Z-12R™ DGPS Reference Station

With Fischer Connectors & RS-422

Operation and Technical Manual

Magellan Corporation
Ashtech Precision Products
471 El Camino Real
Santa Clara, CA USA 95050-4300

Phone and Fax Numbers

- Main
  - Voice: 408-615-5100
  - Fax: 408-615-5200
- Sales
  - US: 800-922-2401
  - International: 408-615-3970
  - Fax: 408-615-5200
- Europe
  - Voice: 44-1753-835-700
  - Fax: 44-1753-835-710
- Support
  - US: 800-229-2400
  - International: 408-615-3980
  - Fax: 408-615-5200

Internet

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

Ashtech

Printed in the United States of America.
Part Number: 630801, Revision A
January, 1999

LIMITED EQUIPMENT WARRANTY

Magellan Corporation (hereinafter "Magellan") warrants, to the original buyer only, that the equipment (hereinafter, "Product") purchased by the buyer (a) conforms to Magellan's published specifications for the model purchased, and (b) is free from defects in material or workmanship. The duration of this warranty is one year from the date of delivery. Any claim for breach of warranty must be brought to Magellan's attention within such one year period and any action on any such claim must be brought within 12 months from the date of delivery. Within a reasonable period of time after a claim, Magellan will correct any failure of the Product to conform to specifications or any defect in materials or workmanship. If Magellan is unable to repair the Product to conform to the warranty after a reasonable number of attempts, Magellan will provide, at its option, one of the following: (a) A replacement product, or (b) a full refund of the purchase price. A repaired or replaced product is warranted for 90 days from the date of return shipment or for the balance of the original warranty period, whichever is longer. These remedies are the buyer's exclusive remedies for breach of warranty.

To obtain warranty service, the buyer must return the Product postage-paid, with proof of the date of original purchase and the buyer's return address, to Magellan or to an authorized service center. Magellan will not be responsible for any loss or damage to the product incurred while it is in transit or is being shipped for repair. It is the buyer's responsibility to arrange for insurance if the buyer so desires.

Magellan does not warrant: (a) Any product, components, or parts not manufactured by Magellan; (b) defects caused by failure to provide a suitable installation environment for the Product; (c) damage caused by disasters such as fire, flood, wind, and lightning; (e) damage caused by unauthorized attachments or modification; (f) damage during shipment; (g) any other abuse or misuse by the buyer; (h) that the Product will be free from any claim for infringement of any patent, trademark, copyright, or other proprietary right, including trade secrets; (i) any failure of the Product to conform to published specifications arising directly or indirectly out of the Government's changes to/of control over the GPS or GLONASS system; (j) damage caused by failures or inaccuracies of the GPS or GLONASS system or its satellites.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INLCUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND IF APPLICABLE, IMPLIED WARRANTIES UNDER ARTICLE 35 OF THE UNITED NATIONS CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

In no case shall Magellan be liable for any special, incidental, or consequential damages arising directly or indrectly out of the ownership, use or operation of the Product, regardless of whether such damages are predicated or based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory. Such damages include, but are not limited to, loss of profits, loss of savings or revenue, loss of use of the Product or any associated equipment, cost of capital, cost of any substitute equipment, facilities or services, the claims of the third parties, including customers and injury to property. This limitation does not apply to claims for personal injury. Some states do not allow limits on warranties, or on remedies for breach in certain transactions. In such states, the limits in this paragraph and the preceding paragraph may not apply.

SOFTWARE LICENSE AGREEMENT

IMPORTANT: BY OPENING THE SEALED DISK PACKAGE CONTAINING THE SOFTWARE MEDIA, YOU ARE AGREEING TO BE BOUND BY THE TERMS AND CONDITIONS OF THE LICENSE AGREEMENT (“AGREEMENT”). THIS AGREEMENT CONSTITUTES THE COMPLETE AGREEMENT BETWEEN YOU (“LICENSEE”) AND MAGELLAN CORPORATION (“LICENSOR”). READ THE AGREEMENT CAREFULLY. IF YOU DO NOT AGREE WITH THE TERMS, RETURN THIS UNOPENED DISK PACKAGE AND THE ACCOMPANYING ITEMS TO THE PLACE WHERE YOU OBTAINED THEM FOR A FULL REFUND.

LICENSE. LICENSOR grants to you a limited, non-exclusive, non-transferable, personal license (“License”) to (i) install and operate the copy of the computer program contained in this package (“Program”) in machine acceptable form only on a single computer (one central processing unit and associated monitor and keyboard) and (ii) to make one archival copy of the Program for use with the same computer. LICENSOR and its third-party suppliers retain all rights to the Program not expressly granted in this Agreement.

OWNERSHIP OF PROGRAMS AND COPIES. This License is not a sale of the original Program or any copies. LICENSOR and its third-party suppliers retain the ownership of the Program and all copyrights and other proprietary rights therein, and all subsequent copies of the Program made by you, regardless of the form in which the copies may exist. The Program and the accompanying manuals (“Documentation”) are copyrighted works of authorship and contain valuable trade secret and confidential information proprietary to the LICENSOR and its third-party suppliers. You agree to excercise reasonable efforts to protect the proprietary interests of LICENSOR and its third-party suppliers in the Program and Documentation and maintain them in strict confidence.

USER RESTRICTIONS. The Program is provided for use in your internal commercial business operations and must remain at all times upon a single computer owned or leased by you. You may physically transfer the Program from one computer to another provided that the Program is operated only on one computer at a time. You may not operate the Program in a time-sharing or service bureau operation, or rent, lease, sublease, sell, assign, pledge, transfer, transmit electronically or otherwise dispose of the Program or Documentation, on a temporary or permanent basis, without the prior written consent of LICENSOR. You agree not to translate, modify, adapt, disassemble, decompile, or reverse engineer the Program, or create derivative works of the Program or Documentation or any portion thereof.

TERMINATION. The License is effective until terminated. The License will terminate without notice from LICENSOR if you fail to comply with any provision of this Agreement. Upon termination, you must cease all use of the Program and Documentation and return them and any copies thereof to LICENSOR.

GENERAL. This Agreement shall be governed by and construed in accordance with the Laws of the State of California and the United States without regard to conflict of laws and provisions thereof and without regard to the United Nations Convention on Contracts for the International Sale of Goods.

Unless modified in writing and signed by both parties, this warranty is understood to be the complete and exclusive agreement betweent the parties, superseding all prior agreements, oral or written, and all other communications between the parties relating to a warranty of the Product. No employee of Magellan or any other party is authorized to make any warranty in addition to those made in this document. This warranty allocates the risks of product failure between Magellan and the buyer. This allocation is recognized by both parties and is reflected in the price of the goods. The buyer acknowledges that it has read warranty, understands it, and is bound by its terms.

This limited warranty is governed by the laws of the State of California, without reference to its conflict of law provisions or the U.N. Convention on Contracts for the International Sale of Goods.

To the extent the foregoing provisions differ from the terms of the sales contract between the buyer and Ashtech, the sales contract will take precedence. The sales contract contains procedural qualifications and other contractual terms relating to the foregoing provisions.

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

LICENSOR AND ITS THIRD-PARTY SUPPLIERS MAKE NO WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING THE PROGRAM, MEDIA, DOCUMENTATION, RESULTS OR ACCURACY OF DATA AND HEREBY EXPRESSLY DISCLAIM ANY WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE AND NONFRINGEMENT. LICENSOR AND ITS THIRD PARTY SUPPLIERS DO NOT WARRANT THE PROGRAM WILL MEET YOU REQUIREMENTS OR THAT ITS OPERATION WILL BE UNINTERRUPTED OR ERROR-FREE.

LICENSOR, its third-party suppliers, or anyone involved in the creation or delivery of the Program or Documentation to you shall have no liability to you or any third-party for special, incidental, indirect or consequential damages (inlcuding, but not limited to, loss of profits or savings, downtime, damage to or replacement of equipment or property, or recovery or replacement of programs or data) arising from claims based in warranty, contract, tort (including negligence), strict liability, or otherwise even if LICENSOR and its third-party have been advised of the possibility of such claim or damages. The liability of LICENSOR and its third-party suppliers for direct damages shall not exceed the actual amount paid for the program license.

Some States do not allow the exclusion of limitation of implied warranties or liability for incidental or consequential damages, so the above limitations or exclusions may not apply to you.

MANUAL DISCLAIMER

THIS MANUAL IS PROVIDED “AS IS”; MAGELLAN MAKES NO WARRANTIES TO ANY PERSON OR ENTITY WITH RESPECT TO THE SUBJECT MATTER OR USE OF INFORMATION CONTAINED HEREIN OR ANY DERIVATIVES THEREOF OR ANY SERVICES OR LICENSES. MAGELLAN DISCLAIMS ALL IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. FURTHER, MAGELLAN DOES NOT WARRANT, GUARANTEE, OR MAKE ANY REPRESENTATIONS REGARDING THE USE, OR THE RESULTS OF THE USE, OF THIS MANUAL IN TERMS OF CORRECTNESS, ACCURACY, RELIABILITY, OR OTHERWISE. THIS PUBLICATION AND FEATURES DESCRIBED HEREIN ARE SUBJECT TO CHANGE WITHOUT NOTICE.

U.S. GOVERNMENT RESTRICTED RIGHTS

The Program and Documentation are provided with RESTRICTIVE RIGHTS. Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subdivision (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 or subdivision 9(c)(1) and (2) of the Commercial Computer Software - Restricted Rights 48 CFR 52.227.19, as applicable.

Should you have any questions concerning the License Agreement or the Limited Warranties and Limitation of Liability, please contact in writing: Magellan Corporation, 471 El Camino Real, Santa Clara, Ca. 95050-4300

Table of Contents

List of Figures

List of Tables

Overview

The Ashtech Z-12R™ GPS receiver provides state-of-the-art precision surveying and navigation capabilities. The Z-12R™, one of the most sophisticated GPS receivers available today, is the first to offer true all-in-view automatic tracking as well as dual frequency smoothing. With twelve independent channels, this receiver records L1 C/A code, L1/L2 P-code, and L1/L2 carrier phase measurements even in the presence of Anti-Spoofing (AS). Its main function is to serve as a reference station in Differential GPS (DGPS) radio beacon installations.

Reference Station

The Reference Station (RS) includes the Reference Receiver and the Modulator. The primary function of the RS is to compute the PRC's for satellites above the elevation mask angle. When possible, the RS may track satellites below the mask angle on available channels, even though it is not broadcasting any pseudorange corrections for them. The RS produces C/A Code Pseudorange Corrections (PRC's) using the GPS observables (at least C/A Code Phase, L1 Carrier Phase and Rate).

PRCs and ancillary information are formatted according to RTCM SC104, modulated within the RS, and output to the radio beacon transmitter.

The RS contains a two-way port for communication with the Control Station (CS) using RSIM messages. A receive-only port is connected to the Integrity Monitor (IM). The IM periodically sends system feedback (RSIM#20) to the RS to assure that the service is being monitored. The IM gives immediate feedback to the RS when it is determined that an anomaly is occurring for a single satellite or that the position solution has exceeded the protection limit.

Integrity Monitor

The Integrity Monitor (IM) analyzes the RS broadcast and verifies that the data is within tolerance. The IM routinely provides positive system feedback to the RS to indicate normal, monitored operation. During out-of-tolerance conditions, the IM generates alarms. The most important alarms are the position and pseudorange correction (PRC) alarms. These require a simple radial error check of the DGPS navigational solution against a reference position and an analysis of the accuracy of individual ranges from the satellites (the latter taking into consideration the known, fixed position of the IM).

The IM measures the integrity of the DGPS broadcast and the content of the DGPS corrections using monitoring processes and integrity processes. The items that are monitored include characteristics of the radiobeacon MSK signal, the RTCM SC-104 message stream, accuracy of DGPS corrected pseudoranges and the resulting positioning using these ranges. Integrity functions ensure that the quality factors in the RTCM SC-104 data are internally consistent and are within the accuracy of the data. An IM can be configured to either report alarms for a particular reference station ID or report alarms for whatever broadcast is being received. When programmed to monitor a particular Reference Station ID which does not match the ID being received, the IM continues to monitor the DGPS broadcast, but does not report alarms, generate system feedback to the RS, or store any archive data.

Control Station

The Control Station (CS) provides capabilities for real time system status monitoring and control of the functional and performance parameters of remote DGPS broadcast sites. Specifically, the control station ascertains the functional status of the broadcast sites which are assigned to it in a network, sets the broadcast site parameters, controls the broadcast site functions, supplies network status information to the broadcast sites for dissemination, and collects and manages various types of performance data from the network of broadcast sites.

One workstation can serve as the Control Station for many DGPS sites, or each site could have a dedicated CS. A dedicated CS can be located at the site or it can be remotely located. For local control, CS functions may be performed on a stand-alone computer or may be integrated into the RS and IM equipment.

The CS is particularly critical for maritime applications which have requirements for high availability (for example harbor/harbor approach). Status monitoring capabilities provided by the CS minimize loss of service by ensuring that system operators are quickly notified in the event of a system failure or Out of Tolerance (OOT) condition. Using the status monitoring capabilities provided by the CS , system operators can correct detected problems remotely, or, if necessary, dispatch technicians to minimize system downtime.

The CS provides for the dissemination of system status and safety messages to navigation users. In certain applications like a harbor/harbor approach, navigation users need information concerning such events as expected system outages, or forecasted GPS outages for planning purposes. The CS formats, schedules, and outputs information messages of this type to enhance service reliability.

The system status provided at the CS is intended to permit recovery operations to be initiated as soon as possible when a system fault has been detected. It is important to be aware that the status monitoring at the CS is not an integral part of the system integrity function. The RS and IM at each broadcast site act together to maintain a broadcast which meets the accuracy and integrity requirements of a particular application.

Fischer Connectors and RS-422

Using weather-proof Fischer connectors in place of the standard DB9 connectors on the Z-12R DGPS Reference Station creates tangible improvements in durability, reliability, and ease of use. Featuring positive locking, precision-machined connector shells and contacts, and high performance contact block materials, Fischer connectors have earned a reputation for toughness and dependability in extreme environments.

Another significant change in this version of the Z-12R is the use of the RS-422 communication standard on ports B, C, and D. In comparison to RS-232, the RS-422 standard provides better immunity to electrical interference and as a result can support longer cable lengths. RS-232 is available on port A so that test and support technicians can communicate with the Z-12R using a standard PC.

The presence of Fischer connectors in place of DB9 connectors does not alter the core functionality or operation of the Z-12-R, but does change some of the basic setup and connection procedures.

General Information

Introduction

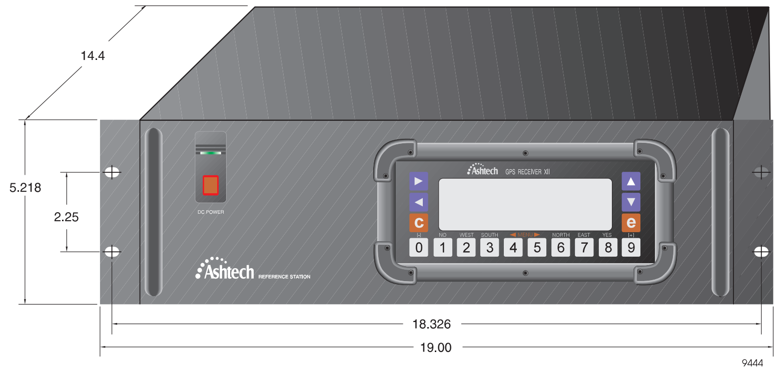


Figure 2.1: Z-12R Receiver

The Z-12R receiver features a specially designed locking power switch. The red square in the center of the switch is the lock. In order to turn on the power, move the red square up and push the rocker switch toward the top of the receiver. When the receiver is turned on the LED in the switch turns on. To turn off the unit, move the red lock and push the rocker switch toward the bottom of the receiver.

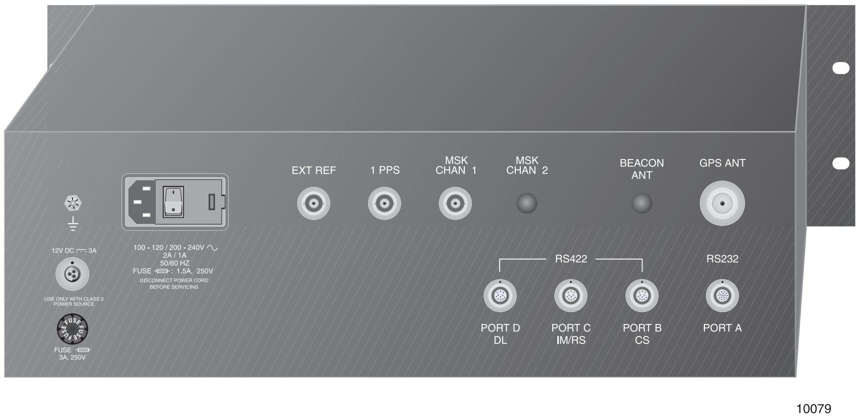


Figure 2.2: Rear Panel

As indicated in figure 2.2, inputs for AC and DC power and one RS-232 serial port (Port A) are available along with three RS-422 serial ports (Ports B, C, and D). These ports conform to the RSIM command message protocol. For more information, refer to Chapter 6, **RSIM Messages**.

Options are available for external frequency input, 1-pulse-per-second (1PPS) output, and MSK signal output for the marine radiobeacons.

The system includes the microstrip antenna, shown in Figure 2.3, mounted on a precision machined platform for accurate positioning above the survey mark.

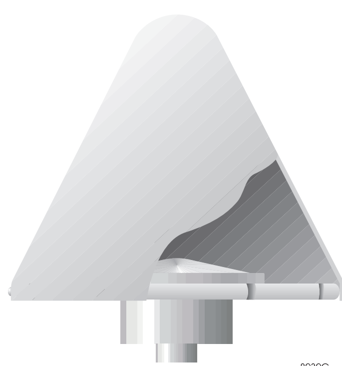


Figure 2.3: Antenna Housing

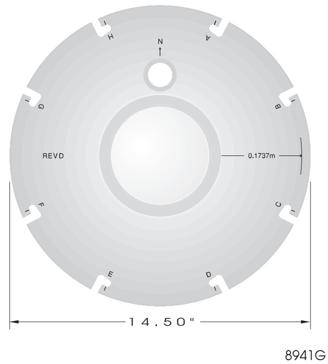


Figure 2.4: Antenna Dimensions

List of Equipment Supplied

Table 2.1 lists the supplied equipment for the Z-12R.

Table 2.1: Supplied Equipment

Part Number	Description
100915	Cable, GPS Antenna, 60 meter (0.5 Quantity)
101373	Fischer 103, 3-pin Straight Connector
101375	Fischer 104, 11-pin Straight Connector (3)
102207	Power Cable, 3-conductor, 110V
103331	Connector, Type BNC, Straight, RG58 (3)
103629	Shipping Box, Rackmount, USCG
103630	Shipping Box, Geodetic Antenna III w/radome
103648	Screw, 12-24x1/2 PH Truss, Steel (4)
103649	Clipnut, 12-24, U-type, Steel, Blk (4)
103824	Connector, Type N, Straight, RG8
600380	Reference Station Software
630801	Z-12R DGPS With Fischer Connectors & RS-422 Operation and Technical Manual
700617	Serial Cable, Fischer to DB9

Table 2.1: Supplied Equipment (continued)

Part Number	Description
700829	Geodetic Antenna 3 w/radome
800596-00	Z-12R Reference Station With Fischer Connectors and RS-422, USCG

Specification Summary

Table 2.2 summarizes the performance specifications of the Z-12R.

Table 2.2: Performance Specification

Specification	Description
RTCM message output	Message types 1, 3, 5, 6, 7, 9-1, 9-3, 15, 16
RSIM message output	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1 1, 12, 13, 20, 21, 22, 23
Radiobeacon output	MSK selectable for 25, 50, 100, or 200 bits per second
Reference input frequency standard	1.00 to 21.00 MHz sine wave 1 vrms 50W
1 PPS output	Within 1 usec of start of GPS second
Weight	Rack mount Z-12R receiver: 14 lbs Antenna: 3.5 lbs (5 lbs with radome)
Input power	AC: 100-120/200 - 240 VAC 2/1A, 50/60 Hz DC: 12 VDC, 3A

Antenna Platform

A geodetic microstrip antenna is seated on a precision machined platform protected by a weatherproof cover. A low-noise preamplifier housed at the base of the antenna provides sufficient gain for a cable up to 30 meters long. Cable specifications are listed in Table 9.2.

For proper antenna height measurement, mount the antenna on a fixed surface and survey in the actual position of the antenna.

If you are placing the antenna over a known surveyed position and must measure the antenna height position, the distance from the center of the antenna to the outside edge of the ground plane is 0.1430 meters.

The antenna platform can be mounted on a variety of tripods and range poles, using either a 5/8 x 11 female threaded connector or a tribrach connector.

Front Panel

The receiver’s front panel, shown in Figure 2.5, includes an 8-line x 40-character backlit LCD displayand a keypad for receiver control and data entry.

Figure 2.5: Front Panel

The Z-12R receiver is easy to operate. Operating controls and the DC power switch are on the front; input and output connections and the AC power switch are on the back.

Access to function settings are found on several easy-to-use screens. 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. All screens are described in detail in Chapter 4, **Screen Operations**. Subscreens are described in Chapter 4, **Screen Operations**, under their top-level screens.

The following keys are used to activate the receiver’s functions:

Table 2.3: Front Panel Functions

Field	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 explains a screen, it identifies the screen by number (for example, 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'.
[ ]	Square brackets are used to indicate all receiver keys except the directional arrows.
< >	Angle brackets are used to indicate computer keys.
[**c**]	Use the [**c**] key to cancel the current entry.

Table 2.3: Front Panel Functions (continued)

Field	Description
[**e**]	Press the [**e**] key to activate the data-entry mode, to save entered values, and to go back to higher level displays; the [**e**] key functions like the <Enter> key on a computer.
▶ ◀	In display mode, use the ▶ key or the ◀ key to change to the next higher or lower numbered screen or subscreen.
▲ ▼	Use these keys 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 the display mode. After two minutes of keyboard inactivity, the backlighting automatically turns off to extend the life of the battery. To restore it, push any key. Ashtech recommends [**c**] because it does not change the display.
▶◀ ▲▼	In data-entry mode, use the arrow keys to move the cursor: to highlight a field or to flash in a character position where the next entry goes. The ▶ key and the ◀ key moves the cursor horizontally and the ▲ key and the ▼ key move it vertically.
Highlight	To highlight a parameter, use an arrow key (▲, ▼, ▶, or ◀) to move the cursor until that field is displayed in inverse video and a character position in that field is flashing.
Toggle	To toggle a field, highlight it and press the [**+**] or [**-**] key until it displays the desired setting. For example, below Screen 4, on the Port A/B/C/D Parameter Selection screens, you can toggle through various baud rates. Use the ▶ 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.

Table 2.4: Screen Display Functions

Screens	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

Table 2.4: Screen Display Functions (continued)

Screens	Display/Function
10	All-in-View Information
11	Visibility Information
12	Bar Code Control

Powering the Receiver

In order to turn the power ON, ensure that the power cable is connected and flip the power switch in the back of the receiver.

Self-Test Messages

At power-up, the receiver performs internal tests to check various components and circuits. As the self-test is completed, the following self-test messages are displayed:

- EPROM Checksum test pass
- XRAM installed
- Mag var checksum OK
- Downloading channel

If the receiver passes all of the tests, the screen will display the message "downloading channel" and proceed to Screen 0. If any test fails, the program halts and an error message denoting the failure is displayed.

Resetting Memory

When powering the receiver for the first time after receiving it from the factory, it is recommended to reset internal and external memory. A reset of the internal memory of the receiver clears the receiver to the factory defaults, including almanac data. Follow the steps below to perform the reset:

1. Turn the receiver OFF
2. While pressing the ▲ key, turn the receiver ON.
3. Keep holding the ▲ key down until the message "*Test of internal RAM. Will clear all data. Press YES within 10 seconds to continue*" is displayed.
4. Press [**8**] (YES) and a message appears: *"Push any key to continue."* Press any key to start normal receiver operation.

A reset of the external memory of the receiver erases all data files displayed on Screen 8 and stored in the memory RAM board. To complete this reset, proceed as follows:

1. Turn the receiver OFF

2. While pressing the ▶ key, turn the receiver on.
3. Keep holding the ▶ key down until the message “test of external RAM. Will clear all data. Press YES within 10 seconds to continue” is displayed.
4. Press [**8**] (YES) and the message “Push any key to continue” appears. Press any key to resume normal operation.

Real-Time Differential

This chapter describes the Real-Time Differential function that is a standard feature in Ashtech Z-12-R receivers.

This chapter contains a general description of real-time differential techniques including major sources of errors, followed by a description of the RTCM-104 message formats (the standardized differential formats), and a detailed explanation of RTCM differential setup, options, and operation.

General

Real-time differential GPS requires a base receiver to compute satellite range corrections and transmit them to remote receivers. The corrections are transmitted in real time to the remote receivers using a telemetry link. Remote receivers apply the corrections to their autonomously measured ranges and use the corrected ranges to compute positions.

The base receiver determines range correction by subtracting the **measured** range from the **true range**, referenced to the surveyed position entered in Screen 4 (Figure 3.1) of the base receiver. The remote receivers subtract the received corrections from their measured ranges and use the corrected ranges for position computation.

A stand-alone GPS receiver can compute a position with an accuracy of approximately ±25 meters with SA off, and approximately ±100 meters with SA on. A remote receiver using C/A code Differential GPS can greatly reduce the effects of SA, achieving accuracy at the level of ±1 meter. A remote receiver using C/A code Differential GPS and dual frequency smoothing can achieve sub-meter accuracy.

The Z-12R receiver can function as a base or remote station. In base mode, the receiver computes the range errors in every cycle. The cycle is nominally each ½ second. The receiver transmits the range corrections using a serial port with a wide selection of baud rates. If using the Z-12R with the MSK modulator, the corrections are transmitted from the MSK port.

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

Sources of Error

The major sources of error affecting the accuracy of GPS range measurements are satellite orbit estimation, satellite clock estimation, ionosphere, troposphere, and receiver noise. The first four are almost totally removed using differential GPS, with residual error in the order of 1 mm for every kilometer between base and remote receivers.

Receiver noise is not correlated between the base and the remote receiver and is not canceled by differential GPS. However, in Z-12R receivers, integrated Doppler is used to smooth the range measurements and minimize the effects of receiver noise.

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

If the receiver loses lock on a satellite, the noise goes back to one meter and smoothing starts from the one-meter level. The loss of lock to a satellite is rare, and typically happens only when the direct path (line of sight) to the satellite is blocked by an object. Total position error (or error-in-position) is a function of the range errors (or errors-in-range) multiplied by the PDOP (three-coordinate position dilution of precision). PDOP is a function of the geometry of the satellites.

RTCM SC104 Format, Version 2.1

This section describes the part of the RTCM SC104 format (Radio Technical Commission for Maritime Special Committee 104) Version 2.1, implemented in the Z-12R receiver. This format is an international standardized protocol developed for the transmission and reception of differential corrections.

When using the receiver in base operation, the Z-12R computes and transmits differential corrections which can be received and used by remote users. A common term for a base station is **reference station**; it is used frequently in this manual. The user equipment has to be set for **remote differential** operation to be able to accept the corrections from the base station. The corrections are applied to improve the accuracy of the positions computed by the user equipment.

When a port is set up to transmit RTCM in base mode, all other output options on that port are disabled and the following message is displayed:

"Port N will output differential data at a rate of xxxx baud"

N is the serial port being used for RTCM and xxxx is the selected baud rate for that port.

Write to the address below for more information about RTCM SC104, Version 2.1:

Radio Technical Commission for Maritime Services

P.O. Box 19087 Washington DC 20036-9087

As a Reference Station

When a receiver is used as a reference station and the RTCM format is selected, the receiver computes differential corrections for up to 9 satellites, converts those corrections to RTCM format and transmits the formatted messages using its serial ports and/or the MSK port. The receiver can generate message types 1, 3, 5, 6, 7, 9-1, 9-3, 15, and 16. Table 3.1 below contains a brief description of each message:

Table 3.1: RTCM Message Types

Component	Function
1	Differential GPS corrections
3	Reference station parameters
5	Health status of satellite
6	Null frame
7	Radiobeacon station parameters
9-1	Differential GPS corrections in groups of 1
9-3	Differential GPS corrections in groups of 3
15	Ionospheric corrections
16	Special Message

The RTCM format uses the 6-of-8 format (data bits A1 through A6 of an 8-bit byte) for communication between the reference station and user equipment.

As Remote Equipment

When the receiver is set for remote differential and the RTCM format is selected, it can accept any type of RTCM message. However it decodes only types 1, 2, 3, 5, 6, 7, 9, 15, and 16 and uses only types 1, 2, and 9 to correct its position computations. The RTCM format includes parity bits which enable the user to detect errors in the transmitted data and prevent erroneous corrections from being used.

RTCM Differential Set Up

Follow the steps below to set the receiver for RTCM differential operation:

1. On Screen 4, press [**e**] to activate data-entry mode.

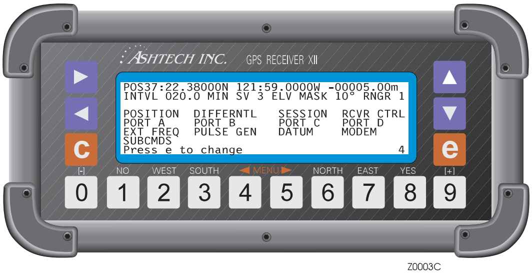


Figure 3.1: Screen 4, Data Entry Mode Screen

2. If the receiver is going to be set as a base station, a surveyed antenna position must be entered in the POS line and the elevation mask (POSITION submenu) should be set to 5° (the elevation mask setting controls the number of satellites for which corrections are generated).
3. Next highlight DIFFERNTL and press [**e**] to go to the Differential Mode Selection screen:

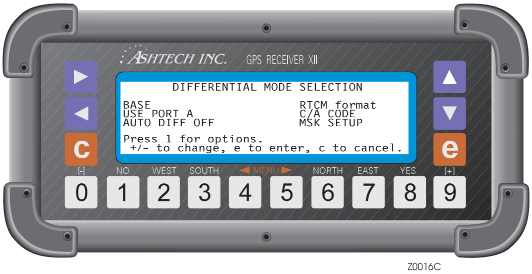


Figure 3.2: Screen 4, Differential Mode Screen

4. Highlight the mode indicator and press the [**+**] or [**-**] key to toggle through the mode options (BASE, REMOTE, and DISABLED) and select the desired mode. Differential mode can also be selected on the RTCM OPTIONS screen.

5. Highlight the output port indicator and use the [**+**] or [**-**] keys to toggle through the port options (PORT A, B, C, or D) to select the serial port you want to use for outputting differential corrections. Press [**e**] to save the new setting.

If you are sending corrections using MSK, select NONE and refer to the MSK SETUP menu.

6. Highlight the C/A code indicator and toggle it to select C/A code or L1 P-code.
7. To turn on the auto differential option, highlight the AUTO DIFF field and press the [**+**] or [**-**] key to set it to ON.
8. Press **[e]** to save the new settings. The specified port and baud rate will be displayed.
9. Press **[e]** again to return to the main display, Screen 4.

RTCM Options

With RTCM format highlighted on the Differential Mode Selection screen, press **[1]** to access the RTCM OPTIONS Menu.

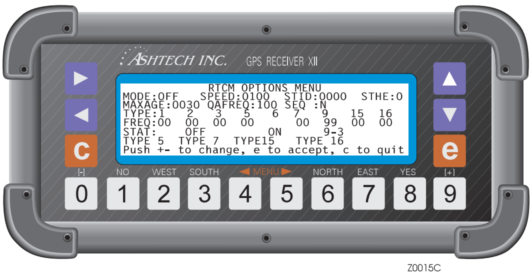


Figure 3.3: RTCM Options Menu Screen

Table 3.2: RTCM Options Menu

Component	Function
MODE	Choices are **BASE**, **REMOTE**, or **OFF**. For a base station, select BASE. For remote Differential, select REMOTE. Differential mode can also be set in the **Differential Mode Selection** screen.
SPEED	Sets the Differential output rate in bits per second (bps). Choices are 25, 50, 100, 110, 150, 200, 250, 300, and 1500 bps. The default is 100 bits per second (An RTCM byte has six significant bits.) This setting is not used in remote mode. When the receiver operates in remote mode, it automatically detects the output rate of the corrections.
STID	Station ID. The reference station identification is entered by the user. It can be set to any number from 0 to 1023.
STHE	Station health . Reference station health can be set to a value from 0 to 7, based on the conditions in Table 3.3.
MAXAGE	In remote mode, specifies a maximum age, in seconds, for differential messages. The remote receiver ignores messages which are older than the MAXAGE setting. It may be set to any integer value from 0 to 1199 seconds. The default setting is 30. In base mode, MAXAGE has three uses: • When a previously healthy satellite is forced unhealthy or starts broadcasting an unhealthy status, RTCM corrections for it are tagged DO NOT USE and no more corrections are sent for this particular satellite. • When an RSIM 20 is received by the RS with a satellite's PR Residual flag set, indicating that the IM detected bad corrections from that satellite, the RS broadcasts a DO NOT USE tag for the satellite's corrections for as long as this condition persists. The RS then resets the correction smoothing for this particular satellite and starts broadcasting corrections for it once again. • When a satellite being tracked by the RS drops below the elevation mask setting, DO NOT USE tags are sent for that particular satellite until its elevation is above the mask setting.
QAFREQ	In remote mode, allows evaluation of the communication quality between the base station and the user equipment. This number is a percent of the parity passed messages. When the total number of received messages reaches QAFREQ, the quality number is reset to 100. QAFREQ may be set to any number from 0 to 999. It defaults to 100. It is not used in base mode.
SEQ	When activated, checks for the sequence number in a message to ensure that messages are arriving in the correct sequence. RTCM messages arriving out of sequence are not used when this setting is enabled. This setting is not used in base mode.

Table 3.2: RTCM Options Menu (continued)

Component	Function
TYPE	Indicates the type of message to be generated. The receiver can generate message types 1, 3, 5, 6, 7, 9-1, 9-3, 15, and 16. The default is message type 9-3. Toggle between 9-1 and 9-3 formats. When L1 P-code is selected, type 10 is displayed instead of type 1. Both messages give differential GPS corrections in Type 1 format.
FREQ	Specifies the period/frequency for message types 1, 3, 5, 7, 9, 15, and 16. Each can be set to a value that ranges from 0 to 99. Zero (0) means no message is generated. 99 generates a message continuously. A value from 1 to 98 specifies time between messages. For message types 1, 9, and 15, the unit of measure is seconds. For message types 3, 5, 7, and 16 the unit of measure is minutes.
STAT	Allows type 2 and 6 messages to be turned ON or OFF.
TYPE 5 TYPE 7 TYPE15 TYPE16	Allows data entry or observation of type 5, 7, 15, and 16 messages, as described on the following pages.

The UDRE scale factor indicates the range of UDRE values for the set of corrections currently being transmitted or received.

Table 3.3: Reference Station Health Conditions

Value	Code	Health Indication
7	111	Reference station not working.
6	110	Reference station transmission not monitored.
5	101	UDRE scale factor = 0.10
4	100	UDRE scale factor = 0.20
3	011	UDRE scale factor = 0.30
2	010	UDRE scale factor = 0.50
1	001	UDRE scale factor = 0.75
0	000	UDRE scale factor = 1.00

RTCM Type 5 Message Submenu

If you select **TYPE 5** from the **RTCM OPTIONS MENU**, the **RTCM TYPE 5 MESSAGE** submenu appears as shown in Figure 3.4. The Type 5 screen is display only; no data can be entered.

