THALES NAVIGATION

ZY-12 GPS Receiver

Information Supplement

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USER NOTICE

This manual comes as a supplement to the Z-12 Operation and Technical Manual (Part No. 630810-01) to cover all operating aspects of the ZY-12 GPS receiver.

Chapter 1 is a copy of chapter 1 from P/N 630810-01 with two additional sections:

- a Back Panel section describing the ZY-12 back panel and the pin-outs for the Power and Port X connectors
- A Specifications section gathering a number of ZY-12 specific features.

Chapter 2 is a copy of chapter 2 from P/N 630810-01 with an additional section about RTCM differential at the end of the chapter (plus revised screen 4).

Chapter 3 is a copy of chapter 3 from P/N 630810-01 with an additional section about the SEC. Module subscreen.

Chapters 5 and 6 are brand new chapters specific to the ZY-12.

Appendix A is a mere copy of Appendix E from P/N 630810-01.

Table of Contents

1

General Information

This manual describes the features of the ZY-12 GPS receiver, Figure 1.1, telling you how to set up the receiver, how to collect data, and how the receiver operates. Many field procedures, such as kinematic surveying, are also described.

Figure 1.1. ZY-12 Receiver

The ZY-12 GPS receiver, making full use of the Navstar Global Positioning System, provides state-of-the-art precision surveying and navigation. The ZY-12 is the first to offer true all-in-view automatic tracking. With 12 independent channels, it automatically tracks all the satellites in view, eliminating the need for manual, programmed, or pre-programmed selection of common satellites between survey sites.

The system includes a microstrip antenna mounted on a precision machined platform for accurate positioning above the survey mark.

The ZY-12 receiver is easy to operate. After you position your tripod, you need only turn the power on. Operating controls are on the front; input and output connections on the back.

Screen Summary

The receiver functions are accessed through various screens, as summarized in Table 1.1. *Information* in the title of a screen means display only. *Control* in the title indicates a screen you interact with, such as Screens 4 and 9. Screens are described in detail in Chapter 3, **Screen Descriptions**.

Table 1.1. Screen Summary

Screen	Display Function
0	Skysearch Information
1	Orbit Information
2	Navigation Information
3	Tracking Information
4	Mode Control
5	Differential Information
6	Waypoint Control
7	Satellite Selection Control
8	System Control
9	Site and Session Control
10	All-in-View Information
11	Visibility Information
12	Bar Code Control

Front Panel

The receiver front panel, Figure 1.2, includes an 8-line x 40-character backlit LCD display, and various keys for controlling the receiver and entering data.

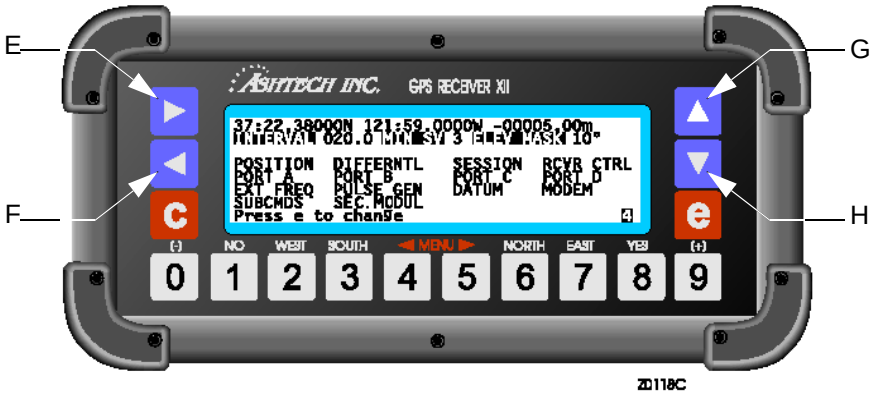

Figure 1.2. Front Panel

Table 1.2 describes the keys that activate the receiver's functions.

Table 1.2. Keys and Functions

Key or Function	Description
0 - 9	Pressing a number key calls up a specific screen directly. The lower right corner of the screen displays the screen number. Whenever the manual discusses a screen, it identifies the screen by number (e.g., Screen 1, Orbit Information). The number keys are used to enter alphanumeric data such as latitude, antenna height, site name. Depending on the particular screen, number keys may have other functions; for example, the [8] key for 'yes'.
c	**c** Use the **c** key to cancel the current entry.
e	Press the **e** key to enter data-entry mode, to save values you have entered, and to go back to higher level displays. (It functions much like the <ENTER> key on a computer.)
E F	In display mode, use the right arrow E key or the left arrow F key to change to the next higher or lower numbered screen or subscreen. In data-entry mode, use the left and right arrow keys to move the cursor to highlight a field or to flash in a character position where your next entry will go.
G H	The up and down arrow **G H** keys are used to scroll through the different pages of a screen, or to raise and lower the contrast when only one page is available and the receiver is in display mode.

HIGHLIGHT: To highlight a parameter, use an arrow key to move the cursor until that field displays in inverse video and a character position in that field is flashing.

SELECT: To select a parameter, highlight it and press the **[e]** key.

TOGGLE: To toggle a field, highlight it and press the **+** or **-** key until it displays the setting you want. For example, below Screen 4, on the Port A/B Parameter Selection screen, you can toggle through various baud rates. Use the right arrow key to highlight the BAUD RATE indicator and press the **+** key or **-** key to scan through 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 to the desired baud rate.

BACKLIGHTING: After two minutes of keyboard inactivity, the backlighting automatically turns off to extend the life of the battery. To restore the display, push any key. The **e** key is recommended, since it does not change the display.

Back Panel

Figure 1.3 shows the connectors and power switch on the back panel. The receiver operates with an input voltage between 10 and 32 Vdc from an external power supply.

Two POWER-IN sockets let you use two external batteries. When only one battery is connected and it comes close to discharge, a continuous tone indicates that the voltage has dropped below 10 volts.

You can connect the second battery to the second connector and continue recording data without interruption. Or you can connect two batteries at once for long unattended observations; the receiver operates from the battery with the higher charge. Table 1.3 describes the items on the back panel.

Figure 1.3. Back Panel

Table 1.3. Back Panel

Item	Description
ON/OFF	Power switch turns the receiver on and off.
EXT REF	BNC connector for optional external reference frequency input.
CAMERA IN	BNC input connector lets you record an accurate event time with a photogrammetry camera-input option and cabling
1PPS	BNC connector outputs a one-pulse-per-second signal synchronized with GPS time.
POWER	Two power connectors in parallel to apply input voltage to ZY-12 (see previously)
PWR OFF	Toggle switch for Power
Red LED	Crypto not keyed
Green LED	Crypto successfully keyed
ZEROIZE	Pushbutton used to zeroize the security key.
ANT	Connector for the GPS antenna cable.
PORT 1 and PORT 2	Four RS-232 serial ports are available, embedded within two 16-pin connectors labeled PORT 1 and PORT 2. Port 1 corresponds to software ports A and C. Port 2 corresponds to software ports B and D. All four ports can be used for all functions.
KYK-13	Connector for Crypto Fill Device

Power Connectors

Use at least 22-gauge wire for external power cables.

- Pin A is the positive 10-32 VDC connection.
- Pin B is ground.
- Pin C: open.

Figure 1.4 below shows one of the two power connectors located at the back of the receiver.

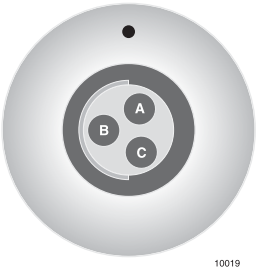

Figure 1.4. Power Connector

RS-232 Connectors

The RS-232 cables used with the ZY-12 receiver should mate with the female 16-pin circular connectors on the receiver (see Figure 1.5 below).

Figure 1.5. RS232 Connector (Port 1, Port 2)

Figure 1.4 below lists pin assignments.

Table 1.4. RS232 Connector Pin-Out

Pin Number	Description	Abbreviation
1	Ground	GND
2	Transmit data port A/B	TXD0
3	Receive data port A/B	RXD0
4	Request to send port A/B	RTS0
5	Clear to send port A/B	CTS0
6	Data set ready port A/B	DSR0
7	Ground	GND
8	Data carrier detect port A/B	DCD0
9	Data terminal ready port A/B	DTR0
10	+5 VDC	+5V
11	Ground	GND
12	Transmit data port C/D	TXD2
13	Receive data port C/D	RXD2
14	Request to send port C/D	RTS2
15	Clear to send port C/D	CTS2

Port A/B is configured for full handshake, while port C/D is not.

Upgrading Firmware

The receiver can be upgraded with new firmware without opening the unit. The receiver contains flash EPROMs which can be uploaded with new firmware from your computer. Updates are shipped on a 3 ½-inch disk accompanied by appropriate instructions. Contact Customer Support for more information.

Automatic Power-Down

The receiver automatically turns itself off if input voltage drops below 10 volts. A beep sounds to indicate low battery, at which time you must shut down and connect a fresh battery.

Accuracy

Static, Rapid Static or Pseudo-Kinematic Survey: 5 mm + 1 ppm

Real-time Differential Position: <1 m (PDOP <4)

Static occupation time: 2 seconds (typ)

Sub-centimeter accuracy with longer occupation time.

Azimuth: 0.15° + 1.5/baseline length in km

Self-test Procedure

Self-test is automatic on power-up. Reacquisition is automatic if loss of lock occurs.

Direct-Y Acquisition and Tracking

Automatic when keyed.

C/A Acquisition and Y Tracking

Automatic when keyed.

Direct Y with L2

Automatic when keyed.

Selective Availability

Selective Availability (SA) is removed, if it is active, when the ZY-12 is keyed. When it is not keyed SA will degrade the accuracy. Currently SA is not active.

Zeroizing Procedure

The ZY-12 is operational when keyed. The zeroizing key will put the ZY-12 into Z-tracking mode.

There are two ways to zeroize:

1. Front Panel, Screen 4, Sub-screen SECURITY MODULE, Zeroize Y/N
2. Serial Command $PASHS,ZER.
3. Push PWR OFF Zeroize on back panel.

2

Getting Started

Operating the Receiver

Set up the receiver and start operation as described in the following procedure.

1. Connect one end of the power cable to a 10-32 VDC power source (generally a battery pack) and the other end to either of the two POWER connectors on the rear panel of the receiver (Figure 2.1).

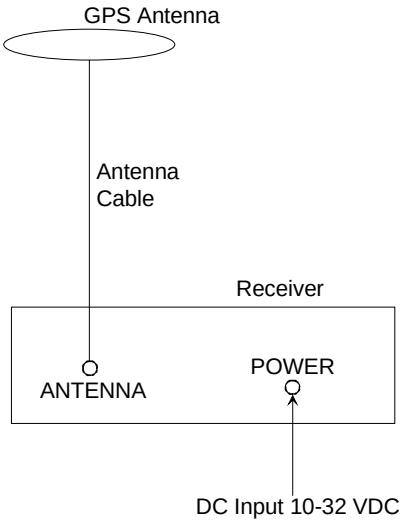

Figure 2.1. Receiver Setup

2. Connect one end of the antenna cable to the GPS antenna and the other end to the ANTENNA connector on the rear panel of the receiver.
3. Measure and record the antenna height (HI, Height of Instrument).
4. Start data collection by setting the ON/OFF switch on the rear panel to ON. This initiates a self-test. If the receiver finds a problem, it stops and displays an error message. If the receiver detects no problems, it briefly flashes the copyright, and then displays Screen 0 (Figure 2.2).

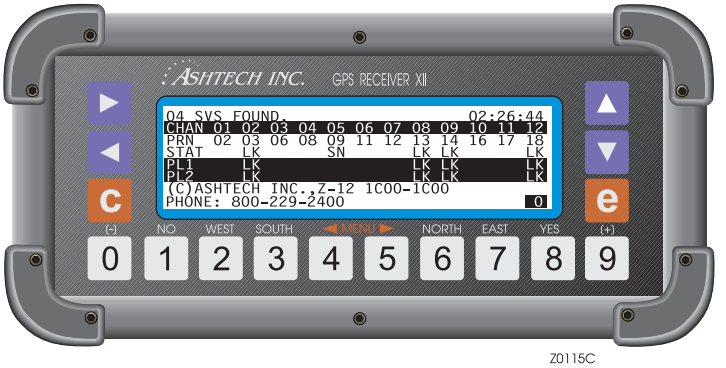

Figure 2.2. Screen 0

In theory, no further interaction with a receiver is required for a static survey. When the receiver is turned on, it automatically:

Searches and locks onto all available satellites

Makes GPS measurements and computes its position

Opens a file and saves all data into this file

When the receiver is turned off after a survey, it automatically saves the collected data and closes the file. At this point, the data stored in the receiver must be transferred (downloaded) to a PC for post-processing.

There are two primary screens for specifying information for a survey. These screens are Screen 4 and Screen 9, described later. To operate the receiver after it has been turned on, continue as follows:

5. On Screen 0, adjust contrast by pressing the up or down key.

   You do not have to enter any information for your survey if the default parameters are suitable. For a static survey, accept the defaults and go to step 8.

6. Go to Screen 4, Mode Control (Figure 2.3) where you can change operational parameters. To access Screen 4, press the **[4]** key.

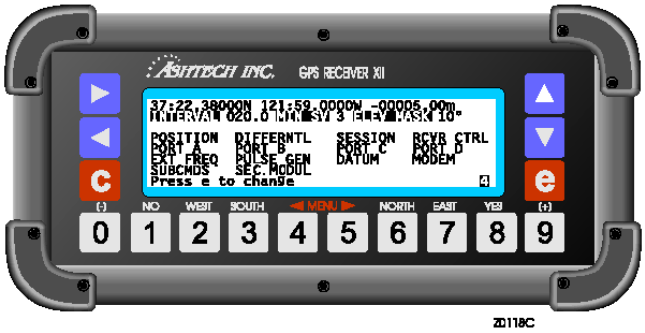

Figure 2.3. Screen 4 - Mode Control

7. The default values work very well for static surveys. However, if you choose to alter a value, press **[e]** to shift to data entry mode. Use an arrow key to move the cursor to the desired parameter, and change its value. Press the **[e]** key to save the changes or the **[c]** key to abandon changes.
8. Call Screen 9, Site and Session Control (Figure 2.4) by pressing the **[9]** key. Like Screen 4, you do not have to alter information to successfully conduct a static survey. However, entering information now assists in automatic processing.

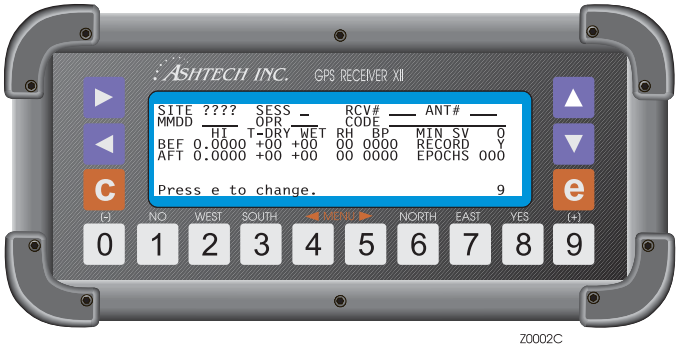

Figure 2.4. Screen 9 - Site and Session Control

Site information can be entered during data collection and do not affect or interrupt the data collection process. The site data is output as an ASCII file when the data is downloaded from the receiver.

9. When it is time to conclude data collection, turn off the receiver by setting the ON/OFF switch on the rear panel to OFF. The receiver automatically saves the collected data, and closes the data file.

Receiver Configuration

To check the factory installed receiver configuration, go to Screen 8 (Figure 2.5).

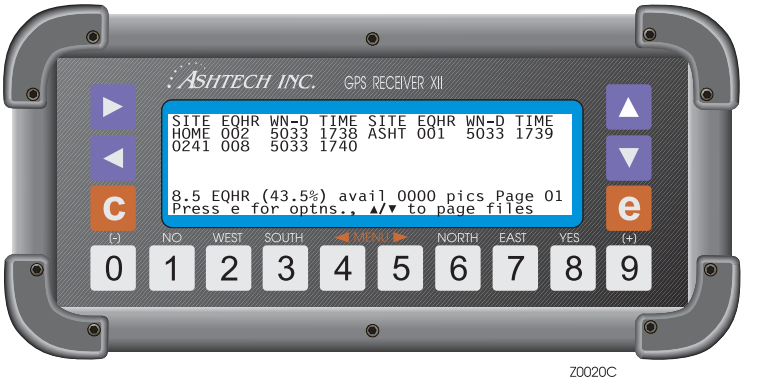

Figure 2.5. Screen 8

Issue command 888 by pressing the **[e]** key, the **[8]** key three times, then the **[e]** key again. The configuration of your receiver appears on the display (Figure 2.6). You need this information when contacting Customer Support.

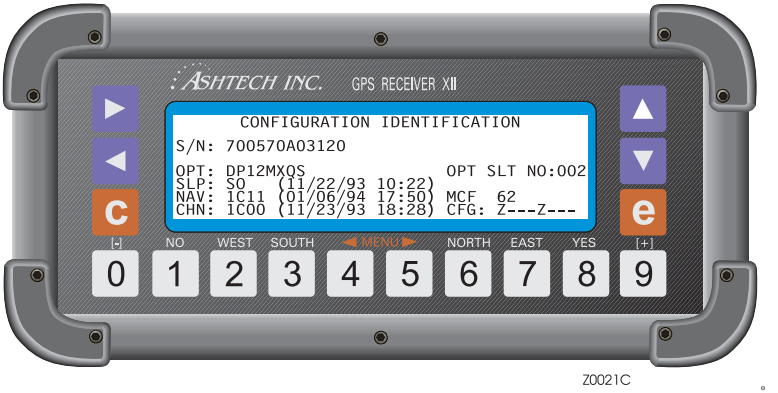

Figure 2.6. Receiver Configuration

S/N is the serial number of the receiver.

OPT is a list of option codes, as listed in Table 2.1. The order is important. A dash (-) means your receiver does not have the corresponding option.

Table 2.1. Option Codes

Code	Installed Option
D or U	D = differential U = remote only
P	Photogrammetry
1	P1
2	P2
M	Remote monitoring
X	External frequency
-	Reserved
-	Reserved
L	Sleep mode
-	Reserved

OPT SLOT NO indicates how many times options have been reloaded into the receiver

SLP indicates the version of the sleep mode firmware, and its release date

NAV indicates the version of navigation firmware and its compilation date.

CHAN indicates the version of channel firmware and its compilation date.

Saving and Resetting User Parameters

When the values of most parameters are modified, they are not saved automatically in the internal memory overriding the defaults, and resets after a power cycle of the receiver.

Modified parameters can be saved by using the command 555. To use this command, from Screen 8, press the **[e]** key, enter 555 and press **[e]** again. The message "**user parameters saved**" displays.

To set parameters back to their original default values, use command 550. To use this command, in Screen 8, press the **[e]** key, enter 550, and press **[e]** again. The message "**default parameters being restored**" displays.

This command updates some parameters to their default values and does not clear the complete internal RAM.

Resetting Memory

A reset of the **internal memory** clears the receiver to the factory defaults, including almanac and ephemeris data. To reset memory:

1. Turn the receiver off.
2. While pressing the up arrow key, turn the receiver on.
3. Keep pressing the up arrow until the message **"Test of internal RAM. Will clear all data. Press YES within 10 seconds to continue"** displays.
4. Press **[8]** (YES), and the message **"Push any key to continue"** should appear shortly. Press any key to continue with receiver normal operation.

A reset of the **external memory** of the receiver erases all data files displayed on Screen 8 and stored in the memory. To complete this reset:

1. Turn the receiver off.
2. While pressing the right arrow key, turn the receiver on.
3. Keep pressing the right arrow until the message **"Test of external RAM. Will clear all data. Press YES within 10 seconds to continue"** displays.
4. Press **[8]** (YES), and the message **"Push any key to continue"** should appear after several seconds. Press any key. The receiver is now ready for use.

Creating a File

Each time the receiver is turned on, a new file is created. The name is the site name that was entered last. This name is preserved when the power is turned off. The receiver can store up to 100 files.

Upon tracking a minimum of three satellites, data records in the last file shown on Screen 8.

If more than 10 files are in memory, files are stored on a different "page" of the screen. To scroll through the pages of files, press the up and down arrows. When the memory is full, the receiver stops recording. Previously recorded data are not overwritten or lost.

