<Enter>

Response:
$GPVTG,179,T,193,M,000.11,N,000.20,K*3E

Item	Significance
$GPVTG	Header
179	Course over ground in degrees
T	True course over ground marker
193	Magnetic course over ground
M	Magnetic course over ground marker
000.11	Speed over ground in knots
N	Knots
000.20	Speed over ground in kilometers/hour
K	Kilometers/hour
3E	Message checksum in hexadecimal

RTCM RESPONSE MESSAGE COMMANDS

RTCM response message commands let you control and monitor operation in differential mode. Table 4 lists the RTCM commands.

Table 4. RTCM Commands

Command	Function
$PASHS,RTC,AUT	Turns auto differential mode on or off
$PASHS,RTC,BAS	Sets receiver to operate as differential base station
$PASHS,RTC,MAX	Sets maximum age of RTCM differential corrections
$PASHS,RTC,MSG	Defines RTCM message, base to remote
$PASHS,RTC,OFF	Disables differential mode
$PASHS,RTC,QAF	Sets quality threshold
$PASHS,RTC,REM	Sets receiver to operate as differential remote station
$PASHS,RTC,SEQ	Checks sequence number of received messages
$PASHS,RTC,SPD	Sets baud rate of base station
$PASHS,RTC,STI	Sets station identification
$PASHS,RTC,STH	Sets health of reference station
$PASHS,RTC,TYP	Enables type of message
$PASHQ,RTC	Request differential mode parameters and status

Turn Auto Differential Mode On/Off

$PASHS,RTC,AUT,x

Turns auto differential mode on or off where x is Y (on) or N (off). When in auto-diff mode the receiver generates raw positions automatically if differential corrections are older than the maximum age, or are not available. Used only in REMOTE mode. .

Example: Turn auto differential mode on
$PASHS,RTC,AUT,Y<Enter>

Set Receiver as Differential Base Station

$PASHS,RTC,BAS,x
Set the SCA-12/12S to operate as a differential base station using RTCM format, where x is the differential port and can be set to A, B, or C.

Example: Set to differential base mode using port B
$PASHS,RTC,BAS,B<Enter>

Set Maximum Age of RTCM Differential Corrections

$PASHS,RTC,MAX,x
Set the maximum age in seconds of an RTCM differential correction above which it will not be used, where x is any number between 1 and 1199. Default is 60. Used only in REMOTE mode.

Define RTCM Message

$PASHS,RTC,MSG,x
Define RTCM message up to 90 characters long that will be sent from the base to the remote. Used 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>

Disable Differential Mode

$PASHS,RTC,OFF
Disables differential mode.

Example:
$PASHS,RTC,OFF<Enter>

Set Quality Threshold

$PASHS,RTC,QAF,x
Sets the number of received differential correction frames in RTCM differential mode above which the quality factor is reset to 100%, where x is any number between 0 and 999. This QAF number is used to compute the QA value where:

QA = good messages/QAF

The QA parameter allows you to evaluate the communication quality between the base and remote stations. The QA value can be seen using the $PASHQ,RTC query command. Default is 100. Used only in REMOTE mode.

Example: Set quality factor to 200
$PASHS,RTC,QAF,200<Enter>

Set Receiver as Differential Remote

$PASHS,RTC,REM,x

Set the SCA-12/12S to operate as a differential remote station using RTCM format, where x is differential port A, B, or C.

Example: Set receiver as differential remote using port C
$PASHS,RTC,REM,C<Enter>

Check Sequence Number

$PASHS,RTC,SEQ,x<Enter>

Checks sequence number of received messages and, if sequential, accept corrections; if not, don't use correction, where x is Y (check) or N (do not check). Default is N. Used only in REMOTE mode. Valid only at beginning of differential operation. After two sequential RTCM corrections have been received, differential operation begins.

Example: Check sequence number
$PASHS,RTC,SEQ,Y<Enter>

Set RTCM Bit Rate

$PASHS,RTC,SPD,x<Enter>

Set the number of bits per second that are being generated to the serial port of the base station, where x is the code for the output rate in bits per second. The available speeds are 25, 50, 100, 110, 150, 200, 250, 300, and 1500. Default is 300 bits per second. Used only in BASE mode.