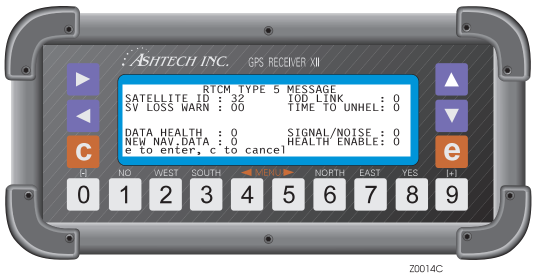


Figure 3.4: RTCM Type 5 Message Screen

Table 3.4: Contents of the RTCM Type 5 Message

Component	Function
SATELLITE	Satellite ID (PRN 1-32).
IOD LINK	Set to 0, indicates this information refers to navigation data with IOD (issue of data) in message types 1, 9, 20, and 21. Set to 1, indicates this information refers to navigation data with IOD in type 2 message.
SV LOSS WARN	Set to 1, indicates that a change in the satellite's health from healthy to unhealthy is scheduled. The healthy time remaining is estimated in the time to unhealthy.
TIME TO UNHEL	Scale factor is five minutes with a range of 0 to 75 minutes.
DATA HEALTH	Standard information concerning satellite navigation data health. Refer to Table 20-VII in ICD-GPS-200. This is a repeat of the three most-significant bits of the 8-bit ephemeris health status words provided in the GPS navigation message.
SIGNAL NOISE	Satellite signal-to-noise ratio as measured at the reference station. Scale factor is 1dB-Hz. Range is 25 to 55 dB-Hz. Zero (0) indicates that the satellite is not being tracked by the reference station.
HEALTH ENABLE	Set to 1, indicates that satellite is to be considered healthy by DGPS User Equipment despite the fact that satellite navigation data indicates the satellite is unhealthy.
NEW NAV.DATA	Set to 1, indicates that new satellite navigation data is being acquired by the reference station and being integrated into the pseudorange correction. There will soon be a new IOD indicated in type 1 message

A Type 5 message is immediately generated for either of two conditions:

- When a satellite which is broadcasting unhealthy is forced healthy.
- When information is given to the RS which indicates a particular satellite will be set unhealthy at some time in the future.

These conditions can be generated using the RSIM 8 serial command. Note that the display only gives information for one satellite, while a broadcast Type 5 message can handle up to 12 satellites.

When scheduled, a Type 5 message is not generated unless one of the above conditions is true. For as long as either condition exists for any satellite, Type 5 messages are broadcast as scheduled.

RTCM Type 7 Message Submenu

If you select **TYPE 7** in the **RTCM OPTIONS MENU**, the **RTCM TYPE 7 MESSAGE** submenu appears, as shown below:

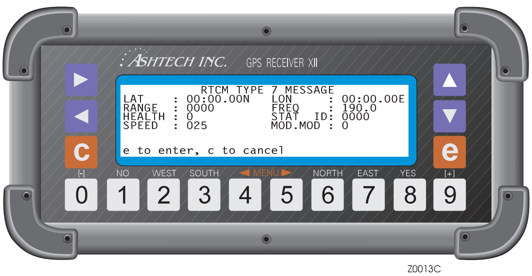


Figure 3.5: RTCM Type 7 Message Screen

In remote mode, this submenu is display only. In base mode, data can be entered.

Table 3.5: RTCM Type 7

Component	Function
LAT	Radio beacon location latitude.
LON	Radio beacon location longitude
RANGE	Radio beacon usable signal range in Km, 0 - 1023 Km
FREQ	Broadcast frequency, 190-599.5 KHz

Table 3.5: RTCM Type 7 (continued)

Component	Function
HEALTH	Radio beacon health, where: • 0 = Radio beacon operation normal • 1 = Unmonitored • 2 = No information available • 3 = Don't use this radio beacon
STAT ID	Broadcast station identification, 0-1023
SPEED	Broadcast bit rate in bits per second, 25-300
MOD.MOD	Modulation mode: 0 = MSK, 1 = FSK
SYNC	Synchronization type: 0 = asynchronous, 1 = synchronous
CODING	Broadcast coding: 0 = no added coding; 1 = FEC coding. If any values entered in the above fields are out of range, an error flashes on the screen and you cannot exit the screen until proper values are entered.

Type 7 messages are generated as scheduled by the user for up to four radio beacon locations. The display only allows entry (and shows information) for one radio beacon location. Use the RSIM 21 serial command to generate Type 7 status information for more than one radio beacon location, .

Changes to any parameters in this message must exist for at least one minute before a new Type 7 message is generated with these changes. If the schedule for a Type 7 message to be broadcast is greater than two minutes after its parameters change, a Type 7 message is automatically generated within two minutes.

RTCM Type 15 Message Submenu

When selecting **TYPE 15** in the **RTCM OPTIONS MENU**, the **RTCM TYPE 15 MESSAGE** submenu appears as shown below:

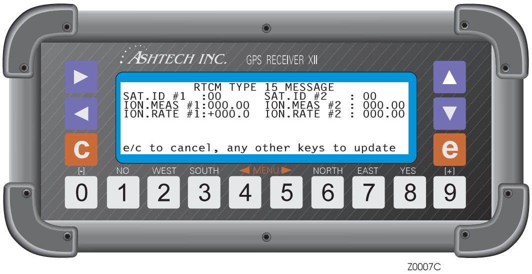


Figure 3.6: RTCM Type 15 Message Screen

This submenu screen is display only; no data can be entered.

Table 3.6: RTCM Type 15

Component	Function
SAT.ID #1/2	Satellite ID (PRN 1-32).
ION.MEAS #1/2	Ionospheric measurement in meters.
ION.RATE #1/2	Ionospheric rate measurement in centimeters per minute.

RTCM Type 16 Message Submenu

When selecting **TYPE 16** in the **RTCM OPTIONS MENU** when the receiver is set to base mode, the **RTCM TYPE 16 MESSAGE** submenu appears as shown below:

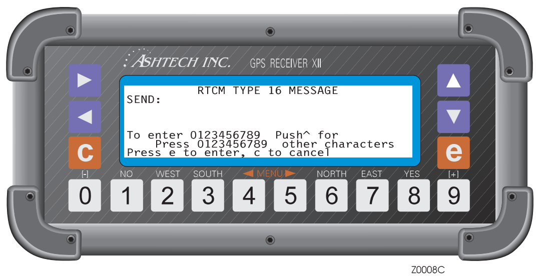


Figure 3.7: RTCM Type 16 "Send Message" Screen

Enter an ASCII message using the keys on the receiver panel. To enter characters other than numbers, use the ▲ key to toggle through the character options and press the numeral key ([**0**] through [**9**]) that corresponds to the desired character. The characters are displayed in blocks of ten. Five sets of characters are available.

The **RTCM TYPE 16 MESSAGE** screen appears as shown below when **TYPE 16** in the **RTCM OPTIONS MENU** is selected and the receiver is set in remote mode,

Figure 3.8: RTCM Type 16 "Receive Message" Screen

This menu contains information about the last TYPE 16 message received.

Accessing MSK Functions

Access to MSK functions is provided in the DIFFERNTL submenu on Screen 4. The following screen appears after pressing the [**e**] key:

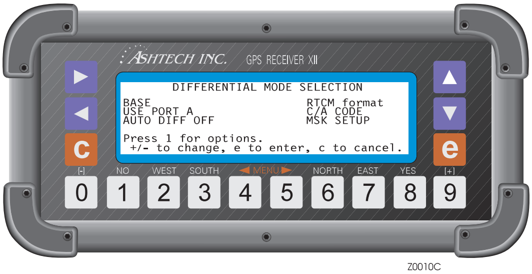


Figure 3.9: Differential Mode Selection Screen

Select **MSK SETUP**. The **MSK SETUP MENU** appears as shown below:

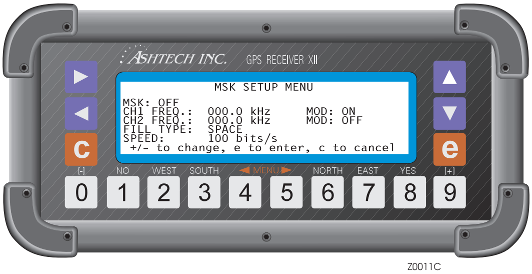


Figure 3.10: MSK Setup Mode Screen

Table 3.7: MSK Setup Menu

Component	Function
MSK	Turns MSK output **ON** or **OFF**. Default is **OFF**.
CH1 FREQ	Sets the carrier frequency of channel 1 from 283.5 to 325.0 kHz in steps of 0.5 kHz. If set to zero (0), no signal is generated. The default is 000.0.
CH2 FREQ	Sets the carrier frequency of channel 2 from 283.5 to 325.0 kHz in steps of 0.5 kHz. If set to 0, no signal is generated. The default is 000.0.

Table 3.7: MSK Setup Menu (continued)

Component	Function
MOD	Sets the RTCM data carrier modulation. Choices are **ON**, **OFF**, or **FILL**. **FILL** modulates the carrier with the fill type. The default is **ON** for channel 1, **OFF** for channel 2.
FILL TYPE	Fill type for RTCM data: Choices are **SPACE**, **MARK**, **ALTER**, or **PARK**. Fills are used to modulate the carrier if there is no RTCM data to send. Default is **SPACE**.
SPEED	Selects bit rate of RTCM data issued from the MSK port: 25, 50, 100, or 200 bits per second. The default is 100.

Reference Station or Base Mode

On the differential mode selection screen, check that the correct output port is selected.

Follow the steps below to set the receiver for base station/reference station mode:

1. Highlight RTCM format on the Differential Mode Selection screen and press [**1**] to access the RTCM Options.

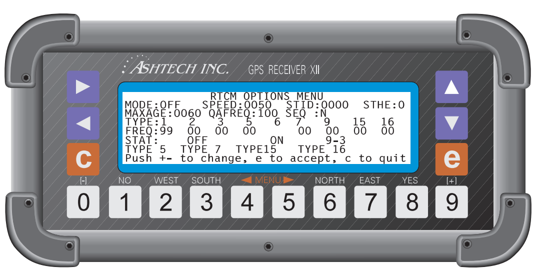


Figure 3.11: RTCM Options Menu Screen

2. The RTCM mode must be set to **BASE**. If not, highlight the mode indicator and press the [**+**] or [**-**] key to toggle it to **BASE**.
3. Check the **SPEED** setting. The default is 100 bits per second (bps). To select a different speed, highlight this field and use the [**+**] or [**-**] keys to toggle to the desired speed.
4. Optionally, set **STID** to a number from 0 to 1023.
5. Optionally, set **STHE** to a number from 0 to 7.

6. Under **FREQ**, set the time interval for the messages to be transmitted. Set type 1 or type 9 frequency to 99 for continuous transmission of differential corrections.
7. When sending an ASCII message, type in the message under the submenu Type 16 (up to 32 characters).
8. Press [**e**] twice to return to the main display on Screen 4.

User Equipment or Remote Mode

Follow the steps below to set the receiver in user/remote differential mode:

1. Highlight **RTCM format** in the **DIFFERENTIAL MODE SELECTION** screen and press [**1**] to access the **RTCM OPTIONS MENU**.

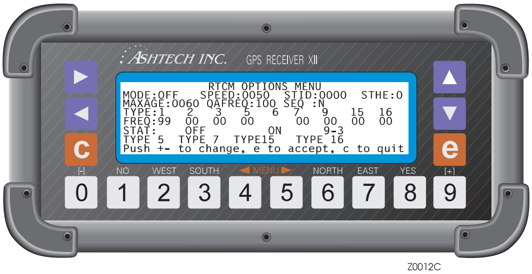


Figure 3.12: RTCM Options Menu

2. In the **RTCM OPTIONS MENU**, highlight the mode field and use the [**+**] or [**-**] keys to toggle to **REMOTE**.
3. For corrections to be applied by the remote, the station ID (STID) in the remote should be the same STID set for the base. To change this field, highlight **STID** and enter the desired number. Setting this field to 0000 means that corrections from any reference station are accepted.
4. To alter **MAXAGE**, highlight it, set it to a number from 0 to 1199 seconds and press the **[e]** key to save the entered value.
5. To change **QAFREQ** (communication quality), highlight it and set it to a number from 0 to 999; press the **[e]** key to save the new setting.
6. Press **[e]** twice to go back to the main display on Screen 4.

XON/XOFF Handshake

It may be necessary to stop a receiver (base mode only) from transmitting; for example, if the buffer in the transmitting equipment is nearly full.

- To stop sending data, send an XOFF (ctrl-s).
- To resume transmitting, send an XON (ctrl-q) command. The base receiver will not start sending messages again until you do this.

Screen Operations

Screen 0: Skysearch Information

Screen 0 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 number.

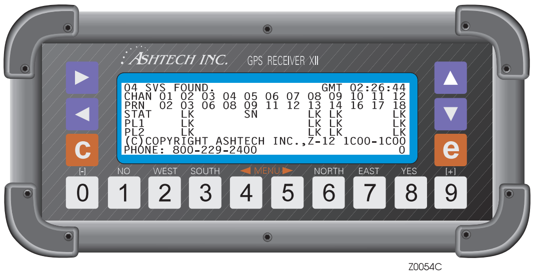


Figure 4.1: Skysearch Information Screen

Screen 0 is a display-only screen. You cannot enter data on it. Use the ▶/◀ to cycle through the other screens one by one, or press one of the numeral keys to go directly to another screen. Pressing the [**7**] key while you are in screen 0 takes you directly to screen 7, while pressing the ▶ key while you are in screen 0 takes you to screen 1.

Table 4.1: Skysearch Information Functions

Component	Function
SVS FOUND	Shows the number of satellites located.
02:26:44	Time in hours, minutes, and seconds is displayed in the upper right corner of Screen 0. The time is displayed in three stages: Before it locks on a satellite, the receiver displays time elapsed since you first turned it on. After locating the first satellite, it reads the satellite time, sets its internal clock, and displays GPS time. After several satellites are located, the reciever collects GPS-to-UTC conversion parameters and displays Greenwich Mean Time (GMT).
CHAN	A static row which lists the receiver channel numbers (1-12).

Table 4.1: Skysearch Information Functions (continued)

Component	Function
PRN	This row lists the PRN numbers of the satellites being tracked by the receiver. If the receiver is unable to lock a given satellite after two minutes, a new satellite is cycled into its channel. A satellite PRN number displayed in reverse video (blue numbers in a white box) indicates that Z tracking mode is in effect for that satellite.
STAT •SN •LK	Shows the current status for each C/A-code channel: • SN indicates that some kind of L-band signal has been detected. If the signal turns out not to be a satellite signal, the receiver continues the search. • When a signal proves to be a satellite signal, this field changes from SN to LK (locked on) and starts the satellite's ephemeris and almanac files. The status typically changes from SN to LK within two minutes of operation.
PL1	Shows the channel lock status for the L1 P-code. Values are SN or LK.
PL2	Shows the channel lock status for the L2 P-code. Values are SN or LK.
Z-12 1C00-1C00	Shows receiver type and firmware version number. Have this information available when calling a service representative with problems.

Screen 1: Orbit Information

Screen 1 displays orbital parameters for each locked satellite. Information such as satellite elevation, azimuth, signal strength, health, and more is displayed here. Screen 1 is display-only; no data can be entered in it.

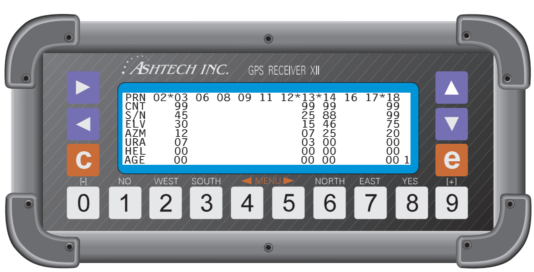


Figure 4.2: Orbit Information Screen

Table 4.2: Orbit Information Functions

Component	Function
PRN	This row lists the PRN numbers of the satellite being tracked by the receiver. An asterisk (*) preceding the PRN number indicates that the satellite is currently locked. If the PRN number is displayed in reverse video (blue numbers in a white box), satellite is in Z tracking mode.
CNT	This row displays a count of the number of epochs of continuous data collected from the corresponding satellite. It is updated every second. It ranges from 0 to 99 and remains at 99 until a cycle slip occurs. A cycle slip causes CNT to reset to zero (0). Cycle slips typically occur when the receiver loses lock on a satellite; they are rare unless there are frequent obstructions in the receiver's line of sight to the satellite.
S/N	Signal-to-noise ratio, a measure of a satellite's signal strength. When it is below 20, the signal is weak; when it is over 50, the signal is strong. Satellites at a low elevation angle display lower S/N values.
ELV	The satellite's elevation angle above horizon, ranging from 0° to 90°.
AZM	The geodetic azimuth of the satellite measured clockwise from 0° geodetic north (referenced to the WGS-84 ellipsoid) in units of 10°. Only two characters are assigned for this value; when it displays 12, read it as 120°. The receiver must computer a position before it can compute elevation and azimuth. Until it locks on to enough satellites to determine its own position, the receiver can use an estimate of position. Enter this estimate in Screen 4, **Mode Control**.
URA	The usable range accuracy of each satellite. Zero (0) indicates high range accuracy; 8 and above indicates low range accuracy.
HEL	Displays the satellite's health (general condition) in hexadecimal. See Chapter 8, **System Control,** for information on interpreting this code.
AGE	Shows how many minutes have passed since lock was lost on the satellite. An ELV of 35 and an AGE of 12 indicates that the satellite was at an elevation of 35° twelve minutes ago when loss of lock occurred. When the satellite is reacquired, age resets to 00.
1	Screen number. Screen 1 displays information for C/A code. Screen P1 displays information for L1 P-code. Screen P2 displays information for L2 P-code. Use the ▲▼ keys to cycle through the screens.

Screen 2: Position & Navigation Data

Screen 2 displays position and navigation information. This is a display-only screen; no data can be entered in it. Screen 2 contains two pages. The majority of the data on the first page relates to position; the second page contains navigation data. Use the ▲▼ keys to cycle between the pages.

Screen 2, Page 1

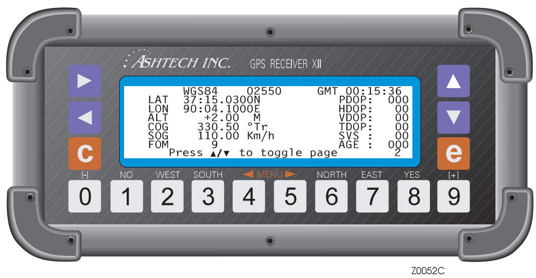


Figure 4.3: Navigational Information Screen

When the receiver is in differential remote mode and AUTO DIFF is set to OFF, the position is updated only when differential corrections are received.

Table 4.3: Navigation Information Functions (Screen 2, Page 1)

Component	Function
WGS-84	Indicates the reference datum of the displayed position. The default is WGS-84. Other datums can be selected in the **DATUM** sub-screen in Screen 4.
02550	Position counter. This field is incremented with every half-second update. **OLD** is displayed when the position data is more than 10 seconds old. When count restarts, the counter begins from last count. If a position is defined in screen 4, POS field, the counter resets to zero and the count resumes.
00:15:36	Greenwich Mean Time (GMT).
LAT	Latitude. Reported in degrees and minutes to four decimal places. **N** = north; **S** = south.
LON	Longitude. Reported in degrees and minutes to four decimal places. **E** = east; **W** = west.

Table 4.3: Navigation Information Functions (Screen 2, Page 1) (continued)

Component	Function
ALT	Altitude. Ellipsoidal height of the antenna in meters.
COG	Course Over Ground. The heading in degrees. The default unit is degrees referenced to true north (Tr). If magnetic mode is selected (See Screen 6), the unit for COG is displayed in degrees referenced to magnetic north (Mg).
SOG	Speed Over Ground. The receiver's velocity in miles per hour (MPH), kilometers per hour (KM/H), or knots (KN). The units are set on Screen 6, function 8: Unit Selection Option.
FOM	Figure of Merit. Indicates the accuracy of the stand-alone position based on satellite range residuals and PDOP. 1 is best; 9 indicates that a position is not being computed.
PDOP	Position Dilution of Precision. Indicates the quality of satellite geometry based on the satellite positions relative to one another. If they 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	Horizontal Dilution of Precision. The two-dimensional horizontal component of PDOP.
VDOP	Vertical Dilution of Precision. The verttical component of PDOP.
TDOP	Time Dilution of Precision. The time component of the position calculation is combined with PDOP (three coordinates) to derive a value for GDOP (Geometric Dilution of Precision).
SVS	Shows the number of satellites currently being used for the position calculation.
AGE	The elapsed time in minutes since the position was computed.

Screen 2, Page 2, Navigation Information

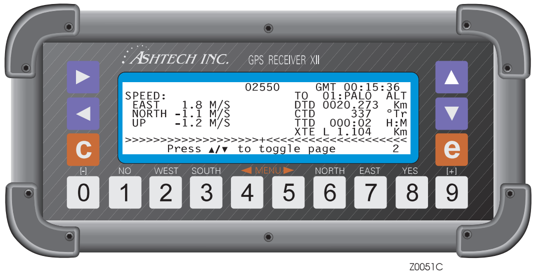


Figure 4.4: Navigation Information Screen (Page 2)

Table 4.4: Navigation Information Functions (Screen 2, Page 2)

Component	Function
SPEED	Speed Over Ground (SOG); displayed in east, north, and up (ENU) components.
TO	Displays the name and number of the TO waypoint, or destination waypoint. Waypoint functions are specified on Screen 6, **Waypoint Control**.
DTD	Distance To Destination. The distance from your present position to the TO waypoint.
CTD	Course To Destination. The course to follow from the present position to the TO waypoint displayed in either true degrees (°Tr) or magnetic.
TTD	Time To Destination. Estimate based on present SOG of the time it will take to reach the destination; measured in hours and minutes (H:M).
XTE	Cross-track Error. A perpindicular measurement of the distance between your present position and the intended track, or course, from the starting position to the the destination. R indicates that the error is to the right of the track; L indicates that the error is to the left of the track. The deviation is measured in kilometers (KM) or miles (MI).
»»»+«««	A graphical representation of the magnitude of the Cross-track Error.

Screen 3: Tracking Information

Screen 3 provides a graphical representation of the data recorded for each tracked satellite.

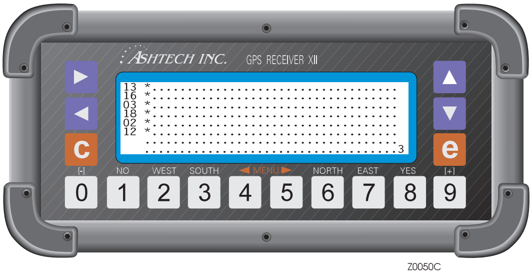


Figure 4.5: Tracking Information Screen

The satellite numbers are displayed in the first column on the left of the screen in the order in which they were acquired. The remaining columns contain dot and star symbols; these symbols are described in Table 4.5. Each symbol represents 5 minutes. The individual columns are partitioned into video/reverse video columns for easy reading. Each partition represents 30 minutes. The maximum display capacity is 180 minutes (3 hours).

Table 4.5: Tracking Information Symbols

Component	Function
dot	Means no data was recorded for that satellite.
star	Means data was recorded for that satellite.

Screen 3 is for display only; no data can be entered.

Screen 4: Mode Control

Screen 4 provides access to the majority of the configuration and parameter settings supported by the Z-12R. Reference position, data recording interval, minimum SVs, and elevation mask can all be set in Screen 4. In addition, there are thirteen sub-screens controlling a host of other parameters, including position fix parameters, differential modes, session programming, receiver control, serial port output, external frequency input, pulse generation, datum selection, modem setup, and system commands.

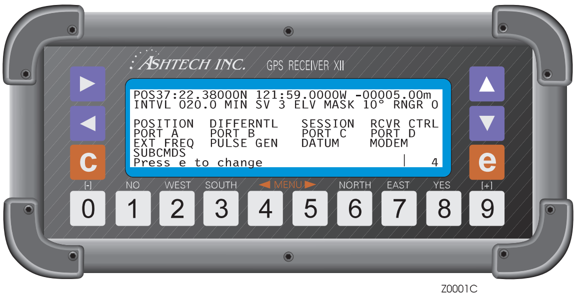


Figure 4.6: Mode Control Screen

Receiver parameters are preset to default values. To change a parameter setting, press [**e**] to shift to data-entry mode. Use the arrow keys to highlight the appropriate field. Besides entering numbers, the numeral keys are also used to enter values such as [**6**] for north or [**8**] for yes. Press [**e**] again to save any new settings.

To clear an altered value, push the [**c**] key. The receiver ignores any changes made since you last pushed the [**e**] key.

To open a receiver-option subscreen, press [**e**] and use the arrow keys to highlight the desired option. Press [**e**] again to open the sub-screen. The sub-screens are labeled as shown below:

- POSITION
- DIFFERNTL
- SESSION
- RCVR CTRL
- PORT A
- PORT B
- PORT C
- PORT D
- EXT FREQ
- PULSE GEN
- DATUM
- MODEM
- SUBCMDS

Receiver Control Parameters

Table 4.6: Receiver Control Parameters Functions

Component	Function
(POSITION)	The entire first row of Screen 4 is occupied by the coordinates of the Z-12R's antenna (latitude, longitude, altitude referenced to the WGS-84 ellipsoid). The first row is not labeled. Use the numeral keys to enter the coordinates, typing zero where necessary. When a field is full, the cursor automatically jumps to the next one. During routine surveying, it is not necessary to enter a position because a pseudo-range position is automatically calculated and displayed on screen 2. Entering a position is necessary only when the receiver is operating in differential base mode, in which case a surveyed reference position must be entered in this row.
INTVL	Recording interval. The value shown in this field specifies how frequently raw data is recorded into memory. The default interval is 20.0 seconds. Press [**e**] to go to data entry mode and use the arrow keys to highlight the INTVL field. Use the numeral keys to enter the desired interval. A setting of 10 seconds ([**0**] [**1**] [**0**]**)** is commonly used in kinematic surveying. • Make sure the recording interval is set correctly before starting the survey. This setting should not be changed once data collection has begun. Data can be recorded at any half-second interval (0.5, 5.5, 10.5). Other subsecond intervals are not allowed.
MIN SV	Sets the minimum number of satellites with valid ephemerides that need to be locked before data recording can begin. The default setting is3.
ELV MASK	Sets the minimum elevation angle for the acceptance of satellite data. The default setting is 10°. To change the angle, press [**e**] to activate the data entry mode and use the arrrow keys to highlight ELV MASK. Use the numeral keys to enter the desired setting. For surveying, data is collected from all satellites above 10°; typically the cut-off angle is further limited only during post-processing. This elevation mask setting controls data recording only. For details on parameters for position computation, see Screen 4, Position submenu.
RNGR	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 only in real time; they cannot be post-processed differentially.

Receiver Configuration Menus

Table 4.7 below contains brief descriptions for each of the sub-screens found in Screen 4. Some of the sub-screens, such as EXT FREQ, are optional and are displayed only when the option has been installed in the receiver. The sub-screens are described in the order shown on the screen in Figure 4.6, taken left-to-right, top-to-bottom.

Table 4.7: Receiver Options

Component	Function
POSITION	The **POSITION FIX PARAMETERS** subscreen allows you to specify criteria for position computation, including settings for DOP masks, altitude mode, etc.
DIFFERNTL	The **DIFFERENTIAL MODE SELECTION** sub-screen is available only if the differential option has been installed. This sub-screen allows you to set various differential GPS parameters, including differential mode, the port used for output or input of differential corrections, etc.
SESSION	The Session Programming subscreen allows you to program up to 10 data-recording sessions. You can specify the start and end times, the day on which the data will be collected, the data recording interval, the type of data files that will be collected, etc.
RCVR CTRL	The **RECEIVER CONTROL MENU** sub-screen sets special receiver parameters.
PORT A PORT B PORT C PORT D	These subscreens allow you to specify serial port output parameters. Settings and options for serial port output are described in detail in Chapter 5, **Serial Port Output Options**.
EXT FREQ	The **EXTERNAL FREQUENCY SETUP** sub-screen is available only if the external frequency (x) option has been installed. This sub-screen allows you to set parameters for external frequency input, .
PULSE GEN	The **PULSE GENERATION PARAMETERS** sub-screen allows you to activate and control the output of a timing pulse. This feature is typically used in photogrammetry.
DATUM SELECT	The **DATUM SELECTION** sub-screen contains a list of 46 datums and includes a sub-screen for entering a user-defined datum. Positions shown on Screen 2 will be rendered according to the selected datum, but position data stored in memory is referenced to WGS-84.
MODEM SETUP	The **MODEM SETUP MENU** sub-screen allows you to select and configure a receiver serial port for communication with a modem.
SUBCMDS	This sub-screen allows you to enter system-level commands. These same commands can also be entered in Screen 8.

Position Fix Parameters

Press [**e**] and use the arrow keys to highlight POSITION. Press [**e**] again to open the **POSITION FIX PARAMETERS** sub-screen. This sub-screen allows you to specify position computation criteria (stored and displayed), such as how many satellites to use, whether to hold altitude fixed, Dilution of Precision (DOP) masks, elevation mask, and whether unhealthy satellites are used. It also allows your to activate the ionospheric model or to compute positions in UTM coordinates.

Figure 4.7: Position Fix Parameters Screen

Use the arrow keys to highlight the desired parameter. Use the numeral keys to enter numbers, typing zero where necessary; use the [**1**] and [**8**] keys to change **Y**es/**N**o settings. When a field is full, the cursor automatically jumps to the next one. Position fix parameters are described in Table 4.8. Press [**e**] to save the new settings and return to Screen 4.

Table 4.8: Position Fix Parameters

Component	Function
POS MODE	Specifies whether to compute altitude or hold it fixed. The choices are 0 - 3. To be used in the position computation, a satellite must be higher than the ELV MASK value specified on this subscreen. 0. Specifies that at least 4 satellites must be tracked before the receiver will compute position. Altitude is never held fixed (default). The following POS MODE settings require a minimum of three satellites to compute position: 1. When three satellites are locked, altitude is held fixed. When more than three are locked, altitude is computed. 2. Altitude is always held fixed regardless of the number of satellites tracked. 3. When three satellites are locked, altitude is held fixed. When more than 3 are locked and HDOP is less than the specified HDOP MASK value, altitude is computed. When more than three satellites are locked and HDOP is equal to or greater than the specified HDOP MASK, altitude is held fixed. When the receiver is first turned on, the altitude is zero. If position mode is set to a value of 1, 2, or 3, an altitude value must be entered in the POSITION row on Screen 4.
ALT MODE	Specifies which altitude is used in an altitude-fixed position solution. The choices are 0 or 1. 0. Uses last entered altitude or last altitude computed if it was computed with VDOP less than the specified VDOP MASK value, depending on which altitude is the most recent. 1. Uses only the altitude entered on Screen 4.
ELV MASK	Sets the minimum elevation angle above which a satellite will be used in the position computation. A satellite falling below this minimum angle is not used in the position computation.
PDOP MASK	Sets the Position Dilution of Precision parameter. The receiver will stop computing positions when PDOP exceeds the specified value. The default is 40.
HDOP MASK	Sets the Horizontal Dilution of Precision parameter. Effective only when POSITION MODE is set to 3. The default setting is 4.
VDOP MASK	Sets the Vertical Dilution of Precision parameter. Effective only when ALT MODE is set to 0. The default setting is 4.
UNHLTHY	Specifies whether or not to use unhealthy satellites in the position computation. If Y is specified, a satellite broadcasting an unhealthy message is used as long as its elevation is above the elevation mask setting. This parameter in no way affects data collection for an unhealthy satellite. Responding N (the default) will not stop the receiver from logging satellite data from an unhealthy satellite. The receiver is programmed to record data from all tracked satellites broadcasting valid ephemerides. (There may be times when data from an "unhealthy" satellite will not be recorded, such as when a satellite is broadcasting invalid orbit data).
ION MODEL	Enables or disables the use of ionospheric and tropospheric models in position computation. The default setting is **N**.

Table 4.8: Position Fix Parameters (continued)

Component	Function
POS COMP	Enables or disables computation of position. The default setting is **Y**.
UTM COORD	Positions in Screen 2 are displayed in UTM coordinates (east, north) instead of geodetic coordinates (lat, lon) when this field is set to **Y**. The default setting is **N**. This parameter does not affect data collection.

Differential Mode Selection

Press [**e**] and use the arrow keys to highlight DIFFERNTL. Press [**e**] again to open the **DIFFERENTIAL MODE SELECTION** sub-screen as shown in Figure 4.8. This sub-screen allows you to set the receiver for differential operation, and also provides access to lower-level screens to specify parameters for RTCM message output. The setup parameters are described in Table 4.9. Press [**e**] to save the new settings and return to Screen 4. This sub-screen is not available unless the Differential (D) option is installed.

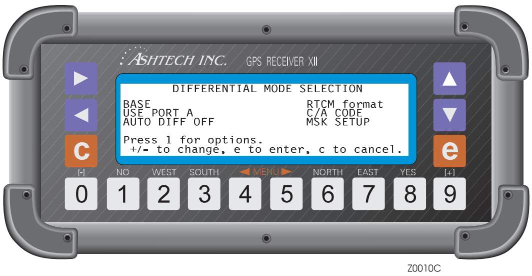


Figure 4.8: Differential Mode Selection Screen

Table 4.9: Differential Mode Selection Parameters

Component	Function
MODE	Sets the differential mode. Choices are **BASE**, **REMOTE**, or **DISABLED**. Use the arrow keys to highlight this field and and press the [**+**] or [**-**] key to toggle to the desired setting. For a reference station, select **BASE**. For user equipment, select **REMOTE**. Select **DISABLED** to turn off differential operation.
RTCM format	With this field highlighted, press the [**1**] key to open the **RTCM OPTIONS MENU.** See Chapter 3, **Real-Time Differential**, for a detailed description of the setting options in this sub-screen.

Table 4.9: Differential Mode Selection Parameters (continued)

Component	Function
USE PORT A	Specifies which port to use for output or input of differential corrections. Choices are **PORT A** - **PORT D** and **NONE**. Press the [**+**] or [**-**] key to toggle to the desired selection. The default is NONE [**e**] to save. Default is NONE. When the Z-12R is transmitting corrections only with the MSK port, set the port to **NONE**.
C/A CODE	Specifies whether standard C/A code RTCM differential or L1 P-code RTCM differential is used. Press [**+**] or [**-**] to toggle to the desired selection. This setting applies only to BASE mode. When L1 P-code is selected, a type 10 message is generated for P-code differential corrections, instead of the type 1 for C/A code differential correction. Both messages have the same format.
AUTO DIFF OFF	Enables or disables auto differential. If set to **ON**, the receiver automatically switches position computation from differential to stand-alone mode when the maximum age of the differential corrections is exceeded, and from stand-alone to differential when corrections resume. The default setting is **OFF**.
MSK SETUP	When this field is highlighted, press [**1**] to open the **MSK SETUP MENU**. This menu allows you to configure parameters for the radio beacon interface. Refer to Chapter 3, **Real-Time Differential**, for a detailed description of the options in this sub-screen.