Closing a File

Files automatically close when the receiver is powered off. During data recording, you can close a file and open a new one without turning off the power:

1. From Screen 8, press **[e]** to shift to data-entry mode. Use the number keys, and enter **[1] [2] [3]**.
2. Pressing **[e]** again closes the file and opens a new one; if no data has been logged to the current file, you cannot open a new file.

Downloading a File

Files in external memory can be downloaded using Remote.exe or Thales Navigation Download programs. The receiver-PC connections are as follows:

1. Connect an RS-232 cable to a serial port (port 1 is preferred) on the receiver and to COM1 (preferred) on the PC.
2. Turn the receiver on.
3. Download the data with the software on your PC.

Deleting a File

You can delete a file at any time. However, before deleting a file, check that it is not needed or the information downloaded.

To delete a file,

1. Go to Screen 8 which displays all files in memory.
2. If there are more than 10 files in the receiver, use the up and down arrow keys to scroll to the page with the desired file.
3. Press **[e]** to shift to data-entry mode. Highlight the file you want to delete.
4. Use the number keys and enter **[4] [5] [6]**. Press **[e]** again and wait until the end of the current cycle for the file to be deleted and erased from the display.

Each time the receiver is turned on, a new empty file is opened. If this file is deleted before closing it, any data collected append to the last file in the list.

Several system-level commands are available to the user. These commands can be entered via Screen 4, SUBCMDS menu, or from Screen 8. Table 2.2 lists the commands.

To use these commands, start by pressing the **[e]** key for data-entry mode. Then use the number keys to enter the desired command. Press the **[e]** key again for the command to be accepted. Pressing **[c]** instead of the final **[e]**, cancels the command and the unit returns to display mode.

Table 2.2. Systel-Level Commands

Command	Function
100	Turn off backlighting after 2 minutes since last key press. (Default)
101	Keep backlighting on; if backlighting is left on, the receiver draws significantly more power.
123	Close a file.
191	Initialize the modem.
550	Reset receiver to original default values.
555	Save user parameters
737	Initialize (reset) RTCM
888	Display configuration identification (information such as serial number, list of installed options, firmware version.
990	Trigger photogrammetry on falling edge of pulse.
991	Trigger photogrammetry on rising edge of pulse.
999	Delete all photogrammetry pictures.

General

To use the RTCM differential option, do the following:

1. On Screen 4, press **[e]** to shift to data-entry mode.
2. If the receiver is the base station, a previously surveyed antenna position must be entered in the POS line. Also, you should lower the elevation mask to about 5°.
3. Highlight DIFFERNTL and press **[e]** to access the Differential Mode Selection screen (Figure 2.7).

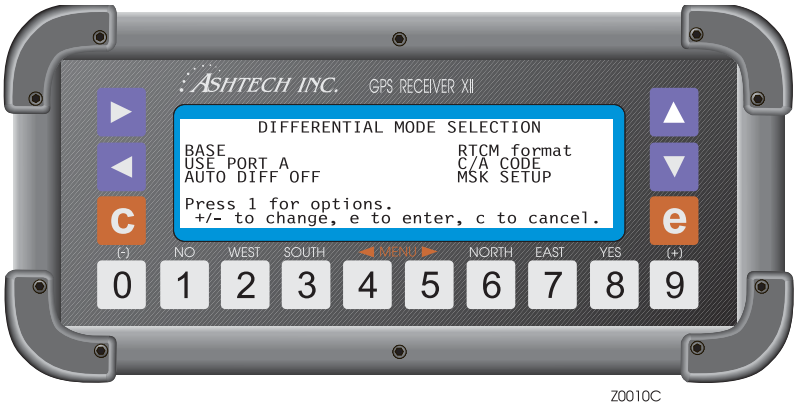

Figure 2.7. Differential Mode Selection Screen

4. Highlight the mode indicator and press **[+]** or **[-]** to toggle it (through base, remote, and disabled) and select the right mode. Select it here or on the RTCM OPTIONS screen.
5. Highlight the output port indicator and toggle it through **USE PORT A** or **B** or **C** or **D** so that it corresponds with the serial port you are using for the differential corrections.
6. If you want the auto differential option enabled, highlight the AUTO DIFF field and press **[+] or [-]** to set it to ON.
7. Press **[e]** to record your new setup. The display shows the specified port and baud rate.
8. Press **[e]** again to return to the main display, Screen 4.

Setting RTCM Format Type 10

1. Highlight **C/A code** and **+/-** to toggle to “L1 P-code”.
2. Highlight **RTCM format** and press [**e**] to view message types. Type 10 will be displayed instead of type 1.

3

Screen Descriptions

This chapter presents detailed descriptions of the various screens that allow you to control the receiver and observe results. Table 3.1 summarizes the screen functions.

Table 3.1. Screen Summary

Screen	Display Function	Page
0	Skysearch Information	20
1	Orbit Information	22
2	Navigation Information	24
3	Tracking Information	27
4	Mode Control	28
5	Differential Information	47
6	Waypoint Control	51
7	Satellite Selection Control	65
8	System Control	66
9	Site and Session Control	69
10	All-in-View Information	71
11	Visibility Information	74
12	Bar Code Control	76

Screen 0 - Skysearch Information

Screen 0 (Figure 3.1) displays the status of the satellites that the receiver finds as it performs a sky search. The number in the lower right corner identifies the screen. Table 3.2 describes the screen parameters.

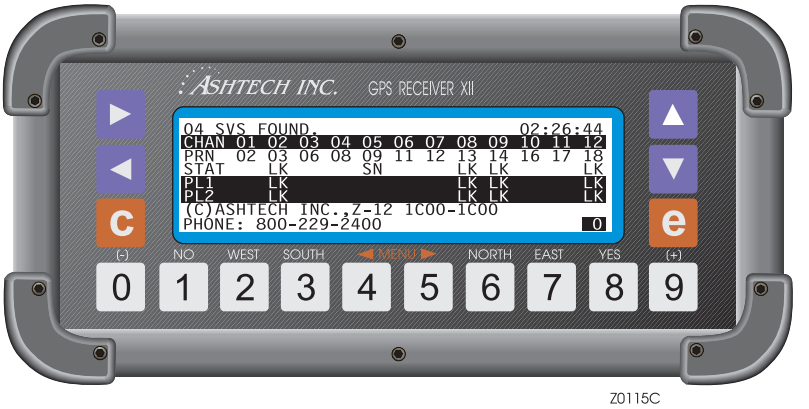

Figure 3.1. Screen 0 - Skysearch Information

Table 3.2. Screen 0 - Skysearch Parameters

Parameter	Description
SVS FOUND	Reports the number of satellites located
02:26:44	Hours, minutes, and seconds are reported in the upper right in 3 stages. Before it locks on a satellite, the receiver displays time elapsed since you first turned it on. After it locates the first satellite, it reads the satellite time, sets its internal clock, and reports GPS time. After it finds several satellites and collects GPS-to-UTC parameters, it changes to GMT.
CHAN	Contains the channel numbers for the associated satellites.
PRN	PRN number of each satellite being searched for. If lock is not acquired on a satellite after 2 minutes, a new satellite cycles into its channel. If the SV PRN numbers are displayed in reverse video (blue numbers in a white box), then the receiver is in Z-mode.
STAT	Current status of each C/A code channel. When the receiver finds a trace of a satellite signal, it reports SN. It has detected some kind of signal; if not a satellite signal, the receiver continues the search. When a signal proves to be a satellite signal, the receiver reports LK (locked on), and then reads the satellite's ephemeris and almanac files. Status generally changes to LK within 2 minutes of operation.

Table 3.2. Screen 0 - Skysearch Parameters (continued)

Parameter	Description
PL1	Indicates the lock status of the P1 code channels. Like the C/A code channel, reports SN (Sniff), LZ (Z tracking, locked without crypto) or LY (P code).
PL2	Indicates the lock status of the P2 code channel. Like the C/A code channel, reports SN (Sniff), LZ (Z tracking, locked without crypto) or LY (P code).
ZY-12 1Y07-1DY4	Reports the type of receiver and the software version number. When calling a service representative with any problem, have this number at hand.

Screen 0 is display only, you cannot enter data on it. To change to other screens in order, press the left or right arrow. To jump to another screen, press a number corresponding to the screen number; for example, to jump to Screen 5, press 5.

Screen 1 - Orbit Information

The receiver collects and displays the orbit parameters from each satellite it has found. It computes and displays information, such as elevation and azimuth, on Screen 1 (Figure 3.2). Screen 1 is display-only, you can not use it to enter information. Table 3.3 describes the screen parameters.

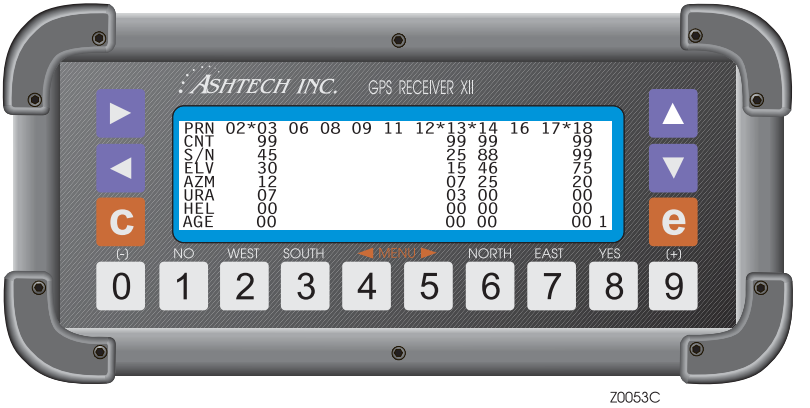

Figure 3.2. Screen 1 - Orbit Information

Table 3.3. Screen 1- Orbit Parameters

Parameter	Description
PRN	The PRN number of each satellite being tracked by the receiver. An asterisk (*****) preceding it says it is currently locked. If the SV numbers are displayed in reverse video (blue numbers in a white box), then that satellite is in Z mode.
CNT	The number of epochs of continuous data collected from this satellite. It is updated every second. It ranges from 0 to 99 and remains at 99 until a cycle slip. If there is a cycle slip or loss of lock, the receiver resets CNT to 0. If CNT often drops to 0, it indicates there are frequent cycle slips with this satellite. However, if the satellite is high in the sky (elevation angle 20° and above), cycle slips are rare unless obstructions exist in the line of sight to the satellite.
S/N	The signal-to-noise ratio, a measure of a satellite's signal strength. When less than 20, the signal is weak; when over 50, the signal is strong. A satellite at low elevation displays a weaker S/N.
ELV	The satellite's angle above horizon, ranging from 0° to 90°.
AZM	Geodetic azimuth of the satellite clockwise from 0° geodetic north in units of 10° (geodetic north according to WGS-84 coordinates). When it displays 12, read it as 120°.

Table 3.3. Screen 1- Orbit Parameters (continued)

Parameter	Description
URA	Indicates the range accuracy of each satellite. When 0, the accuracy is high; when over 8, the accuracy is low.
HEL	Displays the satellite's health (general condition) in hexadecimal.
AGE	Shows how many minutes have passed since lock was lost on the satellite. For example, when ELV is 35 and AGE is 12, the satellite was at an elevation of 35° twelve minutes ago when loss of lock occurred. When the satellite is reacquired, the age resets to 00.
1	The "1" in the lower right corner of the screen indicates the screen number

The receiver needs to know its position to compute elevation and azimuth. Until it locks on to enough satellites to determine its own position, it can use an estimate of position; this estimate can be entered on Screen 4, Mode Control.

Screen 1 displays the satellite information for the C/A channel. To see information on P1 (P-code on L1), press the down arrow; the S/N display is updated for those parameters and the screen number is displayed as P over 1. Press the down arrow again to see P2 (P-code on L2); a P displays over the 2 as the screen number.

Screen 2 - Navigation Information

Based on information received from the GPS satellites, the receiver computes and displays on Screen 2 various components of position. This is a display-only screen, you cannot enter data. Screen 2 consists of two pages (Figure 3.3 and Figure 3.4). Table 3.4 describes the parameters shown on page 1.

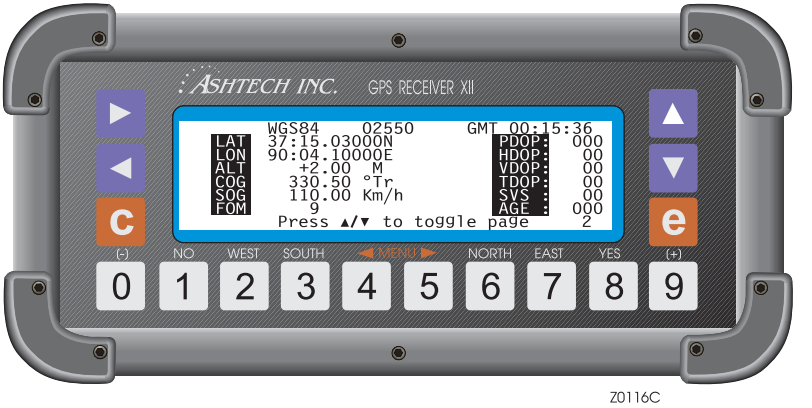

Figure 3.3. Screen 2 - Page 1

Table 3.4. Screen 2 - Page 1 Parameters

Parameter	Description
WGS-84	Indicates the datum of the displayed position. The default is WGS-84. Other datums can be selected in Screen 4, Datum.
02550	Position counter that increments with every half-second update. The display changes to **OLD** when the position data is more than 10 seconds old. When count restarts, the counter begins from last count.
00:15:36	Displays Greenwich Mean Time (GMT) or GPS time (GPS).
LAT	Computed latitude is reported in degrees and minutes to 5 decimal places with N for north and S for south.
LON	Computed longitude is reported in degrees and minutes to 5 decimal places with E for east and W for west.
ALT	Altitude is the ellipsoidal height, in meters.
COG	COG (course over ground) is the heading in degrees. The default unit is in true degrees (Tr). Magnetic mode can be selected in Screen 6.

Table 3.4. Screen 2 - Page 1 Parameters (continued)

Parameter	Description
SOG	SOG (speed over ground) is the receiver's velocity. Can be displayed in miles per hour (labeled MPH), kilometers per hour (KM/H), or knots (KN). The units are set on Screen 6, function 8: Unit Selection option.
FOM	FOM (figure of merit) indicates the accuracy of the stand-alone position based upon satellite range residuals and PDOP. 1 is the best. 9 indicates that a position is not being computed.
PDOP	PDOP (position dilution of precision) is a measure of the strength of the satellite geometry. If the satellites are scattered around the sky, the certainty of a position is better and PDOP is lower than if they are close together. A number above 6 indicates a bad PDOP.
HDOP	HDOP (horizontal dilution of precision) is the two-dimensional horizontal component of PDOP.
VDOP	VDOP (vertical dilution of precision) is the height component of PDOP.
TDOP	TDOP (time dilution of precision) is the time component of PDOP.
SVS	The number of satellites currently being used for the position calculation.
AGE	Reports how many minutes since the position was computed.

Access page 2 of Screen 2 (Figure 3.4) by pressing the up or down arrows. Table 3.5 describes the page 2 parameters.

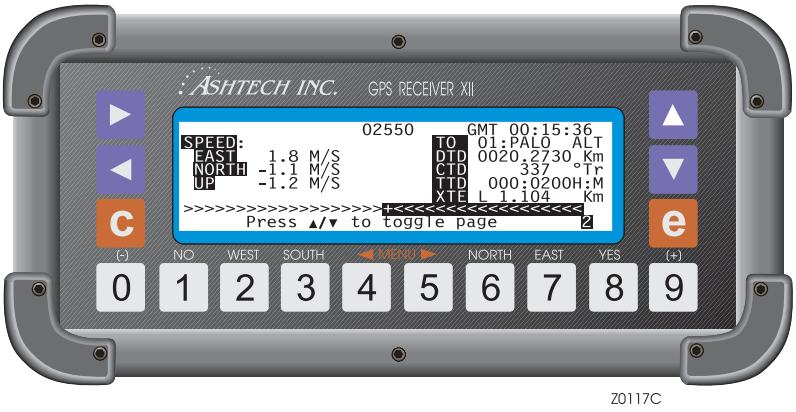

Figure 3.4. Screen 2 - Page 2

Table 3.5. Screen 2 - Page 2 Parameters

Parameter	Description
SPEED	Speed over ground (SOG) parameter displayed in its E (east), N (north), and U (up) (ENU) components.
TO	Displays the TO waypoint, giving its number and name. The waypoint is specified on Screen 6, Waypoint Control.
DTD	Distance-to-destination is the distance from your present position to the waypoint.
CTD	Course-to-destination is the course to follow from your present position to the TO waypoint displayed in either true degrees (°Tr) or magnetic (ºMg).
TD	Time-to-destination is given in hours and minutes (labeled H:M) to the TO waypoint, based on the present SOG.
XTE	Cross-track error indicates deviation from the track between the FROM waypoint and the TO waypoint where R indicates you are right of the track and L indicates you are left of it. The deviation is labeled in kilometers (KM) or miles (MI).
>>>>>+<<<<<	A visual representation of the direction in which to proceed in order to get back on track to the next TO waypoint. This example indicates you take a heading more to the right.

Screen 3 - Tracking Information

Screen 3 (Figure 3.5) displays the data recorded for each tracked satellite. Table 3.6 describes the screen parameters.

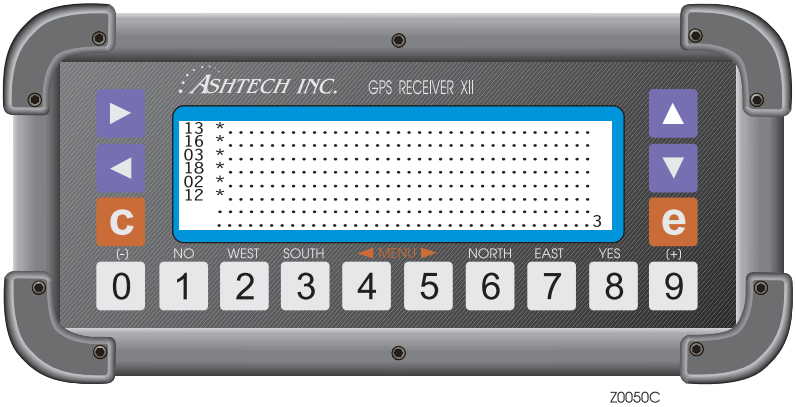

Figure 3.5. Screen 3 - Tracking Information

Table 3.6. Screen 3 Parameters

Parameter	Description
. (dot)	Indicates no data are recorded for that satellite.
* (star)	Indicates data are recorded for that satellite.

The satellite numbers go down the left side in the order in which they are tracked. To the right are columns of dot and star symbols. Each symbol represents 5 minutes. Dark bands mark off 30-minute segments for easy reading, with a maximum display capacity of 180 minutes (3 hours).

Screen 3 is display only, you cannot enter data.

Screen 4 - Mode Control

On Screen 4 (Figure 3.6), you can change several receiver control parameters and access receiver options including:

- Position Fix, Differential Mode
- Session Programming
- Receiver Mode
- Serial Port Setup
- Setting External Frequency
- Pulse Generation
- Datum Selection
- Modem Setup
- Subcommands
- Mission duration parameter setting and Zeroize command.

Access the applicable subscreen via Screen 4. Table 3.7 describes the Screen 4 parameters.