Code	0	1	2	3	4	5	6	7	8

Rate	25	50	100	110	150	200	250	300	1500

Example: Set bit rate to 110 bits/sec
$PASHS,RTC,SPD,3<Enter>

Set Station Identification

$PASHS,RTC,STI,xxxx<Enter>

Set user station identification (user STID) to any value between 0000 and 1023. In RTCM differential mode, corrections will not be applied if the station ID between base and rover are different, unless rover is set to zero. If user STID of rover station is set to zero, the SCA-12/12S will attempt to use the differential corrections it receives, regardless of STID of base station. Default is 0000.

Example: Set site identification to 0001
$PASHS,RTC,STI,0001<Enter>

Set Health of Reference Station

$PASHS,RTC,STH,x<Enter>

Set the health of the reference station, where x is any value between 0 and 7. Used only in BASE mode. Default is 0. The codes for the station health are defined as follows by RTCM:

Code	Health Indication
7	Reference station not working.
6	Reference station transmission not monitored.
5	Specified by service provider.
4	Specified by service provider.
3	Specified by service provider.
2	Specified by service provider.
1	Specified by service provider.

0	Specified by service provider.

Example: Set health to "Reference station not working"
$PASHS,RTC,STH,7<Enter>

Enable Type of Message

$PASHS,RTC,TYP,x,y

Enables the type of message to be sent by the base station and the period at which it will be sent, where x is the type and y is the period. Used only in BASE mode. The following table indicates the type of messages available and the period range setting.

Type	Range
1	0-99 seconds, where 0 is disabled and 99 is generated continuously
3	0-99 minutes, where 0 is disabled and 99 is generated continuously
6	1 = ON, 0 = OFF Default = OFF
9	same as type 1
16	same as type 3

Note that although all messages can be enabled simultaneously, only one can be set to 99. Default is type 6 OFF, type 1 set to 99, and all others set to 00 (disabled).

Example: Enable type 1, sent out every second
$PASHS,RTC,TYP,1,1<Enter>

Request Differential Mode Parameters and Status

$PASHQ,RTC<Enter>

Request differential mode parameters. The response message for the default values of the query command $PASHQ,RTC (differential parameters) is:

```
STATUS:
   SYNC:     TYPE:00  STID:0000  STHE:0
   AGE:+000  QA:100.0%  OFFSET:00
SETUP:
   MODE:OFF  PORT:A   AUT:N
   SPD:0300  STI:0000  STH:0
   MAX:0060  QAF:100   SEQ:N
   TYP:1  2  3  6  9  16
   FRQ:99 00 00 ON 00 00
MSG:
```

Where:

STATUS Displays the status of the following parameters when differential mode is enabled.

- SYNC: Indicates with an * that synchronization between base and remote has been established. Valid only for REMOTE mode.
- TYPE: Indicates type of message being sent (base) or received (received).
- STID: Displays the station ID set in the base station or received from the base station.
- STHE: Displays the station health set in the base station or received from the base station.
- AGE: In BASE mode, displays the elapsed time in seconds between the beginning of the transmission of Type 1 or 9 messages. In REMOTE mode, displays the age of the received messages in seconds.
- QA: Displays the communication quality factor between base and remote. Defined as

$$\frac{\text{number of good measurements}}{\text{---------- x 100}}$$

total number of messages

Valid for REMOTE mode only.

OFFSET: Displays the number of bits from the beginning of the RTCM byte (in case of a bit slippage).

SETUP: Displays the receiver differential parameter settings:

MODE:OFF Displays differential mode either base (BAS), remote (REM) , or disabled (OFF). Default is OFF.

PORT:A Displays the port used to send or receive RTCM corrections. Default is A.

AUT:N Displays Auto Differential Mode. Default is N. Used only in REMOTE mode.

SPD:0050 The number of bits per second sent to the differential serial port. Default is 300. Used only in BASE mode.

STI:0000 The station ID supplied by the user. Default is 0000.