Session Programming Parameters

The session programming feature allows you to pre-set up to 10 observation sessions in the receiver. This option is useful in running routine data collection tasks and is particularly useful when used with the Remote Monitor program. Using the Remote Monitor program with 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. For details, see the REMOTE.EXE module of the GPS Post-processing System Manual.

Press the [**e**] key to activate the data entry mode and use the arrow keys to highlight **SESSION**. Press [**e**] again to open the session programming screen as shown in Figure 4.9.

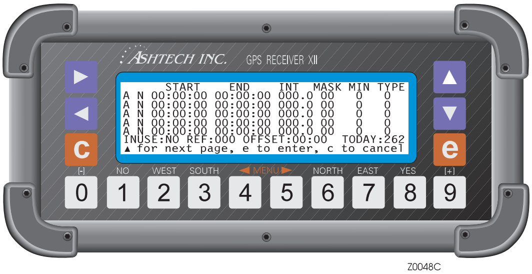


Figure 4.9: Session Program Parameters Screen

Table 4.10 contains descriptions of the session programming parameters. The first column on the left contains the session identifier. Ten sessions (A - J) can be programmed.

The second column is an activation toggle for an individual session. If it is set to **Y**, the session programmed on this line is activated. If it is set to N, the session is inactive. Use the [**8**] and [**1**] keys to toggle **Y** or **N**. Press [**e**] to save the new settings and return to Screen 4.

Sessions are activated only when the INUSE field is also set to Y; see Table 4.10 below.

Table 4.10: Session Programming Parameters

Component	Function
START	Sets the session start time in hours, minutes, and seconds. If an erroneous value is entered, such as 25 hours, this field is either reset to 0 or restored with the most recent legal entry.
END	Sets the session end time here. If the end time is earlier than the start time, the session runs into the following day.
INT	Sets the data recording interval (seconds) for the session. Values between 000.5 and 999.5 seconds are accepted in ½-second increments. If the ¼-second recording option is available, setting **INT** to 999 sets the sampling rate to ¼ second.
MASK	Sets the satellite elevation mask (degrees) for the session.
MIN	Sets the minimum number of satellites that must be above elevation mask before the session begins collecting data. Values for **INT**, **MASK**, and **MIN** set in this sub-screen override the values set in Screen 4 while the session is running. These values are displayed in Screen 4 when the session goes active.

Table 4.10: Session Programming Parameters (continued)

Component	Function
TYPE	Refers to the data type to be collected. Enter 0 for normal geodetic data. See the "Receiver Control Parameters" on page 37, for definitions of data type.
INUSE	The master switch for all sessions. If it is set to **NO**, no programmed session runs, regardless of its individual settings. **YES** activates any sessions where the individual session toggle is set to Y. Use the [**+**] or [**-**] keys to toggle **YES** or **NO**. Whenever this switch is set to **Y**, the active file is closed, a new file is opened, and the **SESSION** field flashes, indicating that session programming is enabled. When a session goes active, a flashing arrow is displayed next to **SESSION** on Screen 4, indicating that 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 current day, applying the entered **OFFSET** value explained below.
OFFSET	This setting is typically used to ensure that each session observes the same satellite window, or to ensure, for the sake of comparison, that each session observes the same satellite window as was observed in some other data collection session. The GPS window advances by 4 minutes each day. In order to observe the same satellite window, the start time of each session must be set 4 minutes earlier than the start time of the session from the preceding day. The start and end times are decremented by the minutes and seconds specified in **OFFSET** and multiplied by the day number. For example, if the offset is 04:00, and if the **REF** day for day 1 is equal to the day shown in the **TODAY** field, then day 1 is offset 0 minutes, day 2 is offset 4 minutes, day 3 is offset 8 minutes, day 4 is offset 12 minutes, etc. If the offset is 04:00, the **REF** day is 100, and **TODAY** is 104, then day 1 is offset 16 minutes, day 2 is offset 20 minutes, day 3 is offset 24 minutes, etc. If set to 00:00, the sessions are opened and closed according to the entered start and end times with no offset applied.
TODAY	Shows the current day. This field cannot be edited.

Receiver Control Subscreen

Press [**e**] and use the arrow keys to highlight RCVR CTRL. Press [**e**] again to open the RECEIVER CONTROL Menu sub-screen as shown in Figure 4.10. This sub-screen sets the operating mode of the receiver. When Z-mode is set to A, the receiver automatically switches from P-mode to Z-mode when A/S is activated and back to P-mode when A/S is turned off. When set to Y it forces the receiver to stay in Z-mode for all SVs, and when set to N it forces the receiver to stay in P-mode for all SVs.

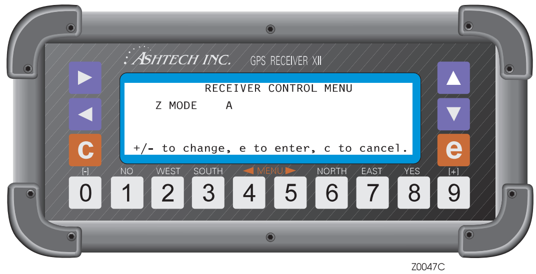


Figure 4.10: Receiver Control Screen

Serial Port Setting

One RS-232 serial port (Port A) and three RS-422 serial ports (Ports B, C, and D) are available on the rear panel of the Z-12R. Pin assignments for the RS-232 and RS-422 cables used to connect to the serial ports on the rear panel of the Z-12R are described in Chapter 9, **Maintenance**.

All ports can output real-time (raw) messages, NMEA messages, and VTS messages. All ports can accept serial port commands, hose data, and send or receive differential corrections. The following descriptions of the screens and settings are referenced to Port A.

Press [**e**] and use the arrow keys to highlight **PORT A**. Press [**e**] again to open the **Port A Parameter Selection** sub-screen shown in Figure 4.11. Use the same steps to open sub-screens for the other serial ports. After setting the desired parameters, press [**e**] to save the new settings and return to Screen 4.

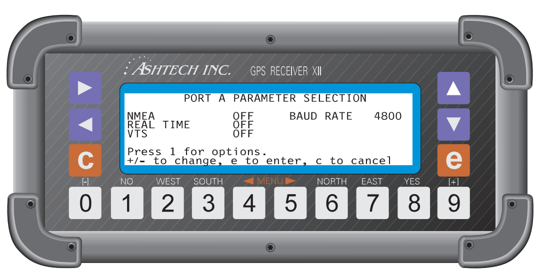


Figure 4.11: Port A Parameter Selection Sub-screen

"Press 1 for options" is displayed when an additional sub-screen is linked to an option field. For example, with the NMEA field highlighted, pressing the [**1**] key opens the **NMEA OPTIONS MENU** sub-screen. The elements in this screen are described in Table 4.11.

Table 4.11: Serial Port Setting

Component	Function
NMEA	Enables or disables NMEA message output. The default setting is **OFF**. Use the arrow keys to highlight NMEA and press the [**+**] or [**-**] key to toggle it **ON** or **OFF**. When set to **ON**, any messages turned on in the **NMEA OPTIONS MENU** sub-screen will be output from the associated port at the selected interval. Refer to Chapter 5, **Serial Port Output Options**, for a list and descriptions of the available NMEA messages and details on selecting NMEA messages for output.
BAUD RATE	Sets the baud rate for serial port output. The default setting is 9600 bits per second (bps). To change this setting, use the arrow keys to highlight **BAUD RATE** and press the [**+**] or [**-**] key to toggle to the desired rate. Choices are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps.
REAL TIME	Enables or disables real-time message output. The default setting is **OFF**. Use the arrow keys to highlight **REAL TIME** and press the [**+**] or [**-**] key to toggle it **ON** or **OFF**. When set to **ON**, any messages turned on in the **MEASUREMENTS OUTPUT ON PORT A** sub-screen will be output according to the **INTVL** setting on Screen 4. Refer to Chapter 5, **Serial Port Output Options**, for descriptions of real-time messages and details on selecting real-time messages for output.
VTS	Enables or disables the output of position messages designed for the VTS (Vehicle Tracking System) option. The default setting is **OFF**. Use the arrow keys to highlight VTS and press the [**+**] or [**-**] key to toggle to the desired selection. Choices are **OFF**, **.3**, and **.4**. Selecting **.3** outputs latitude/longitude to 1/1,000 of a minute from the associated port; selecting **.4** outputs latitude/longitude down to 1/10,000 of a minute from the associated port.

External Frequency Setup

This sub-screen is not available unless the external frequency option (X) is installed. Press [**e**] and use the arrow keys to highlight **EXT FREQ**. Press [**e**] again to open the **EXTERNAL FREQUENCY SETUP** sub-screen (Figure 4.12). This sub-screen allows you to set parameters for input of an external frequency reference. An external frequency reference is used to synchronize receiver data with more precision than can be achieved by the Z-12R's internal oscillator.

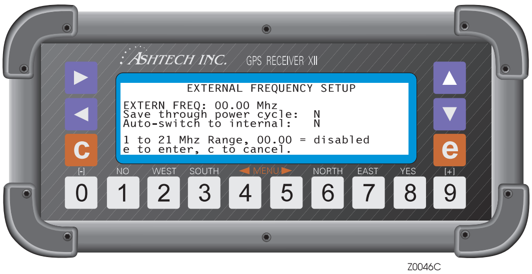


Figure 4.12: External Frequency Setup Screen

The setup parameters are described below in Table 4.12. After setting the parameters, press [**e**] to save the new settings and return to Screen 4. Activation of this function disables the Z-12R's internal oscillator. Interface specifications for external frequency input are shown in Table 4.13.

Table 4.12: External Frequency Parameter Settings

Component	Function
EXTERNAL FREQUENCY	Sets the value of the external frequency input. Use the arrow keys to highlight this field. The setting range is 00.00 - 21.00 MHz, incremented in 10-Khz steps. The default setting is 00.00 MHz. Enter 00.00 to disable the external frequency reference. When the external reference is switched off, receiver data synchronization reverts back to the internal oscillator (TXCO).

Screen Operations

Table 4.12: External Frequency Parameter Settings (continued)

Component	Function
SAVE THROUGH POWER CYCLE	Determines whether external frequency parameters are saved through a power cycle. Use the arrow keys to highlight this field. Pressing [**8**] changes this field to **Y**, indicating that parameters will be saved. Pressing [**1**] changes this field to **N**, indicating that parameters will not be saved. The default setting is **N**. When set to **N**, receiver data synchronization reverts back to the internal oscillator after a power cycle.
AUTO-SWITCH	Determines whether the receiver automatically reverts back data synchronization through its internal oscillator if external frequency lock is lost. Use the arrow keys to highlight this field. Pressing [**8**] changes this field to **Y**, indicating that data synchronization will revert back to the internal oscillator if the receiver loses lock on the external frequency. Pressing [**1**] changes this field to **N**. With **AUTO-SWITCH** set to **N**, if lock to the external frequency source is lost, the unit beeps, and a status screen is displayed on the receiver. This indicates that the receiver has either lost lock on the reference frequency, the frequency is out of range, or that power to the external frequency source has been interrupted. The receiver will not switch back to the internal oscillator. Lock range and other interface specifications are listed in the following table.

Table 4.13: External Frequency Interface Specifications

Parameter	Specification
Input Z	50 ohms
Freq range	1 MHz to 21 MHz in 10-kHz steps
Lock range	± 5 ppm
Amplitude	0.7 to 3 V RMS into 50 ohms
Loop bw	≈ 10 Hz
Power	<100 mW , ≈ 60 mW standby

Pulse Generation Parameters

Press [**e**] and use the arrow keys to highlight **PULSE GEN**. Press [**e**] again to open the **PULSE GENERATION PARAMETERS** sub-screen as shown in Figure 4.13. This sub-screen allows you to set period and offset parameters for a timing pulse output which is synchronized with GPS time. Press [**e**] to save the new settings and return to Screen 4.

The timing pulse is a TTL signal with 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. A BNC connector labeled 1 PPS on the rear panel of the Z-12R is the primary output port for the timing signal. A 1 pulse per second timing signal can also be output from any of the four serial ports, but its parameters cannot be adjusted as can the parameters for the timing pulse that is emitted from the BNC connector.

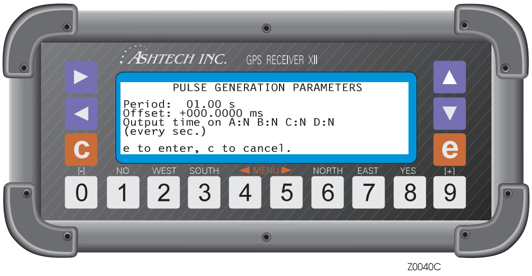


Figure 4.13: Pulse Generation Parameters Screen

Period

When using the BNC connector on the rear panel labeled **1 PPS** for timing pulse output, the period between pulses may be set from a half second up to a maximum of 60 seconds. The default setting is 1 second. When outputting the timing pulse from one of the serial connectors, the timing signal is set to 1 pulse per second and the period cannot be adjusted.

Aligning the Pulse

If system command 990 is issued in the **SUBCMDS** sub-screen, the falling edge of the pulse is synchronized with GPS time. If command 991 is issued, the rising edge is synchronized with GPS time. See Table 4.16 for more information on system commands.

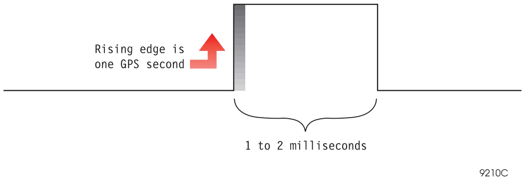


Figure 4.14: Rising Edge Pulse Alignment

Offsetting the Pulse

When outputting the timing pulse from the BNC connector on the rear panel labeled **1 PPS**, the pulse may be advanced or delayed up to 500 ms in 100-nanosecond steps. Press the [**+**] to advance the pulse; use the [**-**] to retard the pulse. The pulse cannot be advanced or delayed when being output from a serial port. Timing pulse accuracy is listed in the following table.

Table 4.14: Timing Pulse Accuracy

Mode	SA On	SA Off
Stand-alone	300-1000 ns	100 ns
Differential	50 ns	50 ns

Output Time on A:N B:N C:N D:N:

A time message synchronized with GPS time can be output every second through serial port A (the rising edge of the pulse is also synchronized with GPS time). The format of the message is shown below, where *dddddd* is time of the week in seconds:

$PASHR,PPS,dddddd

Datum Select Subscreen

Press [**e**] and use the arrow keys to highlight **DATUM**. Press [**e**] again to open the **DATUM SELECT** subscreen as shown in Figure 4.15. This sub-screen allows you to choose a datum from 49 pre-defined datums, or use the **USER DATUM ENTRY** sub-screen to define your own datum. Use the arrow keys to highlight the desired datum. After selecting a datum, press [**e**] again to save the new settings and return to Screen 4. The default datum is WGS-84. Positions on Screen 2 are displayed in accordance with the selected datum. The datum selection also affects NMEA message output. NMEA position messages, such as GLL and GGA, are output with their positions rendered according to the selected datum. Positions stored in memory are always referenced to the WGS-84 datum.

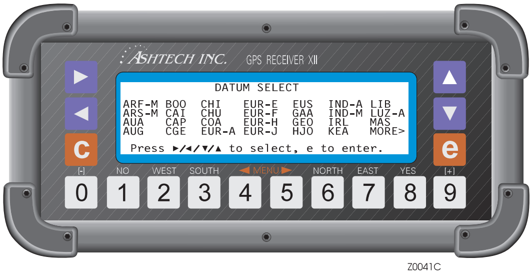


Figure 4.15: Datum Select Sub-screen

If the desired datum does not appear on the first subscreen, use the arrow keys to highlight **MORE** and press the [**e**] key to open another datum sub-screen.

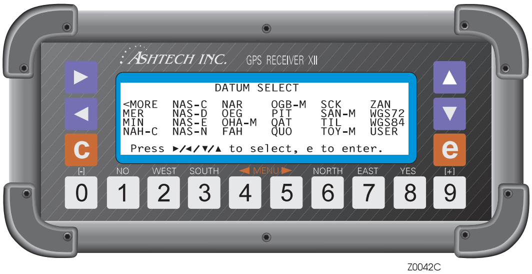


Figure 4.16: DATUM Select Screen - More Datums

User-Defined Datum

This screen allows you to input your own datum parameters. After selecting the USER datum, the following subscreen appears:

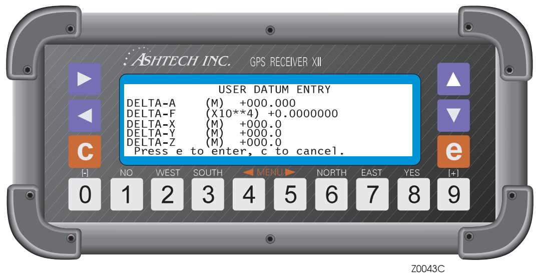


Figure 4.17: User Datum Entry Screen

Follow the steps below to enter a user datum:

1. On Screen 4, press the [**e**] key to shift to data-entry mode.
2. Highlight DATUM and press [**e**].
3. Highlight the MORE option and press [**e**].
4. Highlight the USER option and press [**e**].
5. Use the number keys to enter values in each field. Define the following:
   - Delta axis or delta flattening parameters that are available.
   - Delta -x, y, or z parameters that are available.
6. Press [**e**] to save the new datum parameters and return to Screen 4.

Check the selection by returning to Screen 2. The title of the selected datum (in this case, USER) is displayed above the row containing the latitude of the position.

Modem Setup Menu

Press [**e**] and use the arrow keys to highlight MODEM. Press [**e**] again to open the **MODEM SETUP MENU** sub-screen as shown in Figure 4.18. This sub-screen allows you to set modem interface parameters for remote operation (Table 4.15).

After selecting the desired serial port and modem type, press [e] to save the new settings and return to Screen 4.

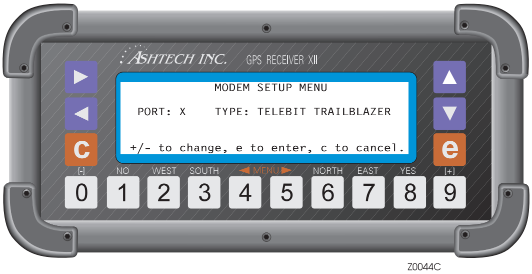


Figure 4.18: Modem Setup Sub-screen

Table 4.15: Modem Setup Subscreen

Component	Function
PORT	Sets the port through which data will be transmitted to the modem. Press the [+] or [-] key to toggle to A or B. Serial ports C and D are not set to initialize a modem.
TYPE	Sets the modem type. Choices are the Telebit® Worldblazer, Trailblazer, Cellblazer, and user-defined. To input the initialization string for the user-defined modem, hightlight **TYPE** and press the [+] or [-] keys to toggle to **USER DEFINED**. Push the down arrow key to open the modem initialization string. Use the up arrow key to cycle through the character sets and use the corresponding numeral keys to enter the desired characters. Press [e] to save the new settings and return to Screen 4.

Subcommands

Press [e] and use the arrow keys to highlight SUBCMDS. Press [e] again to open the Subcommands sub-screen. This sub-screen allows you to enter system-level commands that control functions such as display backlighting, modem initialization, and DGPS initialization. These system-level commands can also be entered in Screen 8 (Figure 4.38).

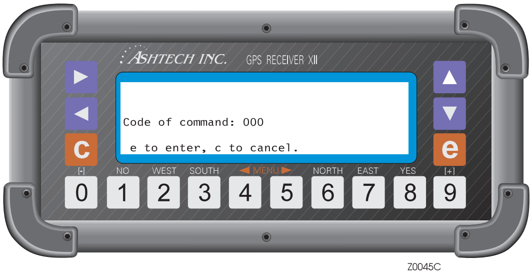


Figure 4.19: Subcommands Sub-screen

Table 4.16 below contains descriptions of the available system commands. Use the numeral keys to enter the desired command. Press [**e**] to save the command and return to Screen 4. Refer to Screen 8, System Control, for more information on System Commands.

Table 4.16: System-Level Commands

Component	Function
100	Turns off backlighting after two minutes have elapsed since last key press. This is the default setting.
101	Keeps backlighting on. **Warning**: The receiver draws significantly more power when the backlighting remains on!
123	Closes the active file.
191	Initializes the modem.
550	Resets the receiver to the original default values.
555	Saves user-entered parameters.
737	Initializes (resets) RTCM.
888	Displays Z-12R configuration data, such as serial number, option list, nav board and channel board firmware version numbers, etc.
990	Causes the falling edge of the timing pulse to be synchronized with GPS time.
991	Causes the rising edge of the timing pulse to be synchronized with GPS time.

Screen 5: Differential Information

This screen contains two pages. Page 1 displays differential information. Page 2 displays information for range residuals and position error. Press the ▲ or ▼ keys to toggle between the pages.

The differential mode (set in the DIFFERNTL sub-screen in Screen 4) determines what information is shown on Page 1 of Screen 5. You must know whether the receiver is set in BASE or REMOTE mode in order to interpret the displayed information.

Page 2, the range residual and position error screen, displays the range residual for each satellite (the difference between the measured and the calculated range), along with the horizontal and vertical position errors.

RTCM Information

The RTCM information displayed on Screen 5 (Figure 4.20) differs depending on whether the unit is set in base or remote mode. In base mode, information about transmitted messages is displayed; in remote mode, information about the received messages is displayed. The elements displayed in this screen are described in Table 4.17 below

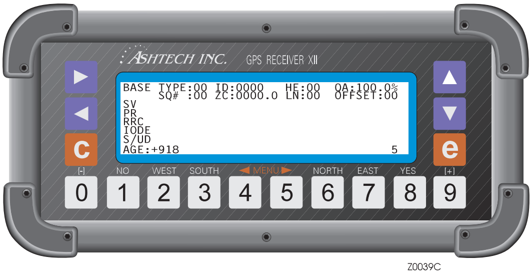


Figure 4.20: RTCM Information Screen

Table 4.17: RTCM Screen: Page 1

Component	Function
TYPE	Indicates the type of message to be generated or that is being received.
STID	The reference station identification number set on the RTCM Options screen (base mode) or received from the base station.

Table 4.17: RTCM Screen: Page 1 (continued)

Component	Function
STHE	Base station health status. Health status is set on the RTCM Options screen or computed based on UDRE values or ones received from the base station. Refer to Chapter 3, **Real-Time Differential**.
SYNC	Indicates whether the receiver is synchronous with a message. An asterisk indicates that the receiver 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 RTCM message sequence number, which is generated by the base station and received by the remote unit.
ZCNT	The Z-count of the RTCM message.
FLEN	The RTCM message frame length.
PRN	The satellite PRN numbers.
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 for the ephemeris.
S/UD	The scale factor and user-differential range error.
AGE	In remote mode, shows the age of received messages in seconds for each satellite. In base mode, gives the time elapsed in seconds since the beginning of the transmission of a type 1 or 9 message until a new type 1 or 9 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 & Position Error

Page 2 of Screen 5 displays values for the range residuals and position errors determined during position computation.

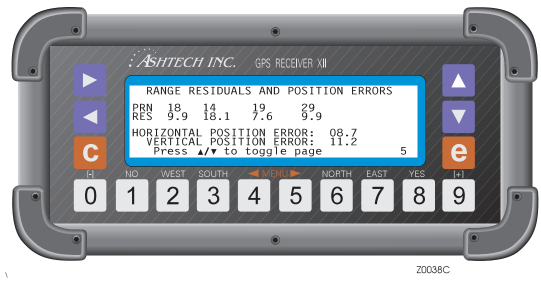


Figure 4.21: Range Residuals and Position Errors Screen

Table 4.18: Range Residuals and Position Errors Keys

Component	Function
PRN	PRN numbers of satellites being tracked.
RES	Range residual associated with each satellite.
HORIZONTAL/VERTICAL POSITION ERROR	Horizontal/vertical RMS position error in meters.

Screen 6: Route & Waypoint Control

Screen 6 displays route and waypoint information, and also allows you to set parameters for route and waypoint functions. You can create waypoints using three different methods. A maximum of 20 waypoints can be strung together to form a route; up to ten routes can be stored in memory. Knowing the coordinates of each point in the route, the receiver can compute the distance between the present position and the next destination point (DTD), the course to follow to reach the next destinatiot (CTD), the time it will take 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. Navigation information is displayed in screen 2, Page 2.

The first line of Screen 6 shows route information in terms of waypoint numbers, and the leg of the route currently being followed is highlighted. The waypoints in the route are displayed in the rows below the first line, one waypoin per row. Each waypoint record consists of a two-digit waypoint number, a seven character name, a latitude, and a longitude. Coordinates are entered in degrees, minutes, decimal minutes. Up to 99 waypoints can be stored in memory.

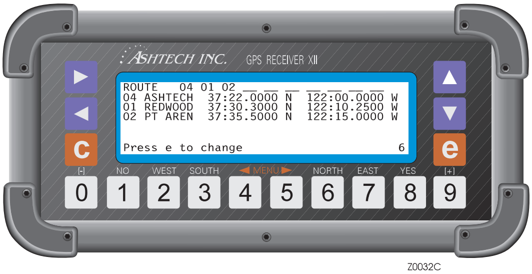


Figure 4.22: Waypoint Control Screen

If no route has been created, Screen 6 displays a route with only waypoint (01), and the list of records shows waypoint 01 with no name and coordinates containing all zeroes.

A sub-screen under Screen 6 contains a menu in which you can set parameters for a variety of waypoint and route functions. Press [**e**] to open this sub-screen (Figure 4.23):

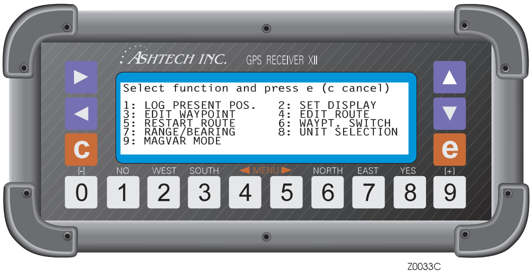


Figure 4.23: Submenu Screen

All but one of the menu items have sub-screens attached to them. Use the arrow keys to highlight a given menu item and press the [**1**] key or the [**e**] key to open the corresponding sub-screen. The sub-screens for items 2, 5, and 6 are opened by pressing **[1]**.

The two main functions within this menu are: **4: EDIT ROUTE** and **3: EDIT WAYPOINT**. EDIT ROUTE allows you to create a route or edit an existing route by adding or deleting waypoints. EDIT WAYPOINT allows you to create waypoints or edit existing waypoints records, whether associated with a route or not.

LOG Present POS

This function saves the present location as a waypoint. There is no sub-screen associated with this function. When you select **1: LOG PRESENT POS**, the receiver records its current latitude and longitude in the next available slot in waypoint memory and names it HERE_XX, where XX is the next sequential number starting with 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 to acknowledge it was stored. The next time screen 6 is opened, the first waypoint line shows the first waypoint of the route.

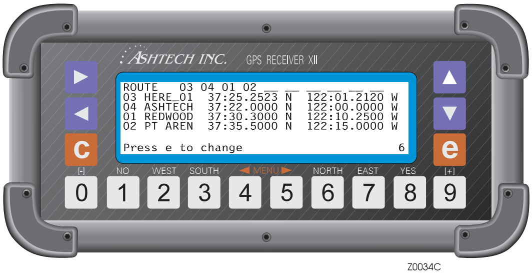


Figure 4.24: First Waypoint of Route Screen

Set Display

This function specifies whether the list of records displayed in Screen 6 are the list of waypoints that make the route, or a specific set of selected waypoints. Use the arrow keys to highlight **2: SET DISPLAY** and press **[1]** to open the **DISPLAY UPDATE MODE** sub-screen as shown in Figure 4.25 below:

Screen Operations

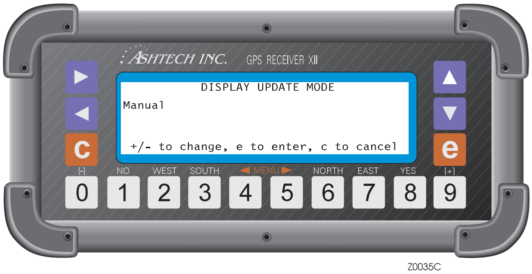


Figure 4.25: Display Update Mode Screen

Press [**+**] or [**-**] to toggle between **MANUAL** and **AUTOMATIC**. When the AUTOMATIC is selected, the list of records of the current and next waypoints in the route is displayed on Screen 6. The default setting is AUTOMATIC. If MANUAL is selected, a set of user-selected waypoints is displayed on Screen 6. Press [**e**] to save the selection and return to the menu.

Follow the steps below to define the set of waypoints displayed when MANUAL mode is selected:

1. Use the arrow keys to highlight **2: SET DISPLAY** and press [**e**]. A simulation of Screen 6 without the route appears.

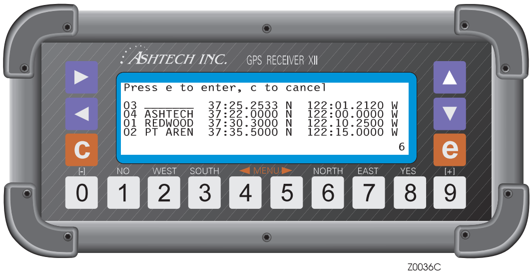


Figure 4.26: Without Route Screen

2. The entry number of the first record is highlighted. Use the ▲▼ keys to scroll through the list until the desired waypoint is found. You can also use the numeral keys to call a waypoint by its number.Use the ▶ key to select the next waypoint.
3. Continue selecting waypoints until your list is complete.
4. Press [**e**] to return to Screen 6 and view the newly selected waypoints.

To once again display waypoints from the current route, return to the sub-screen under **2: SET DISPLAY** and select **AUTOMATIC**.

Edit Waypoint

This function allows you to create new waypoints or edit existing waypoints. Use the arrow keys to highlight **3: EDIT WAYPOINT** and press [**e**] to open the corresponding sub-screen as shown in Figure 4.27 below:

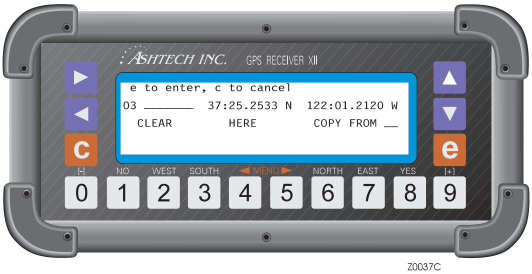


Figure 4.27: Edit Waypoint Screen

Follow the steps below to enter a new waypoint or edit an existing waypoint:

1. Use the ◀▶ keys to highlight the waypoint number field. Use the ▲▼ keys to cycle through the waypoint numbers until the desired waypoint is displayed, or enter a waypoint number to call a specific waypoint.
2. Press the ▶ key to move the cursor to the name field to enter a name for a new waypoint or edit the name of an existing waypoint. Use the ▲▼ keys to cycle through the character sets; press the corresponding numeral keys to enter the desired characters.
3. Use the ▶ key to move to the next field and enter latitude and longitude for the new waypoint or overwrite the coordinates of an existing waypoint (including N or S) and the longitude (including E or W). The cursor will automatically move to the right after a character is entered. Press [**e**] to save the waypoint information. The ▼▲ keys move the cursor from one field to the other; the ◀▶ keys move the cursor from one character to the other.

The EDIT WAYPOINT sub-screen supports three additional functions: **CLEAR**, **HERE**, and **COPY FROM**.

The CLEAR function clears the information in a single waypoint. Follow the steps below to clear a waypoint:

Screen Operations

1. Use the ◀▶ keys to highlight the waypoint number field. Use the ▲▼ keys to cycle through the waypoint numbers until the desired waypoint is displayed, or enter a waypoint number to call a specific waypoint.
2. Use the arrow keys to highlight the CLEAR field and press [e]. The waypoint name is cleared and the latitude/ longitude coordinates are replaced with zeroes.
3. A new waypoint can be entered or the slot can be left empty. Press [e] to save the changes and return to the menu.
4. Press [e] to return to the Screen 6.

The HERE function logs the current position into a selected waypoint number(similar to the LOG POSITION option). This function will overwrite an existing waypoint.

1. Use the ◀▶ keys to highlight the waypoint number field. Use the ▲▼ keys to cycle through the waypoint numbers until the desired waypoint is displayed, or enter a waypoint number to call a specific waypoint.
2. Using the arrow keys to highlight the HERE field and press [e] key. The current position is logged to that waypoint slot. The waypoint is renamed HERE_XX, where XX is the next sequential number assigned to a logged position beginning from 01. This information can be edited if necessary.
3. Press [e] to save the changes and return to the menu.
4. Press [e] to return to the Screen 6.

The COPY FROM function copies the information from one waypoint into another waypoint slot. This function will overwrite an existing waypoint.

1. Use the ◀▶ keys to highlight the waypoint number field. Use the ▲▼ keys to cycle through the waypoint numbers until the desired waypoint is displayed, or enter a waypoint number to call a specific waypoint.
2. Use the arrow keys to highlight COPY FROM. A waypoint number field is displayed next to the COPY FROM field. Use the ▲▼ keys to toggle through the waypoints one at a time, or use the numeral keys to enter the number of the waypoint you want to copy. The coordinates of the waypoint number appearing in this field are displayed at the bottom of the screen.

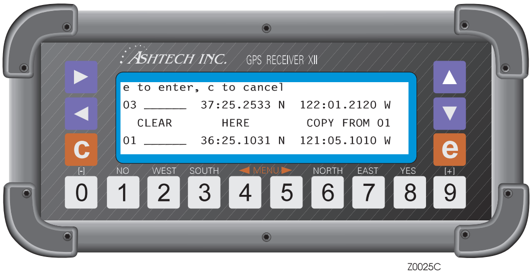


Figure 4.28: Copy From Screen

3. Press [**e**] and the COPY FROM waypoint information is copied to the TO waypoint. Edit the copied information if necessary.
4. Press [**e**] to save the newly copied waypoint.
5. Press [**e**] to return to Screen 6.

Edit Route

This function allows you to create a new route or modify an existing route. You can add waypoints to a route, remove a waypoint from a route, or reverse the order of the waypoints in the route. Use the arrow keys to highlight **4: EDIT ROUTE** and press [**e**] to open the corresponding sub-screen as shown in Figure 4.29:

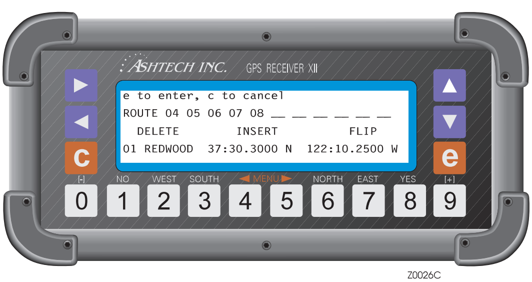


Figure 4.29: Edit Route Screen

The screen shows the current route and, at the bottom of the screen, information associated with the highlighted waypoint. To edit the route, highlight the point to be edited and modify it as necessary. Use the ◀ and ▶ keys to move the cursor from one waypoint to the other. Use the ▲ key to scroll through the waypoint list and modify a waypoint number. Alternatively, use the numbered keys to modify the waypoint number.

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

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

1. Use ▶ and ◀ to highlight the waypoint to be deleted.
2. Using the ▼ key and the ▶ or ◀ key, 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 go back to screen 6.

The INSERT function allows you to add waypoints.

1. Using the ▶ and ◀ keys, highlight the position in the route where you want to add the new waypoint.
2. Using the ▼ key, and the ▶ or ◀ key, highlight INSERT. The selected waypoint blinks.
3. Press **[e]** and waypoint 01 is added. The waypoint previously in that position is moved 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 go back to screen 6.