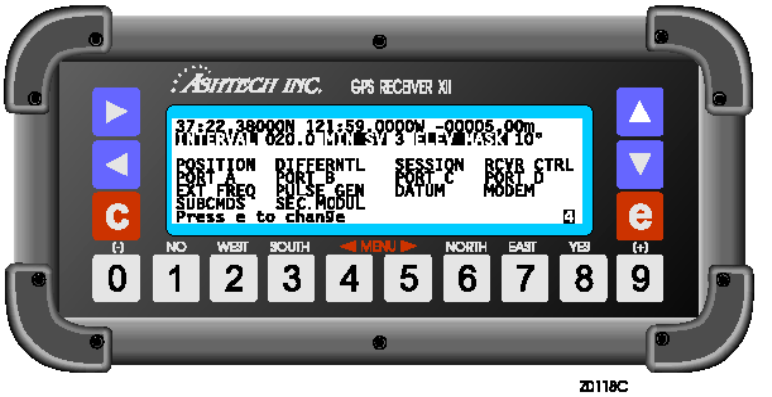

Figure 3.6. Screen 4 - Mode Control

Table 3.7. Screen 4 Parameters

Parameter	Description
First line of display	The entire first line of the display shows the coordinates of the antenna - latitude, longitude, and altitude per the WGS-84 ellipsoid. Press the numbered keys, typing zero where necessary. When a field is full, the cursor automatically jumps to the next one. Position can be entered or displayed in two formats: deg/min or deg/min/sec. The format can be changed under Screen 4, SUBCMDS.
INTERVAL	Recording interval lets you specify how frequently to record data into memory. The default is 20.0 seconds, displayed when the receiver is first turned on. If you want to collect less data, increase this parameter. Conversely if you want more data to examine, decrease the interval, perhaps to 10 seconds. Press **[e]** to go to data entry mode, and press the down arrow until the INTERVAL field is highlighted. Then press the numbered keys such as **0**, **1**, and **0** to enter a 10-second interval. (This is typical for a kinematic survey.) Make sure the recording interval is changed at the beginning of the survey. It should not be changed once data collection has begun. Data can be recorded at any half-second interval (0.5, 5.5, 10.5). Any other subsecond interval is not allowed.
MIN SV	Lets you set the minimum number of satellites with valid ephemerides that need to be locked before data recording can begin. It defaults to 3 when the receiver is first turned on.
ELEV MASK	**L**ets you set the minimum elevation angle below which no satellite data are recorded. Default is 10°. To change the angle, press the right arrow until ELEV MASK is highlighted, then press the numbered keys such as 0 and 0 to enter a 0° angle. For surveying, try to collect everything above 10° and limit the cut-off angle only in post-processing. Note that this mask controls only data recording. For position computation, see Screen 4, Position submenu.
Receiver Options The following entries are Screen 4 options. All options appear on Screen 4 but some can be activated only when they have been installed in your receiver. They are described in the order seen on the screen shown on the first page of this section, left-to-right, top-to-bottom.	
POSITION	Goes to the Position Fix Parameters subscreen where you specify criteria for receiver position computation.
DIFFERNTL	Can be accessed only if the differential option has been loaded into the receiver. When DIFFERNTL is accessed, the receiver goes to the Differential Mode Selection subscreen where you can set up the receiver as a BASE or REMOTE.
SESSION	Calls the Session Programming subscreen which lets you program up to 10 data-recording sessions.
RCVR CTRL	Allows you to set special receiver parameters and control how data and position are stored.

Table 3.7. Screen 4 Parameters (continued)

Parameter	Description
PORT A PORT B PORT C PORT D	Takes you to a subscreen where you can specify serial port output parameters.
EXT FREQ	Can be accessed only if the external frequency (x) option has been loaded into the receiver. When EXT FREQ is selected, the receiver presents a subscreen which lets you set up the external frequency parameters.
PULSE GEN	Goes to the Pulse Generation Parameters subscreen that controls the 1PPS output.
DATUM	Goes to the Datum Selection subscreen where you can select one of 46 possible datums to use for displaying the pseudo-range position shown on Screen 2. Note that this datum is not used for computing the position stored in memory.
MODEM	Lets you set up your modem for Port A, B, C, or D.
SUBCMDS	Lets you enter system-level commands.
SEC. MODUL	Lets you set a mission duration or zeroize the key

Position Fix Parameters

Use the Position Fix Parameters screen (Figure 3.7) to specify position computation criteria (stored and displayed) such as how many satellites to use, when to hold altitude fixed, Dilution of Precision (DOP) masks, elevation mask, and use of unhealthy satellites. You can also enable the ionospheric model to be used for position computation, display computed position in Screen 2 using UTM coordinates, and use point positioning mode.

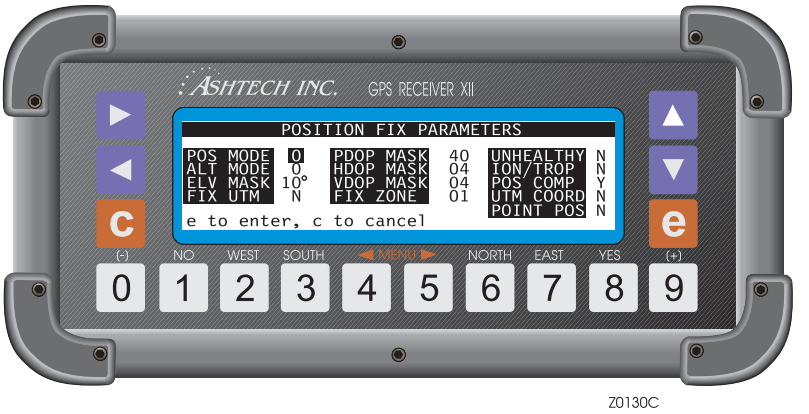

Figure 3.7. Position Fix Parameters

To set a parameter, push the **[e]** key and use the arrow keys to move to the desired parameter. Press the numbered keys, typing zero where necessary. When a field is full, the cursor automatically jumps to the next one. Press **[e]** to save the values and return to Screen 4.

Table 3.8 describes the screen parameters.

Table 3.8. Position Fix Parameters

Parameter	Description
POS MODE	Lets you specify whether to compute altitude or hold it fixed. The field can contain a value ranging from 0 through 3. To be used for position computation, a satellite must be higher than the ELV MASK specified on this subscreen. • 0 specifies that at least 4 satellites be tracked before the receiver computes position. Altitude is never held fixed (default). The following settings for POS MODE require a minimum of three satellites to compute position. • 1 specifies that three satellites are locked, the receiver holds altitude fixed. When more than three are locked, the receiver computes altitude. • 2 specifies when the altitude is always held fixed regardless of the number of satellites tracked. • 3 specifies when 3 satellites are locked, the receiver holds altitude fixed. When more than 3 are locked and HDOP is less than the specified HDOP MASK, it computes altitude. When more than 3 are locked and HDOP is equal to or greater than the specified HDOP MASK, the receiver holds altitude fixed. Remember that when the receiver is first turned on, the altitude is zero. If position mode is set to a value of 1, 2, or 3, enter a value for altitude in the POS field of Screen 4.
ALT MODE	Lets you specify which altitude to use in an altitude fixed position solution. This field can contain 0 or 1 value. • 0 uses last entered altitude or last altitude computed if it was computed with VDOP less than the specified VDOP MASK, depending on which altitude is the most recent. • 1 uses only the altitude entered on Screen 4.
ELV MASK	Allows you to set the minimum elevation angle below which no satellite data are used to compute a position.
FIX UTM	Enables or disables the fixing of the UTM zone. This command is used when you are near a UTM boundary, the receiver is outputting position in UTM coordinates, and you do not want coordinates to shift from one zone to another when the boundary is crossed. Must be used in conjunction with FIX ZONE described below.
PDOP MASK	Lets you define the positional dilution-of-precision parameter. The receiver does not compute position when PDOP exceeds the specified value. The default is 40.

Table 3.8. Position Fix Parameters (continued)

Parameter	Description
HDOP MASK	Lets you define horizontal dilution-of-precision. Effective only when POSITION MODE is set to 3. The default is 4.
VDOP MASK	Lets you define the vertical dilution-of-precision parameter. Effective only when ALT MODE is 0. Default is 4.
FIX ZONE	Lets you set the UTM zone to be held fixed as described above for FIX UTM. Must be used in conjunction with FIX UTM.
UNHEALTHY	Lets you specify whether or not to include unhealthy satellites in the position computation. If Y is specified, a satellite broadcasting an unhealthy message is used to compute a navigation position. Please note that this parameter does not affect data collection for an unhealthy satellite.
ION/TROP	Allows you to enable or disable the ionospheric and tropospheric models to be used in position computation. • M = mathematical ionosphere and mathematical tropospheric models • R = real dual-frequency ionospheric model used, together with the mathematical tropospheric model • N = no model used (default)
POS COMP	Lets you enable or disable the computation of position. USE WITH CAUTION.
UTM COORD	Lets you specify whether to display the compound position in Screen 2 using geodetic coordinates (latitude, longitude) or UTM (east, north) coordinates. If set to Y, UTM coordinates are computed and displayed using the current grid zone.
POINT POS	POINT POS improves the accuracy of a stand-alone absolute position of a stationary receiver from about 50 meters to less than five meters over a period of four hours. Point positioning uses an averaging technique to reduce the effects of SA and other fluctuating errors. Point positioning is standard with the software (no option required).

Differential Mode Selection

The differential mode subscreen allows you to set up the receiver as an RTCM differential base or rover (Figure 3.8). This screen also gives access to lower-level screens where you specify parameters such as RTCM format parameters. This is accessed by selecting DIFFERNTL on Screen 4 and pressing the **[e]** key. If you

do not have the Differential (D) option installed, this subscreen is unavailable. Table 3.9 describes the screen parameters.

Figure 3.8. Differential Mode Selection Subscreen

Table 3.9. Differential Mode Parameters

Parameter	Description
BASE	Toggle field sets the receiver to **BASE**, **REMOTE**, or **DISABLED** mode. Use an arrow key to highlight the mode indicator and press the **+** or **-** key to toggle it.
RTCM format	The 1 key allows you to access the RTCM option subscreen. This subscreen contains several parameters and is described in Chapter 2.
USE PORT A	Lets you specify which port to use for differential mode. Press the **[+]** or **[-]** key to toggle through **PORT A, B, C,** or **D** to correspond with the one you are using. Press **[e]** to save.
MSK SETUP	Sets up interface with MSK (Minimum Shift Keying) transmitter. See MSK Setup discussion following this table.
AUTO DIFF OFF	If set to ON, the receiver automatically switches position computation from differential to autonomous mode when the max age of the differential corrections is exceeded, or differential corrections are not available. Valid only when the receiver is set as a REMOTE.

MSK Setup

Highlighting MSK Setup and press the **[e]** key to access the MSK Setup Menu (Figure 3.9). This menu is applicable only to specialized applications (e.g. US Coast Guard) where the receiver is used in conjunction with an MSK (Minimum Shift Keying) transmitter. Table 3.10 describes the MSK functions.

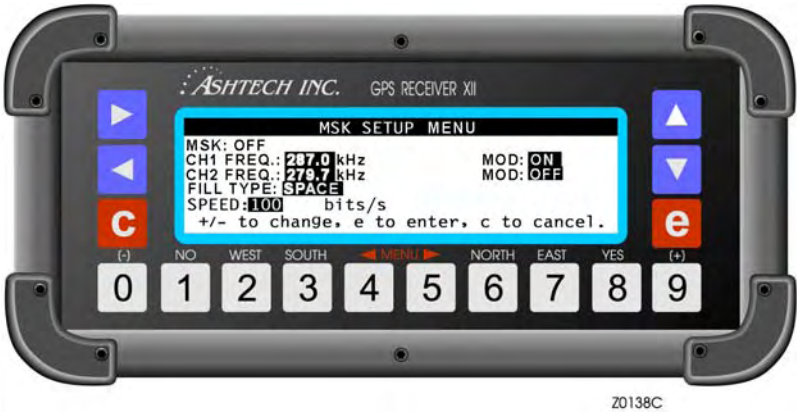

Figure 3.9. MSK Setup Menu

Table 3.10. MSK Setup Parameters

Parameter	Description
CH1 FREQ:	Sets channel 1 frequency in kHz.
CH2 FREQ:	Sets channel 2 frequency in kHz.
SPEED:	Sets keying speed in bits per second.
FILL TYPE:	SPACE, MARK, ALTER or PARK
SNR	Signal-to-noise ratio in dB.
SS	Signal strength in dBmicroV.

Session Program Parameters

The Session Program feature allows you to preset up to 10 observation sessions in the receiver. This option can be useful to normal data collection and is particularly useful when used with the Remote Monitor program in your computer. With the Remote Monitor program and a modem, you can operate a receiver that has been left in a remote location, and download its data files from across the world if necessary.

Initial settings can be made on the receiver and it can be left running. Access this screen (Figure 3.10) from SESSION on Screen 4.

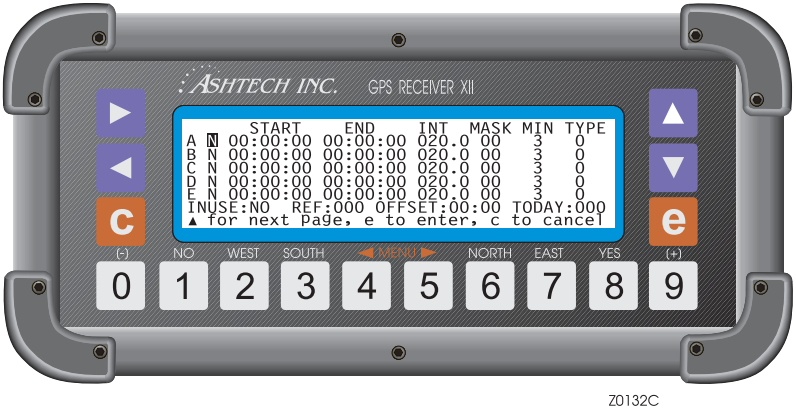

Figure 3.10. SESSION Subscreen

The first column on the left contains the session identifier. Ten sessions, labeled A through J, are possible.

The second column is an individual session toggle. If it is set to Y, the session programmed on this line is activated. If it is set to N, the session is not used. Use the **[8]** and **[1]** keys to toggle the Y and N. Note that sessions are activated only when INUSE is also set to Y or SLP. Individual session parameters are detailed in Table 3.11.

Table 3.11. Session Parameters

Parameter	Description
START	Enter the session start time in hours, minutes, and seconds. If an erroneous value is put here (like 25 hours), it either resets it to 0 or restores the last legal value that it contained.
END	Enter the session end time here. If the end time is earlier than the start time, the session runs into the following day.
INT	Enter data sampling rate in seconds. Values between 000.5 and 999.5 seconds are accepted in ½-second increments.
MASK	Enter the satellite elevation mask in degrees.

Table 3.11. Session Parameters (continued)

Parameter	Description
MIN	The minimum number of satellites that must be visible before the session begins collecting data. The values here for INT, MASK, and MIN override the values set in Screen 4 while this session is running. These values are displayed in Screen 4 when the session goes active and overwrites Screen 4 parameters
TYPE	Refers to the data type collected. Enter 0 for normal geodetic data or 2 for a position-only C-file.
INUSE	A master switch for all sessions. • If INUSE is set to NO, no programmed sessions run, regardless of its individual session setting. If INUSE is set to YES, activates any sessions where the individual session toggle is set to Y. • If the sleep option has been loaded into the receiver, SLP activates the sleep mode. It works essentially like YES, but turns the receiver off between sessions to conserve power. When activated, the sleep mode can be overridden by pressing any key on the front panel of the receiver. Use + and - to toggle. • Whenever INUSE is set to YES, the active file is closed and a new one opened, and the SESSION field flashes, indicating session programming is enabled. When a session goes active, a flashing arrow is displayed by SESSION on Screen 4, indicating data is being recorded.
REF	The reference day (day of the year) for the start and end times. If REF is set to 000, the session does not run. If REF is set to a day of the year later than the present, session programming does not start until REF equals today. If REF is set to a day of the year previous to the present, session programming starts in the present day, applying the offset selected with the REF day as explained in OFFSET.
OFFSET	The displacement of minutes and seconds from the reference day. For a day subsequent to the REF day, the start and end times are decremented by the minutes and seconds specified in OFFSET, multiplied by the day number. (For example, if the offset is 04:00, day 1 is offset 4 minutes, day 2 is offset 8 minutes.) If set to 00:00, the sessions observe during the same time every day. For example, assume a start time for session A of 02:10, an end time is 03:10, REF is day 100, and the OFFSET is 04:00 (4 minutes). If the reference day and offset are not changed on day 101, the start time for session A is 02:06 and the end time is 03:06, or 4 minutes earlier than day 100, thus the receiver can observe the same part of the window every day.

Receiver Control Subscreen

Use the RECEIVER CONTROL subscreen (Figure 3.11) to control the operating mode of the receiver and how data and positions are stored.

Figure 3.11. Receiver Control Subscreen

Z MODE allows you to control when Z tracking is implemented. Z tracking is a method of providing full-wavelength dual-band P-Code data when anti-spoofing (A/S) is present. This parameter can be toggled to A (automatic), Y(es), or N(o):

A - the receiver reverts to Z mode when A/S is detected (default)

Y - the receiver is set to Z mode at all times.

N - the receiver never goes into Z mode.

RANGER MODE controls how data and positions are stored:

0 - indicates geodetic mode. Stores phase data in B-files that can be post-processed differentially using carrier phase or code phase.

1 - stores phase data in B-files that can be post-processed differentially using code phase only. Mode 1 can store more than twice the number of positions as mode 0.

2 - stores smoothed positions in C-files only. These positions can be differentially corrected in real time; they can not be post-processed differentially.

Serial Port Setting

Four RS-232 serial ports are available in the receiver. Two of the ports, A and C, can be accessed through the 16-pin connector labeled PORT 1 on the rear panel. The other two, B and D, can be accessed through PORT 2.

Pin functions for the RS-232 cable that should be used to access the serial ports are described in Chapter 1. Two different serial port cables are available: a single RS-232 cable, P/N 700617 for ports A or B, and a dual serial cable, P/N 700619, for ports A and C or B and D.

All ports output real-time messages, NMEA messages, VTS messages, accept serial port commands, hose data, and operate in differential mode.

Following is a description of the screens and settings for all four serial ports.

Port A/Port B/Port C/Port D Parameter Selection

The Port A Parameter Selection subscreen (Figure 3.12) allows you to specify modes and rate of transmission for serial port A. Access this screen by selecting PORT A on Screen 4. Similarly for Port B, C, or D. Table 3.12 describes the screen parameters.

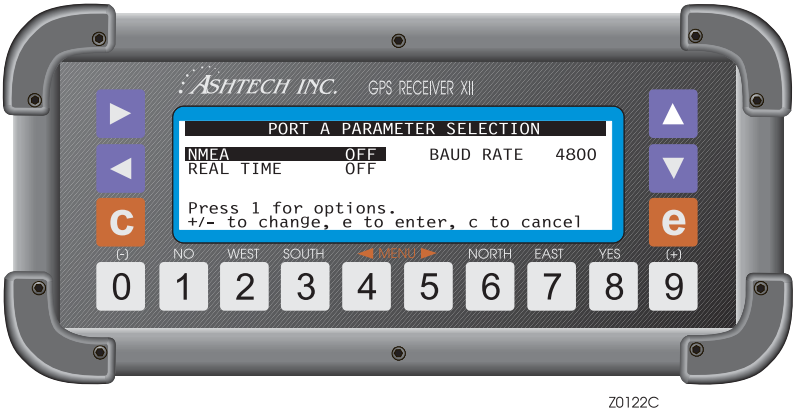

Figure 3.12. Port A Parameter Selection

Table 3.12. Port Parameter Selection Screen Parameters

Parameter	Description
NMEA	Toggles the outputs of NMEA messages through Port A. Highlight NMEA and press the **[+]** or **[-]** key to toggle it ON. Press **[1]** to access the NMEA message subscreen.
BAUD RATE	If the default baud rate of 9600 bits per second is not satisfactory, highlight the BAUD RATE indicator and press the [+] key or [-] key to toggle it to the desired baud rate.
REAL TIME	Toggles the serial output of real-time or raw data messages. Highlight REAL TIME and press the [+] or [-] key to toggle it on. Press [1] to access the REAL TIME message subscreen.

External Frequency Setup

This option lets you input an external frequency to override the receiver's internal oscillator. To configure an external frequency, go to Screen 4 and select EXT FREQ (Figure 3.13). Table 3.13 describes the screen parameters.