STH:0 The reference station health. Set by user. Default is 0. Used only in BASE mode.

MAX:0060 The maximum age, in seconds, allowed for a message to be used to compute a differentially corrected position. Default is 60. Used only in REMOTE mode.

QAF:100 The criteria to be applied when evaluating the quality of communication between base and remote. Used in the computation of QA. Default is 100. Used only in REMOTE mode.

SEQ:N — Indicates if there is a check for sequential received message number for the message to be accepted. Default is N. Used only in REMOTE mode.

TYP: — Indicates the RTCM message types the receiver can generate. Messages available are 1, 3, 6, 9, and 16. Message 2 is not generated. Used only in BASE mode.

FRQ: — Enables message type 6, and indicates the output period for message types 1, 2, 3, 9, and 16. A 0 indicates message disabled, a 99 indicates continuous output, and any other number specifies the number of seconds between transmissions for message types 1 and 9, and the number of minutes between transmissions for all other messages. Default for message type 1 is 99, for message type 6 is OFF, and for all other messages is 00.

MSG: — For BASE mode, it contains the text message, up to 90 characters, that is sent from the base to the remote when message type 16 is enabled. In REMOTE mode, it displays the text message, up to 90 characters, that is received from the base.

If changed parameter values are saved by the $PASHS,SAV,Y set command, after the next power-up, the response to the $PASHQ,RTC query command will display the saved quantities instead of the defaults. $PASHS,RST always reinstates the defaults.

RECOMMENDED READING

Navstar GPS Space Segment/Navigation User Interfaces; ICD-GPS-200, Revision B; Rockwell International, Satellite Systems Division, 2600 Westminster Blvd, PO Box 3644, Seal Beach CA 90740-7644

NMEA Standard 0183: Standard for Interfacing Marine Electronic Navigational Devices; National Marine Electronics Association

RTCM - Recommendations of Special Committee 104, differential NAVSTAR/GPS service, version 2.0, Radio Technical Commission for Maritime Service, PO Box 19087, Washington, DC 20036

CUSTOMER SUPPORT

If you have any problems or need further help, the Ashtech customer support team can be reached by telephone. Before you call, please refer to the documentation that came with your system (both receiver and software manuals). Many common problems are identified within the documentation and suggestions are offered for solving them.

- Check cables and power supplies. Many hardware problems are related to these simple problems.
- If the problem seems to be with your computer, reboot 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.

If none of these suggestions solves the problem, contact the Ashtech customer support team. Have the following information at hand:

Information Category	Your actual numbers
Receiver model	
Receiver serial #	
Software version #	
Software serial #	
Firmware version #*	
Options*	
A clear, concise description of the problem.	

*The firmware version # and options can be obtained using the $PASHQ,RID (receiver identification) command.

Then contact Ashtech customer support at the Sunnyvale facility at the following numbers:

800 Hot Line: 1-800-229-2400
Local Voice Line: (408) 524-1600
FAX Line: (408) 524-1500

COMMON GPS ACRONYMS

ALT	Altitude
ALM	Almanac
AFT	After
AGE	Age of Data
ANT	Antenna
ASCII	American Standard Code for Information Interchange
AZM	Azimuth
BEF	Before
BIN	Binary Index (file)
BM	Bench Mark
BP	Barometric Pressure
C/A	Coarse/Acquisition
	Clear/Access
COG	Course Over Ground
CTD	Course To Destination
DGPS	Differential GPS
DIFF	Differential
DMS	Degrees, Minutes, Seconds
DOP	Dilution Of Precision
DOS	Disk Operating System
DTD	Distance To Destination
EDOP	Elevation Dilution Of Precision
ELEV	Elevation
ELIP	Ellipsoid
ELLIP	Ellipsoid
ELP	Ellipsoid
ELV	Elevation
EMI	Electromagnetic Interference
ENU	East, North, Up
EPHM	Ephemeris
FCC	Federal Communications Commission
FREQ	Frequency
GH	Geoid Height
GLL	Latitude/Longitude for Position
GMST	Greenwich Mean Sidereal Time
GMT	Greenwich Mean Time
GPPS	GPS Post-Processing Software
GPS	Global Positioning System
GPSIC	GPS Information Center
	7323 Telegraph Road
	Alexandria VA 22310-3998
	703-313-5900
HDOP	Horizontal Dilution Of Position
HEL	Health
HI	Height of Instrument
HTDOP	Horizontal/Time Dilution Of Precision
ID	Identification, Integrated Doppler
LAT	Latitude
LCD	Liquid Crystal Display
LNA	Low-Noise Amplifier
LNG	Longitude
LON	Longitude
MMDD	Date format - Month, Date
MSG	RTCM Message
MSL	Mean Sea Level
N	Geodetic Undulation
NAD	North American Datum
NMEA	National Marine Electronics Assoc.
NV	Non-Volatile
PDOP	Position Dilution of Precision
PE	Precise Ephemeris
POS	Position
RAM	Random-Access Memory
RF	Radio Frequency
RFI	Radio Frequency Interference
RH	Relative Humidity
RMS	Root Mean Square
RTCM	Radio Technical Commission for Maritime Services
	P.O. Box 19087
	Washington DC 20036-9087
SE	Site Editor
	Standard Error
SESS	Session
SOG	Speed Over Ground
SS	Static Survey
SV	Satellite Visibility
	Space Vehicle
T-DRY	Temperature - Dry (Celsius)
T-WET	Temperature - Wet (Celsius)
TDOP	Time Dilution Of Precision
UT	Universal Time
UTC	Universal Time Coordinated
VDC	Volts Direct Current
VDOP	Vertical Dilution of Precision
WGS	World Geodetic System
WGS-84	Reference Ellipsoid
WP	Waypoint

THE US COAST GUARD GPS INFORMATION CENTER (GPSIC)

7323 Telegraph Road, Alexandria VA 22310-3998
Tel 703-313-5900 Fax 703-313-5920

OVERVIEW - Since February 1989, the US Coast Guard has developed the requirements and plans for the Civil GPS Service (CGS) and has begun to implement these services. The four CGS functions recognized by the Coast Guard are listed below:

- Provide a GPS Operational Advisory Broadcast (OAB)
- Process applications for the civil use of GPS PPS (Precise Positioning Service)
- Provide precise GPS satellite ephemeris data
- Provide a government interface for civil GPS users

Two agencies perform these functions:

- The GPS Information Center - provides the OAB and precise ephemerides
- The PPS Program Office - processes civil applications to PPS access

The primary source of information for the OAB is the GPS control center at Falcon Air Force Base in Colorado Springs, Colorado. The OAB originates at GPSIC in Alexandria VA and is broadcast during normal working hours, 8AM to 4PM EST, Monday through Friday, except Federal holidays. An answering machine records messages after hours, and calls are returned the next working day. OAB information is updated only during normal working hours, but advisory services are accessible 24 hours, 7 days. OAB presents the following information:

- Status - Current constellation health and availability
- Outages - Recent and future satellite down time
- Almanac - Current projected orbit data for GPS coverage and visibility predictions
- Other - General GPS information and some user documentation

NOTE: Satellite visibility and coverage predictions are not offered by GPSIC. These services are available from commercial sources or commercially available software.

GPSIC VOICE RECORDING - This is a 90-second tape message which contains current satellite status and outage information. The recording is available 24 hours 7 days and can be heard by dialing 703-313-5907. The recording is updated at least daily during normal GPSIC working hours.

WWV/WWVH VOICE BROADCASTS - These short-wave voice broadcasts contain current GPS status and outage information in a 45-second message. The message is broadcast at minutes 14 and 15 past each hour on WWV and at minutes 43 and 44 past the hour on WWVH. The information is updated at least daily during normal GPSIC working hours. WWV and WWVH operate at 5.0, 10.0, and 15.0 MHz.

US COAST GUARD BROADCAST TO MARINERS - GPS status, future outages, and safety advisories are transmitted on the VHF marine radio band. The information is updated weekly and whenever satellite outages occur.