The FLIP function reverses the order of the waypoints in the route.

1. Using the ▼ and the ▶ or ◀ keys, highlight FLIP.
2. Press **[e]** and the order of the waypoints in the route is reversed. The last point is the first destination point of the previous route.
3. Move the cursor to route field and press **[e]** to save the changes.
4. Press **[e]** or **[c]** to go back to Screen 6.

Restart Route

This function allows you to adjust the starting point of the route. The route can be restart the route from the beginning or restart the route from the nearest waypoint to the present position.

To select this function do the following:

1. Select RESTART ROUTE and press [**1**]. The following screen appears:

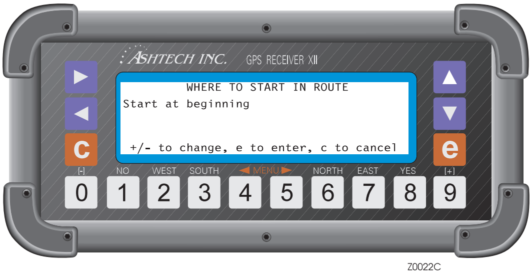


Figure 4.30: Restart Route Screen

2. Press [**+**] or [**-**] to select **Start at beginning** or **Start at nearest**.
3. Press [**e**] to activate the desired selection. If "Start at beginning" was 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" was selected, the receiver computes the closest leg and uses this leg as the navigation reference. This leg in the route is highlighted.

Waypoint Switch

This function sets the mode for advancing the route from one leg to the next. .

1. Use the arrow keys to highlight **6: WAYPT. SWITCH** and press [**1**] to open the corresponding sub-screen as shown in Figure 4.31:

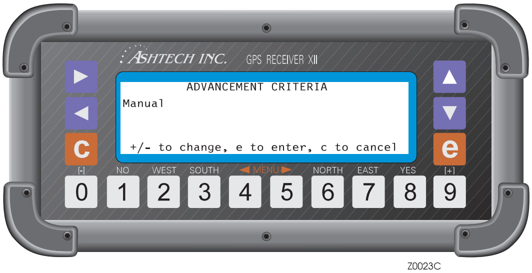


Figure 4.31: Advancement Criteria Screen

2. Press [**+**] or [**-**] to toggle **MANUAL** or **AUTOMATIC** mode. Press [**e**] to save the selection and return to the menu.
3. Press [**e**] to return to Screen 6.

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

In MANUAL mode, the route is advanced to the next leg by highlighting WAYPT. SWITCH and pressing [**e**].

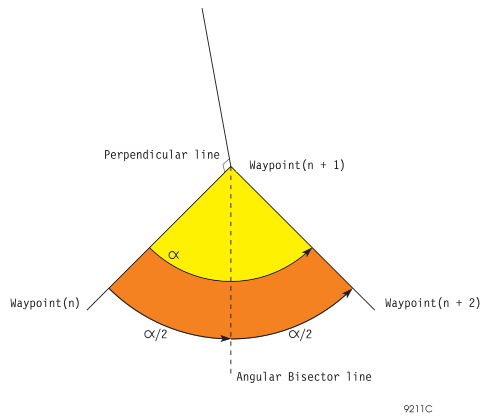


Figure 4.32: Waypoint Switch

Range/Bearing

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

Use the arrow keys to highlight **RANGE/BEARING** and press [**e**] to open the corresponding sub-screen as shown in Figure 4.33:

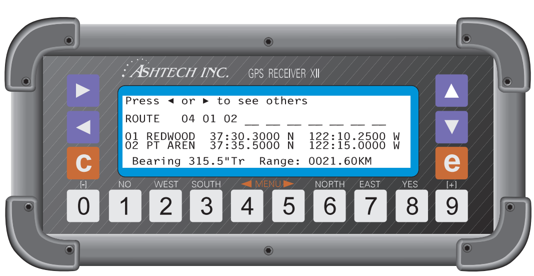


Figure 4.33: Route Display Screen

The display shows the route being followed. One of the legs is highlighted and the coordinates of the waypoints associated with this leg are 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 ◀ and ▶ keys to move the cursor, and the information is automatically displayed at the bottom of the screen. Press **[e]** or **[c]** to go back to the main screen.

Unit Selection

This function specifies 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 (Table 4.3).

Use the arrow keys to highlight **UNIT SELECTION** and press [**e**] to open the corresponding sub-screen as shown in Figure 4.34:

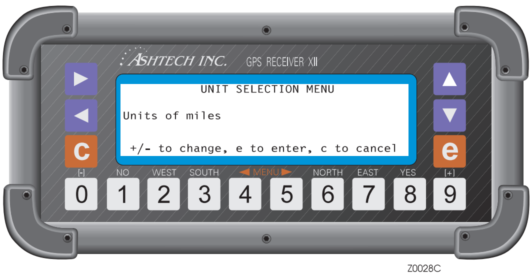


Figure 4.34: Unit Selection Menu Screen

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.

MAGVAR Mode

This function allows you to set the magnetic variation mode used in calculating COG and CTD values appearing in Screen 2 (Table 4.4), COG values in the VTG NMEA message, the bearing value displayed in 7: RANGE/BEARING (Figure 4.33), and bearing values appearing in the APA and BWC NMEA messages.

Use the arrow keys to highlight **9:MAGVAR MODE** and press [**e**] to open the corresponding sub-screen as shown in Figure 4.35:

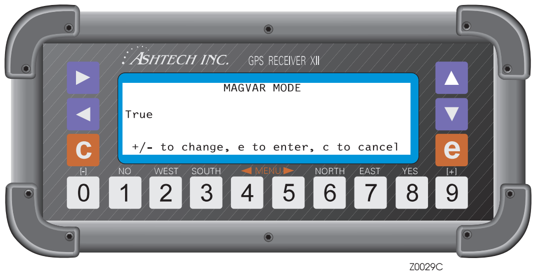


Figure 4.35: MAGVAR Mode Screen

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 appear on the screen, in the AUTO field. This value is 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 are displayed in magnetic degrees (°Mg). When this mode is selected, the following screen appears:

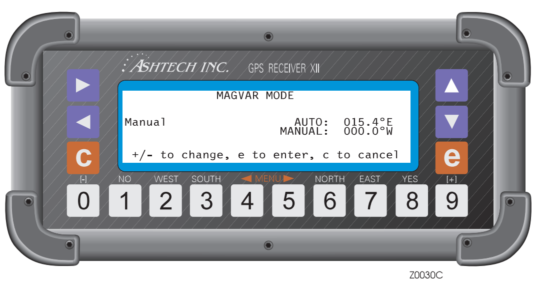


Figure 4.36: MAGVAR Mode (Manual) Screen

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 for reference.

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

Screen 7 Satellite Selection Control

Screen 7 allows you to specify which satellites the receiver will use to compute postions. **Y** indicates that the associated satellite will be used; **N** means that it will not be used.

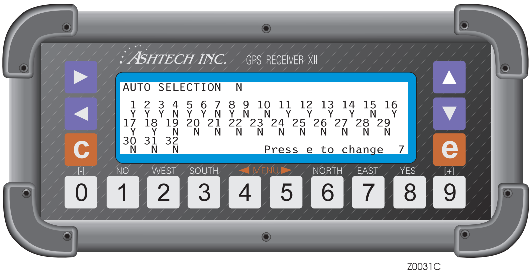


Figure 4.37: Auto Selection Screen

This screen also allows you to set the receiver for automatic or manual selection mode by entering a **Y** or an **N** in the **AUTO SELECTION** field. In automatic mode, all satellites flagged Y can be used to compute positions. Satellites that the receiver cannot lock on are replaced with any other satellite set to **Y**. 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 manual selection mode was activated. If fewer than 12 satellites are specified, the receiver uses only the specified satellites for computing positions.

To select the satellites to be used:

1. Press [**e**] to shift to data-entry mode (a blinking cursor indicates that data-entry mode is active).
2. Use the arrow keys to highlight the desired field.
3. Press [**8**] to enter a **Y**; press [**1**] to enter an **N**.
4. Press [**c**] to cancel the changes or [**e**] to save the new settings.

Screen Operations

Screen 8: System Control

Screen 8 (Figure 4.38) displays a list of the files stored in the receiver's memory. The files are listed in two columns. This screen also allows you to enter system-level commands. The elements in Screen 8 are described in Table 4.19.

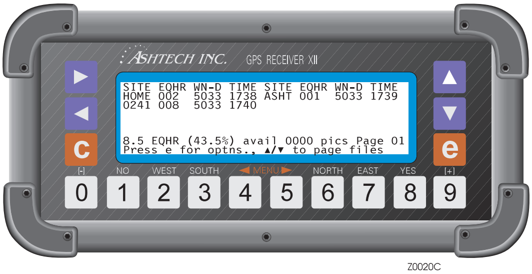


Figure 4.38: System Control Screen

Table 4.19: System Control Screen Elements

Component	Function
SITE	The four-character site name in use when the last epoch of data was recorded. (The site name is entered in 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 intervals while tracking five satellites.
WN	The GPS week number.
D	The day of the week (1=Sunday; 2=Monday; 3=Tuesday; 4=Wednesday; 5=Thursday; 6=Friday; 7=Saturday).
TIME	The time at which the last epoch of data was recorded. the format is hhmm; i.e., 1850 indicates 18:50 GMT.
EQHR (00%) AVAIL	Indicates the available memory in equivalent hours and percent of total memory. A Z-12R receiver with one megabyte of memory displays 19.5 EQHR when empty, which is equivalent to 19.5 hours of data recording capacity based on a 20 second record interval while tracking five satellites.

Table 4.19: System Control Screen Elements (continued)

Component	Function
PICS	In photogrammetry applications, displays the count of camera signals recorded. The count is updated each time a picture is taken or and event is recorded. Since the photogrammetry option is not available for the Z-12R, this field will always contain a zero.
PAGE	Page of the screen where the files being displayed are stored. When the receiver's memory contains more files than can be displayed on one screen, another screen is opened to allow viewing of the additional files.

File Creation

Each time the receiver is turned off and then on, a new file is assigned for data collection (assuming some data was stored in the last file). Its name is the site name that was entered last. This name is saved when the power is turned off. The receiver can store up to 100 files.

When a sufficient number of satellites (3 is the default) is being tracked, data is recorded in the last file shown on Screen 8.

If more than ten files are in memory, files are stored on a different "page" of the screen. Press the ▲▼ keys to scroll through the files. When no more memory is available, the receiver stops recording. Previously recorded data is overwritten or lost.

System-Level Commands

The Z-12R can be programmed with several system-level commands. To use these commands, press [**e**] to activate the data-entry mode, then press the relevant numeral keys to enter the desired command. Press [**c**] to cancel the command or press [**e**] once again to save the new setting. System commands are described in Table 4.20 below.

Table 4.20: System Level Commands and Functions

Command	Function
100	Turns off display backlighting after two minutes have elapsed since last key press (default setting).
101	Keeps backlighting on continuously. **Warning**: The receiver uses significantly more power when display backlighting is left on.
123	Closes the active file.
191	Initializes the modem.

Table 4.20: System Level Commands and Functions (continued)

Command	Function
456	Deletes the highlighted file.
550	Resets the receiver to factory default settings.
555	Saves user parameters.
737	Initializes (reset) RTCM
888	Opens the **CONFIGURATION IDENTIFICATION** screen, which contain receiver configuration data such as the receiver's serial number, the installed options, firmware version numbers for the nav board and channel board, etc.
990	Causes the falling edge of the timing pulse to be synchronized with GPS time.
991	Causes the rising edge of the timing pulse to be synchronized with GPS time.

Closing a File

Follow the steps below to close a file and open a new file without turning off the receiver:

1. Press [**e**] to shift to data-entry mode. Press [**1**] [**2**] [**3**] in sequence.
2. Press **[c]** to cancel or press [**e**] again to close the active file and open a new file. A new file cannot be opened unless data has been recorded in the active file.

Deleting a File

A file can be deleted at any time. Be sure to check that the file is not needed or that the information in it has already been transferred to the post-processing computer.

Each time the receiver is turned on, a new empty file is opened. If this file is deleted before it is closed, any data collected in it will be appended to the file that preceded it.

Follow the steps below to delete a file:

1. If there are more than ten files in the receiver, use the ▲▼ keys to scroll to the desired file.
2. Press [**e**] to shift to data-entry mode. Press [**4**] [**5**] [**6**] in sequence.

3. Press **[c]** to cancel or press **[e]** again to delete the file. A message indicating that file deletion is in progress will be displayed while the receiver erases the file.

Resetting Defaults; Saving User Parameters

Resetting the **internal** memory of the Z-12 R causes all parameters stored in memory to be reset to their default settings. Cycling power on the receiver causes some parameters to revert to the default settings; other parameters will retain their modified settings through a power cycle, overriding the defualt settings. Parameters that are not saved through a power cycle after being modified by the user can be saved by using system command 555. To enter this command, press [**e**] and enter [**5**] [**5**] [**5**]. Press [**c**] to cancel or press **[e]** again to execute the command. The receiver will display a message indicating that user parameters are being saved.

System command 550 resets some parameters to their default settings. Parameters that are not affected by this command can be reset to the default settings manually through the relevant data-entry screens, or the receiver's internal memory can be reset to globally restore default settings for all parameters. Resetting internal memory does not erase recorded files. To use system command 550, press [**e**] and enter [**5**] [**5**] [**5**]. Press [**c**] to cancel or press [**e**] again to execute the command. The receiver will display a message indicating that default parameters are being restored. Refer to Chapter 8, **System Control** for a list of the parameters that are saved by command 555 and restored to default settings by command 550.

Receiver Configuration

System command 888 displays the configuration identification of the receiver. It lists information such as serial number of the unit, all installed options, the navigation firmware version and release date, the channel firmware version and release date, the sleep mode version and release date, and the number of times new options have been loaded. To view the receiver configuration screen (Figure 4.39), press [**e**], enter [**8**] [**8**] [**8**], and press **[e]** again.

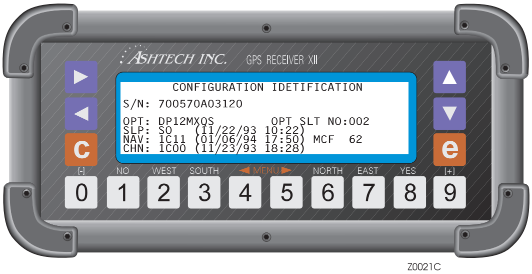


Figure 4.39: Configuration Identification Screen

Table 4.21: Configuration Identification Screen

Component	Function
S/N	The serial number of the receiver
OPT • D or U • P • 1 • 2 • M • X • Q • S	The list of option codes. The order is important. A dash (-) means the receiver does not have the corresponding option. • D = Differential Base/Remote; U = Remote only • Photogrammetry • P1 • P2 • Remote monitoring • External Frequency Input • Quarter-second data recording • DNS (C/A only)
OPT SLOT NO	Indicates how many times the receiver's option set has been programmed
SLP	Indicates the version of the sleep mode firmware and its release date
NAV	Indicates the version of the navigation board firmware and its release date. The next three characters indicate the receiver type (L- or M-), if the unit has a co-processor (C=yes, N=no), and if the program is loaded in flash EPROMs (F) or standard EPROMs (E). The last two numbers indicate the size of the external memory in 100-Kbyte units.
CHAN	Indicates the version of the channel board firmware and its release date.

Screen 9: Site and Session Control

Information for a specific survey can be entered in Screen 9 (Figure 4.40). Details about the survey site, including a 4 character site name, a session name or number, the date, etc., can be entered during data collection and will not affect or interrupt the data collection process. The elements in this screen are described in Table 4.22 below. As noted previously, external memory is required to support these functions.

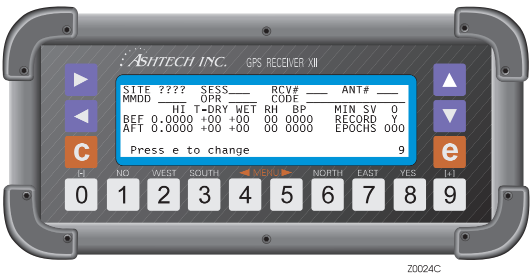


Figure 4.40: Site and Session Control Screen

Table 4.22: Site and Session Control

Component	Function
SITE	Up to four alphanumeric characters can be entered to identify the survey site. This character string is automatically inserted in the filename of the raw data file. If no site name was entered in screen 9, one can always be added during downloading if an accurate site name was not present during data logging.
SESS	One alphanumeric character can be entered to identify the survey session. If no session identifier is entered, the post-processing software automatically assigns one while downloading receiver data to the PC. Default session numbers assigned by the post-processing software are overwritten by any character entered and saved in this field..
RCV#	Up to three alphanumeric characters can be entered to identify the receiver used in the survey session. The last three digits of the receiver serial number are typically entered here.
ANT#	Up to three alphanumeric characters can be entered to identify the antenna used in the survey session. The last three digits of the antenna serial number are typically entered here. If after processing the data a file is found to have out-of-range data, you can check the equipment that gathered it.

Table 4.22: Site and Session Control (continued)

Component	Function
MMDD	Up to four alphanumeric characters can be entered to identify the month and day in which the survey session took place. Only use this field when you want to override the file time tag assigned automatically during downloading. The day of the year is read from the receiver data files time tag. Entering MMDD overrides the default.
OPR	Up to three alphanumeric characters can be entered to identify the survey session operator.
CODE	Up to 13 alphanumeric characters can be entered to more specifically identify a site or session.
HI	The height of the antenna in meters. Ashtech recommends that this value should be entered before or during the survey, as opposed to entering it during post-processing. The post-processing software automatically reads the antenna height and uses it in computing the correct station position. This value must be entered in meters. If not, a correction must be made during post processing. Dry temperature, wet temperature, relative humidity and barometric pressure can be entered on Screen 9. As with the HI measurements, the post-processing software reads and uses the meteorological data in its computations. Most surveys do not need this information and Ashtech recommends not to enter values here. Zero values in these fields cause the software to use the defaults of 20° C, 50% humidity, and 1010 millibars. If you decide to enter values in these fields, use the correct units (Celsius and millibars) and enter values in all fields.
T-DRY	The dry temperature in degrees Celsius.
T-WET	The wet temperature,in degrees Celsius.
RH	The percent value of relative humidity.
BP	the barometric pressure in millibars. Fields to the right are used to modify receiver tracking and recording procedures.
MIN SV	Sets the threshold for an alarm that sounds a continuous beep when the number of satellites being tracked above the elevation mask falls below this specified minimum value. • Press [**e**] to silence the alarm and reset the field to zero.
RECORD	Controls whether or not to record data. **Y** (yes) is the normal mode; **N** (no) means that data will not be recorded. **Warning**: Use this setting with caution!
EPOCHS	Specifies the number of measurement epochs to be tagged with the site name in a kinematic survey. This field counts down after each epoch until it reached 0, at which time the site name changes to ????, signaling the receiver is moving to the next site.

Follow the steps below to enter or change a value on Screen 9:

1. Press [**e**] to shift to data-entry mode (a blinking cursor indicates that data-entry mode is active).
2. Use ◀▶ to highlight the field to be changed.
3. Use ▼ to move the cursor down to the next row (this function differs from the other data entry screens).
4. Use ▲ to cycle through the character sets. Enter the desired character by pressing the corresponding numeral key.
5. Press [**8**] to enter **Y**es; press [**1**] to enter **N**o.
6. Press [**c**] to cancel the entries or press [**e**] to save the entries and disable data-entry mode.

Screen 10: All-in-View Information

Screen 10 (Figure 4.41) shows a polar plot of the visible satellites and their orbital paths. This screen also displays the number of visible satellites, the number of locked satellites, and DOP values. The graphical data shown in this screen is reliable once the receiver has a complete and current almanac and a valid position is displayed in Screen 2. After resetting internal memory, it takes about 12 minutes after locking the first satellite to get a full almanac and display valid information. With a complete almanac in memory, it takes approximately 12 seconds to obtain a full up-to-date screen after a power cycle. If the receiver has not been used for some time, this screen will display information based on old almanac information. Screen 10 can be reached in either of two ways:

- Press **[9]**, then press the ▶ key once.
- Press **[0]**, then press the ◀ key three times.

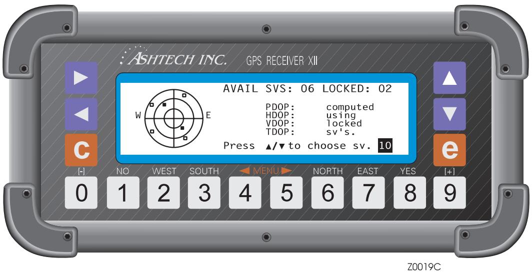


Figure 4.41: All-In-View Information Screen

The All-in-View screen is a graphical representation of the overhead positions of the satellites on an azimuth where 0° (north) is located at the top center of the plot and 180° (south) is at the bottom center of the plot. East and west are labeled on the plot.

- ■ This symbol indicates a satellite that is visible, but not locked.
- H This symbol 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, or bullseye, of the axis is 90°.

Table 4.23: All-In-View Information

Component	Function
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. DOPs of locked satellites are updated every second. The graphic display is updated every 10 minutes. Press ▲▼ to isolate the orbital track of a single available satellite (locked or not) Press ▲ to cycle through the visible satellites one at a time in ascending order starting with the lowest PRN number. Press ▼ to cycle through the visible satellites one at a time in descending order starting with the highest PRN number.

Single Track

The orbital track of a single satellite can be displayed on the polar plot by pressing ▲ or ▼. The track starts at the satellite's rising elevation and azimuth and ends at the satellite's current position. The satellite’s PRN number, its tracking status (VISIBLE /

LOCKED), and numerical values for elevation and azimuth are displayed to the right of the polar plot. This display is updated every ten minutes (Figure 4.42).

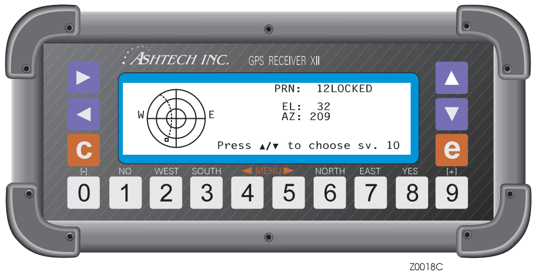


Figure 4.42: Single Track Screen

Screen 11: Satellite Visibility Information

Screen 11 (Figure 4.43) contains a bar graph showing a 24 hour snapshot of visibility periods referenced to each satellite number (1-31) in the GPS constellation. Like Screen 10, the information in this screen is reliable once the receiver has a complete and current almanac and a valid position is displayed on Screen 2. After resetting internal memory, it takes about 12 minutes after locking the first satellite to get a full almanac. With an almanac present, the information in this screen valid approximately 12 seconds after a power cycle. As with screen 10, if the receiver has not been used for some time, the screen will display information based on the old almanac stored in its memory.

You can open this screen in either of two ways:

- Press **[9]**, then press ▶ twice.
- Press **[0]**, then press ◀ twice.

The satellites are referenced to the vertical axis of the bar graph. PRN 1 is referenced to the bottom of the vertical axis; PRN 31 is referenced to the top of the vertical axis. The horizontal axis is referenced to time (GMT). The time range begins two to four hours before the current time and extends 20 to 22 hours after the current time. The dotted vertical lines partition the 24 hour time range into 12 two-hour segments.

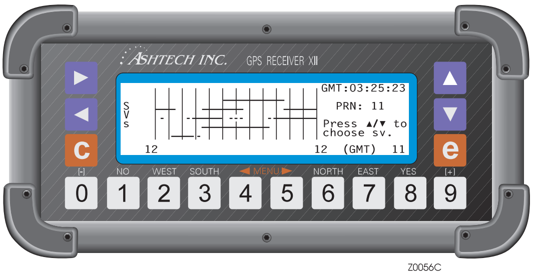


Figure 4.43: Satellite Visibility Screen

Press ▲▼ to move the satellite reference bar up or down the vertical axis. The satellite reference bar is a dotted horizontal line connecting the solid horizontal lines. The solid horizontal lines represent the periods in which a given satellite is visible. The PRN number of the satellite is displayed to the right of the bar graph and is also incremented or decremented according to the movement of the reference bar. The elements in Screen 11 are described in Table 4.24.

Table 4.24: Satellite Visibility Screen Elements

Component	Function
SOLID HORIZONTAL LINES	The solid horizontal lines represent the availability windows for each satellite in the constellation. They are shown in ascending order with PRN 01 at the bottom of the graph and PRN 32 at the top. The start/end times are accurate to 10 minutes.
DOTTED HORIZONTAL LINE	The satellite reference bar. Press ▲▼ to move the bar up or down in the bar graph. The PRN number displayed to the right of the bar graph increments or decrements in conjunction with the movement of the satellite reference bar.
GMT:03:25:23	Current time (referenced to GMT)
PRN 11	The satellite PRN number. Press ▲▼ to cycle up or down through the PRN numbers. The satellite reference bar moves up or down in conjunction with the PRN numbers.
DOTTED VERTICAL LINES	The dotted vertical lines partition the bar graph into 12 two-hour segments. The current time is referenced to GMT and is rounded to the nearest hour. Each time the screen is opened, the time marks are recalculated to show the previous, nearest two hours of availability; as shown in Figure 4.43, **12** and **12 (GMT)** are the times for the first and last vertical lines.

Screen 12: Bar Code Control

Screen 12 allows you to configure the receiver for data input from bar code readers or the Z-12R keyboard in survey or GIS applications. This method allows you enter more descriptive names in association with the data points collected. Information in Screen 9 (Figure 4.40) can also be entered using the bar code reader.

You must specify 9600 baud to be able to scan bar codes.

Only port A is available for bar code scanning.

You can get to Screen 12 in any of three ways:

- From Screen 9 press ▶ 3 times
- From Screen 0 press ◀ once
- Read a bar code. (If the bar code screen is accessed by reading a bar code, the top level of the previous screen is displayed upon exit.)

Figure 4.44: Bar Code Control Screen

A maximum of 80 characters can be entered, combining a bar code reader and inputs for the Z-12R keyboard. A successful scan is signalled by a short beep from both the bar code reader and receiver. If you attempt to enter more than eighty characters, the receiver rejects the scan, displays an error message, and issues a long beep. Error messages are cleared when an entry is adjusted to fit within the 80-character limit.

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

The Z-12R keyboard can also be used to enter characters into the description 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, [e] must be pressed first to activate data-entry mode. Use ▲▼ to cycle through the character sets and press the corresponding numeral key to enter the desired character.

The format in which the description strings are stored is shown in Table 4.25 below:

Table 4.25: Data Entry Storing 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 [e]. This records the data sequence, which is indicated by two short beeps, and disables data-entry mode.

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

- Scan the CLEAR ALL bar code or press the [c] key. This clears the entire data sequence and disables data-entry mode.
- Scan the backspace (BKSP) bar code or press the ▼ key. When only one data entry remains the system goes to Screen 12.

Once the data entered has been stored or cleared, data-entry mode is disabled, and pressing a numeral key will again cause the corresponding screen to open.

BARCODER is an Ashtech program which allows you to create and print bar codes for use in the field. This feature can greatly accelerate the process of entering data into an Ashtech Z-12R GPS receiver. Using the bar code reader to enter information in Screen 9 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, enter the site name and then the number of epochs to be counted down. When the desired parameters have been entered, press [e] to save it in memory and disable data-entry mode.

Serial Port Output Options

This chapter describes two output options always available on Ashtech Z-12R receivers: the Real-Time Data output option and the NMEA output option.

Real-Time Data Output

This section explains the Real-Time Data output option. It tells how to access the appropriate screens and enable the various file types. In addition, it explains each file type format.

This option allows the receiver to send real-time data through serial ports A, B, C, or D and specify the type and format of the outgoing data. The following types and formats are currently available:

Table 5.1: Serial Port Message Type and Formats

Message Type	ASCII Format	Binary Format
MBEN	yes	yes
PBEN	yes	yes
SNAV	not available	yes
SALM	not available	yes
DBEN	not available	yes

An MBEN message contains measurement data. A PBEN message contains position data. An SNAV message contains ephemeris data and is output every 15 minutes; it can be triggered for immediate output any time. SALM messages contain proprietary almanac data. DBEN messages are described in Chapter 7, **Detailed DBEN Message Structure**.

In binary format, the information is output the way it is stored in memory; only a header is added ("$PASHR,MBN,"; "$PASHR,PBN,"; or "$PASHR,SNV,").

The messages can be output through Port A, B, C, or D. Any combination of these files can be output from the same data port.

The transmission protocol defaults are 8 data bits and 1 stop bit, no parity.

The default value for the receiver to output data is every 20 seconds. This value is set in screen 4 by the field INTVL.

Setting Up the Receiver

To set up the receiver for real-time data file transmission, connect it to a computer. Connect the serial cable (P/N 700617) to Port A on the receiver and COM1 on the computer. If COM1 on the computer is not available, use COM2.

Next set up the port by following the directions below. Use the same procedure to set up each port. This procedure describes only Port A setup with the real-time data output option:

1. On Screen 4, press [**e**] to shift to data-entry mode:

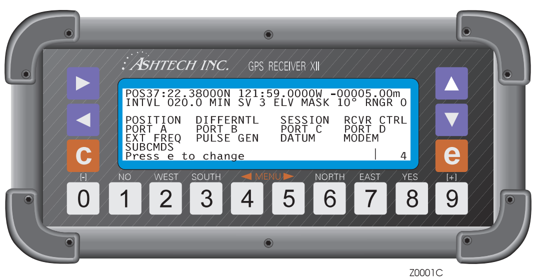


Figure 5.1: Mode Control Screen

2. With PORT A highlighted, press [**e**] to go to the Port A Parameter Selection screen:

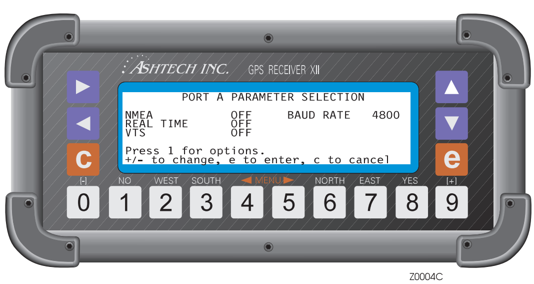


Figure 5.2: Port A Parameter Selection Screen

3. If the baud rate is not satisfactory, highlight it and press [**+**] or [**-**] to toggle through the available speeds.
4. Highlight the REAL TIME indicator and press the [**+**] or [**-**] key to toggle it ON.

5. With REAL TIME highlighted, press [**1**] to go to the Measurements Output on Port A screen:

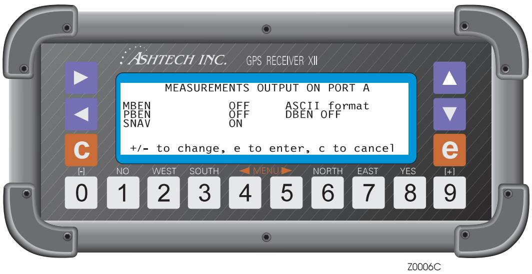


Figure 5.3: Measurement Output on Port A

6. On the Measurements Output on Port A screen, highlight a data type and press the [**+**] or [**-**] key to toggle it ON.
7. Highlight the next data type and toggle it to the desired state. Continue until all desired data types are turned ON.
8. Highlight the format indicator and press the [**+**] key to toggle it so it reads ASCII or BINARY format.
9. Press [**e**] to save the settings and return to the Port A Parameter screen.
10. Press [**e**] once again to return to Screen 4.

If desired, repeat this sequence for Ports B, C, and D. You can send different data types from each port, for example, send PBEN data through Port A and SNAV data through Port B.

If SNAV, SALM, and ASCII formats are selected, only an ASCII header for those messages is displayed. These two messages are not available in ASCII.

Commands

Certain parameters can be set through the serial port of a computer. Each command must be followed by a carriage-return/linefeed. The commands fall into two categories: the setting commands and the query commands. All ports of the receiver are set to decode these commands.

Setting Commands

In the following formats, d indicates a digit, str is a string of characters, and x is a single character.

$PASHS,RCI,ddd.d

Sets the update rate to the specified value.

$PASHS,ELM,dd

Sets the elevation mask.

$PASHS,MSV,dd

Sets the minimum number of satellites to record.

$PASHS,SIT,xxxx

Provides a site name.

$PASHS,SPD,x,d

Sets serial port (where x is A, B, C, or D) baud rate to d:

Table 5.2: Baud Rate Codes

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

$PASHS,RST

Resets all values to their defaults.

$PASHS,POS,ddmm.mmmm,X,dddmm.mmmm,Y,Sxxxxx.xx

Sets the position of the antenna, where ddmm.mmmm is the latitude in degrees (dd) and minutes (mm.mmmm), X is N (north) or S (south), dddmm.mmmm is the longitude, Y is E (east) or W (west), and Sxxxxx.xx is the altitude where S is the sign (+ or -).

$PASHS,LAT,ddmm.mmmm,X

Sets the latitude of the antenna (Screen 4), where ddmm.mmmm is the latitude in degrees (dd) and minutes (mm.mmmm), and X is N (north) or S (south).

$PASHS,LON,dddmm.mmm,Y

Sets the longitude of the antenna (Screen 4), where dddmm.mmmm is the longitude in degrees (ddd) and minutes (mm.mmmm), and Y is E (east) or W (west).

$PASHS,ALT,Sxxxxx.xx

Sets the altitude of the antenna, where Sxxxxx.xx is the altitude and S is the sign (+ or -).

$PASHS,ZMD,switch

sets the mode of the receiver, where switch is A for auto switching, Y for Z-mode, and N for P-mode.

$PASHS,INI,u,v,x,y,z,w

Resets the receiver, where u is port A baud rate code, v is port B baud rate code, x is port C baud rate code, and y is port D baud rate code, according to the table in the $PASHS,SPD command, to which the unit is initialized.

z is the reset memory code according to Table 5.3.

Table 5.3: "z" Codes

z	Action
0	No memory reset
1	Reset internal memory
2	Reset external memory
3	Reset internal and external memory

w is the modem initializing code according to Table 5.4.

Table 5.4: "w" Codes

w	Action
0	No modem initialization

Table 5.4: "w" Codes (continued)

w	Action
A	Modem initialization in port A
B	Modem initialization in port B

$PASHS,USE,dd,x

Enables or disables a satellite where dd is the satellite PRN number and x is uppercase Y (enable) or N (disable). For example, to disable satellite 8, enter:

$PASHS,USE,08,N

$PASHS,FIL,C

Closes the current file.

$PASHS,FIL,D,dd

Deletes file number dd from receiver memory

$PASHS,FIL,D,999

Deletes all files from the receiver external memory

$PASHS,PJT,str

Specifies the project information, up to 24 characters, set in screen 9. The 24 characters are as follows:

- character 1 = SESS
- character 2,3,4 = RCV#
- character 5,6,7 = ANT#
- character 8,9,10,11 = MMDD
- character 12,13,14 = OPR
- remaining characters = code

$PASHS,OUT,x

Turns off any previously specified types of output (see next command), where x, the port, is set to A, B, C, or D.

$PASHS,OUT,x,str1,str2,str3,...

Turns on the specified output type, where x, the port, is set to A B, C, or D. Str can be: NMEA, VTS3, VTS4, MBN, PBN, DBN, SNV, or BIN. For example, to send MBEN and PBEN in ASCII format: $PASHS,OUT,A,MBN,PBN. To cancel an output, repeat the command excluding the str associated with that output type.