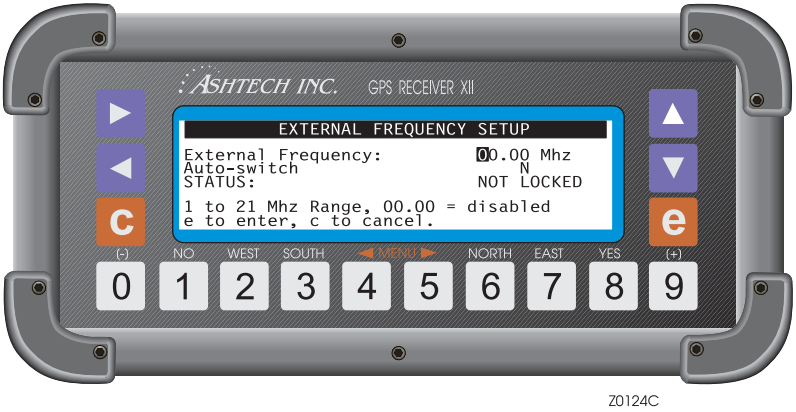

Figure 3.13. External Frequency Setup Screen

Table 3.13. External Frequency Parameters

Parameter	Description
External Frequency	Sets the receiver to the input frequency of the external reference source. Range is 1.00 to 21.00 MHz.
Auto-switch	Toggles Y(es) or N(o). **Y** saves the external frequency parameters after a power cycle. **N** resets the receiver to its internal oscillator after a power cycle.

Press **[e]** to save the parameters. A status display indicates when the external reference is locked. When locked, pressing **[e]** exits that display. If you do not have the external frequency option, you can not access this subscreen.

Pulse Generation Parameters

A one-pulse-per-second (PPS) output option is available. The PPS signal is a TTL signal into a 75-ohm impedance. The signal is normally low and goes high 1 to 2 ms before the falling edge. The rising edge is synchronized with GPS time, as shown in Figure 3.14. The signal is synchronized with GPS time. Access the

Pulse Generation screen (Figure 3.15) by selecting PULSE GEN on Screen 4. Table 3.14 describes the pulse generation parameters.

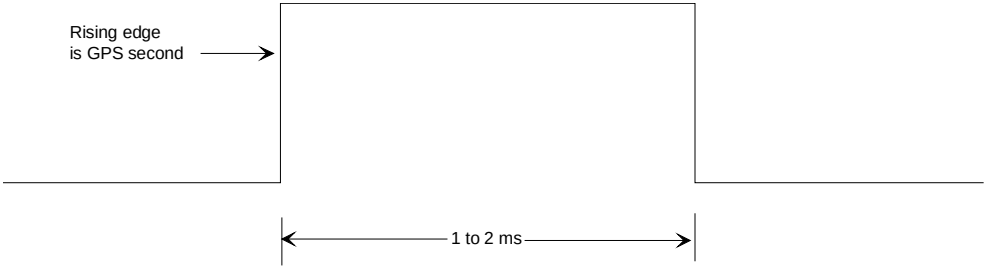

Figure 3.14. One PPS Signal Characteristics

Figure 3.15. Pulse Generation Parameters Screen

Table 3.14. Pulse Generation Parameters

Parameter	Description
PERIOD	The period of the PPS option may be changed from a half second up to a maximum of 60 seconds. Default is 1 second.
OFFSET	PPS may be advanced or delayed up to 500 ms in 100-nanosecond steps. After you specify the period and offset, press **[e]** to save.
OUTPUT TIME ON A:N B:N C:N D:N	Output time message once every second, synchronized with GPS time (rising edge of pulse is also synchronized with GPS time) through serial port A, B, C, or D. Message format is: $PASHR,PPS,dddddd where **dddddd** is the time in seconds of the week

After issuing the 990 command, the falling edge of the pulse is synchronized with GPS time. After issuing the 991 command, the rising edge is synchronized with GPS time.

Datum Select Subscreen

This option lets you specify the datum of the receiver calculated pseudo-range option, or input the parameters for a user-defined datum. (The default is WGS-84.) The datum selected in this screen is only used to compute the position displayed in screen 2. The position stored in memory is always computed using datum WGS-84.

The first datum subscreen is reached by selecting DATUM on Screen 4 (Figure 3.16).

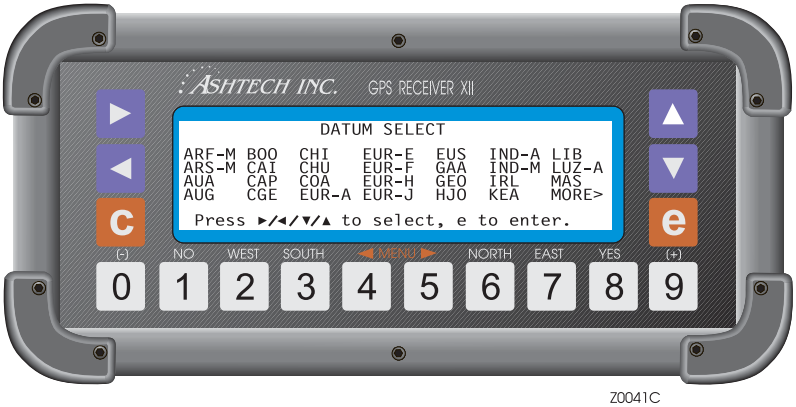

Figure 3.16. Datum Select Subscreen

To select a datum, use the arrow keys to highlight the desired datum and press the**[e]** key; this captures your selection and exits to Screen 4. You can check your selection by returning to Screen 2; the selected datum appears in the upper left.

If the datum you want does not appear on this subscreen, highlight **MORE** and press the **[e]** key. When ARF-M is highlighted, press the left arrow to jump the

cursor to **MORE**. This displays the next datums that are available (Figure 3.17). Select MORE again to view the remaining datums.

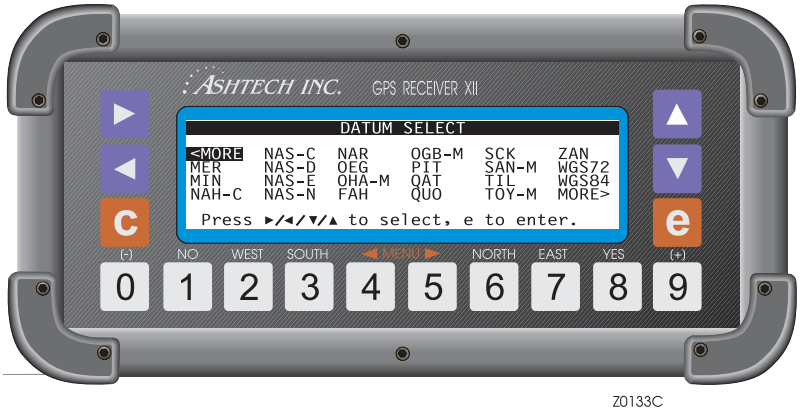

Figure 3.17. More Datums

Fifty datum selections are available under this option. For a complete list, alphabetic by datum, of the transformation parameters that each datum applies to the pseudo-range positions, see Appendix A.

USER lets you input your own datum parameters (Figure 3.18). Table 3.15 describes the screen parameters.

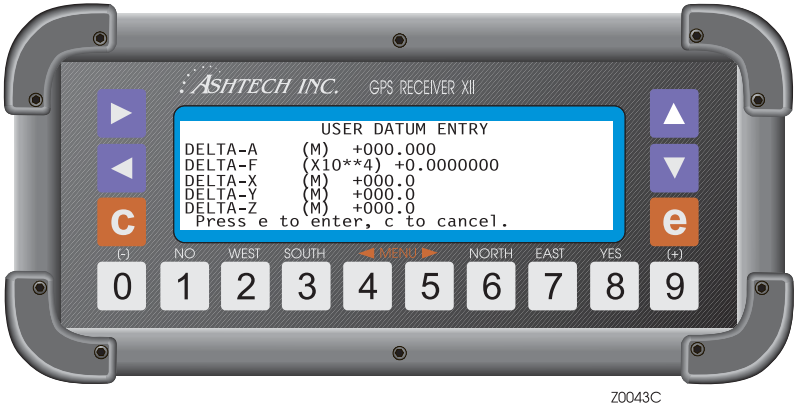

Figure 3.18. User Datum Subscreen

Table 3.15. User Datum Parameters

Parameter	Description
DELTA-A	The difference in the length of the semi-major axis between the WGS-84 reference ellipsoid and the user-defined reference ellipsoid.
DELTA-F	The difference in flattening parameters (1/f × 10^4) between the WGS-84 reference ellipsoid and the user-defined ellipsoid.
DELTA-X DELTA-Y DELTA-Z	The difference in the X, Y, and Z translation parameters between the WGS-84 reference ellipsoid and the user-defined ellipsoid.

Use the number keys to enter values in each field. Define:

delta semi-major axis (a) or delta flattening (1/f) ellipsoid parameters

delta x, y, z translation parameters

To log the values and return to Screen 4, press **[e]**.

You can check your selection by returning to Screen 2; the label USER is visible in the title line. Positions output in this configuration align to the user-defined datum.

Modem Setup Subscreen

This option lets you select the modem type and the port through which data transmit in remote mode. These functions are accessed by selecting MODEM on Screen 4 and pressing the **[e]** key (Figure 3.19) and detailed in Table 3.16.

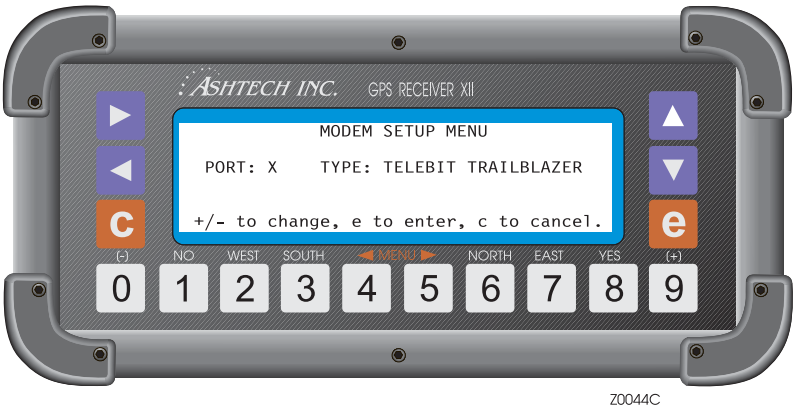

Figure 3.19. Modem Setup Subscreen

Table 3.16. Modem Setup Parameters

Parameter	Description
PORT	Outputs through the specified port. Press the **[+]** or **[-]** key to toggle it to A, B, C, or D.
TYPE	Lets you select the type of modem. The types of modem currently supported are Telebit® Worldblazer, Trailblazer, Cellblazer, and a user-defined modem. To save the selection, press **[e]**. The receiver transmits from the specified port and returns you to Screen 4.

If you are using a modem not listed under TYPE, select USER DEFINED, then press the down arrow key to enter the initialization string (Figure 3.20).

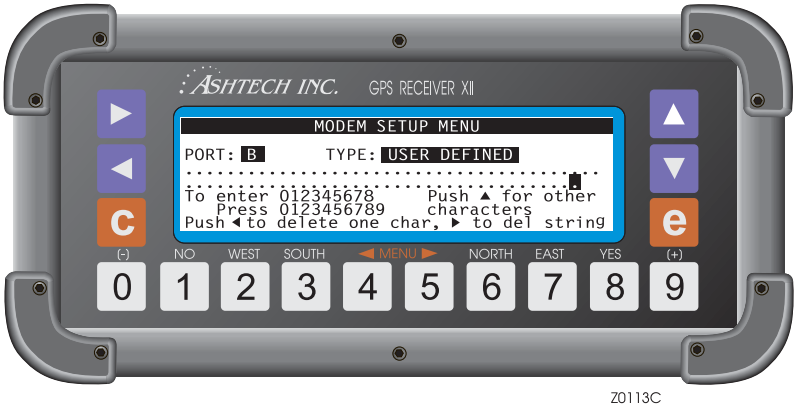

Figure 3.20. Modem Initialization String

Below the PORT/TYPE line are two lines where you can enter the initialization string for your modem. You must get this initialization string from the modem documentation or from the modem manufacturer. The modem initialization string can be quite long; a typical string is shown below.

CFG,ATS111=255S45=255S51=252S58=2S0=1&D2&C1X12E0Q0&W\r\n,MOD,AT&F1\r\n,NAM,US_ROBOTICS,D2c+++AT,C2D,ATO\r\n<CARRIAGERTN> <LINE FEED>

If your initialization string requires characters other than the numbers 0 through 8, press the up button to display more characters, i.e., the alphabet, special characters such as #,*,&,+, etc. After you have entered the string, press the up button until you see CARRIAGE RTN. Enter CARRIAGE RTN, then press the up button again to display LINE FEED. Enter LINE FEED. Now press the **[e]** key to save the string.

Subcommands Subscreen

The SUBCMDS option lets you enter system-level commands; this can also be done through Screen 8. To enter a command, go to Screen 4 and select the SUBCMDS option (Figure 3.21).

Figure 3.21. Subcommands Subscreen

To enter a system-level command, press **[e]** for data-entry mode, then use the numbered keys to enter a 3-digit command. For example, to save user parameters, enter the numeric command **[5]**, **[5]**, **[5]** into the data-entry field and press **[e]** again. The receiver executes the command and returns you to Screen 4.

Table 3.17 lists the available commands.

Table 3.17. Available Commands

Command	Function
100	Turn off backlighting after 2 minutes since last key press. (Default)
101	Keep backlighting on. Warning: if backlighting is on, the receiver draws significantly more power.
123	Close a file.
191	Initialize the modem.
300	Enter/display position in Screen 4 in deg/min format (default)
301	Enter/display position in Screen 4 in deg/min/sec format.
550	Reset receiver to original default values.
555	Save user parameters

Table 3.17. Available Commands (continued)

Command	Function
737	Initialize (reset) RTCM
888	Display configuration identification (information such as serial number, list of installed options, nav board, channel board).
990	Trigger photogrammetry on falling edge.
991	Trigger photogrammetry on rising edge
999	Delete all photogrammetry pictures.

For a detailed explanation of each of the commands, see Screen 8.

SEC. Module Subscreen

This subscreen (Figure 3.22) allows you to set the duration of the mission, in days, and also to run the “Zeroize” command.

Figure 3.22. SEC. Module Subscreen

Screen 5 - Differential Information/Residuals Error/MSK Status

Three different displays are available in this screen:

- Page 1 displays differential information
- Page 2 displays range residuals and position error information
- Page 3 displays MSK status. To toggle between the pages, press the up or down arrows.

RTCM Information

The RTCM information displayed on Screen 5 depends on whether the unit is set as a base or remote station. In base mode, it displays information about transmitted messages; in remote mode, data from received messages (Figure 3.23). Table 3.18 describes the screen parameters.

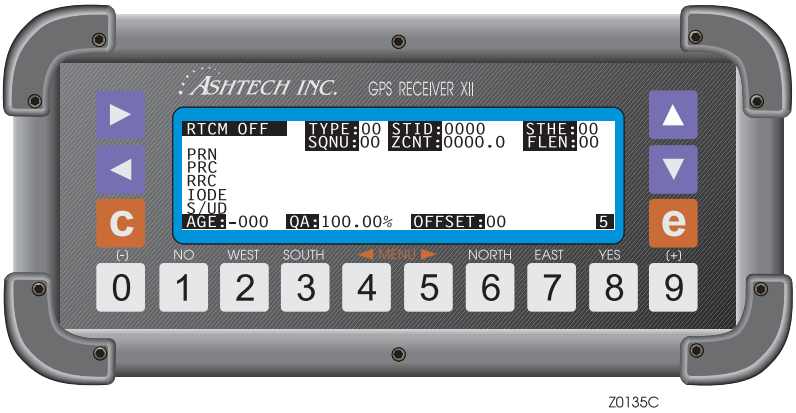

Figure 3.23. Message Data - Screen 5

Table 3.18. Message Parameters

Parameter	Description
RTCM	Displays the receiver's current RTCM mode (OFF, BASE, or REMOTE).
TYPE	Indicates the type of message that is being generated (BASE) or that is being received (ROVER).
STID	The reference station identification, set on the RTCM Options screen (base mode) or received from the base station.

Table 3.18. Message Parameters (continued)

Parameter	Description
STHE	The reference station health, set on the RTCM Options screen (base mode) or received from the base station.
SYNC	Indicates that the receiver is synchronous with a message. It has decoded a message, captured its sequence number (SQNU), and found that its parity was good. The receiver displays a question mark (?) when a given message does not carry the next sequential number expected by the receiver. The question mark may be displayed for the first message since there is no previous message with which to be in sequence.
SQNU	The RTC, message sequence number, generated by the base or received by the remote receiver.
ZCNT	is the RTCM message Z-count.
FLEN	Contains the RTCM message frame length.
PRN	The satellite PRN number.
PRC	The pseudo-range correction in meters. Negative numbers are shown in inverse video.
RRC	The range-rate correction in centimeters per second. Negative numbers are shown in inverse video.
IODE	The issue of the data.
S/UD	The scale factor and user-differential range error.
AGE	For remote mode, shows the age of received messages in seconds. In base mode, gives the time elapsed in seconds since the beginning of the transmission of a type 1 message until a new type 1 message is generated.
QA	The communication-quality factor, defined as: (number of good messages / total number of messages) x 100
OFFSET	The number of bits from the beginning of the RTCM byte in case of bit slippage.

Range Residuals

Page 2 of Screen 5 (Figure 3.24) displays the range residuals and position errors determined during position computation. Table 3.19 describes the screen parameters.

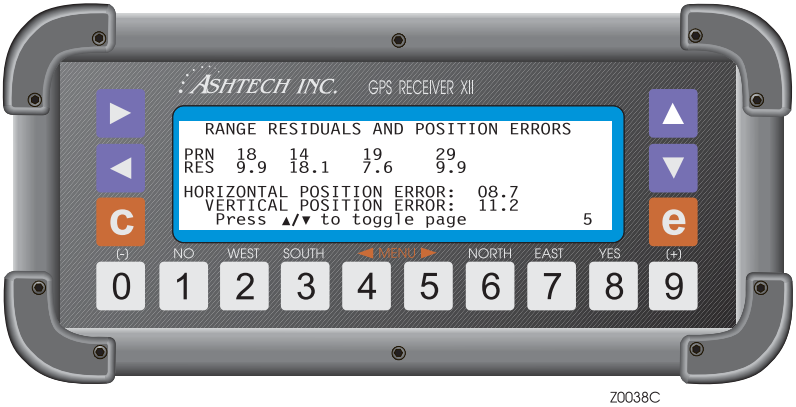

Figure 3.24. Screen 5, Page 2

Table 3.19. Range Residual Parameters

Parameter	Description
PRN	PRN number of satellites being tracked.
RES	Range residual associated with each satellite.
HORIZONTAL/VERTICAL POSITION ERROR:	Horizontal/vertical RMS position error in meters.

MSK Status Menu

Page 3 of Screen 5 (Figure 3.25) displays the status of MSK (Minimum Shift Key) transmission. The screen is applicable only when the receiver is used in conjunction with an MSK transmitter.

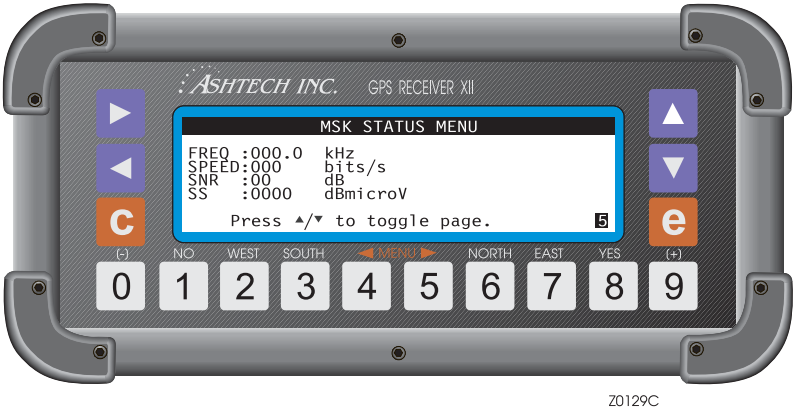

Figure 3.25. Screen5, Page 3 - MSK Status

Table 3.20. MSK Transmission Parameters

Parameter	Description
Freq	Frequency of the MSK transmission in KHz.
Speed	Speed of the MSK transmission in bits per second.
SNR	Signal-to-noise ratio
SS	Signal strength

Screen 6 - Waypoint Control

The Navigation Option allows you to define a navigation route and enter the latitude and longitude of each waypoint included in the route. Knowing the route information and the coordinates of each point, the receiver can compute the distance between the present position and the next destination point (DTD), the course to follow to reach the next destination point (CTD), the time required to reach this point (TTD) based on the present speed over ground, and the cross track error (XTE) which is the deviation from the track between the present position and the next destination waypoint. All this navigation information is displayed in Screen 2.