GPSIC COMPUTER BULLETIN BOARD SERVICE (BBS) - GPSIC operates BBS that lists status, outage, almanac, and other GPS information. The BBS is available to any user free of charge, except for normal telephone fees. To access the BBS, the user will need a computer, a modem, and communication software. Users obtain a User ID password on line during the first session. The following information will be found useful in connecting to the GPSIC BBS.

Call 703-866-3890* for connections at 300 bps/Bell103, 1200 bps/Bell 212A, 2400 bps/CCITT V.22bis, no MNP capability (common US specs, Supramodem 2400).

Call 703-866-3893* for connections at 1200 bps/CCITT V.22bis, 1200 bps/CCITT V.22, 1200 bps/Bell 212A, 2400 bps/CCITT V.22bis, 4800 bps/CCITT V.32, 9600 bps/CCITT V.32 and MNP capabilities level 2,3,4,5, none (DigiCom Systems 9624).

Communications parameters at both numbers:

Asynchronous, no parity, 8 data bits, full duplex, 1 stop bit (10-bit word)

* FTS subscribers: 398-3890/3894 Autovon access is not available.

The BBS ignores the 8th bit of data, restricting the character set to the lower 128 ASCII values. The BBS also checks for ANSI graphics capability, and employs some ANSI graphics if the user's equipment can display them. All users get the same information, but non-ANSI users will not see color images.

DEFENSE MAPPING AGENCY ANMS - The Defense Mapping Agency's Navigation Information Network, Automated Notice to Mariners System is a computer database that contains GPS status, outage, almanac, and other information. GPSIC updates the information at least daily. The information is contained in query number 85.

Users must register with DMA. To obtain a user ID and information booklet, contact:

DMA Hydrographic/Topographic Center
Attention: MCN/NAVINFONET
Washington DC 20315-0030 301-227-3296

DMA BROADCAST WARNINGS - GPSIC provides GPS status, future outages, and safety advisories through the DMA HYDROLANT, HYDROPAC, and NAVAREA warning systems. These warnings are updated weekly and whenever satellite outages occur.

DMA WEEKLY NOTICE TO MARINERS - DMA publishes weekly navigation warnings and notices to mariners in a weekly publication "Notices to Mariners." This publication automatically includes active GPS status and outage information generated by both broadcast and NAVAREA warnings. Distributed by:

Director, DMA
Combat Support Center
Attention: PMSS
Washington DC 20315-0010

NAVTEX TEXT BROADCAST - The Coast Guard Local Notice to Mariners and DMA Broadcast Warnings also include text broadcast that contains the same information as the voice broadcasts. NAVTEX data is broadcast in English at 518 KHz from 16 transmitters worldwide. GPS status and outage information is available on NAVTEX.

REFERENCE DOCUMENTS

Two excellent reference books on GPS theory are:

Wells: *Guide to GPS Positioning* ISBN 0-920-114-73-3
Available from Canadian GPS Associates
Box 5378, Postal Station F Ottawa, Ontario Canada K2C 3J1

King, Masters, Rizos, Stolz, Collins: *Surveying with GPS* ISBN 0-85839-042-6
Available from School of Surveying, University of New South Wales
P.O. Box 1 Kensington, NSW, 2033, Australia

Heavy mathematical treatment:

Leick: *GPS Satellite Surveying* ISBN 0-471-81990-5
Wiley Interscience 605 3rd Avenue New York NY 10158-0012

Excellent overview of geodesy:

Smith: *Basic Geodesy - An Introduction to the History and Concepts of Modern Geodesy without Mathematics* ISBN 0-910845-33-6
Landmark Enterprises, 10324 Newton Way, Rancho Cordova CA 95670

SOURCES OF GPS INFORMATION

National Geodetic Information Center, NOAA
11400 Rockville Pike

Rockville MD 20852 Tel 301-443-8631

Institute of Navigation
1626 16th St. NW

Washington DC 20036

Scripps Orbit and Permanent Array Center (SOPAC)
High-Precision GPS BBS Service
Subscription $7500/year and $3000/year
Shelley Marquez, SOPAC Coordinator
IGPP-UCSD
9500 Gilman Drive La Jolla CA 92093-0225
Tel 619-534-0229 Fax 619-534-8090

International GPS Service for Geodynamics (IGS)
Jet Propulsion Laboratory MS 238-540
Pasadena CA 91109
Tel 818-393-6686
Fax 818-354-8330 or -5072 Internet ren@logos.jpl.nasa.gov.