$PASHS,NME,str,x,switch

Sets individual NMEA messages where str is GLL, GXP, GGA, VTG, GSN, APA, ALM, MSG, XTE, BWC, DAL, GSA, GSV, TTT, RRE, GRS, UTM. x is port A, B, C, or D; and switch is ON or OFF.

$PASHS,NME,PER,ddd.d

Sets the send interval time in NMEA messages.

$PASHS,WPL,ddmm.mmmm,x,dddmm.mmmm,y,wp#,name

Uploads waypoints to the receiver, where ddmm.mmmm is the latitude of the point in degrees (dd) and minutes (mm.mmmm), X is N (north) or S (south), dddmm.mmmm is the longitude, Y is E (east) or W (west), wp# is the way point number, and name is the waypoint name of up to 7 characters.

$PASHS,RTE,WP#,WP#,...

Uploads the route information, where wp# are waypoint numbers up to a maximum of 20.

$PASHS,RTC,str,x

Sets a receiver to handle RTCM format where str is BAS for base or REM for remote. x is the port and can be A, B, C, or D.

$PASHS,RTC,OFF

Turns off differential mode.

$PASHS,RTC,AUT,switch

Enables or disables RTCM auto differential mode, where switch is ON or OFF.

$PASHS,RTC,COD,str

Sets the receiver to use C/A or L1P code for differential corrections, where str is CA or L1P

$PASHS,RTC,SPD,d

Sets the receiver's transmission speed when handling RTCM format where d is a code for the output rate in seconds:

Table 5.5: "d" Code Output Rate

d	Rate
0	25
1	50
2	100
3	110
4	150
5	200
6	250
7	300
8	1500
9	0

$PASHS,RTC,STH,d

Sets the station health when handling RTCM format where d ranges from 0 to 7.

$PASHS,RTC,STI,d

Sets the station ID when handling RTCM format where d ranges from 0 to 1023.

$PASHS,RTC,MAX,d

Sets the maximum age for messages when handling RTCM format where d ranges from 0 to 1199 seconds.

$PASHS,RTC,QAF,d

Sets the communication quality when handling RTCM format where d ranges from 0 to 999.

$PASHS,RTC,MSG,str

Contains an RTCM message to send from the base station where str is up to 32 characters.

$PASHS,RTC,TYP,str,d

Specifies the type of RTCM format to generate where str is type 1, 3, 5, 6, 7, 9-3, 15, or 16; d is the corresponding period/frequency, ranging from 0 to 99. For types 1, 9, and 15, the period is in seconds; all other message type periods are in minutes.

Query Commands

Issue these instructions from the computer, commanding that the receiver send the specified structure. Follow each command with a carriage-return/linefeed.

$PASHQ,MBN

Requests a MBEN structure

$PASHQ,PBN

Asks for a PBEN structure

$PASHQ,SNV,PRN

Requests a SNAV structure for a specific PRN. If no PRN number is entered, it outputs SNAV messages for all PRNs.

$PASHQ,PRT

Asks for the port being used and its baud rate.

$PASHQ,RID

Requests the receiver identification. The format of the response message is:

$PASHR,RID,ZM,30,1011,C05,1C00

where	ZM	= receiver type (Z-12)
	30	= channel options (P1, P2)
	1C11	= nav firmware version
	C05	= loaded options
	1C00	= channel firmware version

The format of the MBEN, PBEN, and SNAV structure sent by the receiver is the one set in the measurements output menu. SNAV is not available in ASCII, so if this format is selected, the receiver outputs an empty message with an ASCII header.

Real-Time Data Files in ASCII

Only MBEN (measurement) and PBEN files can be output in ASCII format. For each satellite and at each epoch (recording time interval), a record is output containing fields in the following order. Each field is separated by a comma. A carriage return/ linefeed separates each satellite record.

MBEN Files in ASCII

The format for MBEN in ASCII is:

Table 5.6: MBEN Format in ASCII

Component	Function
Header	Indicates the type of data sent and allows a resynchronization with the data stream in case some bits were lost in transmission. It reports the receiver configuration. C/A-only contains: $PASHR,MCA, P code L1 and L2 contains: $PASHR,MPC,
Structure Identification	• Sequence tag. Is the time tag used to associate all structures with one epoch. It is in units of 50 ms and modulo 30 minutes (one count = 50 ms and it is reset every 30 minutes). • Number of remaining MBEN structures. There is one structure per locked satellite on every epoch. This parameter tells how many structures remain to be sent for that epoch.
Satellite data	• Satellite PRN number. • Elevation: Satellite elevation angle in degrees. Values range from 0 to 90 degrees. • Azimuth: Satellite azimuth angle in degrees. Values range from 0 to 360 degrees. • Channel index: Receiver channel (1 to 12) to which satellite was locked.

Measurement data for C/A, P-L1, or P-L2	• Warning flag: Flag displaying status of receiver clock, carrier phase signal, and loss of lock.
	  • bit 1 set = see note below
	  • bit 2 set = see note below
	  • bit 3 set = carrier phase questionable
	  • bit 4 set = code phase questionable
	  • bit 5 set = code phase integration not stable
	  • bit 6 set = Z tracking mode
	  • bit 7 set = possible loss of lock
	  • bit 8 set = loss of lock counter reset

The interpretation of bits 1 and 2 is as follows:

- bit 1 = 0 and bit 2 = 0: same as 22 in good/bad flag (see next field)
- bit 1 = 1 and bit 2 = 0: same as 23 in good/bad flag
- bit 1 = 0 and bit 2 = 1: same as 24 in good/bad flag

More than one bit may be set at the same time. For example, if bits 1, 3, and 6 are set at the same time, the warning flag will be 37 (1 + 4 + 32).

- Measurement quality (Good/bad flag) indicates the quality in the measurement of position.
    - 0 = measurement not available and no additional data will be sent
    - 22 = code and/or carrier phase measured
    - 23 = code and/or carrier phase measured, and navigation message was obtained but measurement was not used to compute position.
    - 24 = code and/or carrier phase measured, navigation message was obtained, and measurement was used to compute position.
- Empty field
- Signal to noise ratio (signal/noise): high signal level with low noise level indicates good quality signal. Typical range 15 to 130.
- Phase quality indicator (%): to obtain this value, an equation using carrier phase and integrated doppler is computed. The result should be a value close to an integer. Values from 0 to 5 or 95 to 100 indicate good quality.
- Full carrier phase (in cycles): total number of cycles plus fraction of the range between the antenna and the satellite.
- Code transmit time (ms): length of time of code transmission (Dt or pseudorange). The satellite clock offset correction from GPS time is not included.
- Doppler (10^{-4} Hz): doppler measurement. To get doppler in units of Hz, divide this number by 10,000. Doppler is positive when the satellite is moving away from the antenna, negative if it is moving toward.
- Range smoothing correction (in meters): raw range minus smoothed range. The smoothed range is obtained by filtering the raw range with the integrated doppler.
- Range smoothing quality: indicates how long the raw range has been smoothed. Increments from 0 to 200 in steps of 2 every ½ second, which is the receiver cycle time.

Footer

- Checksum (displayed in decimal) a bytewise exclusive OR (XOR) on all bytes from the sequence tag to the checksum.
- Carriage return, line feed.

PBEN Files in ASCII

The format for PBEN in ASCII is:

- "$PASHR,PBN," header string.
- Receive time: GPS time in seconds of week when code was received.
- Station position: ECEF-X (meters).
- Station position: ECEF-Y (meters).
- Station position: ECEF-Z (meters).
- Latitude ("-" before latitude indicates south.)
- Longitude ("-" before longitude indicates west.)
- Altitude (meters).
- Velocity in ECEF-X (m/sec).
- Velocity in ECEF-Y (m/sec).
- Velocity in ECEF-Z (m/sec).
- Number of satellites used for position computation.
- Site name. 4 characters (operator entered.)
- PDOP
- HDOP
- VDOP
- TDOP

Real-Time Data Files in Binary

MBEN Files in Binary

This section describes the binary MBEN (measurement) file. Its length varies depending on the receiver configuration. The table of file lengths shows the total number of bytes sent.

Table 5.7: Total number of bytes sent

Receiver Configuration	Blocks of Code Data in MBEN binary file	Number of bytes in file
C/A only	C/A	50
P code on L1 and L2	C/A, P-L1, P-L2	108

Table 5.8 describes the binary format of the MBEN file:

Table 5.8: MBEN file in Binary

Field	Bytes	Description
header	11	Indicates the type of data sent and allows a resynchronization with the data stream in case some bits were lost in transmission. Header reports the receiver configuration. C/A-only is: $PASHR,MCA P code L1 and L2 is: $PASHR,MPC,
Block identification, 3 bytes:		
unsigned short	2	Sequence id number in units of 50 ms, modulo 30 minutes (sequence tag).
unsigned char left	1	Number of remaining MBEN structures to be sent for current epoch.
Satellite data, 4 bytes:		
unsigned char svprn	1	Satellite PRN number.
unsigned char elevation	1	Satellite elevation angle (degree).
unsigned char azimuth	1	Satellite azimuth angle (degrees).
unsigned char chnind	1	channel ID (1 to 12).
C/A code data block, 29 bytes:		
unsigned char warning	1	Warning flag
unsigned char goodbad	1	Indicates quality of the position measurement.
spare	1	
unsigned char ireg	1	Signal to noise of satellite observation.
unsigned char qa_phase	1	Phase quality indicator: 0 to 5 and 95 to 100 are normal.
double full_phase	8	Full carrier phase measurements in cycles.
double raw_range	8	Raw range to SV (in seconds), i.e., receive_time - raw_range = transmit time
long doppler	4	Doppler (10^{-4} Hz).

Table 5.8: MBEN file in Binary (continued)

Field	Bytes	Description
long smoothing	4	32 bits where 31-24 are the *smooth_count*, unsigned and normalized, representing the amount of smoothing where: • 1 is least smoothed • 200 is most smoothed • 0 is unsmoothed. Bits 23-0 are smooth_corr, where bit 23 (MSB) is the sign and the LSBs (22-0) are the magnitude of correction (centimeters).
	(29)	P code on L1 block, in the same format as the C/A code data block.
	(29)	P code on L2 block, in the same format as the C/A code data block.
spare	2	
Footer, 3 bytes:		
unsigned char checksum	1	Checksum, a bytewise exclusive OR (XOR) on all bytes from sequence_tag (just after header) to the byte before checksum.
char	1	Carriage return.
char	1	Line feed.

For details on warning flag and good/bad flag, refer to Table 5.8.

PBEN Files in Binary

The PBEN (position data) file corresponds to one epoch. Its format in binary is:

Table 5.9: PBEN File in Binary

Field	Bytes	Contents
$PASHR,PBN,	11	Header
long pbentime;	4	GPS time in 10-3 seconds of the week when data was received.
char sitename [4];	4	4-character site name (operator entered).
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)

Table 5.9: PBEN File in Binary (continued)

Field	Bytes	Contents
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)
uns. short pdop;	2	PDOP.
unsigned short checksum;	2	Checksum word (sum of words from pbentime to PDOP).
char	1	Carriage return.
char	1	Linefeed.
Total bytes	69	

SNAV Files

The SNAV file (ephemeris data) is output only in binary. Its record definitions and the units for orbit data conform to the GPS-ICD-200 standard. This structure has 32 records.

Table 5.10: SNAV Files

Field	Bytes	Contents
$PASHR,SNV	11	Header.
short wn;	2	GPS week number.
long tow;	4	Seconds of GPS week.
float tgd;	4	Group delay (sec).
long aodc;	4	Clock data issue.
long toc;	4	(sec).
float af2;	4	Clock:(sec/sec2)
float af1;	4	(sec/sec)
float af0;	4	(sec).
long aode;	4	Orbit data issue.
float deltan;	4	Mean anomaly correction (semi-circle/sec).
double m0;	8	Mean anomaly at reference time (semi-circle).

Table 5.10: SNAV Files (continued)

Field	Bytes	Contents
double e;	8	Eccentricity.
double roota;	8	Square root of semi-major axis (meters ½).
long toe;	4	Reference time for orbit (sec).
float cic;	4	Harmonic correction term (radians).
float crc;	4	Harmonic correction term (meters).
float cis;	4	Harmonic correction term (radians).
float crs;	4	Harmonic correction term (meters).
float cuc;	4	Harmonic correction term (radians).
float cus;	4	Harmonic correction term (radians).
double omega0;	8	Lon of Asc. node (semi-circles).
double omega;	8	Arg. of Perigee (semi-circles).
double i0;	8	Inclination angle at reference time (semi-circles).
float omegadot;	4	Rate of right Asc. (semi-circles per sec).
float idot;	4	Rate of inclination (semi-circles per sec).
short accuracy;	2	(coded).
short health;	2	(coded).
short fit;	2	Curve fit interval (coded).
char prnnum;	1	(SV PRN number -1)
char res;	1	Reserved byte.
unsigned short checksum;	2	Checksum word (sum of words from wn to res).
char	1	Carriage return.
char	1	Linefeed.
Total bytes	145	

NMEA Output Option

This section describes the NMEA option installed on Ashtech Z-12 receivers. It tells how to set up the receiver and enable the various output formats. In addition, it includes the format of each NMEA message.

NMEA messages can be output through Port A, B, C, or D. Any combination of these messages can be output from the same data port. The message output rate is set on the NMEA OPTIONS screen. The rate can be set to any value between 0.5 and 999.5 seconds.

The transmission protocol default is: 8 data bits and 1 stop bit, no parity.

Setting Up the Receiver

To use the receiver with NMEA format messages, you must set up output specifications such as port and baud rate. Any combination of ports A, B, C, or D can be used for output. Use the same procedure to set up each one. This procedure describes only Port A setup.

1. On Screen 4, press [**e**] to shift to data-entry mode:

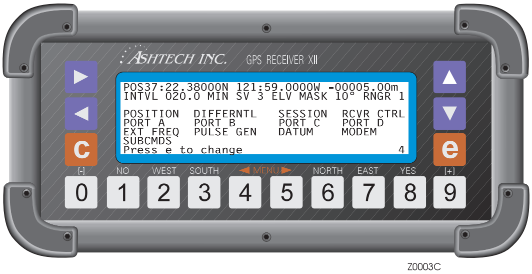


Figure 5.4: Screen 4, Setup

Serial Port Output

2. Highlight the PORT A indicator and press [**e**] to go to the Port A Parameter Selection screen:

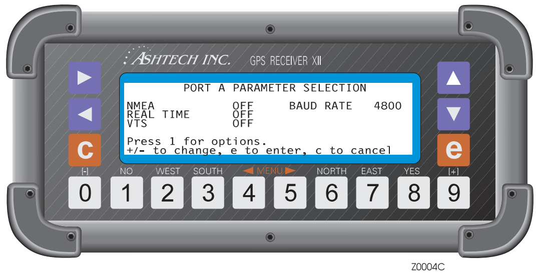


Figure 5.5: Screen 4, Port A Parameter Selection

3. On the Port A Parameter Selection screen, highlight the NMEA indicator and press the [**+**] or [**-**] key and toggle it so that it reads ON. Press [**e**] to save this specification.
4. To change the baud rate, highlight the BAUD RATE indicator and, using the [**+**] or [**-**] key, toggle it the desired baud rate. Press [**e**] to save this specification.
5. To specify message formats, highlight the NMEA indicator again and press [**1**] to go to the NMEA OPTIONS Menu--Port A screen:

Figure 5.6: NMEA Options Menu Port A

6. On the NMEA Option Menu--Port A screen, ON or OFF is flashing by a message format. Using the [**+**] or [**-**] key, toggle to ON for the desired message format. Continue until all the formats needed have been turned on.
7. Messages are sent every five seconds (default), but the interval can be changed to a value from 000.5 to 999.5 seconds. To change the value,

highlight the numeric field next to Send Interval and press the numbered keys.

8. Press [**e**] to save the settings and return to the PORT A PARAMETER SELECTION screen.
9. Press [**e**] again to return to Screen 4.

If desired, repeat this sequence for Port B. Different types of NMEA messages can be sent from each port, for example, send GLL messages through Port A and GXP through Port B. However, the same Send Interval applies to both ports. The same procedure applies to Ports C and D.

NMEA Message Types

The NMEA sentence that is output is a string of ASCII characters with comma delimiters. The length of the fields varies depending on its precision. When information is not available or output, it is indicated as ",," (a null argument).

The following is an example of an NMEA sentence.

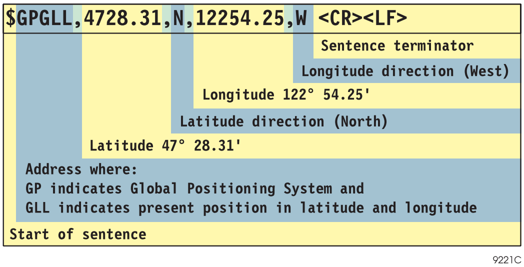


Figure 5.7: NMEA Sentence (Example)

The message formats are shown on the following pages according to their order on the NMEA Option Menu. Each starts with the talker identifier and three-character message-type identifier (that is, $GPGLL). The data fields are numbered left to right; x is a decimal digit; ± is a plus or minus sign; and E flags exponential notation.

Refer to the NMEA 0183 Standard for Interfacing Marine Electronic Navigational Devices for more details on sentence format protocols.

Latitude/Longitude for Position

Format:

$GPGLL,xxxx.xxxxx,N,xxxxx.xxxxx,W,hhmmss.ss,A<CR><LF>

Table 5.11: Latitude/Longitude Field Descriptions

Fields	Significance
1	Latitude in degrees, decimal minutes
2	N = north, S = south
3	Longitude in degrees, decimal minutes
4	W = west, E = east
5	UTC of position (hours, minutes, seconds, tenth of seconds)
6	Status, A = valid, V = invalid

Example:

$GPGLL,3723.28101,N,12202.24101,W,180236.14,A<CR><LF>

Present Position Fix with Time of Fix

Format:

$GPGXP,hhmmss.ss,xxxx.xxxxx,N,xxxxx.xxxxx,W<CR><LF>

Table 5.12: Present Position Field Descriptions

Fields	Description
1	UTC of fix (hours, minutes, seconds, tenths of second)
2	Latitude (in degrees, decimal minutes)
3	North or South
4	Longitude (in degrees, decimal minutes)
5	East or West

Example:

$GPGXP,015324.00,3723.28332,N,12202.24301,W <CR><LF>

Global Positioning System Position

Format:

$GPGGA,hhmmss.ss,xxxx.xxxxx,N,xxxxx.xxxxx,W,x,xx,xx.x,±xxxxx,M,
±xxxx.x,M,xx,xxxx<CR><LF>

Table 5.13: GPS Field Descriptions

Fields	Significance
1	UTC of position (hours, minutes, seconds, tenth of a second)
2	GPS latitude (degrees, decimal minutes)
3	Latitude north (N) or south (S)
4	GPS longitude (degrees, decimal minutes)
5	Longitude east (E) or west (W)
6	GPS quality indicator (where 1 = GPS Available, 2 = DGPS available)
7	Number of GPS satellites being used
8	Horizontal dilution of precision (HDOP)
9,10	Antenna height in meters and M for meters
11,12	Geoidal height in meters and M for meters
13	Age of differential GPS data
14	Differential reference station ID

Example:

$GPGGA,015454.00,3723.28513,N,12202.23851,W,1,4,03.8,+00012,M,
+0000.0,M,14,1010 <CR><LF>

COG/SOG

Format:

$GPVTG,xxx.xx,T,xxx.xx,M,xxx.xx,N,xxx.xx,K<CR><LF>

Table 5.14: COG/SOG Field Descriptions

Fields	Significance
1,2	COG (Course Over Ground) and T for true
3,4	COG and M for magnetic variation

Table 5.14: COG/SOG Field Descriptions

Fields	Significance
5,6	SOG (Speed Over Ground) and N for knots
7,8	SOG (Speed Over Ground) and K for km/hr

Example:

$GPVTG,329.01,T,346.31,M,000.07,N,000.13,K <CR><LF>

SNR of GPS Satellites Being Tracked

Format:

$GPGSN,xx,xx,xxx,xx,xxx,xx,xxx.....xxx <CR><LF>

Table 5.15: SNR of GPS Field Descriptions

Fields	Description
1	Number of svs currently being tracked. When 0, message terminates after this field. For a nonzero count, the subsequent fields give each satellite number and its SNR.
2	Satellite number
3	Signal-to-noise ratio for satellite
4,5	Two fields for each tracked satellite, similar to fields 2 and 3
Last field	Age of differential data. 999 when in stand-alone mode.

Example:

$GPGSN,04,19,038,14,136,18,117,15,036,999 <CR><LF>

Autopilot Format

Format:

$GPAPA,A,A,x.xxx,L,N,A,A,xxx,T,xxx <CR><LF>

Table 5.16: Autopilot Format Field Descriptions

Fields	Description
1	Suspect or ambiguous (where A = valid, V = invalid)
2	Cycle lock (where A = valid, V = invalid)

Table 5.16: Autopilot Format Field Descriptions

Fields	Description
3	Cross-track error
4	Sense (where L = left, R = right)
5	N for nautical miles
6	Arrival circle (A = valid, V = invalid)
7	A for arrival perpendicular (crossing the line which is perpendicular to the course line and which passes through the destination waypoint)
8	Bearing to destination from origin
9	M for magnetic, T for true north
10	Destination waypoint identifier

Example:

$GPAPA,A,A,9.999,R,N,A,A,069,M,001<CR><LF>

Almanac Message

Each sentence contains an almanac for each satellite in the GPS constellation.

Format:

$GPALM,xx,xx,xx,xxx,xx,xxxx,xx,xxxx,xxxx,xxxxxx,xxxxxx,xxxxxx,
xxxxxx,xxx,xxx <CR><LF>

Table 5.17: Almanac Messages Field Descriptions

Field	Description
1	Total number of messages
2	Message number
3	Satellite PRN number
4	GPS week
5	SV health
6	Eccentricity
7	Almanac reference time (seconds)
8	Inclination angle (semicircles)
9	Rate of ascension (semicircles/sec)
10	Root of semimajor axis

Table 5.17: Almanac Messages Field Descriptions

Field	Description
11	Argument of perigee (semicircle)
12	Longitude of ascension mode (semicircle)
13	Mean anomaly (semicircle)
14	Clock parameter (seconds)
15	Clock parameter (sec/sec)

Example:

$GPALM,20,01,28,674,00,5C1E,1D,09BC,FD30,A10D27,BBD4EB,
8CB47B,E35E03,FFA,000<CR><LF>

RTCM Message

Outputs RTCM Types 1,3,5,7,9,15, and 16. The first 7 fields of this message are the same for every RTCM type.

$GPMSG,xx,xxxx,xxxx.x,x,xxx,hhmmss

Table 5.18: RTCM Messages Field Descriptions (1-7)

Field	Description
1	RTCM message type
2	Station identifier
3	Z count in seconds and tenths
4	Sequence number
5	Station health
6	Total number of characters after the time item
7	UTC time in hours, minutes, seconds

The other fields are defined below for each specific RTCM message type.

Message Type 1, or 9 Format: RTCM Corrections

$GPMSG,xx,xxxx,xxxx.x,x,x,xxx,hhmmss,x,xx,+/-xxxx.xx,
+/-x.xxx,xxx,...<CR><LF>

Table 5.19: RTCM Messages Field Descriptions (8-17)

Field	Description
8	User differential range error (UDRE)
9	Satellite PRN number
10	Pseudo-range correction (PRC) in meters
11	Range rate correction (RRE) in meters/second
12	Issue of data (IODE)
13-17	Same as fields 8-12 but for next satellite

Example:

$GPMSG,09,0001,2220.0,1,0,127,213702,1,12,-0081.30,+0.026,235,1,
26,-0053.42,-0.070,155,2,02,+0003.56,+0.040,120 <CR><LF>

Message Type 3 Format: Reference Station Coordinates

$GPMSG,xx,xxxx,xxxx.x,x,x,xxx,hhmmss,+/-xxxxxxx.xx,
+/-xxxxxxx.xx,+/-xxxxxxx.xx <CR><LF>

Table 5.20: Message Type 3 Format Field Descriptions

Field	Description
8	Reference station ECEF X component
9	Reference station ECEF Y component
10	Reference station ECEF Z component

Example:

$GPMSG,03,0001,2220.0,1,0,127,213702,-2691561.37,
-4301271.02,+3851650.89<CR><LF>

Message Type 5 Format: Satellite Health Status

$GPMSG,xx,xxxx,xxxx.x,x,x,xxx,hhmmss,xx,x,x,xx,x,x,xx,
xx...<CR><LF>

Table 5.21: Message Type 5 Field Descriptions

Field	Description
8	Satellite PRN number
9	IOD link
10	Data health
11	Satellite SNR, dB-Hz
12	Health enable
13	New navigation data
14	Loss of satellite warning
15	Time to unhealthy. Scale factor is 5 minutes with a range between 0 and 75.
16-23	Same as fields 8-15 but for next satellite

Example:

$GPMSG,05,0001,2220.0,1,0,127,213702,23,0,0,41,0,0,1,35<CR><LF>

Message Type 7 Format: Radio Beacon Station Almanac

$GPMSG,xx,xxxx,xxxx.x,x,x,xxx,hhmmss,ddmm.mm,a,dddmm.mm,
a,xxxx,xxx.x,x,xxxx,xxx,x,x,x<CR><LF>

Table 5.22: Message Type 7 Field Descriptions

Field	Description
8	Latitude in degrees, minutes, decimal minutes
9	Direction of latitude
10	Longitude in degrees, minutes, decimal minutes
11	Direction of longitude
12	Radio beacon range, km
13	Radio beacon frequency, kHz
14	Radio beacon health
15	Broadcast station ID

Table 5.22: Message Type 7 Field Descriptions

Field	Description
16	Broadcast bit rate, bits/second
17	Modulation mode
18	Synchronization type
19	Broadcast code

Example:

$GPMSG,07,0001,2220.0,1,0,127,213702,3722.4,N,12159.85,W,100,
293.5,0,0001,200,0,0,0<CR><LF>

Message Type 15 Format: Ionospheric Corrections

Note that this message may contain information for one or two satellites.

$GPMSG,xx,xxxx,xxxx.x,x,x,xxx,hhmmss,xx,xxx.xx,
+/-xxxx.x,xx,xxx.xx,+/-xxxx.x<CR><LF>

Table 5.23: Message Type 15 Field Descriptions

Field	Description
8	Satellite ID #1
9	Ionospheric measurement #1, meters
10	Ionospheric rate measurement #1, cm/min
11	Satellite ID #2
12	Ionospheric measurement #2, meters
13	Ionospheric rate measurement #2, cm/min

Example:

$GPMSG,15,0001,2220.0,1,0,127,213702,04,035.44,-0012.6,
24,062.13,+0086.2<CR><LF>

Message Type 16 Format:

$GPMSG,xx,xxxx,xxxx.x,x,x,xxx,hhmmss,aaaaaa...<CR><LF>

Table 5.24: Message Type 16 Field Descriptions

Field	Significance
8	Message in ASCII text

Cross-Track Error

Format:

$GPXTE,A,A,xxx.xxx,L,N<CR><LF>

Table 5.25: Cross Track Error Field Description

Fields	Description
1	SNR (where A = valid, V = invalid).
2	Cycle lock (where A = valid, V = invalid)
3	Cross-track error
4	Steer left or right (where L = left, R = right)
5	Units (nautical miles)

Example:

$GPXTE,A,A,019.999,R,N <CR><LF>

Bearing and Distance

Great Circle Format:

$GPBWC,hhmmss.ss,xxxx.xxxx,N,xxxxx.xxxx,W,xxx.xx,T,xxx.xx,M,
xxx.xxx,N,xxx <CR><LF>

Table 5.26: Bearing and Distance Field Descriptions

Field	Description
1	UTC of bearing (hours, minutes, seconds, tenth of a second)
2	Latitude of waypoint (degrees, decimal minutes)
3	North (N) or south (S)
4	Longitude of waypoint (degrees, decimal minutes)
5	East (E) or west (W)
6,7	True bearing and T for true

Table 5.26: Bearing and Distance Field Descriptions (continued)

Field	Description
8,9	Magnetic bearing and M for magnetic
10,11	Distance and N for nautical miles
12	Waypoint identifier

Example:

$GPBWC,015454.00,0000.0000,N,00000.0000,E,069.00,T,84.73,M,
999.999,N,001<CR><LF>

Almanac

In the DAL format, the + sign is suppressed for a positive value in the power of e. The spaces are for readability.

Format:

$PASHR,DAL,xx,xx,x.xxxxxxxE±xx,xxxxxx,x.xxxxxxxE±xx,
±x.xxxxxxxE±xx,x.xxxxxxxE±xx,±x.xxxxxxxE±xx,±x.xxxxxxxE±xx,
±x.xxxxxxxE±xx,±x.xxxxxxxE±xx, x.xxxxxxxE±xx,xxx <CR><LF>

Table 5.27: Almanac Field Descriptions

Fields	Description
1	Satellite PRN number
2	Satellite health
3	Eccentricity
4	toe, reference time for orbit (in seconds)
5	i0, inclination angle at reference time (semicircles)
6	omegadot, the rate of right ascension (semicircles/sec)
7	roota, the square root of semi-major axis (meters 1/2)
8	omega0, the longitude of the ascension node (semicircle)
9	omega, the argument of perigee (semicircle)
10	m0, the mean anomaly at reference time (semicircle)
11	af0, clock parameter (in seconds)
12	af1, clock parameter (sec/sec)
13	wn, GPS almanac week number

Example:

$GPDAL,14,00,5.2795410E-03,032768,3.0565721E-01,
-2.4811015E-09,5.1536948E03,5.8827317E-01,8.8243234E-01,
-8.8568139E-01,8.2015991E-05,7.2759576E-12,571<CR><LF>

DOP and Active Satellites

Format:

$GPGSA,x,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x
<CR><LF>

Table 5.28: DOP and Active Satellites Field Descriptions

Field	Description
1	Mode: M=manual, A=automatic
2	Mode:1=fix not available, 2=2D, 3=3D
3,4,5,6,7, 8,9,10,11, 12,13,14	Satellites used in solution (null for unused fields)
15	PDOP
16	HDOP
17	VDOP

Example:

$GPGSA,M,3,,23,28,11,,,17,,,,21,,3.4,2.0,2.8 <CR><LF>

Satellites in View

Gives the number of satellites in view, PRN numbers, elevation, azimuth, and SNR. There are four satellites maximum per transmission, and additional satellite data is sent in 2nd or 3rd messages. The total number of messages being transmitted and the number of message are indicated in first two fields.

Format:

$GPGSV,x,x,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,xxx,xx <CR><LF>

Table 5.29: Satellites in View Field Descriptions

Field	Description
1	Total number of messages (1 to 3)
2	Message number (1 to 3)
3	Total number of satellites in view
4	Satellite PRN number
5	Elevation (degrees)
6	Azimuth (degrees)
7	SNR (0 to 99 dB)
8,9,10,11	Same as 4,5,6,7 but for second satellite
12,13,14,15	Same as 4,5,6,7 but for third satellite
16,17,18,19	Same as 4,5,6,7 but for fourth satellite

Example:

$GPGSV,2,1,06,23,53,041,99,28,55,273,99,11,24,326,55,17,36,101,68 <CR><LF>

Trigger Time Tag Serial Output Message

This trigger signal is generated through the camera in input located on the backpanel of the receiver. The following message is output on the selected port on each trigger epoch being generated

Format:

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

Table 5.30: Trigger Time Tag Field Descriptions

Field	Description
1	Day of the week, with 1 being Sunday and 7 being Saturday
2	GPS time tag in hours, minutes, decimal seconds

Example:

$PASHR,TTT,3,18:01:33.1200417 <CR><LF>

Satellite Range Residuals and Position Errors

This message displays the satellite residuals and horizontal and vertical position errors displayed in menu 5.

Format:

$GPRRE,xx,xx,sxx.x.................,xx.x,xx.x <CR><LF>

Table 5.31: Satellite Range Residuals Field Descriptions

Field	Description
1	Number of satellites used to compute position
2,3	Two fields for each tracked satellite with satellite number and range residual
Last 2 fields	Horizontal position error and vertical position error, respectively

Example:

$GPRRE,05,23,+8.4,28,-9.2,11,-2.2,17,+3.2,21,+12.2,34.4,49.7 <CR><LF>

GPS Satellite Range Residuals

This message displays the range residual for each of the satellites being used to compute position.

Format:

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

Table 5.32: GPS Satellite Range Field Descriptions

Field	Description
1	Current UTC time of GGA position (hours, minutes, decimal seconds)
2	Mode m used to compute range residuals 0 = residuals were used to calculate the position given in the matching GGA line 1 = residuals were recomputed after the GGA position was computed
3	Range residuals for each satellite used in position computation. The order of the residuals matches the order of the satellites in the GSV message, where empty fields indicate that SV is not being used to compute position.

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

Position Using UTM Coordinates

Format:

$PASHR,UTM,hhmmss.ss,xxx,xxxxxx.xx,xxxxxxx.xx,x,xx,xx.x,
±xxxxx,M,±xxxx.x,M,xx,xxxx <CR><LF>

Table 5.33: Position Using UTM Field Descriptions

Field	Description
1	UTC of position (hours, minutes, decimal seconds)
2	Zone for coordinates
3	East UTM coordinate (meters)
4	North UTM coordinate (meters)
5	GPS quality indicator where 1 = GPS available, 2 = DGPS available
6	Number of GPS satellites being used
7	Horizontal dilution of precision (HDOP)
8,9	Antenna height in meters and M for meters
10,11	Geoidal height in meters and M for meters
12	Age of differential data
13	Differential reference station ID

Example:

$PASHR,UTM,015454.00,10S,588757.62,4136720.05,1,04,03.8,
+00012,M,,M,14,1010 <CR><LF>

RSIM Messages

Reference Station/Integrity Monitor (RSIM) messages provide standard equipment input/output data formats, in order to facilitate the flow of information between the Reference Station (RS), Integrity Monitor (IM), and Control Station (CS) of a DGPS. The number of message definitions is minimized to reduce equipment complexity, however, this constraint requires that the same message be reusable for various functions; the usage can be determined from the context of its transmission, as indicated in the first paragraph of each of the RSIM message definitions.

RSIM messages 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 20, 21, 22, and 23 are implemented for the Reference Station (RS). The other RSIM messages are used along with the Control Station to communicate between other devices such as the Integrity Monitor. Refer to Table 6.1

The firmware has been implemented such that RSIM messages can be output to ports A (the RS-232 Special Test port), B (the Control Station port), or D (the Data Logger port). The same RSIM message can be output in more than one port at a time. For example, a user can have RSIM 13 messages output to both ports B and D at the same time.

Conventions

The following conventions apply to the RSIM message definitions.

Message Designations

A limited number of RSIM messages are oriented towards marine radiobeacon (RBN) applications. However, they have been designed so as to not preclude use in other applications. RSIM message types are referred to as "RSIM#". RTCM SC104 message types are referred to as "RTCM#".