After accessing Screen 6 (Figure 3.26) the top line indicates the route information, in terms of waypoint numbers, where the current leg is highlighted. The remaining screen displays a list of records showing the current and next waypoints in the route. Each waypoint record consists of a 2-digit waypoint number, a 7 character name, a latitude, and a longitude. Coordinates are entered in degrees, minutes, decimal minutes. Up to 99 waypoints can be stored and a route can be composed of up to 20 waypoints.

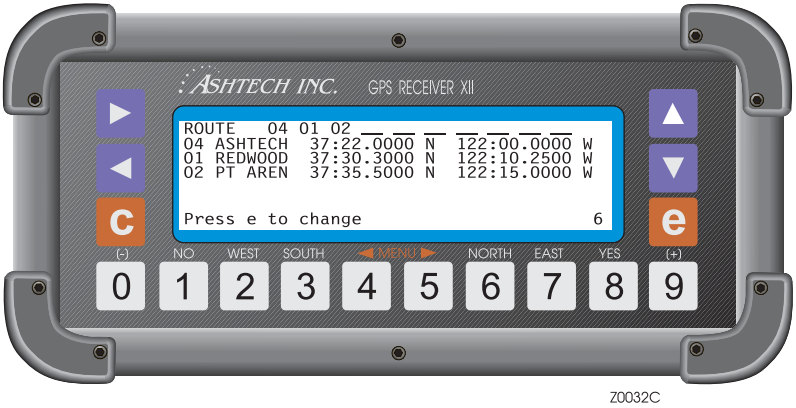

Figure 3.26. Screen 6 - Waypoint Control

If no information has yet been defined, Screen 6 shows the route with only waypoint 01, and the list of records show waypoint 01 with no name and coordinates.

Within Screen 6 the menu allows you to enter the information required for this option to be active. To access these functions, go to Screen 6 and press **[e]** (Figure 3.27).

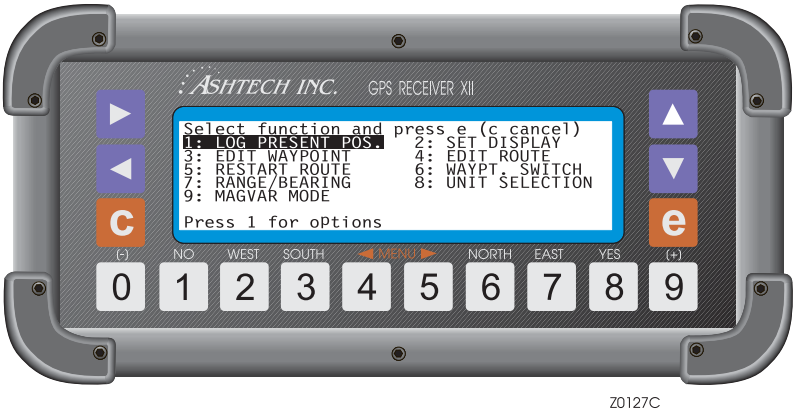

Figure 3.27. Screen 6 - Menu Functions

To activate all functions, press the corresponding number and the screen changes for that function. Alternatively, highlight the function and press **[e]**.

To see the options associated with functions 2,5 and 6, highlight the function and press [1].

The two main functions within this menu are: **4: EDIT ROUTE** and **3: EDIT WAYPOINT**. EDIT ROUTE allows you to create or edit a route, and add or delete points from the route. EDIT WAYPOINT allows you to define a list of waypoint records (associated or not with the route) where the name and coordinates of each waypoint have to be included.

1: Log Present Pos

This function allows you to save your present location as a waypoint. When you select 1: LOG PRESENT POS, the receiver records its current latitude and longitude in the next available waypoint in the list and names it HERE_XX, where XX is the next sequential number beginning from 01. Up to 99 positions (HERE_01 to HERE_99) can be logged this way. The logged position is momentarily displayed in Screen 6, in the first waypoint line, acknowledging it was

stored. Next time Screen 6 is accessed, the first waypoint line shows the first waypoint of the route (Figure 3.28).

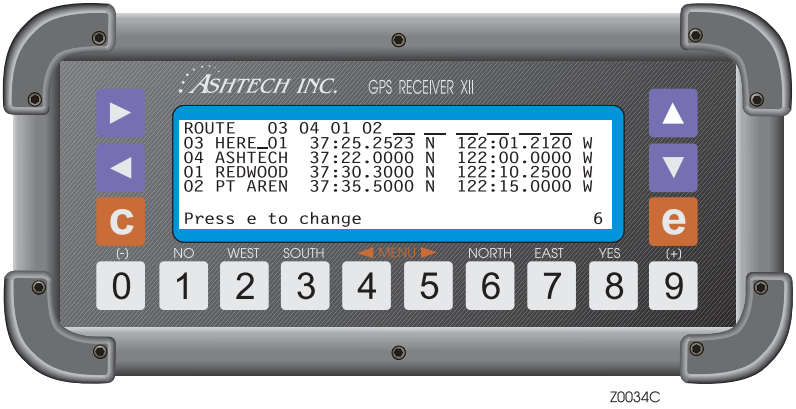

Figure 3.28. Screen 6 - Waypoints

2: Set Display

This function specifies whether the list of records displayed in Screen 6 is the list of waypoints that make the route, or a specific set of selected waypoints.

To access this function highlight "SET DISPLAY" and press **[1]** (Figure 3.29).

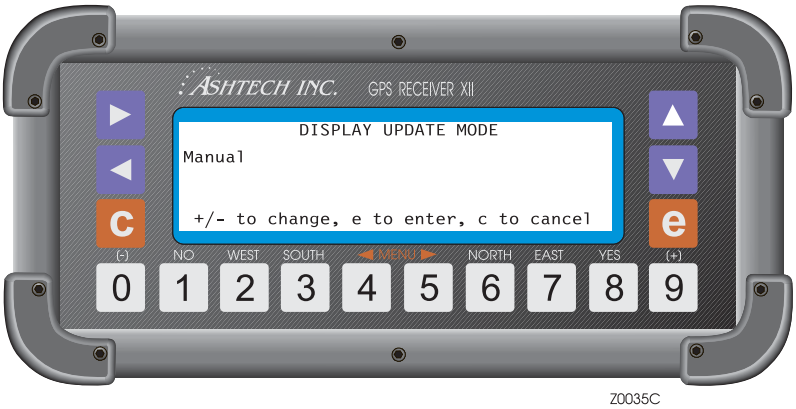

Figure 3.29. Set Display

Press **[+]** or **[-]** to toggle between MANUAL and AUTOMATIC. When the AUTOMATIC option is selected, the receiver automatically displays the list of records of the current and next waypoints in the route. By default the receiver is

set to AUTOMATIC. If instead, MANUAL is selected, the receiver displays a specific set of selected waypoints. To save this selection and return to the main menu, press **[e]**.

To define the set of waypoints displayed in MANUAL mode, proceed as follows:

1. Highlight the function "SET DISPLAY" and press **[e]**. A simulation of Screen 6, without the route, displays (Figure 3.30).

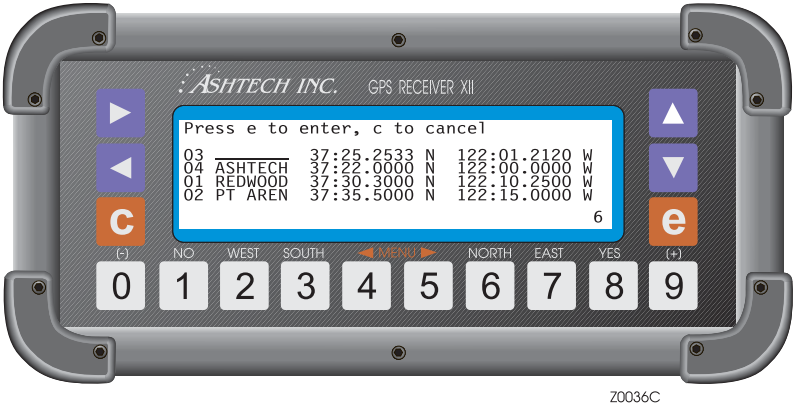

Figure 3.30. Screen 6 - Without Route

2. The first record entry number is highlighted. Using the up and down arrows, scroll through the list until the desired waypoint is found. Or, using the numbered keys, enter the waypoint number, and the name and coordinates of that waypoint displays.
3. Using the right arrow, select the next waypoint.
4. Continue selecting until satisfied.
5. Press **[e]** and the set of selected waypoints display in Screen 6.

   To return Screen 6 to the waypoints list, select AUTOMATIC.

3: Edit Waypoint

This function lets you create, edit and/or clear a waypoint, and to copy the information of one waypoint to another.

To access this function highlight EDIT WAYPOINT, and press **[e]** (Figure 3.31).

Figure 3.31. Edit Waypoint

To edit a waypoint proceed as follows:

1. With the waypoint number highlighted, cycle through the list of waypoints, using the up and down arrows, until the desired waypoint is displayed. Alternatively, using the numbered keys, enter the waypoint number.
2. Press the right arrow to move the cursor to the name field and to bring up the alphanumeric conversion table at the bottom of the screen. Enter the waypoint name.
3. Using the down arrow, move to the next field and overwrite the latitude (including N or S) and the longitude (including E or W). From the data field, press **[e]** to save the waypoint information. Note that the up and down arrows allow you to move from one field to the other, while the left and right arrows allow you to move from one character to the other.

The EDIT WAYPOINT option has three additional functions available: CLEAR, HERE, and COPY FROM.

The CLEAR function allows you to clear the information of a waypoint. To use this function, do the following:

1. Select a waypoint with the waypoint number highlighted and using the up and down arrows, or the numbered keys.
2. Using the cursor, highlight the CLEAR field and press the **[e]** key. The name of the waypoint clears and the latitude and longitude reset to zero.
3. From the data field, press the **[e]** key to save the changes. If desired, you can edit a new waypoint.

4. Press **[e]** to return to the main screen.

The HERE function allows logging the current position into a selected waypoint (similar to the LOG POSITION option).

1. Select a waypoint with the waypoint number highlighted and using the up and down arrows, or the numbered keys.
2. Using the cursor, highlight the HERE field and press the **[e]** key. The current position logs to that waypoint position and the information displayed on the screen. The waypoint renames to HERE_XX, where XX is the next sequential number assigned to a logged position beginning from 01.
3. From the data field, press the **[e]** key to save the changes. If desired, you can edit a new waypoint.
4. Press **[e]** to return to the main screen.

The COPY FROM function allows you to copy the information of one waypoint to another.

1. Using the up and down arrows, or the numbered keys, select the waypoint you want to copy TO.
2. Using the cursor keys, highlight COPY FROM. A waypoint displays by the COPY FROM field and its coordinates display at the bottom of the screen. Using the up and down arrows, or the numbered keys, select the waypoint you want to copy FROM, as shown in Figure 3.32.

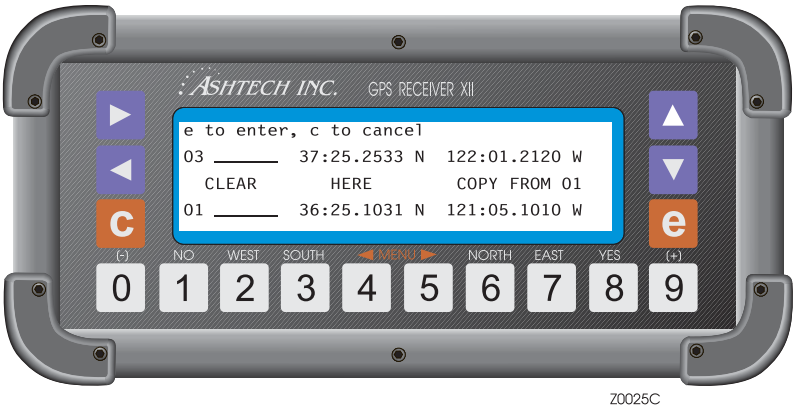

Figure 3.32. Copy Waypoint From

3. Press **[e]** and the FROM waypoint information is copied to the TO waypoint. Edit the copied information if necessary.
4. From the data field, press **[e]** to save the waypoint.

   If desired, you can now edit a new point. If not, press **[e]** to return to Screen 6.

4: Edit Route

This option allows you to create or modify a route. You can edit, add, or remove waypoints from the route, and also reverse the order of the waypoints in the route.To select this option, highlight EDIT ROUTE and press **[e]** (Figure 3.33).

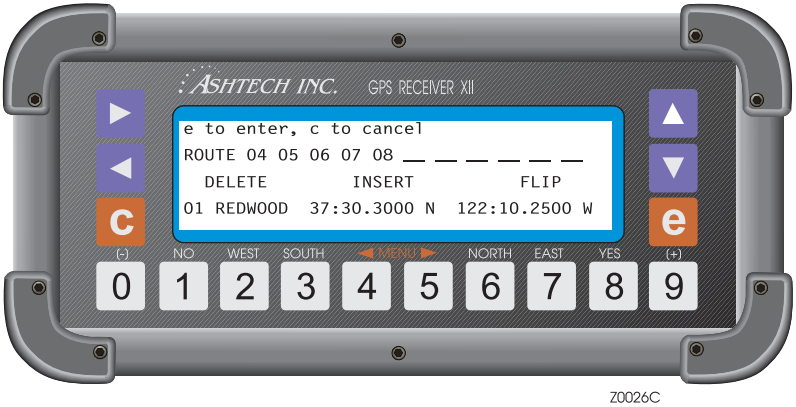

Figure 3.33. Edit Route

The screen shows the current route and, at the bottom of the screen, the information associated with the highlighted waypoint. To edit the route, highlight the point you want to edit and modify it as necessary. Use the left and right arrow keys to move the cursor from one waypoint to the other. The up arrow key allows you to scroll through the waypoint list and modify a waypoint number. Alternatively, you can use the numbered keys to modify the waypoint number.

The EDIT ROUTE option has three additional functions available: DELETE, INSERT, and FLIP.

The DELETE function allows you to delete a waypoint from the route.

1. Use the left and right arrows to highlight the waypoint you want to delete.
2. Using the down arrow and the left and right arrows, highlight DELETE. The selected waypoint blinks.
3. Press **[e]** and the waypoint is deleted.
4. Move the cursor up to the route field and press **[e]** to save the changes.
5. Press **[e]** or **[c]** to return to Screen 6.

The INSERT function allows you to add waypoints:

1. Using the left and right arrows, highlight the position in the route where you want to add the new waypoint.

2. Using the down arrow, and the left and right arrows, highlight INSERT. The selected waypoint blinks.
3. Press **[e]** and waypoint 01 is added. The waypoint previously in that position moves one location to the right and the added way point blinks.
4. Move the cursor up to the route field to edit the newly entered waypoint and press **[e]** to save.
5. Press **[e]** or **[c]** to return to Screen 6.

The FLIP function allows you to reverse the order of the waypoints in the route.

1. Using the down arrow and the left or right arrows, highlight FLIP.
2. Press **[e]** and the order of the waypoints in the route reverses. The last point is the first destination point of the previous route.
3. Move cursor to route field and press **[e]** to save change.
4. Press **[e]** or **[c]** to return to Screen 6.

5: Restart Route

The restart function allows you to instruct the receiver to modify the route according to two options available: restart the route from the beginning or restart the route from the nearest waypoint to your present position.

To select this function do the following:

1. Select RESTART ROUTE and press **[0]** (Figure 3.34).

Figure 3.34. Restart Route

2. Using the + or - keys, toggle between "start at beginning" and "start at nearest". Select one.

3. Press **[e]** and the receiver restarts the route. If "start at beginning" were selected, the receiver points TO the first waypoint and uses the current position at that time to navigate FROM. The first waypoint is highlighted. If "start at nearest" were selected, the receiver computes the closest leg and uses this leg as the navigation reference. This leg in the route is highlighted.

6: Waypoint Switch

This function allows you to advance manually or automatically to the next leg of the route.

To access the options of this function highlight "WAYPT. SWITCH" and press 0 (Figure 3.35).

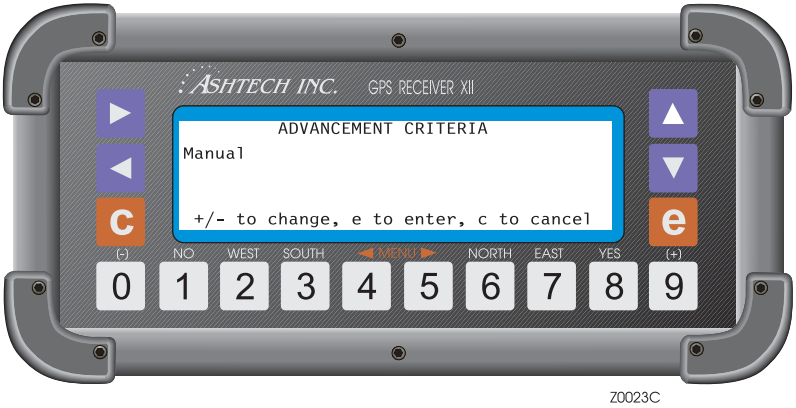

Figure 3.35. Waypoint Switch

Press + or - to toggle between MANUAL and AUTOMATIC, and press **[e]** to save the selection.

When the AUTOMATIC option is selected, the receiver automatically advances to the next leg of the route every time an imaginary angular bisector line (line dividing the angle between the present and next leg of the route in two) under the TO waypoint, or a perpendicular line over the TO waypoint, is crossed.

When the MANUAL option is selected, whenever the WAYPT.SWITCH function is activated (highlight WAYPT. SWITCH and press the **[e]** key), the receiver advances to the next leg of the route (Figure 3.36).

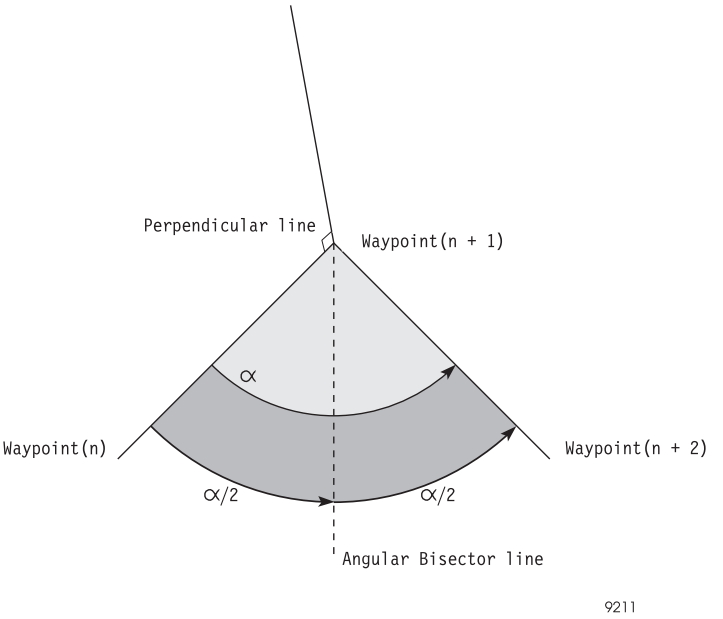

Figure 3.36. Next Leg

7: Range Bearing

This function calculates the range and bearing between any two consecutive waypoints in the route.

To use this function, highlight RANGE/BEARING and press **[e]** (Figure 3.37).

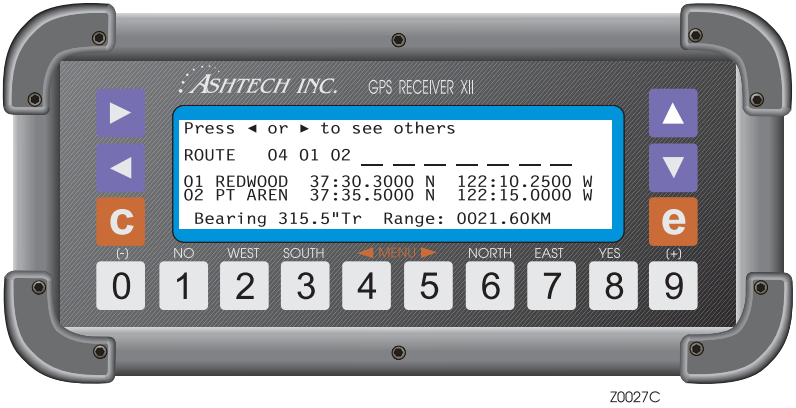

Figure 3.37. Route Display

The display shows the route being followed. One of the legs is highlighted and the coordinates of the waypoints associated with this leg are being displayed in the next two lines. The last line shows the bearing and range values for that leg. To display the range and bearing for a different leg, use the left and right arrows to move the cursor, and the information automatically displays at the bottom of the screen. Press **[e]** or **[c]** to return to the main screen.