ASHTECH BULLETIN BOARD

GENERAL

If you have a modem and communications software in your computer, you can access information from Ashtech's computer bulletin board system

(BBS). Two data lines are available 24 hours a day, 7 days a week, except for short periods when the system is off-line for maintenance. The Ashtech BBS uses the TBBS BBS software and provides several important services. You can download a current almanac, get the status of the GPS satellites, get NANUS (Notices Advisory to Navstar Users), and look at solar and geomagnetic data from SESC (Space Environment Services Center) in Boulder, Colorado. On occasion, the BBS has been used to carry software updates and document files.

The first time you call, you will be able to log on and browse for up to 30 minutes, but you will not be able to download. During this initial logon, you will be asked for identifying information and a password; anonymous callers will not be given access to the system. Remember exactly how you entered your name and how you spelled your password; write them on paper, they will be your entry into the system in the future.

When you have logged on and registered, the SYSOP will verify your status as a customer, and establish your security code commensurate with the hardware and software you are using.

The BBS phone numbers are:

Line 1	408-524-1527	2400 to 28800 baud
Line 2	Automatic rollover if line 1 is busy	2400 to 14400 baud

Parameters are:

N,8,1
(No parity, 8 bits, 1 stop bit, full duplex)

LOGON PROCEDURE

1. Set the communications parameters:

   No parity, 8 data bits, 1 stop bit, full duplex

2. Set a baud rate between 1200 and 28,800.
   PEP users may need to set additional modem registers for protocol support. Use the commands s50 = 255 and s111 = 20, where 20 is X/Y modem.

3. Dial the Ashtech BBS number 408-524-1527 using your modem software. Answer the logon questions.

4. Log off and give the system operator an opportunity to establish your account. This is generally done as soon as possible, so it is reasonable to try to log on the next business day.

To download, logon and follow the instructions on the menu.

If you have a Telebit© modem, Ashtech can support a communications rate of 19200 baud. For slower speeds, it takes a while to negotiate the baud rate. Make sure that you have plenty of time in the "Wait for Carrier Detect" parameters of your software and your modem. Ashtech recommends 60 seconds for the software and 90 seconds for the modem. Set the S7 register in the modem using the command s7 = 90.

MULTI-LINE OPERATION

Regardless of which line you use, if that line is busy, you will automatically be rolled over to the other line if it is not in use. This may mean that callers on Line 1 at 19200 baud may not be able to connect at maximum baud rate if Line 1 is busy. This is normal operation.

PROTOCOLS SUPPORTED

XMODEM	Widely supported, uses 128-byte blocks. Good for moderately noisy lines. May cause file integrity problems by rounding.
XMODEM-1k	Uses 1024-byte blocks. Supposedly better for 2400 baud+. May cause file integrity problems by rounding.
YMODEM	Also known as YMODEM Batch, passes filename and size, eliminating rounding problems. Capable of multiple file transfer (batch).
YMODEM-G	Fast protocol for use only with error-free data links. Not recommended.
SEAlink	Passes filename and size, eliminating rounding problems. Capable of file transfer (batch). Good for noisy line conditions and links where delays occur (satellite-based long distance, or packet-switched networks).
KERMIT	Slow, but works with almost any transmission medium.
SuperKERMIT	Same as KERMIT, but faster. Good for noisy line conditions and where delays occur (satellite-based long distance, or packet-switched networks).

ZMODEM	Newer protocol that supports batch and exact file size. Good for noisy conditions. Includes all ZMODEM-90™ extensions.
ASCII	Only for users with no other protocols available. No error checking, not recommended.

The preferred protocols are ZMODEM, SEAlink, YMODEM.