NMEA0183/IEC1182 Common Conventions

RSIM formats make use of many of the same conventions used for proprietary sentences in the National Marine Electronics Association (NMEA) 0183 Standard for Interfacing Marine Electronics Devices, Version 2.00. This standard is identical to IEC 1162. NMEA 0183 is generally applicable to user equipment, not service provider equipment. Its style was adapted to facilitate the interoperability of RSIM equipment. Per paragraph 5.2.1.3 of that standard, the three-character mnemonic code "RCM" is assumed for RTCM, so the proprietary "$PRCM" address field begins each RSIM message. Each RSIM message ends with a delimiter, checksum, and end-of-sentence delimiter (*hh<CR><LF>). In the RSIM Messages, UTC Time and the Lat. and Long. fields follow the format in Table 6.1 of NMEA 0183. Any field can be left null when not required. Also, the multiple line message scheme used in the NMEA 'ALM' message is used by RSIM. Exceptions of note to NMEA data format protocols include:

Maximum Number of Characters

Maximum number of characters in a sentence may exceed 82, contrary to NMEA paragraph 5.3. This will simplify future growth and eliminate barriers to field size, thereby allowing variations in the precision within fields.

Repeating Fields

Repeating fields used in RSIM#1, #22, and #23 are not seen in NMEA; this feature of RSIM means the number of fields in the sentence may not be specified from the message type, contrary to NMEA paragraph 5.3. Note that it may not be possible to add additional fields and still be backward compatible.

Checksum

The checksum used in the RSIM messages is required, not optional as in the NMEA standard.

Hardware Interface Protocol

NMEA hardware and data transmission specifications are not data format protocols, and are not required; for example, use of EIA-422 and 4800 baud are not considered essential features for equipment to be in compliance with the RSIM recommended standards.

Null Fields

Null fields are delineated by a comma at the beginning and at the end of a null field. This is especially important when optional fields are involved. When the remainder of a message would contain only null fields, the message is terminated.

Floating Point Numbers

Zeroes, as opposed to blanks, are required before or after decimal points (for example, 0.25 and not .25, 15.0 and not 15.).

RSIM Message Grouping

In messages which require data to be sent in groups of three, the last message may contain data for one or two satellites. For example, if data were being sent on 8 satellites the last message of the composite message would contain data on two satellites.

Illustration of Use

The following scenarios illustrate the general use of the RSIM Messages.

Typical Transaction

Figure 6.1, shows a typical transaction between the CS and the RS. In this example, the CS checks the status of the data link parameters by sending RSIM#1 requesting RSIM#10 which is denoted by the notation 1(10) and appears as an actual message which looks like ($PRCM,1,10,1,,,*0D<CR><LF>). After the RS sends the requested messages, the CS processes the data. If the CS wanted to perform a reset it would send RSIM#3 in order to accomplish this. Resetting the RS triggers a self-test routine in the RS, which then generates a RSIM#5.

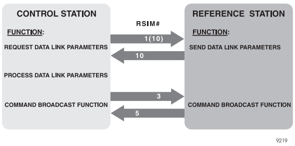


Figure 6.1: Control Station & Reference Station

Normal Operating Condition

During normal operations, the CS will receive periodic status reports from the broadcast sites under its control. A typical set of RSIM Messages that would serve as a status report would consist of RSIM#15 and #18. As an example, these messages could be sent every two minutes, with the reporting times for the different sites being

RSIM Messages

offset. RSIM#1 would be used to set the output interval and the synchronization start time for each set. This would result in a low rate of message traffic over the communications network.

Alarm Recovery Mode

When a CS needs to reset a broadcast site following an alarm, it needs all of the requisite information to determine the proper corrective action in the shortest period of time. The operator may request several types of data encompassing multiple RSIM Messages so that various parameters can be simultaneously evaluated.

Guidelines

The following paragraphs describe some of the issues that must be addressed, and provide additional information about the RSIM messages.

Satellite Health

Satellite health is indicated in subframe 1 of the navigation message for the satellite in view. It may differ from values in subframe 4 and 5 of other satellites; see ICD-GPS-200: 20.3.3.3.1.4 and 20.3.3.5.1.3 (TABLE 20-VII). Paragraph 3.2.6 of the RTCM SC104 Version 2.1 document describes satellite health assessment. A decision by a service provider to force a satellite healthy reflects confidence in DGPS to correct an error deemed excessive by the GPS control segment. If a PRN is forced healthy by the RS, the IM will automatically resume use of that PRN. Forcing a satellite unhealthy removes from consideration signals that may be out of specification before the GPS control segment has uploaded a new health message. In the RSIM messages, "Force Healthy" is equivalent to "Health Enable" in RTCM#5.

Satellite health status can be forced healthy or unhealthy for DGPS users with RSIM#8. More detailed information on satellite health can be queried via RSIM#7 and #9. RSIM#7 indicates the health status broadcast by the satellite in the navigation message. Indications of trouble with a particular PRN may also be noted by the RS in unreasonably high PRC or RRC and reported in RSIM#12. Trouble with a PRN after application of the DGPS correction may be detected at the IM and reported in RSIM#17.

Timing

Setting the intervals for reporting messages, archiving data, and scheduling broadcasts must be compatible with system capabilities. It may not be possible to report or archive all the data generated. If recording all the data is required, then the system hardware must operate at sufficient speeds and have enough memory.

For outgoing message origination, timing must be sufficiently precise to eliminate the potential for two consecutive outgoing alarms to have the same time. Likewise, for broadcasting, when there is a contention between two scheduled messages, the later message must be transmitted as soon as possible thereafter. The service provider must consider data link capacity and schedule the broadcast mix so that collisions are infrequent.

RSIM Message Definitions

The RSIM message titles are listed in Table 6.1, which is followed by the definitions of the RSIM messages, which follows the discussion of RSIM#23, lists the variables used in the RSIM messages.

Table 6.1: RTCM SC104 RSIM Message Types

RSIM#	Title	Page
1	RSIM MESSAGE# QUERY/REPORTING INTERVAL	122
2	RSIM UNRECOGNIZED MESSAGE ALARM	123
3	RSIM CONTROL COMMANDS	124
4	RSIM DATA ARCHIVE CONTROL	125
5	RSIM DIAGNOSTIC REPORT/ALARM	126
6	GPS RECEIVER PARAMETERS	127
7	GPS RECEIVER SATELLITES STATUS	128
8	SATELLITE HEALTH CONTROL	130
9	SATELLITE HEALTH STATUS	131
10	REFERENCE STATION DATA LINK PARAMETERS	132
11	REFERENCE STATION ALARM THRESHOLDS	134
12	REFERENCE STATION ALARMS	134
13	REFERENCE STATION CORRECTION DATA	135
20	INTEGRITY MONITOR SYSTEM FEEDBACK	136
21	RTCM BROADCAST ALMANAC PARAMETERS	138
22	RTCM BROADCAST SCHEDULING	139
23	RTCM UNIVERSAL MESSAGE	140

RSIM#1: RSIM Message# Query/Reporting Interval

Implemented queries/reporting intervals for RSIM's 1, 4, 5, 6, 7, 9, 10, 11, 12, 13, 21, 22, and 23.

When the RSIM Message Type is specified as 13 (or 23) and a 0 is entered for the Output Interval, RSIM 13 (or 23) messages will be sent every time new corrections are broadcast from the RS.

When querying RSIM 13 ($PRCM,1,13,1) or RSIM23 ($PRCM,1,23,1), the latest corrections computed by the RS (not necessarily transmitted) will be output. Note that the RS computes new corrections every 0.5 second and transmits them every 2 to 10 seconds, depending on the format of the corrections specified (that is, RTCM Type 1, Type 9-3, or Type 9-1).

Usage:

1. CS sends to RS to request a RSIM message report or to set up RSIM message reporting intervals.
2. RS sends to CS in response to query for RSIM#1 settings currently in effect.

```
FIELD # 1   2 3 4   5   6
        ^   ^ ^ ^   ^   ^
$PRCM,1,x.x,x,x,x.x,x.x,...*hh<CR><LF>
```

Where:

1 - RSIM Message Type Desired

2 - Destination Port

RS

1 = CS	(Port B)
2 = Data Recorder	(Port D)
3 = Reserved	(Port A)

3 - Enable

0 = Off

1 = On

4 - Output Interval

5 - Synchronization Start Time (seconds into first hour)

6 - Additional message types, destination port, enable, interval, & synch fields as required

1. CS requests a single message of a particular type by specifying the RSIM# and the destination port, and leaving fields 3-5 null. This will generate the desired response, but will not change the state of reporting requirements.

2. Setting interval to "0" means that RSIM# is to be generated any time it has new data to transmit. Therefore, to enable messages only upon alarm status change, set enable on with an interval of zero.

3. The Synchronization Start Time sets the time into the hour when the enabled message should first be output. It allows for simultaneous observations when desired, or to avoid contention for communications at CS.

4. To get a readout of reporting intervals set at the RS, RSIM#1 request is used to elicit a RSIM#1 response; RS responds by sending one set of fields 1-5 for every type it has set Enable=on.

5. CS may set reporting intervals for RSIM#23 to request RS forwarding of RTCM broadcast messages digitally.

6. When an alarm message (including RSIM#20) is enabled with a set interval, a change of state will still generate an immediate alarm.

7. There are two methods that can be used with RSIM#23 to get specific RTCM Message Types. If the Output Interval in field 4 is set to a non-zero value, then several RSIM#23's will be sent, one for each RTCM Message Type being broadcast, with the most recent broadcast information for each type. If the Output Interval is set to zero, then an RSIM#23 will be sent for each new broadcast RTCM Message. This second method can be used to check scheduled RTCM broadcasts by enabling RSIM#23 with an interval of zero for a short time period including the scheduled broadcast time.

RSIM#2: RSIM Unrecognized Message Alarm

The RS provides this message when an unrecognized RSIM command is given through any of the serial ports. If any out-of-range or illegal values are entered in any of the RSIM message fields, an RSIM 2 will be given indicating that the input command/query was rejected.

Usage:

RS or IM send to CS; typically, would indicate system communications trouble, or incoming message originator software incompatibility.

```
FIELD # 1         2
        ^         ^
$PRCM,2,hhmmss.ss,x.x*hh<CR><LF>
```

Where:

1. UTC Time of Alarm
2. Incoming Unrecognized Message RSIM#

1. Any "$PRCM" messages received without a usable RSIM#, are reported using this message, with field 2 null.

2. No action is taken on faulty messages, including those with parity errors, other than to report with RSIM#2.

3. "$PRCM" messages with field type/range errors will be trapped and will prompt generation of this report (unless handled by a special case of RSIM#5).

RSIM#3: RSIM Control Commands

When a DGPS computational reset is given ("PRCM,3,D"), all of the RS's pseudorange and range rate corrections are reset for every satellite tracked.

When a partial reset is given ("PRCM,3,P"), SV tracking is reset but all setup parameters are retained and the almanac is saved. This is equivalent to a power cycle.

When a full reset is given ("PRCM,3,F"), all setup parameters are reset to their default values and the almanac data is cleared. See Table 7 for the ranges and default values of the RSIM setup parameters.

Usage:

CS sends to execute various degrees of reset at the RS or IM.

```
FIELD # 1
        ^
$PRCM,3,a*hh<CR><LF>
```

Where:

1. Reset Command

   D = DGPS computation reset

   P = Partial reset

   F = Full reset

1. **Partial/Full reset causes self-test routine to execute. Receiving unit will generate a RSIM#5 Diagnostic Report message with the results.**

RSIM#4: RSIM Data Archive Control

This message allows for "raw" data logging capability to port D (the "DL" port). The raw data includes the MBN (pseudorange, carrier phase, and Doppler measurements), PBN (position, velocity, and time), and SNV (satellite ephemeris data) messages in binary format. The structures of these data messages are given in chapter 5 of the Z-12R Operating Manual.

Entering a "non-null" Logging Interval starts the data output ("$PRCM,4,x"), while entering a null for Logging Interval will stop the data output ("$PRCM,4,").

For test purposes, the DATALOGR program may only be run successfully on Port D when RSIM 4 is not "on". This is because DATALOGR cannot establish a good communications link to the receiver on the same port that the receiver is sending data.

DATALOGR captures the raw data in the B-file and E-file, which are binary. The B-file and E-file can then be converted to RINEX format by running the ASHTORIN program.

The data recording interval cannot be set by DATALOGR. To set the proper recording interval, first run DATALOGR and start collecting the data. Then issue RSIM 4 with the desired recording interval (that is, "$PRCM,4,1.0" for a one second interval).

Usage:

1. CS uses to control RS outputs to data logging device port. Archived data format is not RSIM#-defined; any proprietary stream able to be converted to provide key fields required is acceptable.
2. RS sends in response to CS queries.

```
FIELD # 1
        ^
$PRCM,4,x.x*hh<CR><LF>
```

Where:

1. Logging Interval

1. **If field 1 is null, data is not to be archived. If zero, all available archive data is to be output, at the lowest available interval (½ second). If different from null or 0, all available archive data is to be output at the specified interval.**

RSIM#5: RSIM Diagnostic Report/Alarm

When the RS is operating normally and computing position, the "NORMAL" message will be sent to the CS (Port B). When turning on the receiver or performing a partial or full reset function, a "RECEIVER INITIALIZATION COMPLETE" message will be sent. Other messages (which indicate receiver warnings not covered in the RSIM messages) will be sent automatically to the CS. They are implemented as described below:

"POSITION DID NOT CONVERGE (PDOP MAY BE HIGH)"

"POSITION OLD (CHECK NUMBER OF SVS TRACKED)"

"EXTERNAL FREQUENCY NOT LOCKED (CHECK EXTERNAL CLOCK)"

"EXTERNAL FREQUENCY NOT LOCKED (SWITCHED TO INTERNAL)"

"SV xx: BAD C/A RANGE SMOOTHING"

"SV xx: BAD PL1 RANGE SMOOTHING"

"SV xx: BAD PL2 RANGE SMOOTHING"

"WARNING: 0.5 MS TASK OVERLOAD"

"WARNING: 10 MS TASK OVERLOAD"

"WARNING: 100 MS TASK OVERLOAD"

"WARNING: 0.5 SECOND TASK OVERLOAD"

"WARNING: 1 SECOND TASK OVERLOAD"

"WARNING: 5 SECOND TASK OVERLOAD"

"WARNING: CHANNEL xx MISALIGNMENT"

The first two messages occur when position is not computed. The message "NORMAL" will also automatically be sent to the CS (Port B) when these problems clear. If any "BAD RANGE SMOOTHING" occurs, the raw range measurements will be used instead for that epoch. All the "WARNING"-type messages are indications of problems that occurred and have been instantaneously corrected. It is recommended to perform a full reset if any of the above warning messages occur frequently.

Usage:

RS uses to provide manufacturer-defined system status in the form of ASCII strings. May be initiated by the RS upon detecting a fault condition (i.e., alarm). Also used for reporting diagnostic self-test results (in response to RSIM#3). If RS queried for this message, upper case "NORMAL" will be the typical response, unless unresolved fault conditions remain.

```
FIELD # 1         2
        ^         ^
$PRCM,5,hhmmss.ss,c--c*hh<CR><LF>
```

Where:

1. UTC Time of Alarm
2. ASCII Diagnostic Text (<=56 chars)

   "NORMAL" = No system malfunctions detected.

1. Other than "NORMAL" diagnostic codes as appropriate to equipment and service provider policy.

2. For multiple failures, multiple messages are sent.

RSIM#6: GPS Receiver Parameters

The RS's identification number (RS ID) and precise GPS antenna location is set through this message. Note that the Altitude field expects ellipsoidal height and a "-" sign for negative values and no sign for positive values. Also, a variable external frequency field has been implemented to allow the user to input any frequency between 1.00 Mhz and 21.00 Mhz (to the nearest 10 kHz).

The Mask Angle for Broadcast (default is 10 degrees) corresponds to the "position" mask angle - see the POSITION sub-screen of Screen 4. The RS will generate corrections only for those satellites above this mask angle. When a satellite drops below the mask angle, "DO NOT USE" corrections will be sent by the RS for a set period of time (see below).

The Maximum Age of RTCM Corrections (default is 30 seconds) has three uses in the RS:

1. When a previously healthy satellite is forced unhealthy or starts broadcasting unhealthy, its RTCM corrections will be set to the "do not use" values for this period of time and then no more corrections will be sent for this particular satellite.
2. When an RSIM 20 is received by the RS with a satellite's PR Residual flag set (indicating that the IM detected bad corrections from that satellite), the RS will broadcast "DO NOT USE" values for the satellite's corrections for this period of time. The RS will then reset the correction smoothing for this particular satellite and start broadcasting its corrections again.

3. When a satellite with elevation over elevation mask drops below the mask, its RTCM corrections will be set to the “do not use” values for this period of time and then no more corrections will be sent for this particular satellite.

Usage:

1. CS uses to set DGPS receiver mode of operation at RS.
2. RS sends in response to CS queries.

```
FIELD # 1   2 3   4       5 6        7 8   9   10
        ^   ^ ^   ^       ^ ^        ^ ^   ^   ^
$PRCM,6,x.x,a,x.x,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x*hh
<CR><LF>
```

Where:

1. RS ID
2. Frequency Source
   - I = Internal
   - E = External
3. External Source Frequency
4. Reference Position - Latitude in degrees, minutes
5. N or S
6. Reference Position - Longitude in degrees, minutes
7. W or E
8. Altitude - Ellipsoidal
9. Mask Angle for Broadcast
10. Maximum Age of RTCM Correction

RSIM#7: GPS Receiver Satellites Status

Reports all satellites above the horizon, whether tracked or not, based on almanac data. The elevation mask angle is not used in this message to determine which SVs are sent. If the satellite is not tracked, the C/No, URA, and health fields are reported as nulls.

1. Note that after performing a full reset, complete almanac data is not available for 12.5 minutes.

Usage:

Used by RS or IM to report observations of GPS satellites.

```
FIELD # 1 2 3         4    5    6    7    8    9    a
        ^ ^ ^         ^    ^    ^    ^    ^    ^    ^
$PRCM,7,x,x,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x,

b   c   d   e   f   g   h   i   j   k   l
^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^
x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
```

Where:

1. Total Number of Messages
2. Message #
3. UTC Time Observed
4. PRN #
5. Azimuth
6. Elevation
7. C/No
8. URA
9. SV Health

a. PRN #

b. Azimuth

c. Elevation

d. C/No

e. URA

f. SV Health

g. PRN #

h. Azimuth

i. Elevation

j. C/No

k. URA

l. SV Health

1. Composite message, in groups of 3 PRN’s.

2. Report all PRN’s that are tracked, (whether declared healthy or not in GPS Ephemeris), and that are visible.

3. Azimuth and elevation are computed at receiver. If a PRN is visible (based on this almanac-based computation) but isn't tracked, the C/No, URA, and health fields are reported as null.

4. SV Health field is reported by the ephemeris.

RSIM#8: Satellite Health Control

Satellites can be forced healthy so that corrections will be generated even if the satellite is broadcasting unhealthy; or forced unhealthy so that corrections will never be generated for that satellite.

If a valid "Loss of Satellite Warning Time" is entered in RSIM 8 for an SV, an RTCM 5 message will automatically be generated and broadcast at the next available time for that SV. The Interval of RTCM 5 messages (set using RSIM 22) does not come into play - the RTCM 5 message will still be output even if its Interval is set to "0".

Usage:

CS uses to control RS operation; this RSIM type is never queried.

```
FIELD # 1   2 3
        ^   ^ ^
$PRCM,8,x.x,x,hhmmss.ss*hh<CR><LF>
```

Where:

1. PRN #

   99 is a special code to perform the function indicated in field 2, for all 32 PRNs

2. Health Control Code

   0 = Use GPS Broadcast Health

   1 = Force Healthy

   2 = Force Unhealthy

3. Loss of Satellite Warning Time (UTC)

1. Use RSIM#7 or #9 to get satellite health status. RSIM #7 will display health as broadcast in almanac data. RSIM #9 will display health as broadcast in almanac data and as set by RSIM #8.

2. Loss of Satellite Warning Time is used by RS for generation of RTCM#5, if used by service provider. If no warning or if not implemented, leave null.

RSIM#9: Satellite Health Status

Reports health and tracking status of all the satellites.

Usage:

RS sends upon CS request.

```
FIELD # 1         2 3 4 5 6 7 8 9 a b c d e f g h i j k
        ^         ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^
$PRCM,9,hhmmss.ss,x,x,x,x,x,x,x,x,x,x,x,x,x,x,x,x,x,x,x,

l m n o p q r s t u v w x
^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^
x,x,x,x,x,x,x,x,x,x,x,x,x*hh<CR><LF>
```

Where:

1. UTC Time
2. Status of PRN 1
3. Status of PRN 2
4. Through x - Status of PRN 3 through PRN 32

Status:

0 = Not Tracked

1 = Healthy/Tracked

2 = Unhealthy/Tracked

3 = Forced Healthy/GPS Ephemeris Unhealthy

4 = Forced Healthy/GPS Ephemeris Healthy

5 = Forced Healthy/Not Tracked

6 = Forced Unhealthy/GPS Broadcast Healthy

7 = Forced Unhealthy/GPS Broadcast Unhealthy

8 = Forced Unhealthy/Not Tracked

1. Status 0, 1, and 2 indicate satellite health is to be determined from the GPS broadcast health transmitted by the satellite ephemeris in question.

RSIM#10: Reference Station Data Link Parameters

Controls the parameters which will generate the MSK modulation of the RTCM corrections over the radio beacon. When queried ("$PRCM,1,10,1"), the parameters for two channels will be output. Below is a description of how the fields in this message relate to the MSK Setup Menu in the DIFFERENTIAL subscreen of Screen 4:

Table 6.2: Differential Subscreen of Screen 4

Field	Description
Channel	Only Channel 1 has been implemented for this version of the RS.
Frequency	The range is from 283.5 KHz to 325.0 KHz.
Operating Mode:	0: MOD = "ON", FILL TYPE = "SPACE" 1: MOD = "FILL", FILL TYPE = "ALTER" 2: MOD = "OFF" 3: FREQ = "0.0"
Broadcast Bit Rate	Can be set to 25, 50, 100, or 200 bits per second.
Modulation Mode:	0: MOD = "ON", MSK = "ON" 1: not implemented. 2: not implemented. 3: MOD = "OFF"
Synchronization Type	Not implemented.
Broadcast Coding	Not implemented.
Beacon Identifier	4 alpha-numeric character field and is not always related to the RSID.

Usage:

1. CS uses to set parameters that determine mode of operation of the RS in generating the DGPS broadcast.
2. RS uses to respond to queries for this message.

```
FIELD #  1 2   3 4   5 6 7 8
         ^ ^   ^ ^   ^ ^ ^ ^
$PRCM,10,x,x.x,x,x.x,x,x,x,c--c*hh<CR><LF>
```

Where:

1. Channel

2. Frequency
3. Operating Mode
    0 = Normal DGPS Data Link Operation
    1 = Alternating 1 and 0
    2 = Carrier Only
    3 = No Signal
4. Broadcast Bit Rate
5. Modulation Mode
    0 = MSK
    1 = FSK
    2 = ID Morse Keying
    3 = No Modulation
6. Synchronization Type
    0 = Synchronous
    1 = Asynchronous
7. Broadcast Coding
    0 = No Added Coding
    1 = Forward Error Correction Added
8. Beacon Identifier

1. Service provider broadcast standard will determine which fields are required in a given implementation.

2. Assumes that broadcast power (and thus range) is not adjustable through the RS modulator, but frequency is.

3. This message doesn't affect information disseminated in the RBN Almanac, RTCM#7. RSIM#21 performs that function.

4. Fields 1 and 8 provide the capability to use a two channel modulator for generating the Radiobeacon Morse Code Identifier along with the DGPS data modulation.

RSIM#11: Reference Station Alarm Thresholds

Sets up the RS alarm thresholds for number of satellites tracked, the pseudorange and range rate corrections (PRC and RRC), and the IM system feedback time. The default values are:

- Minimum Number of SVs = 3
- PRC Limit = 655.34 meters (same as the RTCM PRC scale factor limit)
- RRC Limit = 1.0 meters / second
- IM Feedback Time Limit = 3.0 seconds

Usage:

1. CS uses to set RS alarm thresholds.
2. RS uses to report parameters in use when queried by CS.

```
FIELD #  1 2   3   4
         ^ ^   ^   ^
$PRCM,11,x,x.x,x.x,x.x*hh<CR><LF>
```

Where:

1. Quantity Satellites Alarm Minimum
2. PRC Alarm Threshold
3. RRC Alarm Threshold
4. IM System Feedback Time Threshold

1. If threshold is exceeded, or if minimum is not met, alarm is raised to CS using RSIM#12.

RSIM#12: Reference Station Alarms

Provides alarms when any of the alarm thresholds, set up in RSIM 11, are exceeded. These alarms are generated within 0.5 seconds. By default, this message has been set to output upon any alarm status change (that is, "$PRCM,1,12,1,1,0").

Usage:

RS uses to send CS notification of alarms when they occur or cease, or when queried.

```
FIELD #  1         2 3 4 5
         ^         ^ ^ ^ ^
$PRCM,12,hhmmss.ss,a,a,a,a*hh<CR><LF>
```

Where:

1. UTC Time

2. Insufficient Satellites Alarm
   I = Insufficient Satellites
   S = Sufficient Satellites, Clear Alarm
3. Unmonitored Alarm
   F = Unmonitored, no IM System Feedback message
   W = Unmonitored, wrong RS ID
   U = Unmonitored, other
   M = Monitored, Clear Alarm
4. High PRC Alarm
   H = High PRC
   N = Normal PRC, Clear Alarm
5. High RRC Alarm
   H = High RRC
   N = Normal RRC, Clear Alarm

1. If RS queried for this, parameters within normal ranges are indicated with the "Clear" state.

RSIM#13: Reference Station Correction Data

Reports the RTCM correction data for every satellite, including the raw computed UDRE values (not the broadcast UDRE range representations). The PR Acceleration is not computed by the RS and its field will be null.

Usage:

RS uses to report most recent DGPS computations at time message is originated.

```
FIELD #  1 2 3         4   5   6   7   8   9   a   b   c
         ^ ^ ^         ^   ^   ^   ^   ^   ^   ^   ^   ^
$PRCM,13,x,x,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x

d   e   f   g   h   i   j   k   l   m   n   o
^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^
x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
```

Where:

1. Total Number of Messages
2. Message #

3. UTC Time of Message
4. PRN #
5. PRC
6. RRC
7. PR Acceleration
8. UDRE
9. RTCM Modified Z-Count

a. IOD
b. PRN #
c. PRC
d. RRC
e. PR Acceleration
f. UDRE
g. RTCM Modified Z-Count
h. IOD
i. PRN #
j. PRC
k. RRC
l. PR Acceleration
m. UDRE
n. RTCM Modified Z-Count
o. IOD

1. Composite message, in groups of 3 PRN's.

RSIM#20: Integrity Monitor System Feedback

The RS can handle RSIM 20 messages coming in at any rate through Port C from the IM.

Usage:

IM uses to provide frequent positive feedback to RS to independently validate proper system performance.

```
FIELD #  1   2 3
         ^   ^ ^
$PRCM,20,x.x,x,x.x*hh<CR><LF>
```

Where:

1. RS ID
2. Position Flag

   0 = Position Inside Threshold

   1 = Position Outside Threshold

   2 = Unable to Check DGPS Integrity: Indicate "Unmonitored"
3. PR Residual

   0 = All Inside Threshold

   1 .. 32 = PRN# Outside Threshold

1. RS ID is determined from the data link broadcast. This makes it possible for the RS to know whether or not its own corrections are being checked by the IM.

2. Gives individual PR trouble information, which may enable the RS to take corrective action. Only one PRN can be flagged bad at a time. Corrective action includes broadcasting "DO NOT USE" corrections for a period set by the Maximum Age of RTCM Corrections (RSIM 6) for the bad satellite. The RS then resets the correction smoothing for the bad satellite, and resumes broadcasting its corrections.

3. If computed position is outside threshold defined in RSIM#16, Position Flag will be raised and RS sets its station health to "7" to indicate unhealthy until this flag clears.

4. If RS doesn't receive this message before time threshold specified in RSIM#11 is exceeded, RS must alarm to CS using RSIM#12, and set broadcast "Unmonitored" in RTCM message headers.

5. Under high IM HDOP conditions, this system feedback message will be sent with position flag indicating "unmonitored."

6. No null fields should ever be sent in an RSIM#20 Message.

RSIM#21: RTCM Broadcast Almanac Parameters

The parameters describing up to four different radio beacon reference stations may be input through this message.

Usage:

1. **CS sends to RS to set RBN almanac information stored at that RS. Setting these parameters does not affect functional operation of equipment; affects promulgation of information to users in RTCM#7.**

2. **RS sends in response to CS queries. Provides the current status; can be multiple lines.**

```
FIELD #  1   2   3       4 5        6 7   8   9
         ^   ^   ^       ^ ^        ^ ^   ^   ^
$PRCM,21,x.x,x.x,llll.ll,a,yyyyy.yy,a,x.x,x.x,x,

a   b   c d e
^   ^   ^ ^ ^
x.x,x.x,x,x,x*hh<CR><LF>
```

Where:

1. Total Number of Messages
2. Message #
3. Latitude in degrees, minutes
4. N or S
5. Longitude in degrees, minutes
6. W or E
7. Radiobeacon Range
8. Frequency
9. Health
   - 0 = Radiobeacon Operation Normal
   - 1 = Unmonitored
   - 2 = No information available
   - 3 = Don’t use this Radiobeacon

a. RS ID

b. Broadcast Bit Rate

c. Modulation Mode

  0 = MSK

  1 = FSK

d. Synchronization Type

  0 = Synchronous

  1 = Asynchronous

e. Broadcast Coding

  0 = No Added Coding

  1 = Forward Error Correction Added

1. Lat/Long is position of broadcast site.

2. Recommended RS broadcast for itself, to advise current listeners of service range; along with two adjacent sites.

RSIM#22: RTCM Broadcast Scheduling

By default (after a full reset or cold start), the Correction Generation Method is set to null to indicate that no corrections are being transmitted. It is recommended that a valid RS position be entered (RSIM 6) before setting up a Correction Generation Method. This will ensure that proper corrections are generated.

For all RTCM message types, the RS will accept Interval values in seconds. The corrections messages, RTCM 1, 9, and 15, allows any Interval value. But for RTCM 3, 5, 7, and 16, the Interval value must be an even multiple of 60 seconds. The Z-12-R schedules these messages in minutes.

For example: The command "$PRCM,22,2,5,120.0,7,600.0,16,60.0" schedules RTCM 5 every two minutes, RTCM 7 every ten minutes, and RTCM 16 every one minute.

Usage:

1. CS sends to RS to schedule RTCM message broadcast content.
2. RS sends in response to CS queries. RS shall respond with all message types in use and their broadcast intervals.

```
FIELD #  1 2   3   4   5
         ^ ^   ^   ^   ^
$PRCM,22,x,x.x,x.x,x.x,...*hh<CR><LF>
```

Where:

1. Correction Generation Method
   1 = RTCM#1's
   2 = RTCM#9's in groups of 3 PRN's
   3 = RTCM#9's for individual PRN's
2. RTCM Message Type #
3. Interval
4. Synchronization Start Time
5. Additional RTCM#, Interval, & Synch fields {2-4} as required.

1. At RS, one RTCM# should be set to an interval of zero; RS will transmit that type whenever other types aren't due. This should not conflict with the broadcasts of corrections, which are sent continuously unless an interval other than zero is specified in field 3.

2. If interval value is null, that RTCM# won't be broadcast.

3. Refer to RSIM#8 and service provider broadcast standard in scheduling RTCM#5 messages

RSIM#23: RTCM Universal Message

This message has two purposes. First, it provides the RTCM messages in Universal format. It can be output every time a new RTCM correction message is generated by the RS or at a regular interval. When queried during an epoch when corrections were not sent by the RS, the response will only give the current time and nulls for the rest of the fields.

Second, RSIM 23 allows a user to enter a message to be sent by RTCM Type 16. For example, if a user wanted the RS to broadcast the message "MARK", the command: $PRCM,23,,16,,,,,,5062994,4923424" should be given. All fields in this command are null except for the RTCM# to be Transmitted and the RTCM Words that represent the message string. These RTCM words are formed as follows: break up the message string in groups of three characters (add spaces when necessary) - "MAR" and "K<sp><sp>". Determine the hex values for each character - "M" = 4d, "A" = 41, "R" = 52, "K" = 4b, "<sp>" = 20. Convert the hex values of the 3-character strings to decimal values -2dec("4d4152") = 5062994, hex2dec("4b2020") = 4923424. These are the RTCM words.

An RSIM 22 will also need to be given to set up an interval for the RTCM 16 message.

Usage:

CS uses to convey a RTCM#16 to the RS for transmission.

RS uses to convey RTCM broadcast data in digital format, if needed by the application.

```
FIELD #  1         2   3   4   5 6   7 8   9
         ^         ^   ^   ^   ^ ^   ^ ^   ^
$PRCM,23,hhmmss.ss,x.x,x.x,x.x,x,x.x,x,x.x,...*hh<CR><LF>
```

Where:

1. UTC Time
2. RTCM# To Be Transmitted
3. RS ID
4. Modified Z-Count
5. RTCM Sequence #
6. RTCM Frame Length
7. RTCM Station Health

   0-5: Defined by service provider

   6: Unmonitored

   7: Unhealthy
8. RTCM Word
9. Additional Field 8 RTCM Words as required.

1. CS sends desired information to RS as follows: required RTCM header information in RSIM fields 1-7, leaving fields to be assigned at the RS "null"; text for the body of the RTCM message follows as a series of base ten integer representations of the RTCM words without parity. Each repetition of RSIM Field 8 is to be converted into the actual binary values of the 24 bits of RTCM data, and then parity is added for each word at the RS.

2. When sent by the CS, for example, UTC Time could be converted (by the RS) from a decimal value (provided by the CS) to binary for transmission as Modified Z-Count. Likewise, the CS could leave the UTC Time field null and the RS would assign the Modified Z-Count when the RTCM message is generated for broadcast.