8: Unit Selection

This function allows you to specify the units (miles, knots, kilometers) used to display the ALT (altitude), SOG (speed over ground), DTD (distance to destination), and XTE (cross track error) values in Screen 2.

To select this function, highlight UNIT SELECTION and press **[e]** (Figure 3.38).

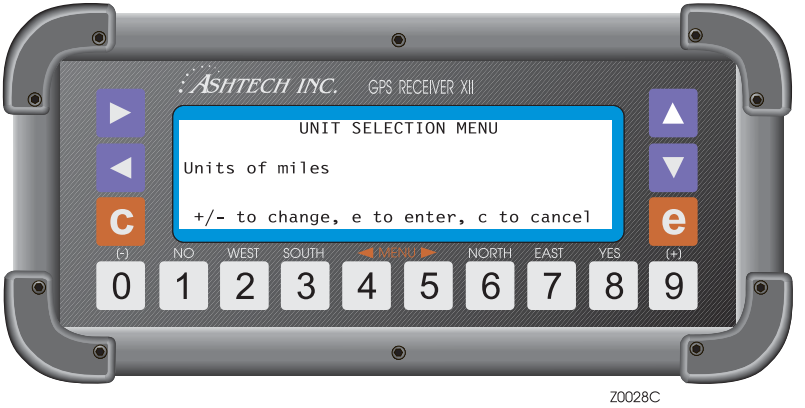

Figure 3.38. Unit Selection

Press + or - to toggle to MILES, KM, or KNOTS. Then press **[e]** to save the change and return to the main menu.

When MILES or KNOTS are specified, the altitude (ALT on Screen 2) is displayed in feet.

9: Magvar Mode

This function allows you to define the magnetic variation mode used when displaying the COG and CTD values in Screen 2 and VTG NMEA message, and the bearing value displayed in 7: RANGE/BEARING (Screen 6), and the APA and BWC NMEA messages.

To select this function, highlight **9:MAGVAR MODE** and press **[e]**. The magnetic variation mode screen (Figure 3.39) displays.

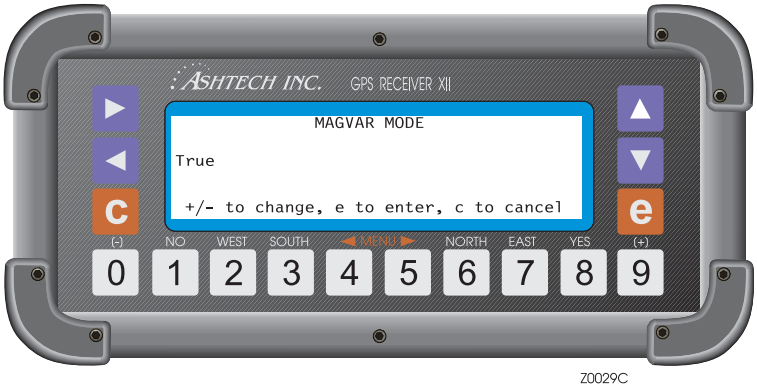

Figure 3.39. Magvar Mode

With the magnetic variation field highlighted, press + or - to toggle between the three modes available: TRUE, AUTOMATIC, or MANUAL.

When the TRUE mode is selected, the COG, CTD, and bearing values are displayed using true degrees (°T).

When the AUTOMATIC mode is selected, the magnetic variation used to display the COG, CTD, and bearing values are shown in the AUTO field. This value is determined, based on the current latitude and longitude, from the magnetic variation table. The COG, CTD, and bearing values are displayed in magnetic degrees (°Mg).

When the MANUAL mode is selected, the magnetic variation used to compute the COG, CTD, and bearing values is the one entered in the MANUAL field. These values display in magnetic degrees (°Mg) (Figure 3.40).

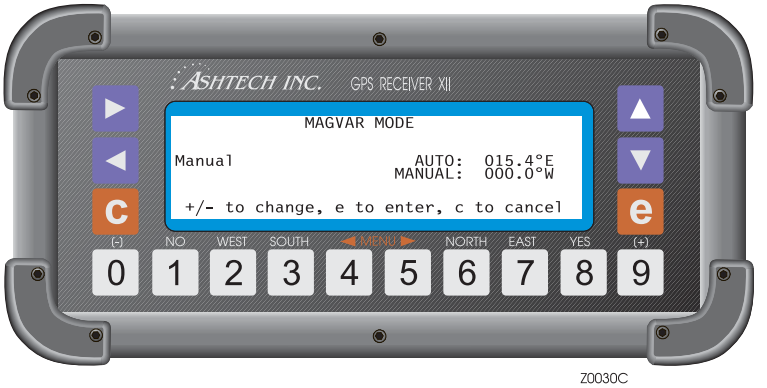

Figure 3.40. Magvar Manual Mode

Highlight the field by MANUAL and enter the magnetic variation to be used. The value displayed in the AUTO field is the value used when the AUTOMATIC mode is selected and is displayed just for reference.

To save the selection, press the **[e]** key. To exit without saving, press the **[c]** key.

Screen 7 - Satellite Selection Control

Use Screen 7 (Figure 3.41) to specify whether to include or omit specific satellites for tracking. Y indicates that the associated satellite are used; N means that are not used.

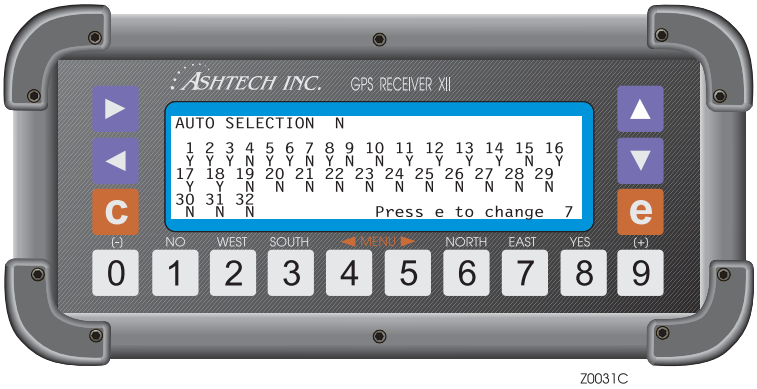

Figure 3.41. Screen 7 - Satellite Selection Control

Also on this screen, you can put the receiver in AUTOMATIC selection or in MANUAL mode by entering either a Y or an N in the AUTO SELECTION field. In automatic mode, all satellites flagged Y are considered for tracking. Of these, satellites that the receiver cannot lock on are replaced with others. Specifying Y for a satellite instructs the receiver to try to lock on, and, if it cannot, to replace it with another Y satellite. The receiver skips over those satellites designated N.

In manual mode (AUTO SELECTION is set to N), the letter Y in a satellite instructs the receiver to select that satellite even when it is not visible. The receiver does not replace it with any other satellite. In this mode, if you specify more than 12 satellites, the receiver uses only the 12 that were displayed on the 12 channels on Screen 0 at the time you went to manual mode. If you specify fewer than 12, the receiver tracks only the specified satellites.

To select the satellites you wish to use:

1. Press **[e]** to shift to data-entry mode. (A blinking cursor indicates that the screen is in data-entry mode.)
2. Press the left and right arrows to highlight the field you want to change.
3. Press **[8]** to include the satellite or **[1]** to omit it.
4. When the flag is acceptable, press **[e]** to save it in memory.

   Pressing **[c]** cancels all entries made since the first **[e]** was pressed.

Screen 8 - File Display and System Control

Screen 8 (Figure 3.42) lists the files stored in the receiver's memory, and accepts system-level commands. Each file is an entry in the two-column display. Table 3.21 describes the screen parameters.

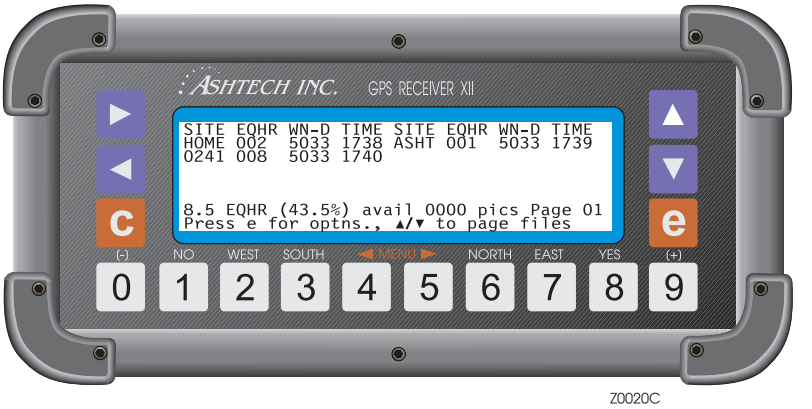

Figure 3.42. Screen 8 - File Display

Table 3.21. File Control Parameters

Parameter	Description
SITE	Four-character site name, the site name in use when the last epoch of data was recorded. (can be changed from Screen 9, Site and Session Control.)
EQHR	Equivalent hours, used instead of bytes or kilobytes to indicate file size. 1 EQHR is equivalent to one hour of data recorded at a 20-second record interval for 5 satellites.
WN	The GPS week number.
D	**T**he day (1=Sunday; 2=Monday; 3=Tuesday; 4=Wednes-day; 5=Thursday; 6=Friday; 7=Saturday).
TIME	Time when the last epoch of data was recorded. It is in the form hhmm (e.g., 1850 indicates 18:50 GMT.)
EQHR (00%) AVAIL	Indicates the available memory in equivalent hours and percent. For example, a ZY-12 receiver with the standard one megabyte of memory displays 19.5 EQHR when empty; this is equivalent to 19.5 hours of record capability at 20 seconds record interval for 5 satellites.

Table 3.21. File Control Parameters (continued)

Parameter	Description
PICS	In photogrammetry applications, displays the count of camera signals recorded. Updated each time a picture is taken or event recorded. For more information refer to Application 3, *Photogrammetry Option.*
Page	Page of the screen where the files being displayed are stored.

System-Level Commands

Several system-level commands are available to the user. To use these commands, start by pressing the **[e]** key for data-entry mode. Then use the number keys to enter the desired command. Press the **[e]** key again for the command to be accepted. Pressing **[c]** instead of the final **[e]** cancels the command and returns the receiver to display mode. Table 3.22 summarizes the available commands.

Table 3.22. System-Level Commands

Command	Function
100	Turn off backlighting after 2 minutes since last key press (default).
101	Keep backlighting on. Caution: If backlighting is left on, the receiver draws significantly more power.
123	Close a file.
191	Initialize the modem.
456	Delete the highlighted file.
550	Reset receiver to original default values.
555	Save user parameters.
737	Initialize (reset) RTCM.
888	Display configuration identification (information such as serial number, list of installed options, nav board, channel board).
990	Trigger photogrammetry on falling edge.
991	Trigger photogrammetry on rising edge.
999	Delete all photogrammetry pictures.

Closing a File

The current file close automatically when the receiver turns off. During data recording, you can close a file and open a new one without turning off power.

1. Press **[e]** to shift to data-entry mode. Use the number keys and enter **[1][2][3]**.
2. Press **[e]** again to close the file and open a new one; if no data has been logged to the current file, a new file can not be opened.

Deleting a File

You can delete a file at any time. However, before deleting a file, verify that it is not needed or the information has already been transferred to the post-processing computer.

Note that each time the receiver is turned on, a new empty file is opened. If this file is deleted before closing it, any data collected appends to the last file in the list.

To delete a file:

1. If there are more than 10 files in the receiver, use the up and down arrow keys to scroll to the page with the desired file.
2. Press **[e]** to shift to date-entry mode. Highlight the site (file) you want to delete.
3. Use the number keys and enter **[4][5][6]**. Press **[e]** again and wait until the end of the current cycle for the file to be deleted and erased from the display.

Screen 9 - Site and Session Control

Use Screen 9 (Figure 3.43) to enter information about a specific site. Site information can be entered during data collection and does not affect or interrupt the collection process. Table 3.23 describes the screen parameters.

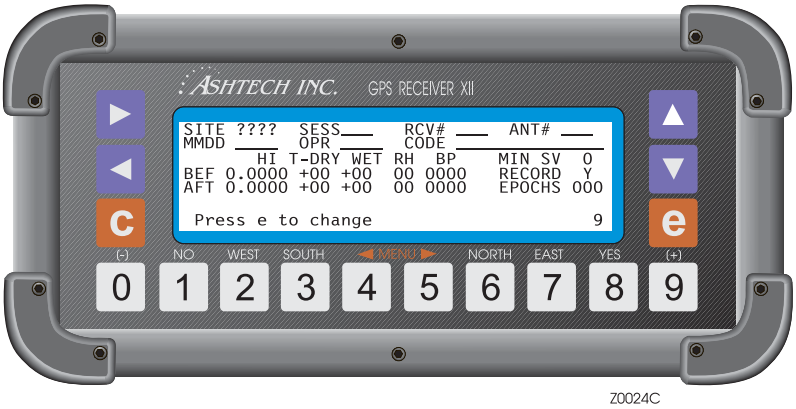

Figure 3.43. Screen 9 - Site and Session Control

Table 3.23. Site and Session Control Parameters

Parameter	Description
SITE	The name of a site, 4 alphanumeric characters, tagged with the raw data in order to record which site you were occupying during that time period. This same site identifier is used to name your data files when you are transferring them to your computer. If you forget to enter a site name, you can fix it during downloading.
SESS	The identifier (letter or number) of the session. The download software puts in this parameter while you are downloading to the PC after data collection. However, if you wish to override the default sessions, you may enter a letter or number here.
RCV#	The receiver identifier, three alphanumeric characters.
ANT#	The antenna identifier, three alphanumeric characters. Entering the last three digits of the antenna and receiver serial number is good practice in case there are problems with the equipment.
MMDD	Indicates the month and day of the session.
OPR	Identifies the operator, 3 alphanumeric characters.
CODE	Can contain up to 13 alphanumeric characters of user comment to further identify a site.

Table 3.23. Site and Session Control Parameters (continued)

Parameter	Description
HI	The height of the antenna in meters. If you enter it during the survey, it saves you having to enter it during post-processing. The post-processing software automatically reads the antenna height and uses it in computing the correct station position. Make sure the values are in metric or you will have to correct this in post-processing.
T-DRY	Contains a record of the dry temperature, in degrees Celsius.
T-WET	Contains a record of the wet temperature, in degrees Celsius.
RH	Records the percent of relative humidity
BP	Barometric pressure in millibars.
Fields to the right are used to modify receiver tracking and recording procedures.	
MIN SV	Sets an alarm that sounds a continuous beep when the number of satellites being tracked above the elevation mask falls below this specified minimum. Used during kinematic surveying. To silence the alarm, press the **[e]** key.
RECORD	Lets you control whether or not to record data. Y (yes) is the normal mode; N (no) means do not record data. Use with caution.
EPOCHS	Specifies the number of measurement epochs to be logged with the site name in a kinematic survey. It counts down after each epoch until it reaches 0, at which time the site name changes to**????**, indicating the receiver is moving to the next site.

To enter or change a value on Screen 9:

1. Press **[e]** to shift to data-entry mode. (A blinking cursor indicates that the screen in data-entry mode.)
2. Use the left and right arrows to highlight the field you want to change.
3. Use the down arrow to move the cursor down a line. Note that its function here differs from the other data entry screens.
4. Use the up arrow to display the alphanumeric conversion table.
5. Press **[8]** for "yes" or **[1]** for "no" responses.
6. Examine your entries; they can be changed again by moving the cursor to the desired field and re-entering the information. When the values are acceptable, press **[e]** again to save them in memory.

   Pressing **[c]** cancels all entries. Pressing **[e]** or **[c]** after data entry returns the screen to display mode.

Screen 10 - All-in-View Information

Screen 10 (Figure 3.44) shows a polar plot of the currently available satellites and their orbital paths. The display is reliable once the receiver has a complete almanac and a valid position in Screen 2. From cleared internal memory, the receiver takes about 12 minutes after lock to acquire a full almanac and display correct information. With an almanac present (power cycle) the receiver takes approximately 12 seconds to present a full up-to-date screen.

Figure 3.44. Screen 10 - All-in-View Information

Access Screen 10 by one of two ways:

- Press **[9]** then press the right arrow, or
- Press **[0]** first and press the left arrow three times.

The ALL-IN-VIEW screen shows satellite overhead position graphically on an azimuth where 0° (north) is located at the top center of the plot and 180° (south) is at the plot's bottom center. East and west are labeled on the plot. A l indicates a satellite that is visible but not locked. A **H** indicates a satellite that is locked.

The circles represent varying satellite elevations: the outer circle is 0° elevation, the middle is 30°, and the innermost is 60°. The center of the axis is 90° (directly overhead).

Table 3.24 describes the screen parameters.

Table 3.24. All-In-View Parameters

Parameter	Description
AVAIL SVS	reports how many satellites are visible.
LOCKED	reports how many satellites are locked.
DOPS	displays DOP values computed using satellites with elevation equal to or greater than position elevation mask. Current DOPs of locked satellites are updated every second. The graphic display updates every 12 minutes. To isolate the orbital track of a single available satellite (locked or not), press the down or up arrow. The up arrow displays the orbital track of the next available satellite, in ascending order, starting with the lowest PRN number. The down arrow displays the orbital track of the next available satellite, in descending order, starting with the highest PRN number.

Single Track

The orbital track of a satellite is displayed on the same polar plot (Figure 3.45). This is reached by pressing the up or down arrow on the All-in-View screen. The track starts at the satellite's rising elevation and azimuth and ends at the satellite's current position. This display is updated every 10 minutes.

Table 3.25 describes the screen parameters.

Figure 3.45. Orbital Track

Table 3.25. Orbital Track Parameters

Parameter	Description
PRN: 12 LOCKED	displays the current satellite number, as well as its current elevation (EL) and its azimuth (AZ). It reports status as LOCKED or AVAILABLE. (PRN 12 is an example.) When you press the up arrow, the receiver displays the orbital track of the next higher number available/locked satellite. Pressing it when the highest numbered PRN is displayed returns to ALL-IN-VIEW.

The down arrow scroll down the list, showing the path of the next lower number satellite.

Screen 11 - Visibility Information

Screen 11 (Figure 3.46) lets you see the time when each satellite is visible. The display is fully reliable once the receiver has a complete almanac and a valid position which can be entered on Scree 4 by the user or be computed. From cleared memory without an almanac present, it takes about 12 minutes after lock to get full almanac and display complete information. With an almanac present, it takes approximately 12 seconds. As with Screen 10, if the receiver has not been used for some time, the screen displays old almanac information.

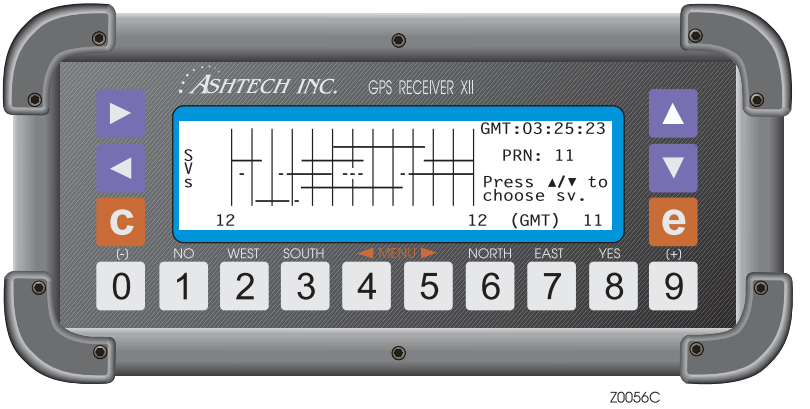

Figure 3.46. Screen 11 - Visibility Information

Access this screen by one of two methods:

Press **[9]** and the right arrow twice, or

Press **[0]** and the left arrow until Screen 11 displays.

This bar graph displays the availability periods of satellites over 24 hours, showing you 2 to 4 hours before and 20 to 22 hours after the current time. Table 3.26 describes the screen parameters.