DOWNLOADING FILES

1. After a successful logon, you will get the MAIN MENU.

```
                Ashtech Customer Support
Main Menu                                          Line 0

<R>egister with System Operator
<B>ulletins
<F>ile Sections
<A>lter User Parameters
<D>isplay User Settings
<P>assword Change
<C>hat with System Operator

<O>  Top Menu                          <-> Previous Menu
<G>oodbye                              <L>ength of call
```

2. From the MAIN menu, select F for File Sections. This will bring up the FILE SECTIONS menu.

```
                Ashtech Customer Support
File Sections                                      Line 0

<C>ustomer Download
<S>oftware Download
<F>irmware Download
<D>ealer Download
<U>pload a file
<E>mployee Download
<C>hat with System Operator

<O>  Top Menu                          <-> Previous Menu
<G>oodbye                              <L>ength of call
```

3. From the FILE SECTIONS menu, select S for Software Download. This will bring up the SOFTWARE DOWNLOAD MENU.

```
                Ashtech Customer Support

Software Download Menu                              Line 0
<A>lmanac
<M>ission Planning 3.0.00
<1>G.P.P.S 5.1.00
<2>G.P.P.S. 5.2.00
<F>illnet 3.2.00
<R>  PRISM II (S/W Key Required)
<T>ML (Terramodel Macro Language)
<3> Plus III Download Area
<O> Remote Monitoring S/W v. 5.1.00
<D>imension
<U>serware

<O> Remote Monitoring S/W v.          <-> Previous Menu
<G>oodbye                             <L>ength of call
```

NOTE

You may not see all the entries shown above. The entries you see will depend upon your level of access (security code), as assigned by the SYSOP.

4. From the SOFTWARE DOWNLOAD menu, select the item you want to download. This will bring up a file library showing you a list of files available for download, sometimes with a description of the file's purpose, date, and time of the file, as well as its size in bytes. For example, to download the current almanac, select <A> for Almanac. The BBS will present the ALMANAC menu.

```
Type P to Pause, S to Stop listing

ALM95.003    2240

<D>ownload, <P>rotocol, <E>xamine, <New>, <L>ist, or <H>elp
Selection or <CR> to exit:
```

In the second line of the menu, "ALM95.003" is the almanac filename, "95" indicates the year, "003" the day, and "2240" the file size in bytes.

5. Select D for download, and the BBS will ask you for the filename you want to assign to the almanac. This will be the name of the file when it is loaded into your system.

6. Type the desired filename and press <ENTER>.

7. The BBS will present the protocol menu.

```
        Select from the following transfer protocols:

   T - TYPE file to your screen
   C - ASCII with DC2/DC4 Capture
   A - ASCII only no Control Codes
   X - XMODEM
   O - XMODEM-1K
   Y - YMODEM (Batch)
   G - YMODEM-g (Batch)
   S - SEAlink
   K - KERMIT
   W - SuperKERMITY (Sliding Windows)
   Z - ZMODEM-90 (Tm)

   Choose one (Q to Quit):
```

8. Select the protocol you want to use, and press <ENTER>. From this point, the procedure depends upon your setup. Perform the procedures required by your setup, and the BBS will download to the selected file to your computer.

9. To log off, type Q and press ENTER.

Ionosphere Information

For latest ionosphere information, use the Space Environment Services Center BBS:

303-497-5000 2400, N, 8, 1 F

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TIPS FROM THE FIELD

The two most frequent causes of lost data are cable failures and inadequate power supply. Prevent these disasters and ensure the success of your survey by being adequately prepared before you go to the field. Take a Survey Saver Emergency Kit containing:

- At least one battery, fully charged
- Power cables - have one with alligator clips for use with your vehicle battery, and make it extra long
- Antenna coaxial cable
- Connectors for power cable and antenna coaxial cable
- Battery-powered solder gun and solder
- A spray can of electrical contact cleaner. Clean your connectors before and after each use
- An inexpensive multimeter for monitoring battery voltage and for checking continuity and shorts in cables
- Wire stripper, side cutter, electrical tape

Don't knot or kink your cables, walk on them, stand on them, drive over them, or stow them carelessly.

Figure 1. Ashtech SCA-12 GPS Receiver 1
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