3. A RTCM#16 sent by the CS will be broadcast one time, unless scheduled by RSIM#22 for periodic transmission.

Table 6.3: List of RSIM Variables

Name	Units	Range	Type	RSIM#	Default Font
RSIM Message Type Desired		1-23	Variable Length Integer	1	
Destination Port		1-3	Fixed Length Integer	1	
Enable		0-1	Fixed Length Integer	1	
Output Interval	seconds	0-99999	Variable Length Integer	1	
Synchronization Start Time	UTC seconds	0-3599	Variable Length Integer	1	
UTC Time of Alarm	hours, minutes, seconds	000000.0-235959.9	Fixed/ Variable Length Time	2,5,17	
Incoming Unrecognized Message RSIM#	RSIM#	1-23	Variable Length Integer	2	
Reset Command		D/P/F	Fixed Alpha	3	
Logging Interval	seconds	0-99999.0	Variable Length Float	4	20.0
ASCII Diagnostic Text	To be determined		Variable Length Text	5	
RS ID	ID number	0-1023	Variable Length Integer	6,20,21,23	
Frequency Source		I/E	Fixed Alpha	6	I
External Source Frequency	MHz	1.00-21.00	Floating Numeric	6	0.0
Reference Position-Latitude	degrees, minutes	0000.0 - 8959.0	Fixed/ Variable Length Latitude	6	0000.0
North/South		N/S	Fixed Alpha	6	N
Reference Position-Longitude	degrees, minutes	00000.0-17959.0	Fixed/ Variable Length Longitude	6	6
West/East		W/E	Fixed Alpha	6	E
Altitude	meters		Floating Numeric	6	0.0
Mask Angle for Broadcast	degrees	0.0-90.0	Floating Numeric	6	10.0
Maximum Age of RTCM Correction	seconds		Floating Numeric	6	60.0
Total Number of Messages		1-4	Fixed Length Integer	7,13, 21	

Table 6.3: List of RSIM Variables (continued)

Name	Units	Range	Type	RSIM#	Default Font
Message #		1-4	Fixed Length Integer	7,13, 21	
UTC Time Observed	hours, minutes, seconds	000000.0-235959.9	Fixed/ Variable Length Time	7	
PRN #		1-32 or 99	Variable Length Integer	7,8,13	
Azimuth	degrees	0.0-360.0	Floating Numeric	7	
Elevation	degrees	0.0-90.0	Floating Numeric	7	
C/No	decibel Hertz		Floating Numeric	7	
URA	meters		Floating Numeric	7	
SV Health		0-63	Variable Length Integer		
Health Control Code		0-2	Fixed Length Integer	8	0
Loss of Satellite Warning Time (UTC)	hour, minutes, seconds	000000.0-235959.9	Fixed/Variable Length Time	9,12,23	
UTC Time	hours, minutes, seconds	000000.0 - 235959.9	Fixed/Variable Length Time	9,12, 23	
Status of PRN		0-8	Fixed Length Integer	9	0
Channel		1-2	Fixed Length Integer	10	
Frequency	kHz	283.5-325.0	Floating Numeric	10	
Operating Mode		0-3	Fixed Length Integer	10	0
Broadcast Bit Rate	bits per second		Variable Length Integer	10,21	100
Modulation Mode		0-3	Fixed Length Integer	0	0
Synchronization Type		0-1	Fixed Length Integer	10,21	N/A
Broadcast Coding		0-1	Fixed Length Integer	10,21	N/A
Beacon Identifier			4 alpha numeric characters	10	0
Quantity Satellites Alarm Minimum			Fixed Length Integer	11	3

Table 6.3: List of RSIM Variables (continued)

Name	Units	Range	Type	RSIM#	Default Font
PRC Alarm Threshold	meters		Floating Numeric	11	655.34
RRC Alarm Threshold	meters/ second		Floating Numeric		1.0
IM System Feedback Time Threshold	seconds		Floating Numeric	11	3.0
Insufficient Satellites Alarm		I/S	Fixed Alpha	12	
Unmonitored Alarm		F/W/U/M	Fixed Alpha	12	
High PRC Alarm		H/N	Fixed Alpha	12	
High RRC Alarm		H/N	Fixed Alpha	12	
UTC Time of Message	hours, minutes, seconds	000000.0-235959.9	Fixed/ Variable Length Time	13	
RRC	meters/ second		Floating Numeric	13	
PR Acceleration	meters/ second2		Floating Numeric	13	
UDRE	meters		Floating Numeric	13	
RTCM Modified Z-Count	GPS seconds	0.0-3599.4	Floating Numeric	13,23	
IOD		0-255	Variable Length Integer	13	
Position Flag		0-2	Fixed Length Integer	20	
PR Trouble Indicator		0-32	Variable Length Integer	20	
Latitude	degrees, minutes	0000.0 - 8959.0	Fixed/ Variable Length Latitude		
North/South		N/S	Fixed Alpha	21	N
Longitude	degrees, minutes	00000.0 - 17959.0	Fixed/ Variable Length Integer	21	00000.0
West/East		W/E	Fixed Alpha	21	E
Radiobeacon Range	kilometers		Variable Length Integer	21	0
Frequency	kHz		Floating Numeric	21	0.0

Table 6.3: List of RSIM Variables (continued)

Name	Units	Range	Type	RSIM#	Default Font
Health		0-3	Fixed Length Integer	21	0
Correction Generation Method		1-3	Fixed Length Integer	22	"Null"
RTCM Message Type #		1-64	Variable Length Integer	22	
Interval	seconds		Floating Numeric	22	
Synchronization Start Time	UTC seconds into first hour	0-3599	Variable Length Integer	22	

Detailed DBEN Message Structure

General

DBEN is a binary message which contains the message header, receiver time, receiver site ID, GPS pseudo-range and carrier phase measurements, checksum and message tail. It is similar to an MBEN message but it is bitwise compressed and the decoding program must perform bitwise manipulation in order to decode it properly.

DBEN Message Structure

A complete DBEN message can be divided into three parts:

Message Header

Message Data

Message Tail

More fine division is as follows:

0$XXYYR,TZZ

[DML]

[Data]

[ChkSum]

<CR><LF>

Number of bits and detailed explanation of each part are listed as follows:

Message Header Part

Table 7.1: Message Header

Num. of bits	Symbol	Content
8	$	To mark the beginning of a message.
8x2	XX	The message sender ID. This is what you would have entered in receiver at field Receiver is: of RECEIVER IDENTIFICATION sub-screen in receiver menu 4/SubCommand

Table 7.1: Message Header (continued)

Num. of bits	Symbol	Content
8x2	YY	The message designator ID. This is what you would have entered in receiver at field Remote is: of RECEIVER IDENTIFICATION sub-screen in receiver menu 4/SubCommand
8x2	R,	To indicate it is a responding message (always be "R,").
8	T	To identify if the message is in compressed form (P for PACKED) or uncompressed form (R for UNPACKED)
8x3	ZZ,	Is the message type, This is what you would have selected in the receiver's DBEN DATA FORMAT SELECTION sub-screen.
16	DML	Length of Message Data Part [Data], after DML and before ChkSum, in units of bytes

Total bits : 104

Message Data Part

Table 7.2: Message Data

Number of Bits	Symbol	Content
30	RTime	Receiver time in units of GPS milliseconds of week
8x4	Site ID	Receiver four-character site ID
32	PRN	SVPRN for the satellites which have data to be followed. It is a bitwise indication. Starting from least significant bit, bit 1 corresponds to SVPRN #1, bit 2 corresponds to SVPRN #2, and so on. If a given bit is 1, it means that SVPRN has data, 0 otherwise.

The following repeats for each data slot and each SV.

31	PR	Pseudorange in units of 1.0e-10 seconds (or 0.1 nanoseconds). Multiply this value by 1.0e-10 to pseudo-range in seconds. A zero value may be sent for bad pseudo-range.
1	WN	Warning bit (1- bad carrier phase, 0 - good carrier phase)
1	SIGN	Sign bit (1 - negative carrier phase value, 0 - positive carrier phase value)

28	PH_I	Integer part of the carrier phase measurement in cycles
11	PH_F	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 above part are a module of 16 bits

Total bits: ceil ((94 + 72*N_{slot}*N_{svs})/16) * 16,

ceil (a) means truncates to +Inf, e.g., ceil (3.1) = 4, ceil (3.5) = 4, ceil (3.95) = 4.

N_{slot} is number of data slot in given message type, see following table DBEN Message Definition for number of slot in each message type.

N_{svs} is number of SVs.

For Z-XII with firmware version ALS0 (04/14/94 14:05) This is one bit flag right after WN to indicate widelane cycle-slip (for RWL type only, not implemented for other DBEN message type yet). This is interpreted in PNAV software as Type 1 DBEN message (in PNAV version 3.0.00T release Alpha0#, Menu ALT-R/F5). Without this flag is interpreted as Type 0 DBEN message.

Message Tail:

Table 7.3: Message Tail

Number of Bits	Symbol	Content
16	[Chk Sum]	The word-wise (16 bits) sum of the [Data] message. It is a cumulative unsigned short sum of the [Data message], after DML, before this ChkSum.
8x2	<CR><LF>	To mark the end of message.

Total bits: 32

DBEN Message Types

Five types of DBEN messages are implemented for real-time PNAV, as listed in Table 7.4. Each type of message can be in the form of PACKED or UNPACKED. The pseudo-range can be raw pseudo-range (UNSMOOTHED) or smoothed pseudo-range with internal carrier phase smoothing (SMOOTHED).

Table 7.4: DBEN Message Definition

Message ID	Message type in receiver screen	Observables	num. of slots
RCA	C/A CODE:	C/A code + CAL1 carrier phase	1
RWL	WIDE LANE:	(PL1 code + PL2 code)/2 + (L1 carrier phase - L2 carrier phase)	1
RP1	L1 P CODE:	C/A code + CAL1 carrier phase + PL1 code + PL1 carrier phase	1
RP2	L2 P CODE:	C/A code + CAL1 carrier phase + PL2 code + PL2 carrier phase	2
RPC	FULL P CODE:	PL1 code + PL1 carrier phase + PL2 code + PL2 carrier phase or CA code + CAL1 carrier phase + PL2 code + PL2 carrier phase	2

Currently, Doppler is not included in the DBEN message.

One epoch message size of each type of DBEN message is listed in Table 7.5

Table 7.5: DBEN Message Size (bits)

Number of satellites									
Message Type	4	5	6	7	8	9	10	11	12
RCA, RWL	520	600	664	744	808	888	952	1032	1096
RP1, RP2, RPC	808	952	1096	1240	1384	1528	1672	1816	1960

With Doppler

Table 7.6: Doppler Message Size (bits)

Number of Satellites									
RCA, RWL	632	728	824	920	1016	1112	1208	1304	1400
RP1, RP2, RPC	1016	1208	1400	1592	1784	1976	2184	2376	2568

Use this table to determine the data link rate requirement. For example, for a typical application tracking at most eight satellites, if a once-per-second update rate is required, there are 1384 bits of data in the DBEN message. The minimum requirement for a modem would be: 2400 BAUD with nearly 100% duty cycle.

Message Compression

The message is in UNPACKED format. In a future implementation, a PACKED format will reduce the message length by 50%.

Pseudo Range Smoothing

Normally, the raw pseudo-range is output UNSMOOTHED. In a future implementation, the pseudo-range (code) is modified with receiver internal carrier phase smoothing corrections (SMOOTHED).

System Control

This chapter describes the self-test messages, unhealthy GPS codes, and default parameters. In addition, it contains procedures for clearing the internal and external memory.

Self-Test Messages

At power-up, the Z-12R receiver performs internal tests to check various components and circuits. As the self-test is completed, the respective self-test messages are displayed:

EPROM checksum test pass

XRAM installed

Mag var checksum OK

Downloading Channel

If all tests pass, the screen will display the message "downloading channel" and go to Screen 0. If any test fails, the program halts with the corresponding self-test message.

Unhealthy Codes

The unhealthy code used with GPS satellite identification consists of two hexadecimal digits. They represent four bits each and need to be converted to a single 8-bit binary number. The binary number is then broken so the three most significant bits represent the health of the data (Table 8.1). The second grouping (five bits) reflects the health of the signal (Table 8.2). For example, to translate the code 3C (as displayed on the receiver):

1. First, write it as two 4-bit groups: 0 0 1 1 and 1 1 0 0
2. Then write as one 8-bit number: 0 0 1 1 1 1 0 0
3. Regroup to three and five digits: 0 0 1 and 1 1 1 0 0
4. Read 001 from Table 8.1 and 11100 from Table 8.2. 001 reports a parity error; 11100 indicates the satellite is temporarily out of range.

Table 8.1: NAV Data Health (Bits 0 through 2)

Bit 0	Bit 1	Bit 2	NAV Data Health
0	0	0	All data okay
0	0	1	Parity failure
0	1	0	TLM/HOW format problem
0	1	1	Z count in HOW is bad
1	0	0	Subframes 1, 2, 3: One or more elements in words 3 through 10 of one or more subframes are bad
1	0	1	Subframes 4, 5: One or more elements in words 3 through 10 of one or more subframes are bad
1	1	0	All uploaded data is bad
1	1	1	All data is bad. TLM word and/or HOW and 1 or more elements in any one or more subframes are bad

Table 8.2: NAV Data Health (Bits 3 through 7)

Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	NAV Data Health
0	0	0	0	0	All signals okay
0	0	0	0	1	All signals weak
0	0	0	1	0	All signals dead
0	0	0	1	1	All signals - no data modulation
0	0	1	0	0	L1P signal weak
0	0	1	0	1	L1P signal dead
0	0	1	1	0	L1P signal - no data modulation
0	0	1	1	1	L2P signal weak
0	1	0	0	0	L2P signal dead
0	1	0	0	1	L2P signal - no data modulation
0	1	0	1	0	L1C signal weak
0	1	0	1	1	L1C signal dead
0	1	1	0	0	L1C signal - no data modulation
0	1	1	0	1	L2C signal weak
0	1	1	1	0	L2C signal dead
0	1	1	1	1	L2C signal - no data modulation

Table 8.2: NAV Data Health (Bits 3 through 7) (continued)

Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	NAV Data Health
1	0	0	0	0	L1P and L2P signals weak
1	0	0	0	1	L1P and L2P signals dead
1	0	0	1	0	L1P and L2P signals - no data modulation
1	0	0	1	1	L1C and L2C signals weak
1	0	1	0	0	L1C and L2C signals dead
1	0	1	0	1	L1C and L2C signals - no data modulation
1	0	1	1	0	L1 signal weak
1	0	1	1	1	L1 signal dead
1	1	0	0	0	L1 signal - no data modulation
1	1	0	0	1	L2 signal weak
1	1	0	1	0	L2 signal dead
1	1	0	1	1	L2 signal - no data modulation
1	1	1	0	0	SV is temporarily out; do not use during current pass.
1	1	1	0	1	Satellite will be temporarily out. Use with caution.
1	1	1	1	0	Spare
1	1	1	1	1	More than one combination would be required to describe the anomalies found.

Resetting Memory

A reset of the internal memory of the receiver clears the receiver to the factory defaults, including almanac data. To complete this reset, proceed as follows:

1. Turn the receiver off.
2. While pressing the ▲ key, turn the receiver on.
3. Keep holding the ▲ key down until the message "Test of internal RAM. Will clear all data. Press yes within 10 seconds to continue" is displayed.
4. Press **[8]** (yes) and a message appears: "Push any key to continue." Press any key to continue with the receiver normal operation.

System Control

A reset of the external memory of the receiver erases all data files displayed on Screen 8 and stores them in the memory RAM board. To complete this reset, proceed as follows:

1. Turn the receiver off.
2. While pressing the ▶ key, turn the receiver on.
3. Keep holding the ▶ key down until the message "Test of external RAM. Will clear all data. Press yes within 10 seconds to continue" is displayed.
4. Press **[8]** (yes) and the message "Push any key to continue" appears. Press any key. The receiver is now ready for use.

Receiver User Parameters

Receiver user parameters are stored in the internal memory of the receiver. Initially, they are set to their default values, but can be overridden in two different ways, depending on the parameter. Some are overridden automatically when their values are modified through their corresponding screens, and others are saved in memory when issuing the command 555 in Screen 8. Once parameters are saved in the internal memory, powering the receiver off does not change their values.

Some of these parameters can be set back to their default values by issuing the command 550. To set all parameters back to their default values, do an internal memory reset of the receiver.

The following table lists all receiver user parameters, showing their default values. It also lists which parameters are saved automatically when their values are modified through their corresponding screen, which are saved with command 555 and which are set to their defaults with command 550.

Table 8.3: Receiver User Parameters

Parameters	Default	Saved Autom	Saved By 555	Reset By 550
SCREEN 4				
POS	0	Yes	No	No
REC INT	20.0	Yes	Yes	Yes
MIN SV	3	No	Yes	Yes
ELEV MASK	10	Yes	Yes	Yes
RNGR	0	No	Yes	Yes
POSITION				
POS MODE	0	Yes	No	No

Table 8.3: Receiver User Parameters (continued)

Parameters	Default	Saved Autom	Saved By 555	Reset By 550
ALT MODE	0	Yes	No	No
ELV MASK	10	No	Yes	Yes
UNHEALTHY	N	No	Yes	Yes
PDOP MASK	40	No	Yes	Yes
HDOP MASK	04	No	Yes	Yes
VDOP MASK	04	No	Yes	Yes
COMP POS	Y	No	Yes	Yes
ION MODEL	N	No	Yes	Yes
UTM COORD	N	No	Yes	Yes
DATUM	WGS84	No	No	No
SESSION				
START, END	0	Yes	No	No
INT	20.0	Yes	No	No
MASK, MIN, TYPE	10,3,0	Yes	No	No
INUSE	N	Yes	No	No
REF	000	Yes	No	No
OFFSET	00:00	Yes	No	No
DIFFERNTL				
MODE	Disabled	No	Yes	Yes
AUTO DIFF	Disabled	No	Yes	Yes
OUTPUT PORT	A	No	Yes	Yes
CODE	C/A	No	Yes	Yes
RTCM				
SPD	0100	Yes	No	Yes
STID	0000	Yes	No	No
STHE	0	Yes	No	No
FREQ (TYPE 1)	00	Yes	No	Yes
FREQ (TYPE 2)	00	Yes	No	Yes
FREQ (TYPE 3)	00	Yes	No	Yes

Table 8.3: Receiver User Parameters (continued)

Parameters	Default	Saved Autom	Saved By 555	Reset By 550
FREQ (TYPE 5)	00	Yes	No	Yes
FREQ (TYPE 7)	00	Yes	No	Yes
FREQ (TYPE 9)	99	Yes	No	Yes
FREQ (TYPE 15)	00	Yes	No	Yes
TYPE 9 GROUP	9-3	Yes	No	Yes
FREQ (TYPE 16)	00	Yes	No	Yes
TYPE 6	On	Yes	No	Yes
SEQ	N	Yes	No	Yes
MAXAGE	0030	Yes	No	No
QAFREQ	100	No	No	No
MESSAGE	Empty	Yes	No	Yes
MSK				
MSK	Off	Yes	No	No
CH1 FREQ & MOD	000.0/Off	Yes	No	No
CH2 FREQ & MOD	000.0/Off	Yes	No	No
FILL TYPE	Space	Yes	No	No
SPEED	100	Yes	No	No
PORT A, B, C OR D				
NMEA	Off	No	Yes	Yes
All NMEA Messages	Off	Yes	No	No
Send Interval	005	Yes	No	Yes
Real Time	Off	No	Yes	Yes
MBEN	Off	No	Yes	Yes
PBEN	Off	No	Yes	Yes
SNAV	Off	No	Yes	Yes
SALM	Off	No	Yes	Yes
FORMAT	ASCII	No	Yes	Yes
VTS	Off	No	Yes	Yes
BAUD RATE	9600	Yes	No	Yes

Table 8.3: Receiver User Parameters (continued)

Parameters	Default	Saved Autom	Saved By 555	Reset By 550
PULSE GEN				
PERIOD	01.00	No	Yes	Yes
OFFSET	+000.0000	No	Yes	Yes
OUTPUT ON A	N	No	No	No
OUTPUT ON B	N	No	No	No
EXT FREQ				
FREQUENCY	00.00	No	Yes	Yes
SAVE	N	No	Yes	Yes
MODEM				
PORT	A	No	Yes	Yes
TYPE	Telebit World Blazer	No	Yes	Yes
RCVR CTRL				
Z MODE	A	Yes	No	No
SCREEN 7				
AUTO SELECTION	Y	No	Yes	Yes
ALL SATELLITES	Y	No	Yes	Yes
SCREEN 9				
SITE	????	Yes	No	Yes
SESS	----	Yes	No	Yes
RCV#	----	Yes	No	Yes
ANT#	----	Yes	No	Yes
MMDD	----	Yes	No	Yes
OPR	----	Yes	No	Yes
CODE	------------	Yes	No	Yes
HI	0.0000	No	No	No
T-DRY	+00	No	No	No
WET	+00	No	No	No
RH	00	No	No	No
BP	0000	No	No	No

Table 8.3: Receiver User Parameters (continued)

Parameters	Default	Saved Autom	Saved By 555	Reset By 550
MIN SV	0	No	No	No
RECORD	Y	No	No	No
EPOCHS	000	No	No	No

Maintenance

This chapter provides information about antenna and power cables used with the Z-12R receiver, information about radio interference, and various maintenance procedures.

General

1. DC Input Power

   12 VDC. 3A Use only with Class 2 Power source

CAUTION
Disconnect the power cord before servicing the receiver.

2. Rack Mounting Instructions

   The unit is to be mounted in a standard 19” rack utilizing the four 12-24 x 1/2” Truss steel screws provided. Ashtech part number 103649.

WARNING
DO NOT BLOCK THE VENTS OR FANS OF THE RACK MOUNT CABINET OR ANY OTHER EQUIPMENT THAT IS MOUNTED IN THE CAB INET

3. Temperature Ranges

   Operating Range -20 to +55 C

   Storage Range -30 to +75 C

Antenna Cables

The antenna cable shown in Figure 9.1, may be up to 30 meters long. A line amplifier is available for greater distances. Other technical specifications are shown in Figure 9.2. The supplied cable is a 30-meter Belden 8214 (RG-8/U-type, but with better loss specifications).

The cable uses type-N male connectors at both ends which are center captured. If a non-Ashtech cable is to be used, it must be the same type and have the same connectors as noted above.

Type 8214 RG-8 cable meets these specifications, but other RG-58/U and RG-8/U cables may not. Make sure any substitute cables satisfy Ashtech electrical requirements or the GPS receiver may not perform properly.

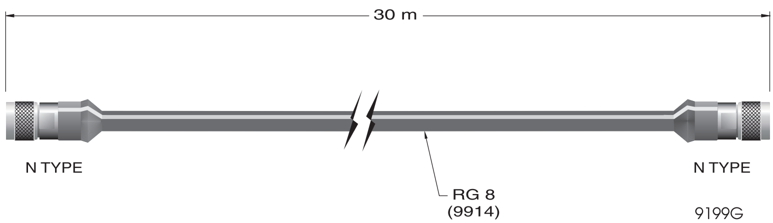


Figure 9.1: Antenna Cable

Table 9.2: Antenna Cable Electrical Specifications

Component	Function
Insertion loss	12 db max. (at 1.5 GHz)
Characteristic impedance	50 ohm (nominal)
DC resistance	0.5 ohm ground braid and center conductor

Power Cable Pinouts

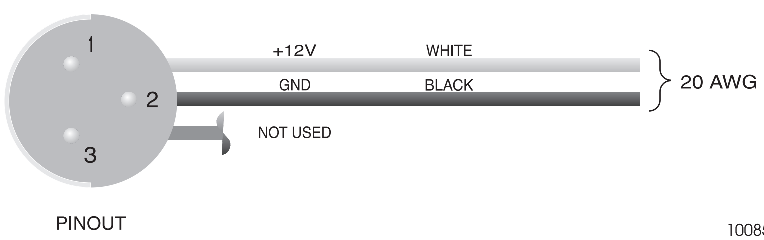


Figure 9.3: Power Cable Pinouts

Pinouts for the power cable are shown in Figure 9.3 above. Use 20 AWG wire or larger when fabricating this cable.

RS-232 / RS-422 Pinouts

The RS-232 and RS-422 Fischer connector pinouts are shown in Figure 9.4. Use 24 AWG cable in shielded, twisted pairs when fabricating this cable. Use full handshaking when communicating with external equipment.

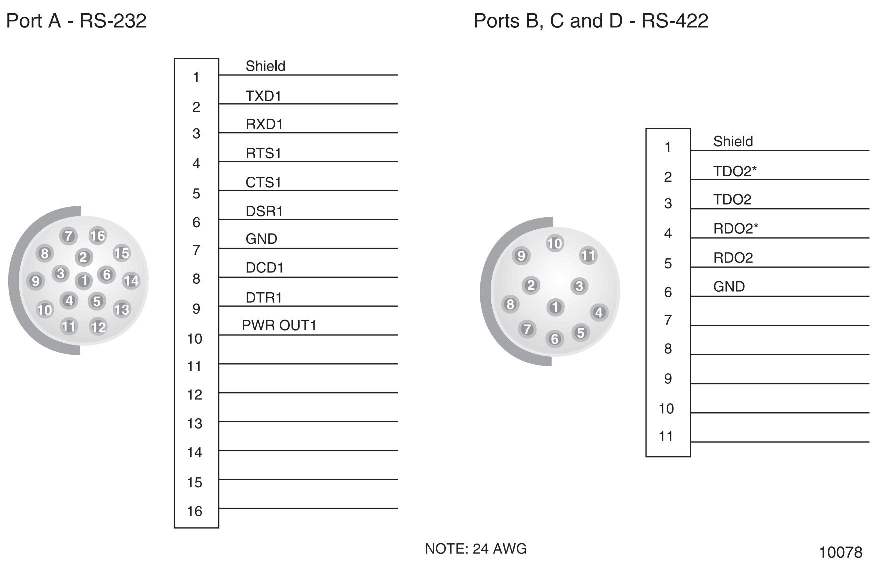


Figure 9.4: Connector Pin Assignments

Radio Interference

Ashtech recommends that the user verify that the broadcast frequencies of any hand-held or mobile communications devices do not interrupt or obstruct GPS receivers during data collection.

WARNING
Some radio transmitters and receivers (such as FM radios) can interfere with the operation of GPS receivers if operated in close proximity.

Power Consumption

The maximum power consumption of the Z-12R receiver with backlighting on is 18 watts when operating from DC, 32 watts when operating from AC.

Internal Batteries

Two lithium batteries maintain saved parameter data. The batteries are rated at 1.8 AH and have an operating life of ten years in this application. The batteries should be monitored after nine years of use, and replaced after ten years.

If the batteries need to be replaced, the unit must be returned to Ashtech.

Lithium Battery Disposal Instructions

WARNING
DANGER OF EXPLOSION. IF BATTERY IS INCORRECTLY REPLACED. DISPOSE OF USED BATTERIES ACCORDING TO MANUFACTURER'S INSTRUCTIONS.

Sleep Mode

If internal voltage drops below 10.4 VDC, the receiver goes into the sleep mode. After voltage is restored, the next power cycle resumes normal operation. Memory and stored parameters are protected.

AC to DC Power Conversion

The AC-to-DC power converter converts AC power to 15 VDC, which in turn drives an internal regulated power supply. The internal regulated power supply can operate from any voltage input between 11 and 16 VDC. It is extremely unlikely that severe external transients can propagate through the converter and disrupt normal operation of the receiver.

Fuse Replacement

The receiver contains both AC and DC fuses. This section explains how to replace each of these.

DC Fuse

The DC fuse is located on the lower left-hand side of the rear panel, shown in Figure 9.5.

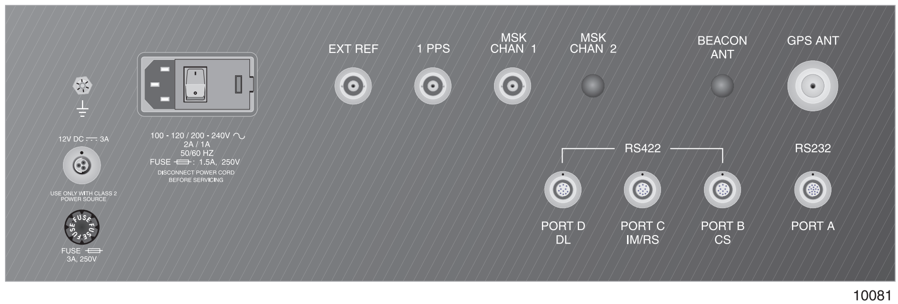


Figure 9.5: Fuse Location

Replace this fuse as follows:

1. Grasp the fuse knob firmly and turn it one-half turn to the left and remove it.
2. Remove the old fuse.
3. Put a new fuse (3A, 250v) into the receptacle.
4. Replace the fuse knob and turn it on-half turn to the right to secure it.

AC Fuse

The AC fuse is located in the power module on the rear of the unit as shown in Figure 9.6.

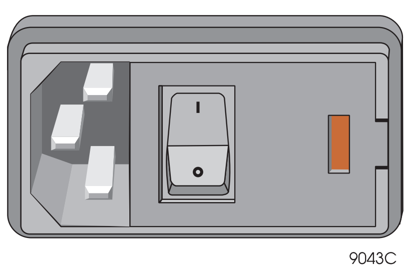


Figure 9.6: Power Module

Replace the fuse as follows:

1. Using a flat-bladed screwdriver, open the fuse latch shown in Figure 9.7.

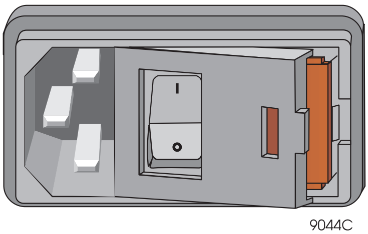


Figure 9.7: Fuse Latch

2. Open the latch as far as possible.
3. Slide out the fuse container as shown in Figure 9.8.

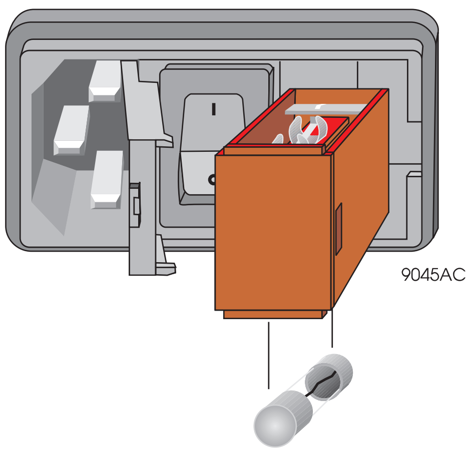


Figure 9.8: Fuse Container

4. Remove the old fuse from the **bottom** of the the fuse container and replace it with a new one (1.5A, 250v). DO NOT PUT THE FUSE IN THE TOP. Make sure the metal clip on the top of the container remains in place.
5. Slide the fuse container back into the power module.
6. Close the fuse latch.

Upgrading Firmware

General

The Z-12R receiver contains flash EPROMs that can be upgraded with new firmware without opening the unit. Updates are obtained through the Ashtech customer support group, and can be loaded into the receiver with a personal computer.

PLZ is the Ashtech program that updates the firmware in Z-12 receivers. PLZ uses the following program files:

- NAV.DAT - binary data file containing the Nav firmware
- BIN.DAT - binary data file containing the channel firmware

These files are found on the distribution disk along with PLZ.EXE, the loading program which uploads NAV.DAT and BIN.DAT into the receiver.

Program Execution

1. Before executing PLZ, either copy PLZ.EXE and the program files from the distribution disk to your computer hard disk, or execute PLZ from the distribution disk. If you execute PLZ from the distribution disk, more execution time is required to read the data file and send it to each receiver.
2. Before executing PLZ, have power supplied to the receiver and the RS-232 communications cable attached to the computer and the receiver. Either COM1 or COM2 on the computer can be used. Only Port A on the receiver can be used.

3. With the receiver powered on, start PLZ by typing the following command at the DOS prompt:

   PLZ <ENTER>The program defaults for PLZ.EXE are set to run a main program load from PC serial port COM1 at 115200 baud on an VGA/EGA screen. Different options can be set by using the following format:

   PLZ -x -yy +z

   where

   -*x* is the PC serial port (-2 for COM2)

   -*yy* can be either :

   -*bt* boots load instead of a main program load

   -*mn* sets the display for monochrome screen

   +*z* sets baud rate where y is an integer from 5-9:

   +5 sets the baud rate to 9600

   +6 sets the baud rate to 19200

   +7 sets the baud rate to 38400

   +8 sets the baud rate to 57600

   +9 sets the baud rate to 115200

Multiple options may be selected, separated by a space. For example, entering “PLZ -mn -2 +5” selects COM2 at a baud rate of 38400 and sets the display for monochrome.

WARNING
DO NOT disconnect the cable from the receiver or turn off the receiver until the program completes execution.

Once the program has begun execution, the following information is displayed on the monitor screen:

ASHTECH Z-XII PROGRAM LOADER CSC 1.1

>> SETTING UP INTERFACE TO THE RECEIVER

SENDING PROGRAM TO THE RECEIVER

1ST MEMORY LOADING

2ND MEMORY LOADING

The display shows the program loading status. The symbol >> points to the current process step, and the step is highlighted.

The transmission status consists of two execution steps:

- The interface setup step where an RS-232 connection is established between the receiver and the computer and the receiver is prepared to receive the program data
- The program transfer step where the program data is transferred to the receiver.

The receiver reprogram status consists of two stages, represented by two separate lines

1ST MEMORY LOADING

2ND MEMORY LOADING.

When each stage is in execution, a percentage complete for that stage is displayed. The stage is complete when the percentage indication is 100.

4. After the program has finished execution and returns to the operating system prompt, disconnect the communications cable from the serial port and turn off the receiver using the power switch.
5. Reset the receiver internal and external memory as described in Chapter 8, **System Control**.
6. The receiver firmware program has now been properly updated. To confirm the new version, turn on the receiver. The new version appears in the lower right corner of menu 0.

Maintenance

Warning Messages

Warning messages are displayed by the PLZ program to inform the user of potential problems during the program execution.

When the receiver is in the reprogramming stages, the following message appears at the bottom of the screen:

WARNING
Keep the receiver turned on until the end of program loading!

Do not turn off the receiver or disconnect the cable from the receiver until the completion of PLZ program execution. The receiver's main program will be corrupted, and a boot load will be necessary.

Error Messages and Abnormal Termination

When errors are detected during program execution, PLZ displays an appropriate error message and terminate the loading process.

1. When the program data files are not found in the default directory, the following message appears:

   ERROR: FAILED TO FIND NAV.DAT FILE

   Correct this error by loading the NAV.DAT and BIN.DAT files into the default directory and restarting the execution of PLZ.

2. If PLZ fails to establish communication with the receiver, the following message appears:

   ERROR: RS232 TRANSMIT PROBLEM PROGRAM LOADING FAILED

   If this problem occurs, make sure that each of the program execution steps above has been followed and both the power supply and cables are working. Also ensure that the receiver is powered on and the cable is plugged into the correct port. Restart the receiver and repeat the steps above. If the problem recurs, call Ashtech customer support.

3. When invalid program data is transferred to the receiver, the message

   INVALID CHECKSUM

   may appear at the bottom of the screen.

   This can occur for either of two reasons:

   - The baud rate is too fast for the computer serial port. Set a lower baud rate (9600 suggested) as described in step 3 of the Program Execution section.
   - One of the .DAT files has become corrupted. Either recopy the files from the disk or re-download the files from the Ashtech Bulletin Board.

   In either case, a boot load is necessary. See below for instructions on boot loading.

   If this problem continues, call Ashtech customer support.

4. If the program abnormally aborts at the SENDING PROGRAM TO THE RECEIVER stage and does not load the program at all, it is likely that the baud rate is too high for the computer. If this happens, the main program is now corrupted and a boot load will be necessary.

   Exit the program using the ESC key and follow the boot procedure described below, then run the PLZ program at a lower baud rate.

Boot Loading

Once the program has started sending program data to the receiver, any abnormal termination (power failure, program hang up, checksum errors) corrupts the main program, and a normal main program load is no longer possible. In these cases, a boot load is necessary. Perform this as follows:

1. Exit the PLZ program by using the ESC key on the computer.
2. Turn the receiver off, then on while pressing the **[0]** key. The receiver indicates that the main program has been corrupted by displaying the following message

   SERIAL PORT A HAS BEEN SELECTED. WAITING FOR MAIN PROGRAM LOAD

   If the hose cable is connected to receiver Port B, press and hold the **[9]** key when you turn the receiver back on. The first part of the message should now read

   SERIAL PORT B HAS BEEN SELECTED
3. At the DOS prompt, enter:

   PLZ -bt <ENTER>
4. To reduce the baud rate, use one of the baud rate options described in step 3 of Program Execution, for example:

   PLZ -bt +7

   runs the boot load at a baud rate of 38400.
5. The PLZ program should run normally at this point.

Ashtech-to-RINEX Conversion

Ashtech's ASHTORIN software converts Ashtech B-files, E-files, optional S-files, and optional D-files into the RINEX (Receiver INdependent EXchange) format. This allows data collected from receivers of different manufacturers to be combined.

Ensure that there is enough room to create a file on the specified drive; if not, ASHTORIN will terminate with an appropriate error message.