Table 3.26. Visibility Parameters

Parameters	Description
HORIZONTAL LINES	Satellite availability windows shown in ascending order with PRN 01 at the bottom and PRN 32 at the top. The start/end times are accurate to 10 minutes
GMT:03:25:23	GMT time

Table 3.26. Visibility Parameters (continued)

Parameters	Description
PRN 11	In the upper right corner, contains the number of the PRN whose window is currently marked by the dotted reader-line. Pressing the up or down arrow raises or lowers the reader-line.
VERTICAL LINES	2-hour time marks. The current time is stated as GMT and is rounded to the nearest hour. Each time the screen is entered, the time marks are recalculated to show the previous, nearest 2 hours of availability; 12 and 12 GMT are the times for the first and last vertical lines.

Screen 12 - Bar Code Control

Use Screen 12 (Figure 3.47) to input bar code or keyboard data to mark a survey site or GIS data point. This method lets you enter more descriptive names for post-processing with the software. In addition, Screen 9, Site and Session Information, can also be entered using the bar code reader. **You must specify 9600 baud to be able to scan bar codes**. Only ports A and B are available for bar code scanning.

Figure 3.47. Screen 12 - Bar Code Control

Access Screen 12 by one of three methods:

- Go to Screen 9 and press the right arrow 3 times, or
- Go to Screen 0 and press the left arrow, or
- Read a bar code. (If the bar code screen is accessed by reading a bar code, the top level of the previous screen displays upon exit.)

You can enter a maximum of 80 characters, combining a bar code reader and keyboard. A successful scan is signalled by a short beep from both the bar code reader and receiver. If you try to enter more, the receiver rejects the last scan, displays an error message, and issues a long beep. Error messages are cleared when an entry is made within the 80-character limit.

Each entry is displayed in reverse video. If you make an entry error, you can delete it by scanning the backspace (BKSP) bar code or pressing the down arrow. To clear an entire entry sequence, scan the CLEAR ALL bar code or press the **[c]** key.

The keyboard can also be used to enter characters into a field. Once data has been entered using the bar code reader, keyboard entry can begin immediately. If the bar code reader has not been used, the **[e]** key must be pressed first.

Table 3.27 defines the format used for storing each data entry sequence.

Table 3.27. Data Entry Format

Field	Bytes
ID = 6	2
Length of entered data	2
Time tag	8
Entered data	80 (max.)
Checksum	2

To store the entered data and a time tag in an internal file, read the ENTER bar code or press the **[e]** key. This records the data sequence, emits two short beeps, and exits to Screen 12.

To clear the entered data, do one of the following:

- Read the CLEAR ALL bar code or press the **[c]** key. This clears the entire data sequence and exits to Screen 12.
- Read the backspace (BKSP) bar code, or press **[?]** when only one data entry remains, to exit to Screen 12.

Once the entered data has been stored or cleared, pressing a numbered key accesses the corresponding screen.

BARCODER is an application which creates bar codes that can be printed and carried to the field so that field personnel can readily enter data into the receiver. Using the bar code reader to enter Screen 9 data is described in the BARCODER program reference document.

When entering individual characters for Screen 9 data fields, the bar code screen appears and shows these characters as they are read. The appropriate data entry code must then be read to place the entry into the Screen 9 field.

When using the epoch counter in kinematic surveying, first enter the site name and then the number of epochs to be counted down. When the name is acceptable, press **[e]** to save it in memory and return to display mode.

4

Serial Port Output

This chapter describes two standard data output features on ZY-12 receivers: Real-time data output and NMEA output. Setup for serial output is set in Screen 4.

Real-Time Data Output

This section covers real-time data output. It tells how to access the appropriate screens and enable the various real-time messages, and also details the format of each message.

Real-time data, or raw data, can be output through any of the ZY-12's four serial ports (A, B, C, D). It is typically sent to a computer or other data terminal equipment. Specify the type and format of the outgoing data, as listed in Table 4.1. The following types and formats are available:

Table 4.1. Real-Time Data Formats

Message Type	ASCII Format	Binary Format
MBEN (measurement data)	Yes	Yes
PBEN (position data)	Yes	Yes
SNAV (ephemeris data)	Not available	Yes
SALM (proprietary almanac)	Not available	Yes
DBEN (pseudo-range and CPD measurements)	Not available	Yes
EPB (raw ephemeris)	Not available	Yes

- MBEN messages contain measurement data for each satellite tracked during the session.

- PBEN messages contain position and velocity data.
- SNAV message contains satellite ephemeris data. SNAV is output every 15 minutes, but can be queried for immediate output any time.
- SALM messages contain satellite almanac data in an proprietary format. Like SNAV messages, SALM messages are output at 15-minute intervals, but can also be queried anytime for immediate output.
- DBEN is a compacted message which contains one epoch of GPS pseudo-range and carrier phase measurements. DBEN is a differential correction message and should be used only when the receiver is set as a base station.
- EPB messages contain raw ephemeris data as specified in the ICD-GPS-200.

Both the ASCII and binary formats have an ASCII header added to the beginning of the data string: "$PASHR,PBN" for the PBEN message; "$PASHR,MPC" for the MBEN message; etc. Messages that are not available in ASCII format, such as SALM and SNAV, are output in binary regardless of which format is selected.

Real-time messages can be output in any combination from the receiver's RS-232 data ports. The default output interval is 20 seconds. To change this value, go to Screen 4, press **[e]**, use the arrow keys to highlight **INTERVAL**, and use the numeral keys to enter the desired interval. Press **[e]** once again to save the new setting.

SERIAL OUTPUT PROTOCOL
8 Data Bits, 1 Stop Bit, No Parity

Setup for Real-time Data Output

The steps below outline the setup for real-time data output, including message selection, format, and baud rate. This procedure describes setup for Port A:

1. Connect a download cable between Port A on the receiver and a COM port on your computer. If COM1 is not available, use COM2.

2. On Screen 4, Figure 4.1, press **[e]** to activate the data-entry mode. Use the arrow keys to highlight **Port A**.

Figure 4.1. ZY-12 Screen 4

3. Press **[e]** to call the **Port A Parameter Selection** screen, Figure 4.2.

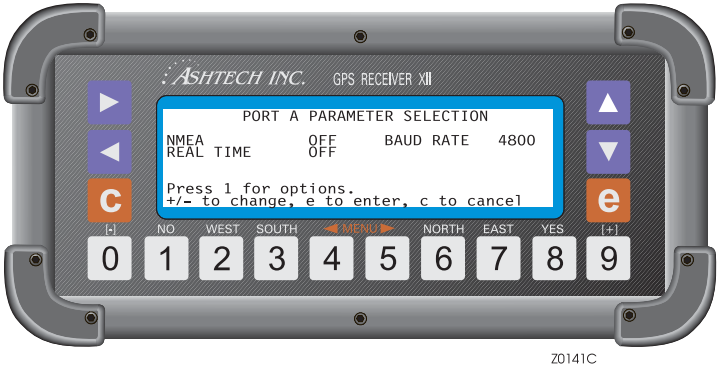

Figure 4.2. Port A Parameter Selection

4. Use the arrow keys to highlight **Real Time** and press **1** to call the **Measurements Output on Port A** screen.

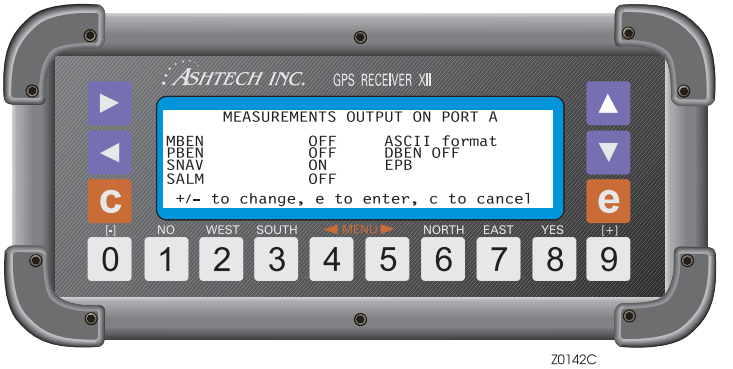

Figure 4.3. Measurements Output on Port A Screen

5. To select a message for output, use the arrow keys to highlight the desired message and press **[+]** or **[-]** to toggle it on. Repeat this step for each message you want to output. To disable a message, highlight the desired message and press **[+]** or **[-]** to toggle it off.
6. Highlight the format field to and press **[+]** or **[-]** to select ASCII or binary format. The default is ASCII. Press **[e]** to save the new settings and return to the **Port A Parameter Selection** screen.
7. Check the Baud Rate field. If the baud rate does not match the baud rate of the device to which the ZY-12 is connected, use the arrow keys to highlight the baud rate field and toggle **[+]** or **[-]** to chose the correct rate.
8. Highlight **Real Time** and press **[+]** or **[-]** to turn on real-time output.
9. Press **[e]** to save the new settings and return to screen 4.

   Repeat these steps for any of the other ports you want to use for data output. You can send different messages from each port. For example, you can set the ZY-12 to send PBEN messages through Port A and SNAV messages through Port B.

Contents of Real-time Messages

Real-time messages are output in binary format, although MBEN and PBEN can also be output in ASCII. Messages output in binary format have the following structure:

"HEADER,MESSAGE ID,DATA + CHECKSUM[CRLF]"

The header field always contains "$PASHR". The message identifier field contains a three character string and is followed by a field containing the binary data string. The header, identifier, and data fields are comma delimited. Depending on the message selected, the checksum is contained in the last one or two bytes of the binary data string. All real-time messages are terminated with a Carriage Return/ Line Feed [CRLF] delimiter. The MBEN message comes out as shown below when binary format is selected:

"$PASHR,MPC,<Binary Data String>[CRLF]"

The structure for messages output in ASCII format is similar, but the data string is divided into comma delimited fields. Most of the fields contain numeric data comprised of either integers, real numbers, or values in which integers and real numbers are combined. The MBEN message has a three-digit checksum in the last data field before the carriage return/line feed. The PBEN message does not have a checksum when output in ASCII format:

"HEADER,MESSAGE ID,DATA+CHECKSUM[CRLF]"

The MBEN message comes out as shown below when ASCII format is selected:

"$PASHR,MPC,<ASCII Data String>*Checksum[CRLF]"

Table 4.2 contains symbols and the types of data represented by them used to illustrate real-time message structures in the ASCII format:

Table 4.2. ASCII Message Parameter Symbols

Symbol	Parameter Type	Example
d	Numeric integer	3
f	Numeric real	2.45
m	Combined numeric (integer and real) for lat/lon	037:21.0682
s	Character string	PALO
h	Hexadecimal number	A5

MBEN Message

MBEN messages contain satellite measurement data, including satellite PRN, elevation, azimuth, SNR, channel index, and more. MBEN can be output in either ASCII or binary format. A separate message is generated for each tracked satellite above the elevation mask. Table 4.3 and Table 4.4 outline the contents of the MBEN message for the binary and ASCII formats.

The structure of the MBEN message in binary format is shown below:

$PASHR,MPC,<Satellite Measurment Data + Checksum>

Table 4.3. MBEN Message Structure [Binary Format]

Binary Type	Size	Contents
unsigned short	2	sequence tag (unit: 50 ms) modulo 30 minutes
unsigned character	1	number of remaining struct to be sent for current epoch.
unsigned character	1	satellite PRN number.
unsigned character	1	satellite elevation angle (degree).
unsigned character	1	satellite azimuth angle (two degree increments).
unsigned character	1	channel ID (1 - 12).
C/A code data block 29 bytes		
unsigned character	1	Warning flag
unsigned character	1	Indicates quality of the position measurement. (good/ bad)
character	1	(set to 5 for backward compatibility)
unsigned char	1	Signal to noise of satellite observation (db.Hz)
unsigned character	1	Spare
double	8	Full carrier phase measurements in cycles.
double	8	Raw range to satellite (in seconds); i.e., receive time - raw range = transmit time
long	4	Doppler (10^{-4} Hz).
long	4	Bits 0 - 23: Smooth correction (bit 0 - 22 = magnitude of correction in cms, bit 23 = sign) Bits 24 - 31: Smooth count, unsigned (0 = unsmoothed; 1=least smoothed; 200 = most smoothed)
	(29)	P code on L1 block (same format as C/A code data block)
	(29)	P code on L2 block (same format as C/A code data block)
unsigned character	1	Checksum, a bytewise exclusive OR (XOR)
total bytes	97	

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

The structure of the MBN message in ASCII format is shown below:

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

Table 4.4. MBN Message Structure [ASCII format]

Parameter	Description	Units	Range
d1	Sequence tag. This is the time tag used to associate all structures with one epoch. It is in units of 50 ms and modulo 30 minutes.	50 ms	0 - 36000
d2	Number of remaining structures		0 - 11
d3	Satellite PRN number		1 - 32
d4	Satellite elevation	degrees	0 - 90
d5	Satellite azimuth	degrees	0 - 360
d6	Channel index		1-12
C/A Code Data Block			
d7	Warning flag (see Table 4.5)		0 - 255
d8	Good/bad flag (see Table 4.6)		22 - 24
d9	Space		5
d10	signal to noise indicator	dB Hz	30 - 60
d11	spare		0
f12	Full carrier phase	cycles	±999999999.9
f13	Code transmit time	ms	0 - 999999999.9
f14	Doppler measurement	10^{-4} Hz	±99999.99999
f15	Range smoothing correction. Raw range minus smoothed range.	meters	0 - 99.99
d16	Range smoothing quality		0 - 200
PL1 Code Data Block			
d17	Warning flag (see Table 4.5)		0 - 255
d18	Good/bad flag (see Table 4.6)		22 - 24

Table 4.4. MBN Message Structure [ASCII format] (continued)

Parameter	Description	Units	Range
d19	5 for backward compatibility		5
d20	Signal to noise indicator	dB Hz	30 - 60
d21	spare		
f22	Full carrier phase	cycles	0 - 999999999.999
f23	Code transmit time	ms	0 - 99.9999999
f24	Doppler measurement	10^{-4} Hz	±99999.99999
f25	Range smoothing correction. Raw range minus smoothed range	meters	0 - 99.99
d26	Range smoothing quality		0 - 200
PL2 Code Data Block			
d27	Warning flag (seeTable 4.5)		0 - 255
d28	Good/bad flag (see Table 4.6)		22 - 24
d29	5 for backward compatibility		5
d30	Signal to noise indicator	dB Hz	30 - 60
d31	spare		
f32	Full carrier phase	cycles	0 - 999999999.999
f33	Code transmit time	ms	0 - 99.9999999
f34	Doppler measurement	10^{-4} Hz	±99999.99999
f35	Range smoothing correction. Raw range minus smoothed range	meters	0 - 99.99
d36	Range smoothing quality		0 - 200
ccc	Checksum Displayed in decimal. A bytwise exclusive OR (XOR) on all bytes from the sequence tag to the checksum (starts after MPC, and includes the last comma before the checksum).		

Table 4.5. Warning Flag Settings

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

Table 4.6. Measurement Quality [Good/Bad Flag]

Value of d_8	Description
0	Measurement not available and no additional data is sent
22	Code and/or carrier phase measured
23	Code and/or carrier phase measure, 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

Note: In the MBEN message, goodbad = 25 and warning = 35 implies Z-tracking (non-keyed operation). If it is in Y-mode (keyed operation), gotmeas flag will be 24.

PBEN Message

PBEN messages contain position data, including velocity data, DOP values, and time. PBEN can be output in ASCII or binary format. Table 4.7 and Table 4.8 below outline the contents of the PBEN message in binary and ASCII format.

The structure of the PBEN message in binary format is shown below:

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

Table 4.7. PBN Message Structure (binary format)

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

The structure of the PBEN message in ASCII format is shown in below:

$PASHR,PBN,f1,f2,f3,f4,m5,m6,f7,f8,f9,f10,d11,s12,d13,d14,d15,d1

Note that a checksum is absent from the PBEN message when ASCII format is selected.

Table 4.8. $PASHR,PBN Message Structure (ASCII)

Parameter	Description	Range
f1	Receiver time with seconds of the week when code is received	0 - 604800.00
f2	Station position: ECEF-X (meters)	±9999999.9
f3	Station position: ECEF-Y (meters)	±9999999.9
f4	Station position: ECEF-Z (meters)	±9999999.9
m5	Latitude in degrees and decimal minutes (ddmm.mmmmmm) Positive north.	±90

Table 4.8. $PASHR,PBN Message Structure (ASCII) (continued)

Parameter	Description	Range
m6	Longitude in degrees and decimal minutes (dddmm.mmmmmm) Positive east.	±180
f7	Altitude (meters)	±99999.999
f8	Velocity in ECEF-X (m/sec).	±999.99
f9	Velocity in ECEF-Y (m/sec).	±999.99
f10	Velocity in ECEF-Z (m/sec).	±999.99
d11	Number of satellites used for position computation.	3 -12
s12	Site name	4 character string
d13	PDOP	0 - 99
d14	HDOP	0 - 99
d15	VDOP	0 - 99
d16	TDOP	0 - 99

SNAV Message

The SNAV message contains satellite ephemeris data, including values for orbital parameters, satellite health status, clock corrections, etc. SNAV is output in binary format only. One message is output for each satellite being tracked. Table 4.9 below outlines the contents of the SNAV message.

The structure of the SNAV message is shown below:

$PASHR,SNV,<Ephemeris Data + Checksum>

Table 4.9. $PASHR,SNV Message Structure

Binary Type	Size	Contents
short	2	Wn. GPS week number
long	4	Seconds of GPS week
float	4	Tgd. Group delay (sec)
long	4	IODC. Clock data issue
long	4	toc. second
float	4	af2. sec/sec2 (clock correction)
float	4	af1. sec/sec (clock correction)

Table 4.9. $PASHR,SNV Message Structure (continued)

Binary Type	Size	Contents
float	4	af0. sec (clock correction)
long	4	IODE Orbit data issue
float	4	Δn.Mean anomaly correction (semi-circle/sec)
double	8	M0. Mean anomaly at reference time (semi-circle).
double	8	e. Eccentricity
double	8	(A)1/2. Square root of semi-major axis (meters 1/2).
long	4	toe.Reference time for orbit (sec).
float	4	Cic. Harmonic correction term (radians).
float	4	Crc. Harmonic correction term (meters).
float	4	Cis. Harmonic correction term (radians).
float	4	Crs. Harmonic correction term (meters).
float	4	Cuc. Harmonic correction term (radians).
float	4	Cus. Harmonic correction term (radians).
double	8	(OMEGA)0. Lon of Asc. node (semi-circles).
double	8	ω. Argument of Perigee (semi-circles)
double	8	I0. Inclination angle at reference time (semi-circles).
float	4	OMEGADOT. Rate of right Asc. (semi-circles per sec).
float	4	IDOT. Rate of inclination (semi-circles per sec).
short	2	Accuracy
short	2	Health
short	2	Curve fit interval (coded).
char	1	Satellite PRN number -1
char	1	Reserved byte.
unsigned short	2	Word checksum
Total =	132 bytes	

SALM Message

The SALM message contains much of the same data available in the SNV message, but also includes an almanac week reference. Like SNAV, the SALM message is output in binary format only. One SALM message is output for each

satellite for which the receiver has collected almanac data. Table 4.10 below outlines the contents of the SALM message.

The structure of the SALM message is shown below:

$PASHR,ALM,<Almanac Data + Checksum>

Table 4.10. ALM Message Structure

Type	Size	Contents
short	2	Satellite PRN -1
short	2	Health. see ICD - 200 for description
float	4	e. Eccentricity
long	4	toe. Reference time for orbit (sec)
float	4	I0. Inclination angle at reference time (semi-circles).
float	4	OMEGADOT. Rate of right Asc. (semi-circles per sec).
double	8	(A)1/2. Square root of semi-major axis (meters 1/2).
double	8	(OMEGA)0. Lon of Asc. node (semi-circles).
double	8	ω. Argument of Perigee (semi-circles)
double	8	M0. Mean anomaly at reference time (semi-circle).
float	4	af0. sec
float	4	af1. sec/sec.
short	2	almanac week number
short	2	GPS week number
long	4	Seconds of GPS week
unsigned short	2	Word checksum
Total bytes70		

DBEN Message

DBEN messages contain differential correction data used for the carrier phase differential (CPD). Each DBEN message represents one epoch of GPS pseudo-range and carrier phase measurements. DBEN is a "packed", or compressed, message. The size of a DBEN message depends on the number of satellites being tracked. DBEN data includes time, satellites PRN, and pseudo-range and carrier phase measurements for each satellite being tracked. Tables A.11 through A.13 below outline the contents of DBEN messages.

The structure of the DBEN message is shown below:

$PASHR,RPC, <Data Length> <Packed Data> <Checksum>

Table 4.11. $PASHR,RPC

Parameter	Type	# of bytes	Description
data length	unsigned short	2	number of bytes in <packed data> part
packed data	unsigned char[]	data length	see below
ChkSum	unsigned short	2	Accumulative unsigned short summation of the <packed data>, after <data length> before <ChkSum>

<packed data> Parameter:

Table 4.12. $PASHR,RPC Packed Parameter Descriptions

Data Type	Symbol	Range	Resolution	Compressed # Bits	Description
double	rcvtime	0 - 604800000	1 msec	30	Receiver time in GPS milliseconds of week
char[4]	site ID			32	Receiver's four character's site ID
long	PRN			32	PRN for the satellites which have data in this message. It is a bitwise indication. Starting from least significant bit, bit 1 corresponds to Satellite PRN #1, bit 2 corresponds to Satellite PRN #2, and so on. Bit value of 1 means that Satellite PRN has data in this message, 0 otherwise.
The following data repeats for each satellite whose corresponding bit in PRN is "1":					
double	PL1		1.0E-10 seconds	31	Pseudorange in units of 1.0e-10 seconds (or 0.1 nanoseconds). Multiply this value by 1.0e-10 to get pseudo-range in seconds. A zero value indicates bad pseudo-range
char	WN			1	Warning bit 1- bad carrier phase and has possible cycle-slips 0 - good carrier phase
	Sign		1	1	Carrier phase sign bit 1 - negative carrier phase value 0 - positive carrier phase value
long	PH_I		1	28	Integer part of the carrier phase measurement in cycles
double	PH_F		15.0E-4	11	Fractional part of the carrier phase measurement in units of 5E-4 cycles. Multiply this number by 5E-4 to get fractional carrier phase in cycles. Whole carrier phase measurement = PH_I + PH_F*5.0E-4

Zeros are padded so that all of <Packed Data> part is a module of 16 bits.

Total number of bits in <Packed Data>: ceil ((94 + 72*2*Nsvs)/16) * 16

<Data Length> = ceil ((94 + 72*2*Nsvs)/16) * 2, in which ceil (a) means truncates to +Inf, e.g., ceil (3.1) = 4, ceil (3.5) = 4, ceil (3.95) = 4. Nsvs is number of satellites.

Table 4.13 shows DBEN message sizes in relation to the number of satellites being tracked:

Table 4.13. DBEN Message Sizes

# of Satellites	bits	bytes
4	808	101
5	952	119
6	1096	137
7	1240	155
8	1384	173
9	1528	191
10	1672	209
11	1816	227
12	1960	240

EPB Message

The EPB message contains actual broadcast ("raw") ephemeris data. See the ICD-GPS-200 for a definition of the parameters. Each subframe word is right-justified in a 32-bit long integer.

The structure of the EPB message is shown below:

$PASHR,EPB,d,<Ephemeris Data + Checksum>

Table 4.14 outlines the response format.

Table 4.14. $PASHR,EPB Response Format

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

Table 4.14. $PASHR,EPB Response Format (continued)

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

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Security Function Tests

Contact the security officer and give the number and serial number of the units ready for the security function tests. All the following tests are performed in a temperature chamber set at 55° C, but this is not a requirement.

Many of the following tests can be performed and verified either by the receiver's front panel controls and display or by serially communicating with the receiver from a PC. Instructions are included for both, but it is only necessary to perform one method, whichever is most convenient.

The receiver should be connected to an antenna and a PC.

1. Turn on the receiver by lifting the switch on the back.
2. On the PC, from Windows, double-click on the Ashtech EVALUATE icon to start the EVALUATE program.
3. Once Evaluate has started, select "Connect to GPS Receiver", then click "OK". At the "Connection Parameters" screen, select appropriate computer communications (COM) port. If this is the first time that EVALUATE has been run, click on "Port Setup". Make sure the Port Settings are: 9600 Baud, 8 Data Bits, None Parity , and 1 Stop Bit. Click "OK", and then click "Connect".
4. If the UUT (Unit Under Test) is communicating correctly, click "OK" at the "Initialization complete" screen. Press "Ctrl-T" to bring up the "GPS Receiver Terminal" screen. In this screen "$PASH" commands can be sent to the ZY-12.
5. If a data log of commands and responses is required, press <F2> now to start the data logger. Disregard the epoch counter at this time. The data logger can be used to log any ASCII messages to and from the UUT. Note that the program automatically names the log file. Press <F2> again at any time to close the log file. The file can be renamed.

SECURITY NOTE: Any and all Y-mode data logged onto test computers should be downloaded and saved ONLY on controlled media. The Y-mode data must be downloaded immediately after test, and deleted off the test computers.

6. With EVALUATE, from the Terminal screen, type "$PASHQ,RID" <Enter> and verify that the firmware loaded is the current version of 1Y07.
7. LOAD SECURITY KEY

   The security officer will load the security key into the receiver. The security officer will verify that the security key has been loaded by observing the indications on the security keying device and the Crypto keying LEDs on the back of the receiver. A lit green LED indicates a successful load. A lit red LED means the load was unsuccessful and should be retried.
8. After loading the security key, verify that the receiver locks to satellites using the following commands as necessary:

   Type "**$PASHQ,STA**" <Enter>

   Type "**$PASHQ,POS**" <Enter>

   Send the command "**$PASHQ,STA**"<Enter> repeatedly to observe the receiver until it has locked to a number of satellites and has changed from GPS to UTC time in the $PASHR,STA response. [Note this may take from 10 to 20 minutes.]

   The satellite locked status can also be monitored by observing the ZY-12's screen 0. Where satellites are locked, the "STAT" row will show "LK". For PL1 and PL2, "LZ" will indicate that the receiver has locked onto a satellite on that channel in Z-mode. To observe GPS time change to UTC time on the receiver, go to screen 2. However, here GPS time will change to GMT time, instead of UTC.

9. SET MISSION DURATION

   After the receiver has changed from GPS to UTC time, check that Mission duration can be set. Under the guidance of the security officer:

   - Set the mission duration by accessing screen 4. Press <e>, then highlight 'SEC. MODULE", and press <e> again. Set MISSION DURATION to "005", then press <e> twice.

     If the Mission Duration was entered successfully, the message "MISSION DURATION ACCEPTED" will appear.
   - **Or, by computer,** type "**$PASHS,DMD,005**" <Enter> where 005 is the mission duration in days.

     Observe that the command was successful with the response:

     "$PASHR,DMD,1, MISSION DURATION ENTERED"

> SECURITY NOTE: DO NOT enter the mission duration command more than one time after a security key load. A second mission duration command may erase the security key.

10. ENSURE RECEIVER ENTERS "Y-MODE"
    1. The ZY-12 should stay locked to the satellites. Observe screen 0 for the status of the satellites locked. By computer, type "**$PASHQ,STA"** <Enter>
    2. When the receiver has locked to satellites, check that the receiver has a key and has entered Y-mode by the following steps:
       - Observe the ZY-12's screen 0. Where satellites are locked, the "STAT" row will still show "LK". For PL1 and PL2, "LZ" will change to "LY" to indicate that the receiver has locked onto a satellite on that channel in Y-mode.
       - Entering into Y-mode can also be verified by computer by typing "PASHQ,KEY" <Enter>.
       - The receiver is in the Y-mode if the receiver responds with: "$PASHR,KEY,Y"

Note: It may take 10-20 minutes for the receiver to enter Y-mode the first time.

The receiver is not in Y-mode if the response is "$PASHR,KEY,N". If the receiver is not in Y-mode, continue to monitor the receiver for an additional 10-20 minutes using the KEY query until you receive the "$PASHR,KEY,Y" response, or by observing the "LY" indications on screen 0.

Verify that each satellite has entered Y-mode by typing "**PASHQ,MBN**" <Enter> and observing the MBN message flag. The data field in position 18 of the $PASHR,MBN message indicates "25" when the receiver is in Z-mode for L1, and "24" to indicate the receiver is in Y-mode. Similar values in data field position 28 are for L2.

Type "**$PASHQ,MBN**" <Enter> and check the field for the 24 indicating Y-mode for each satellite and for both L1 and L2 frequency. Note if there are 6 satellites locked in Y-mode, then there should be 12 indications of the "24" response.

11. LOCK ALL CHANNELS TO ONE SATELLITE IN "Y-MODE"
    1. Verify that the receiver has locked onto at least 4 satellites by observing screen 0.

       Verify that at least one satellite has a S/N value > 50. Note the satellite with the highest S/N.

       Observe screen 2 and verify that the receiver has produced a position.
    2. Go to screen 7. Press <e>. Set AUTO SELECTION to "N". Set "N" for each satellite starting at "1" up to the satellite noted in Step 11.1. Leave that satellite set to "Y". Press <e>. Now go to screen 8. Press <e>. The 3-digit field at the bottom of the screen should be highlighted. Enter in "987" in that field and press <e>.

3. Go to screen 0 and observe all 12 channels are now set to that satellite. Observe that "STAT" indicate "LK" for all 12 channels, and that PL1 and Pl2 indicates "LY" for all 12 channels. This may take a few minutes to occur.

   Go to screen 1. Observe for all 12 channels the S/N is the same value, ± 1. Press the <up-arrow> key and verify the same condition for the next screen. Repeat one more time so that the 3 screens showing values for "1", "P1", and "P2" in the lower right corner are checked. This refers to C/A, LP1, and LP2 respectively.

   All channels being in Y-mode can also be checked with the KEY and MBN message:

   - Type "**$PASHQ,KEY**" <Enter> and observe that the receiver has entered Y-mode with the "$PASHR,KEY,Y" response.
   - Type "**$PASHQ,MBN**" <Enter> and observe that all channels show "24" for L1 and L2 frequency. Note when 12 channels are locked, then there should be 24 indications of the "24" response.

4. To exit the Channel test, perform a "soft" reset of the ZY-12 with the following command:

   Type "**$PASHS,INI,5,5,5,5,0,0**" <ENTER>.

   The receiver should return to normal Y-mode tracking.

12. PERFORM SECURITY ERASE
    1. Zeroize the security key:

       Type "**$PASHS,ZER**" <Enter>.

       Observe that the command was successful with the acknowledge response: "$PASHR,ZER,1,ZEROIZE EXECUTED".
    2. The security key can also be zeroized by accessing screen 4. Press <e> and highlight "SEC.MODULE". Press <e> and set ZEROIZE to "Y". Press <e> twice. The messages "ZEROIZE COMMAND IN PROGRESS" and then "ZEROIZE EXECUTED" will show on the screen if the command was successful.
    3. When the security key has been zeroized, the satellite lock status on screen 0 will revert to "LZ" instead of "LY".

       If you do not observe the proper zeroize response, repeat the command to confirm that the security key was erased. **If the security key cannot be confirmed as erased with the proper response, immediately notify the security officer and follow security procedures for an incomplete key erase**.

6

Key Loading Instructions

Receiver Firmware Upload

1. Be sure the receiver is loaded with the latest firmware “1Y07".

Initial Self Test & Crypto Board Test

1. Plug in the power and antenna cables into the respective outlets on back of the receiver.
2. Turn on the receiver.

Command a ZEROIZE of the Crypto board to observe proper functioning of the Crypto board zeroize function. To perform a ZEROIZE, select Menu 4, Sec Modul, set the ZEROIZE KEY entry to YES "Y", and press "e" two times. The Crypto board is zeroized if it responds with the proper message: “ZEROIZE EXECUTED”.

KYK13 Load Instructions

The KYK-13 can be used to store up to six keys. The KYK-13 has a selection knob (marked 1 through 5 and Z ALL), a command knob (marked OFF, ON and Z), a load INIT switch, and a load indicator light.

To load keys in the KYK-13, perform the following steps:

1. Connect the KOI-18 to the KYK-13.
2. Turn the KYK-13 selection knob to the desired buffer.
3. Open the latch on the KOI-18.
4. Insert the paper tape (printed side up) into the slot marked IN.
5. Turn the KYK-13 command knob to ON.
6. Push the load INIT switch on the KYK-13.

7. Pull the paper tape through the KOI-18.
8. Turn the KYK-13 command knob to OFF.
9. Press the load INIT switch on the KYK-13. If the key was loaded successfully, the load indicator light on the KYK-13 will flash.
10. If more keys are needed to be loaded, turn the selection knob on the KYK-13 to the desired buffer, and start again at step 3.

To Load Keys from the KYK-13 into the receiver, perform the following steps:

1. Insure the receiver is on and in INIT or NAV mode, and that the correct date and desired mission duration have been entered.
2. Connect the KYK-13 to the interface box.
3. Turn on the KYK-13 selection knob to the desired buffer.
4. Turn the KYK-13 command knob to ON.
5. Press the Start Load sequence switch on the interface box. Wait at least five seconds. If the key was loaded successfully, the load indicator light on the interface box will flash.
6. Turn the KYK-13 command knob to OFF.
7. If more keys need to be loaded, turn the selection knob to the desired buffer and start at Step 4.

A

Datums

This appendix presents transformation parameters that are used by GPS receivers to convert pseudo-range positions, shown on Screen 2, from WGS-84 into the desired datum. The datums are from Deptartment of Defense document SS-M/V-500, Rev. P, 16 Oct. 1991. Receiver datum codes are selected from a subscreen of Screen 4 on the receiver DATUM SELECT option.

- Geoid heights computed using spherical harmonic expansion and WGS-84 EGM.
- WGS-84 minus local geodetic systems. All values in meters.

Table A.1. Datum Translation Parameters

Reciver Datum Codes	Local Geodetic System	Area	Reference Ellipsoid	Parameter Differences		Transformatio Parameters		
				a (m)	f $\times 10^4$	X(M)	Y(M)	Z(M)
ARF-M	ARC 1950	Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbawe	Clarke 1880	-112.145	-0.54750714	-143	-90	-294
ARS-M	ARC 1960	Kenya, Tanzania	Clarke 1880	-112.145	-0.54750714	-160	-8	-300
AUA	Austr. Geod. 1966	Australia, Tasmania Island	Aust. Nat'l.	-23	-0.00081204	-133	-48	148
AUG	Austr. Geod. 1984	Australia, Tasmania Island	Aust. Nat'l.	-23	-0.00081204	-134	-48	149

Table A.1. Datum Translation Parameters (continued)

Reciver Datum Codes	Local Geodetic System	Area	Reference Ellipsoid	Parameter Differences a (m)	f ×10^4	Transformatio Parameters X(M)	Y(M)	Z(M)
BOO	Bogota Observatory	Columbia	Int'l.	-251	-0.14192702	307	304	-318
CAI	Campo Inchauspe	Argentina	Int'l.	-251	-0.14192702	-148	136	90
CAP	Cape	S. Africa	Clarke 1880	-112.145	-0.54750714	-136	-108	-292
CGE	Carthage	Tunisia	Clarke 1880	-112.145	-0.54750714	-263	6	431
CHI	Chatham 1971	Chatham Island, New Zealand	Int'l.	-251	-0.14192702	175	-38	113
CHU	Chua Astro	Paraguay	Int'l.	-251	-0.14192702	-134	229	-29
COA	Corrego Alegre	Brazil	Int'l.	-251	-0.14192702	-206	172	-6
EUR-A	European 1950	Western Europe: Austria, Denmark, France, F.R.Germany, Netherlands, Switzerland	Int'l.	-251	-0.14192702	-87	-96	-120
EUR-E	Eur. 1950	Cyprus	Int'l.	-251	-0.14192702	-104	-101	-140
EUR--F	Eur. 1950	Egypt	Int'l.	-251	-0.14192702	-130	-117	-151
EUR-H	Eur. 1950	Iran	Int'l.	-251	-0.14192702	-117	-132	-164
EUR-J	Eur. 1950	Sicily	Int'l.	-251	-0.14192702	-97	-88	-135
EUS	European 1979	Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland	Int'l.	-251	-0.14192702	-86	-98	-119
GAA	Gandajika Base	Rep. of Maldives	Int'l.	-251	-0.14192702	-133	-321	50
GEO	Geodetic Datum 1949	New Zealand	Int'l.	-251	-0.14192702	84	-22	209
HJO	Hjorsey 1955	Iceland	Int'l.	-251	-0.14192702	-73	46	-86

Table A.1. Datum Translation Parameters (continued)

Reciver Datum Codes	Local Geodetic System	Area	Reference Ellipsoid	Parameter Differences a (m)	f ×10^4	Transformatio Parameters X(M)	Y(M)	Z(M)
IND-A	Indian	Thailand, Vietnam	Everest	860.655	0.28361368	214	836	303
IND-M	Indian	Bangladesh, India, Nepal	Everest	860.655	0.28361368	289	734	257
IRL	Ireland 1965	Ireland	Modified Airy	796.811	0.11960023	506	-122	611
KEA	Kertau 1948	W. Malaysia Singapore	Modified Everest	832.937	0.28361368	-11	851	5
LIB	Liberia 1964	Liberia	Clarke 1880	-112.145	-0.54750714	-90	40	88
LUZ-A	Luzon	Philippines, excl Mindanao Island	Clarke 1866	-69.4	-0.37264639	-133	-77	-51
MAS	Massawa	Eritrea, Ethiopia	Bessel 1841	739.845	-0.10037483	639	405	60
MER	Merchich	Morocco	Clarke 1880	-112.145	-0.54750714	31	146	47
MIN	Minna	Nigeria	Clarke 1880	-112.145	-0.54750714	-92	-93	122
NAH-C	Nahrwan	Saudi Arabia	Clarke 1880	-112.145	-0.54750714	-231	-196	482
NAS-C	North American 1927 (CONUS)	North America	Clarke 1866	-69.4	-0.37264639	-8	160	176
NAS-D	Alaska	Alaska	Clarke 1866	-69.4	-0.37264639	-5	135	172
NAS-E	Canada	Canada incl. Newfoundland Island	Clarke 1866	-69.4	-0.37264639	-10	158	187
NAS-N	Central America	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico	Clarke 1866	-69.4	-0.37264639	-6	127	192
NAR	North American 1983	Alaska, Canada, Central America, CONUS, Mexico	GRS 80	0	-0.00000016	0	0	0
OEG	Old Egyptian	Egypt	Helmert 1906	-63	0.00480795	-130	110	-13

Table A.1. Datum Translation Parameters (continued)

Reciver Datum Codes	Local Geodetic System	Area	Reference Ellipsoid	Parameter Differences a (m)	f ×10^4	Transformatio Parameters X(M)	Y(M)	Z(M)
OHA-M	Old Hawaiian	Hawaii	Clarke 1866	-69.4	-0.37264639	61	-285	-181
FAH	Oman	Oman	Clarke 1880	-112.145	-054750714	-346	-1	224
OGB-M	Ordnance Survey of Great Britain 1936	England, Isle of Man, Scotland, Shetland Islands, Wales	Airy	573.604	0.11960023	375	-111	431
PIT	Pitcairn Astro 1967	Pitcairn Island	Int'l.	-251	-0.14192702	185	165	42
QAT	Qatar National	Qatar	Int'l.	-251	-0.14192702	-128	-283	22
QUO	Qornoq	South Greenland	Int'l.	-251	-0.14192702	164	138	-189
SCK	Schwarzeck	Nambia	Bessel 1841	653.135	0.10037483	616	97	-251
SAN-M	South American 1969	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paaguay, Peru, Venzuela, Trinidad, Tobago	South Amer-ica 1969	-23	-0.00081204	-57	1	-41
TIL	Timbalai 1948	Brunei, East Malaysia, Sarawak, Sabah	Everest	860.655	0.28361368	-689	691	-46
TOY-M	Tokyo	Japan, Korea, Okinawa	Bessel 1841	739.845	0.10037483	-128	481	664
WGS 72	WGS 1972		WGS 72	-2.0	-0.3121057	0	0	-4.5
WGS 84	WGS 1984		WGS 84	0	0	0	0	0.0
ZAN	Zanderij	Surinam	Int'l.	-251	-0.14192702	-265	120	-358

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