Input Data Files

ASHTORIN uses the Ashtech B-files, E-files, optional S-files, and optional D-files as input data.

Output Data Files

ASHTORIN can generate three different files, an Observation file, a Navigation file, and a Meteorological file. Some applications require one Observation file and one Meteorological file for each site per session; others require only the Observation file. Only one Navigation file must be generated per session, as long as the converted E-file spans the entire session.

Program Execution

Change to the directory containing the receiver files to be converted.

At the DOS prompt, type

ASHTORIN<ENTER>

to bring up the standard version screen followed by ASHTECH Source Files/RINEX Target Files Menu 2.1, (Figure A.2):

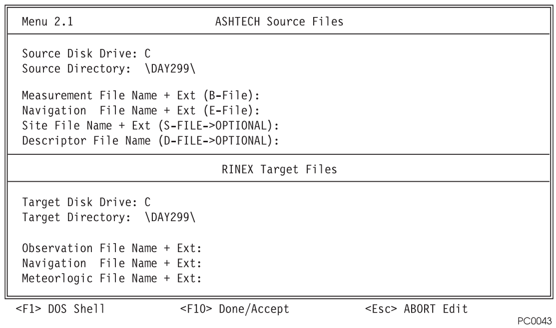


Figure A.1: Ashtech Source File Screen

Ashtech Source Files

The top section, defines the Ashtech files that you want to convert. This section contains the data entry fields:

Source Disk Drive: and Source Directory

Initially, the volume and path from which ASHTORIN was executed (in this case, C:\DAY299). Move the cursor to the field to be change, and type in the desired file location.

File Name + Ext: B-File, E-File, S-FILE (OPTIONAL), and D-FILE (OPTIONAL).

RINEX Target Files

The bottom section, defines the RINEX files that will be created. This section contains the following data entry fields:

Target Disk Drive: and Target Directory

Initially, the volume and path from which ASHTORIN executed (in this case, C:\DAY299). Move the cursor to the field to be changed, and type in the desired file location:

File Name + Ext: **Observation, Navigation and Meteorological.**

When typing in an **ASHTECH Source** measurement file name (for example, the sample B-file, BMAPRA90.299), ASHTORIN automatically fills in the corresponding E-file and S-file name in its appropriate field and suggests a set of RINEX file names in the **RINEX Target Files** section; observe, typically:

```
Menu 2.1                     ASHTECH Source Files

Source Disk Drive: C
Source Directory:  \DAY299\

Measurement File Name + Ext (B-File):    BMAPRA90.299
Navigation  File Name + Ext (E-File):    EMAPRA90.299
Site File Name + Ext (S-FILE->OPTIONAL): SMAPRA90.299
Descriptor File Name (D-FILE->OPTIONAL):

                              RINEX Target Files

Target Disk Drive: C
Target Directory:  \DAY299\

Observation File Name + Ext:  MAPR2991.90O
Navigation  File Name + Ext:  MAPR2991.90N
Meteorlogic File Name + Ext:  MAPR2991.90M

<F1> DOS Shell          <F10> Done/Accept          <Esc> ABORT Edit
                                                                PC0044
```

Figure A.2: Menu 2.1 ASHTECH Source Files / RINEX Target Files

Ashtech recommends naming the RINEX output files with the O-suffix for the observation filename, N-suffix for the navigation filename, and M-suffix for the meteorological filename. This format follows the standard RINEX naming convention for output files:

ssssdddf.yyt

where:

ssss	is a 4-character station name designator.
ddd	is the day of the year of the first record.
f	is the file sequence number to within a day.
yy	is the year.
t	is the file type where **O** indicates observation file, **N** indicates navigation file, and **M** indicates meteorological data file.

After the source files and the target files have been entered and the correct drive and directory established, press <F10> to access the Program Options Menu 2.0 (Figure A.3):

```
                         Menu 2.0

              Program Options:

              A) File Input/Output Menu
              B) Create RINEX Observation File
              C) Create RINEX Navigation File
              D) Create RINEX Meteorological File
              E) Exit

        <F1> - DOS Shell    <F10> - Accept Selection
                                                  PC0045
```

Figure A.3: Menu 2.0 Program Options

This menu provides the options of:

a. Return to the File Input/Output Menu,

b. Create Observation File,

c. Create Navigation File, or

d. Create Meteorological file.

To choose the desired option, use the arrow keys followed by **<ENTER>** or the **<F10>** key, or press the letter for the desired action.

1. To create an Observation file a valid B-file and E-file must be found.
2. To create a Navigation file a valid E-file must be found.
3. To create a Meteorological file no input files are required.
4. ASHTORIN creates an output file using the name you specify on Menu 2.1 (Figure A.2).
5. If the output file already exists, it is overwritten and the original file data is destroyed. In addition, a valid output filename must be entered to access the appropriate option.
6. If the above input file requirements are not met for a particular output file, ASHTORIN will not allow you to enter that menu screen.

Option A: File Input/Output Menu

When selecting this option, the software returns to the ASHTECH Source Files/RINEX Target Files menu screen (Figure A.2), typically after an Ashtech-to-RINEX conversion is completed.

Option B: Create RINEX Observation File

1. Select Program Option B; observe, typically:

```
                    Menu 2.2 - Rinex Observation File
 Station Name:    ????
 Station Number:
 Observers Name:  SDH
 Observing Agency:
 Agency Creating Current File:
 Comments:

 Receiver Type (ie: L-XII, M-XII, etc.): RANGER
 Receiver Serial Number (last 4 digits): 696
 Antenna Type  (ie:Sensor Microstrip):
 Antenna Serial Number (last 4 digits):  901
 Type of Data   1 = L1,  2 = L2:         0

 Antenna Offsets: North   0.0000 (m)   Slant Distance   1.7390 (m)
                  East    0.0000 (m)   Radius           0.0000 (m)
                                       Delta Vertical   0.0000 (m)

 All Optional Headers: N

<F1> DOS Shell    <F5> Accept/Return    <F10> Process         <Esc> ABORT Edit
                                                                        PC0046
```

Figure A.4: Menu 2.2 Information Screen

In this screen:

2. ASHTORIN automatically extracts from the B-file and displays the current site identifier in the **Station Name** data field and the **Type of Data** in the corresponding field.
3. If the current directory contains a valid S-file associated with the B-file selected, ASHTORIN automatically extracts from the S-file and displays, in the corresponding field the **Observers Name**, the receiver type, the receiver serial number, and the slant distance.
4. Menu 2.2 (Figure A.4) consists of four sections:
   - Agency Information
   - Equipment and Data Information
   - Antenna Offsets Information
   - All Optional Headers selector

Any of the entries can be changed and any of the other fields completed in these sections as desired.

The most recent entry to the fields Station name, Agency Creating Current File, and Comments applies globally to the following screens:

- Menu 2.2 - Rinex Observation File
- Menu 2.4 - Rinex Navigation File (except **Station name**)
- Menu 2.3 - RINEX Meteorological File

Agency Information (Top Section)

Station Name

Initially contains the site identifier of the first epoch from the B-file; in this case ????. It can contain up to 60 alphanumeric characters.

Observers Name

Is from the S-file (if any), in this case, SDH; ____ means that no name was entered in the receiver.

Station Number

Optionally, up to 20 alphanumeric characters.

Observing Agency

Optionally up to 40 alphanumeric characters identifying the agency that surveyed the point.

Agency Creating Current File

Optionally up to 20 alphanumeric characters identifying the organization post-processing the data.

Comments

Optionally up to 60 alphanumeric characters for other relevant and noncomputational data.

Equipment and Data Information (Second Section)

Receiver Type

Initially displays the parameter from the S-file (if any); in this case, RANGER. It identifies the equipment used in the survey.

Receiver Serial Number

Initially displays the parameter from the S-file (if any); in this case, 696. Ashtech recommends at least the last three digits of the serial number of the equipment used in the survey.

Antenna Type

Fill this optionally, as required.

Antenna Serial Number

Initially displays the parameter from the S-file (if any); in this case, **901**. Ashtech recommends at least the last three digits of the serial number.

Type of Data

Displays the parameter from the B-file; in this case, **0**. The data type affects subsequent post-processing of the RINEX Observation file. Possible values from the B-file are:

Table A.1: B-File Parameters

Field	Description
0	Code phase only
1	C/A L1-only data
2	C/A L1 and codeless L2
3	C/A and P-code on L1
4	C/A on L1 and P-code on L2
5	C/A, P-code on L1, and P-code on L2

Antenna Offsets (Third Section)

North, East, Radius, and Delta Vertical

Initially default to zero meters. **Slant Distance** is initially at least 0.0001 meter because it must exceed the radius for antenna height computation. If ASHTORIN finds an S-file, **Slant Distance** is the value therein; type in accurate data to achieve valid results in post-processing.

All Optional Headers (Bottom Section)

The default is **N**o and puts the required header information in the observation file (that is, RINEX version number and type-through time of last observation). If you type **Y**es, in addition to the standard information, ASHTORIN first scans the entire B-file so that it can report the number of satellites which were recorded and, for each satellite, its PRN and number of observations of each measurement.

The Observation file will take this form where the optional header information is shaded:

```
            OBSERVATION DATA                                    RINEX VERSION/TYPE
     21-MAY-92 12:23 PGM/RUN BY/DATE                            ASHTORIN COMMENT
CN1                                                             MARKER NAME
                                                                MARKER NUMBER
PHG                                                             OBSERVER/AGENCY
358               LM-XII2                 6FP3                  REC#/TYPE/VERS
                                                                ANT#/TYPE
-2691570.0600  -4301212.2700 3851725.6600                       APPROX POSITION XYZ
       0.0001         0.0000       0.0000                       ANTENNA: DELTA H/E/N
 1        1                                                     WAVELENGTH FACT L1/2
 6       L1  L2  C1  P2  D1  D2                                 #/TYPES OF OBSERV
 5                                                              INTERVAL
1991     10  24  18  15   5.000000                              TIME OF FIRST OBS
1991     10  24  19  20   0.003000                              TIME OF LAST OBS
 5                                                              # OF SATELLITES
 3      780 780 780 780 780 780                                 PRN / # OF OBS
16      780 780 780 780 780 780                                 PRN / # OF OBS
17      780 780 780 780 780 780                                 PRN / # OF OBS
20      780 759 780 759 780 759                                 PRN / # OF OBS
23      780 776 780 776 780 776                                 PRN / # OF OBS
                                                                END OF HEADER
```

```
91 10 24 18 15  5.0000000  0   5   3 23 20 16 17                0.000898760
    987687.82319    769626.25517   28569964.835   21075179.767   -320.644
      -249.829
    3057595.89416   1747946.15115  31938240.726   24443462.043   -2743.328
     -2137.674
    -4425084.60818 -3448117.14116  29845916.732   22351133.402    3999.467
      3116.498
    -2913737.44518 -2270439.14116  29673527.704   22178742.396    2920.611
      2275.824
    1583846.53119   1234162.88717  28907100.551   21412313.564   -707.822
      -551.543
```

Processing the Conversion

1. When all data is properly entered, press **<F10>** to create the Observation file.
2. ASHTORIN indicates processing in progress by the message **WORKING** and a rotating line in the upper left corner of the screen.
3. To interrupt processing in progress press the **<ESC>** key; observe:

   Are You Sure (Y/N)?

If you type **N**, ASHTORIN continues to process as if no interruption occurred.

If you type **Y**, ASHTORIN aborts processing and returns you to Program Options Menu 2.0 (Figure A.3) without finishing the RINEX Observation file.

When creation is complete, the system returns to Program Options Menu 2.0.

Option C: Create RINEX Navigation File

Select Program Option C; observe:

```
Menu 2.4 - Rinex Navigation File
-------------------------------------------------------------
Agency Creating Current File:

Comments:
-------------------------------------------------------------

<F1> DOS Shell    <F5> Accept    <F10> Process    <Esc> ABORT Edit
                                                            PC0047
```

Figure A.5: RINEX Navigation, Option C

Agency Information (Top Section)

Agency Creating Current File

Optionally up to 20 alphanumeric characters identifying the organization post-processing the data.

Comments

Optionally up to 60 alphanumeric characters for other relevant and noncomputational data.

Processing the Conversion

When all data is properly entered, press the **<F10>** key to create the Navigation File and return to Program Options Menu 2.0 (Figure A.3).

Option D: Create RINEX Meteorological File

To create a Meteorological file, no input files are required, however ASHTORIN extracts information from S-files and/or B-files (if present) as described later in this section.

Select Program Option D; observe:

```
Menu 2.2 - Rinex Observation File

Station Name:
Agency Creating Current File:
Comment:

PRESS - Preasure            RHUMD - Relative Humidity
DTEMP - Dry Temperature     ZWET  - Wet Zenith Path Delay (for WVR data)

READING    DATE      TIME      PRESS    DTEMP   RHUMD   ZWET
          (YMD)     (UTC)      (mbs)     (C)     (%)    (mm)
   1    1992\12\18  22:54: 2   1010.0    20.0    50.0    0.0
   2    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   3    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   4    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   5    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   6    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   7    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   8    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
   9    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0
  10    1992\12\18  22:54: 2      0.0     0.0     0.0    0.0

<F1> DOS Shell    <F5> Accept/Return    <F10> Process        <Esc> ABORT Edit
                                                                        PC0048
```

Figure A.6: RINEX Meteorological File, Option D

Station Name

Initially contains the site identifier (if present) of the first epoch from the B-file. It can contain up to 60 alphanumeric characters.

Agency Creating Current File

Optionally up to 20 alphanumeric characters identifying the organization post-processing the data.

Comments

Optionally up to 60 alphanumeric characters for other relevant and noncomputational data.

Up to 10 READINGs are tagged by DATE (year\month\day) and TIME for the defined data fields (PRESS - Pressure, etc.). The DATE and TIME columns initially display the current computer date and time, and the first READING line displays standard conditions.

If an S-file was selected in Menu 2.1, ASHTORIN extracts the meteorological conditions from the S-file into the bottom area of the menu. If an S-file was not specified, ASHTORIN uses default meteorological parameters.

Make any corrections or additions desired.

When all data is properly entered, press <F10>, to create the Meteorological file and return to Program Options Menu 2.0.

Option E: Exit

This option returns the system to DOS or the calling program.

Warning Messages

File seems to be Truncated

Means that the input file does not contain complete records (for example, a file with incorrect format).

File Cannot be opened for reading

Means that the file name does not exist in the path declared.

File Cannot be opened for writing

Means that the file could not be written to (may be write protected).

Error Messages

Invalid Drive\Dir

Means that the directory path could not be found on the drive specified. ASHTORIN will not continue until a valid "drive/dir" is specified.

Slant distance and\or radius out of range

Means that the radius input is larger than the slant distance to the antenna and the program can not calculate the correct antenna height. ASHTORIN will not continue until a smaller radius or a larger slant distance is entered.

Bendata file of incorrect format

Means the B-file was downloaded with a version of the HOSE program prior to Version 4.1.00; such a file must be run through the CONVERT program (as described in this chapter) before using ASHTORIN. If the data was downloaded from a receiver using firmware version 6A or 6B, see the discussion in the CONVERT section of this chapter. ASHTORIN will not work on data files collected using receiver firmware versions prior to 6A.

Receiver frequency entry out-of-range

Means that an illegal value is in the Type-of-Data entry.

DATALOGR Software

Ashtech's DATALOGR software logs data from the GPS receiver to the computer in real-time. This module works only with those receivers which contain the real-time output option.

Input Data Files

None.

Output Data Files

DATALOGR generates two output files on the target drive of the data logging computer. These files, a B-file and E-file, are directly usable by the Ashtech post-processing software.

It should be noted that the program does not produce an S-file (or site file) which is used to expedite automatic processing. Automatic processing can still be performed without the S-file by entering antenna height data when the project file is edited.

Program Execution

In order to receive the data, the computer must be connected to the GPS receiver from which the data will be transferred. This connection is made using a full handshake null modem cable. One end of the cable plugs into a GPS receiver serial port; the other end of the cable plugs into the computer port. If COM1 is not available, use COM2.

To start DATALOGR, at the DOS prompt, type:

DATALOGR <CR>

The screen shows a display similar to following:

```
 PC Comm Port: 1               Communication Rate:   9600 BAUD

Target Disk Drive: C           Free Disk Space:         8640 Kbytes
Target Directory:  \GPPS\DAY165
Template: ____A90.165      B-File: ---closed---     E-File: ---closed---



      <Esc> To Exit           <F1> DOS Shell            <F10> Start
                                                                   PC0049
```

Figure B.1: DATALOGR Screen

The display shows three sections, each in a separate box. They are:

1. Communications
2. Target System
3. Status Information

In the communications section communications parameters can be selected; that is, communication port 1 or 2 (for COM1 and COM2, respectively) and communication speed. To select the communication speed, press the <PgUp> or <PgDn> keys until the desired speed appears.

The target system section allows for the selection of target disk drive, target directory path, and target file names. As in program HOSE, the template prompt allows for the entry of the "base" file name. Specifically, the information entered here will be used to generated the target B-file and E-file names according to the recommended file naming convention. At program start-up, the clock of the target computer is used to generate the session, year, and day fields of the template; that is, only the 4-character site name is not supplied.

The status information section is used to provide status information during communication with the receiver, and is blank for this example.

After the target file names have been entered, press <F10> to begin data logging. At this time, DATALOGR checks that the named files exist and asks permission to overwrite them if they do exist, as shown below:

```
 PC Comm Port: 1               Communication Rate:   9600 BAUD

Target Disk Drive: C           Free Disk Space:         8632 Kbytes
Target Directory:  \GPPS\DAY165
Template: 0514A90.165      B-File: B0514A90.165     E-File: E0514A90.165

File B0514A90.165 already exists on disk.
 Do you wish to [A]ppend, [O]verwrite, or a[B]ort opening: O
File E0514A90.165 already exists on disk.
 Do you wish to [A]ppend, [O]verwrite, or a[B]ort opening: O
                                                                   PC0050
```

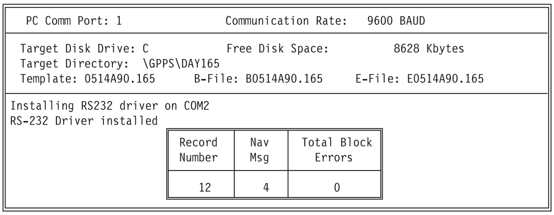
Figure B.2: DATALOGR Status

After the target files have been opened successfully, DATALOGR tries to establish the data link. If the data link has not been established properly, the following message appears in the status section:

> **ERROR**: While attempting to initialize the communications port, a line status check detected one of the following conditions:
>
> 1. Cables not connected properly (e.g., wrong receiver port);
> 2. Cables not fastened securely; and/or
> 3. Receiver power not "ON".
>
>   Ensure cables are connected (with FULL NULL MODEM) and receiver power is on.
>
> Press any key when ready to try again. . . .

For proper operation of DATALOGR when connected to serial ports C or D of the Z-12R receiver, include the "-i" option (for example, type "DATALOGR -i").

Once the data link is established, you'll see a screen similar to:



PC0051

Figure B.3: DATALOGR, Option "i"

If either the record number or the number of navigation messages do not increase, one of the following conditions exists:

1. Not enough satellites are being tracked by the receiver.
2. An epoch interval has not transpired since the time the connection was established.
3. The communication cable is not properly connected.

To end a data logging session press **<Esc>**. The output files will then be closed and the data link will be terminated.

Command Line Options

If desired, you can execute DATALOG specifying the following command line parameters:

Table B.1: Command Line Options

Command	Description
- ?	Lists options.
- a	Downloads an almanac file real time.
- b	Specifies the communication rate (BAUD).
- c	Sets the communications port.
- f	Updates FAT of the b, c file at t (seconds) interval.
- I	Ignores the status lines.
- p	Logs position data only.
- n	Do not poll COMM speed.
- y	Specifies the template name to be used for B & E files.

These parameters can exist in any order, but their related parameters must follow them in the same order, as shown in the following examples:

Table B.2: Command Parameters

Command	Function
DATALOGR -?	The (-?) lists the command line options and provides a brief description of what the command does.
DATALOGR -a	The (-a) option downloads an almanac file in real time. This command is typically used on receivers that don't have internal memory.
DATALOGR -b	The (-b) option sets the communication baud rate. To initialize DATALOGR to 9600 baud, enter the following command: • DATALOGR -b 9600 <CR>
DATALOGR -c	The (-c) sets the communication port to either COM1 or COM2. To start DATALOGR on COM2, enter the following command: • DATALOGR -c 2 <CR>

Table B.2: Command Parameters (continued)

Command	Function
DATALOGR -f	The (-f) option allows you to set a time interval to write the EOF marker. This causes the file to be closed every "N" seconds in order to protect against power outages that typically cause data loss. To set the time interval to 10 seconds, enter the following command: • DATALGR -f 10 <CR>
DATALOGR -I	The (-I) options causes DATALOGR to ignore status information coming from the receiver. **Use this setting with caution.**
DATALOGR -p	The (-p) option causes the logging of only the position data when the data is viewed using the filetool program the code observables are not seen

HOSE Software

HOSE extracts (or downloads) data from Ashtech GPS receivers. After the receivers have collected the field measurement data, the receivers are connected to the computer using a cable, and the data is extracted from the GPS receivers into the computer for post-processing.

Input Data Files

There are no input data files. HOSE extracts the data stored in the GPS receiver internal memory.

Output Data Files

The extracted satellite measurement data is saved as "B-files" (BEN files), satellite ephemeris (orbit) data into the "E-files" (EPHM files), and site information into the "S-files" (SITE files). If the Ranger 2 mode is selected in the receiver, then a C-file will be downloaded instead of a B- and E-file. Optionally, a photogrammetry data file and the almanac file can be downloaded, and a waypoint file can be downloaded, edited, and uploaded back to the receiver.

Program Execution

In order to download the data, the receiver must be connected to the computer to which the data will be transferred. This connection is made using a full handshake null modem cable. One end the cable is plugged into a serial port on the receiver (Port A, B, C, or D); the other end of the cable plugs into the computer port (COM1 or COM2). The drawing for this cable is shown on the last page of this section. HOSE will attempt to communicate at 38400 baud using COM1. You can specify another communications port or change the baud rate via the command line as described later in this appendix, or you can select the option to change communication parameters.

To start HOSE, type the following command at the DOS prompt:

HOSE <CR>

The program momentarily displays the opening menu:

```
Program: HOSE    Version 5.0.00   Releaser: 01/21/93
                        by
                  ASHTECH, Inc.
                 1170 Kifer Road
               Sunnyvale, CA 94086
Copyright (c) 1988, 1989, 1990, 1991, 1992. All rights reserved.
```

PC0053

Figure C.1: Menu Screen

The opening menu is followed by status information. This status information describes the program configuration (either the default or command-line selected).

If HOSE detects a communication problem, it displays an error message:

ERROR: Cannot initialize COM port.

If this occurs, the only main menu option which can be executed is option C as discussed below.

Main Menu and Display

The HOSE main menu is displayed below:

```
Main Options:

 A) Display receiver directory.      E) Reset for new receiver.
 B) Download receiver files.         F) Read photogrammetry data.
 C) Change communication parameters. G) Read almanac data.
 D) Change destination path.         H) Edit waypoints.

File Path: C:\GPPS\TUTOR.001             Receiver Type: LM-XII
 Files: BEN = closed  EPHM = closed    Disk Space:  16352 KB
       SITE = closed        BAUD: 38400    PORT: COM1

Installing RS232 driver on COM1
RS-232 Driver installed

<Esc> - Quit                       <CR> of <F10> - Accept
```

PC0052

Figure C.2: HOSE Main Menu

The main menu is composed of four sections:

1. Option selection section
2. Status information section

3. Supplementary information section.
4. Quit/Execute section.

You select options by: 1) highlighting the desired option and pressing the **<CR>** key or, 2) by directly pressing the letter associated with the option. The supplementary information section (the bottom portion of the screen) displays various information depending on the option selected.

The middle section of the main menu is called the Status information section. Contained in this section of the display are the following:

1. Destination file path and destination file names.
2. Available disk space.
3. The current communication rate.
4. Receiver type.
5. Active communication port of the target computer.

The destination file names are entered via main menu option B. Once files have been read from the receiver, these files become closed, requiring you to open another set prior to the next read. The project subdirectory destination path may be changed via option D, and the communication speed may be changed via option C.

Option Selection Section

The option selection section of the display provides you with a list of program options:

a. Display Receiver Directory.
b. Download receiver files.
c. Change communication parameters.
d. Change destination path.
e. Reset for new receiver.
f. Read photogrammetry data
g. Read almanac data
h. Edit waypoints

To select an option, highlight it by using an arrow key, then press <CR> or <F10>. You can also select an option by typing the letter associated with it; for example, to select option A) Display Receiver Directory, type <A>.

To terminate the program, press <Esc>. This provides a proper exit from the program, ensuring that all files are properly closed.

Option A: Display Receiver Directory

Option A provides you with a listing of the files stored in the memory of the receiver. The directory information is displayed in the Supplementary information section of the main display:

```
Main Options:
A) Display receiver directory.       E) Reset for new receiver.
B) Download receiver files.          F) Read photogrammetry data.
C) Change communication parameters.  G) Read almanac data.
D) Change destination path.          H) Edit waypoints.

File Path: C:\GPPS\TUTOR.001________ Receiver Type: LM-XII
Files: BEN = closed___ EPHM = closed___ Disk Space: _16352 KB
     SITE= closed_______     BAUD: 38400    PORT: COM1

---------- SITE INFORMATION ----------

# NAME  BYTES  WEEK  TIME   SES  RCR  ANT  MMDD  OPR CODE
0 RICK  11150  522   384479  A   514  113  ____  RS_ASHTECH STATIC SITE____
1 HWAY  24413  524   388009  B   514  113  ____  RS_HIGHWAY BASELINE______
```

PC0058

Figure C.3: Main Option Menu

Included in the directory information are the following:

Table C.1: Directory Information

Component	Description
#	Session Number (use this number when selecting files to be read from the receiver).
NAME	The last site name entered by the receiver operator.
BYTES	The number of bytes the file occupies in the memory of the receiver (NOTE: This will NOT be the size of the files stored on disk - the data files on disk will typically be larger).
WEEK	GPS week of the file.
TIME	Seconds of GPS week of the file.
SES	Receiver operator entered information.
RCR	Taken from receiver menu 9; receiver serial number
ANT	Taken from receiver menu 9; antenna serial number
MMDD	Taken from receiver menu 9; month and day entered by operator
OPR	Taken from receiver menu 9; operator's initials
CODE	Taken from receiver menu 9; operator-entered comments

Option B: Download receiver files.

This option calls up a selection screen similar to the following:

```
DOWNLOAD TEMPLATE   BEN file    EPHM file   SITE file
 Y  RICKA90.009 BRICKA90.009 ERICKA90.009 SRICKA90.009
 Y  HWAYB90.025 BHWAYB90.025 EHWAYB90.025 SHWAYB90.025

Receiver Files:
 NAME WORDS WEEK TIME SES RCR ANT MMDD OPR CODE
 RICK 11150 522 384479 A  514 113 ____ RS ASHTECH STATIC SITE
 HWAY 24413 524 388009 B  514 113 ____ RS HIGHWAY BASELINE

 <Esc> - ABORT OPERATION             <F10> - Accept/Start Download
                                                          PC0057
```

Figure C.4: Selection Screen

The bottom half of the screen shows the directory of the receiver files, while the top half shows the automatically created names for the files to be created on the computer. Each line of the top half corresponds with the bottom half.

Sessions may be selected or de-selected for downloading. If the SELECT column is set to **<N>**, the file will not be downloaded. This screen also allows editing of the filenames, either by changing the template field, or by editing the individual file names.

You can move between prompts by using the **<arrow>** and **<TAB>** keys (and **<Shift>+<Tab>** for reverse). Normal editing is provided within prompt fields: insert using <Ins>; delete character using <Backspace>, and then type in correct information.

When satisfied with the file selections and names, press <F10>. HOSE attempts to open all of the files prior to downloading. If any of the files already exist in the current directory, a message similar to the following is displayed:

- Opening output files for session 0
- File BRICKA90.009 already exists on disk.
- Do you wish to [O]verwrite or [A]bort opening: 0

If you press **<A>**, HOSE terminates the file naming and downloading procedure. If you press **<O>**, HOSE overwrites the existing file.

As the files are being downloaded, the downloading status is displayed:

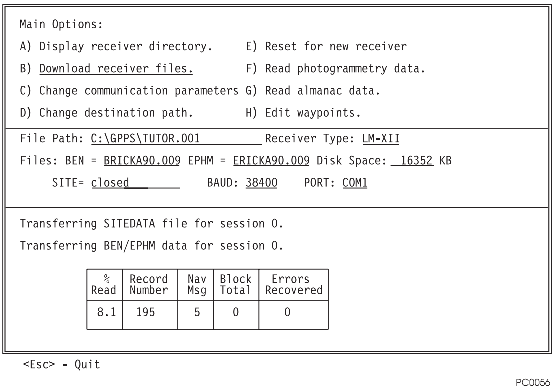


Figure C.5: Main Options Menu

HOSE continuously checks the amount of free disk space available on the target disk. If, during any file transfer, there is not enough space for the remaining data to be transferred, the following message is displayed:

- Not enough free disk space for requested operation.

If you are getting a lot of Block Errors, the baud rate for data transfer may be set too high. Use HOSE option C, 'Change Communication Parameters," to lower the baud rate.

When the download is completed, a summary screen is displayed:

Figure C.6: Download Summary Menu

In addition to the <PgUp> and <PgDn> keys, the <UpArrow> and <DownArrow> keys may be used to scan through the session summary. This summary is appended to the download summary file in the current directory under the filename HOSE.SUM.

Option C: Change Communications Parameters.

Option C provides a means of changing either or both the communication speed or computer communications port. Upon selecting option C, the following selection menu is displayed:

Figure C.7: Option C, Change Communication Parameters

Move the cursor to the desired communication rate via the arrow keys or by the letter associated with the desired speed, and press <CR> or <F10>.

This menu provides selectable baud rates which are available for a given receiver. For receivers which are not capable of 56000 and 112000 baud the menu will not display these selections. Move the cursor to the desired communication rate and/or COMM port and press <CR> or <F10>.

If the requested change does not occur due to an error, the following message is displayed:

ERROR: While attempting to initialize the communications port, a line status check detected one of the following conditions:

1. Cables not connected properly;
2. Cables not fastened securely; and/or
3. Receiver power not on.
    - Ensure cables are connected (with FULL NULL MODEM) and receiver power is on.
    - Press any key when ready to try again. . . .

Follow the instructions provided. If the message occurs repeatedly, then it is probable that one of the following conditions exist:

1. Cables are connected to an incorrect port of the target computer.
2. The cable between the receiver and target computer is NOT a Full Handshake Null Modem Cable.
3. Receiver is turned off.
4. The computer COMM port is not configured as a data communications equipment (DCE) port. If the computer port is a data terminal equipment (DTE) port, then use a full handshake cable or add a null modem adapter to the HOSE cable.

A large number of checksum errors occuring during a file transfer may be an indication of a faulty connection between the receiver and the computer. To remedy the problem, make sure the mechanical connections to each port are solid. If communication errors persist, try using a shorter cable (maximum length is 100 feet), decreasing the communication rate, or connecting to another port on the reciever.

If you remove the power from the receiver while HOSE is running, you will have to restart the program.

Finally, Ashtech strongly recommends that you do not disconnect communication cables from one receiver to another without using Option E Reset for new receiver. Disconnecting the receiver cable without resetting the computer and receiver could create problems with the computer data files.

Option D: Change Destination Path

This option will display a screen as follows:

```
Menu: Change File Destination
 Drive: C
 Directory path: \GPPS\TUTOR.001

  <ESC> - ABORT OPERATION     <F1> - DOS Shell     <F10> - ACCEPT/DONE
                                                                PC0059
```

Figure C.8: Option D, Change Destination

To download data into a different drive and/or directory, enter the appropriate drive and path information and press <F10> to accept the new directory path name.

Option E: Reset for New Receiver

This option provides a means of properly switching from one receiver to the next without having to restart HOSE. To use this option, select the option and follow the instructions provided as shown below:

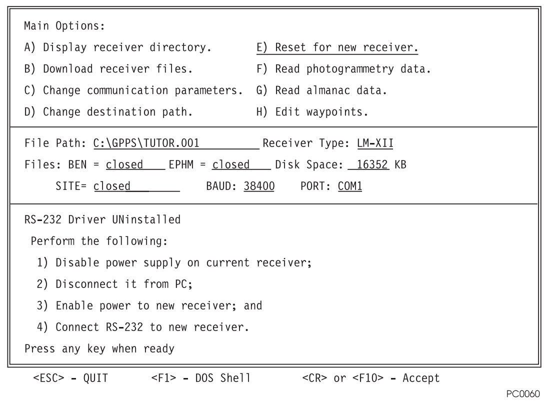


Figure C.9: Option E, Reset for New Receiver

Option F: Read Photogrammetry Data

Option F will read any photogrammetry data stored in the receiver memory. If this option is selected and the receiver has no stored photogrammetry data, the following message will be displayed:

There is not any photogrammetry data to read.

The file generated will either be named PHOTO.DAT or according to the file name template given for session 0 of the file naming menu. Specifically, if the template name is used, then the photogrammetry data file will be named P followed by the file name template.

Option G: Read Almanac Data

Option G will read any almanac data stored in the receiver memory. Choosing this option will cause HOSE to automatically name and create the output almanac data file.

If the file name generated by HOSE corresponds with one in the target directory, that file will be overwritten.

The output file name will be of the form ALMyy.ddd where, yy is the year and ddd is the day of the almanac. These dates are taken from the almanac data - not from the computer's internal clock.

Option H: Edit Waypoints

This option lets you download waypoint files from the receiver or directly create waypoint files. Start by turning on the receiver and connecting it to the computer with a data cable. On the GPPS main menu, select option B) Download Receiver, and from the HOSE menu, select option H:

```
Main Options:
A) Display receiver directory.       E) Reset for new receiver.
B) Download receiver files.          F) Read photogrammetry data.
C) Change communication parameters.  G) Read almanac data.
D) Change destination path.          H) Edit waypoints.
```

PC0061

Figure C.10: Option H, Edit Waypoint

When you select option H) Edit Waypoints, you'll see this screen where you choose the waypoint file to download:

```
        Choose Way-Point File To Download
    WAY-POINT FILENAME: *.way
```

PC0062

Figure C.11: Option H, Waypoint File to Download

You can type in a file name or a specification such as *.way to summon a display of all files with that extension. When you press <CR>, you'll see a list of all matching files in the current directory:

Select a file to edit by highlighting its name and pressing <CR> again. Its file name is displayed in the WAY-POINT FILENAME field on the second line of the display; its path is displayed on the next line.

- When you specify an existing file, its waypoints are displayed on the Route and Waypoint Line (shown below) so you can edit them.
- If you enter the name of a new file, the screen remains blank so that you can enter new waypoints. To summon a blank Route and Waypoint Line, press the <F5> key.

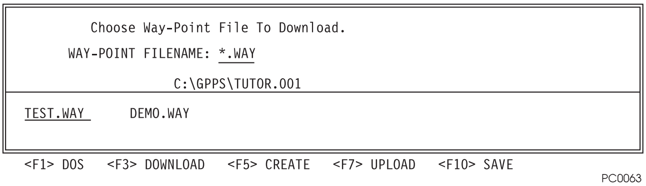


Figure C.12: Waypoint File Name

Alternately, you can download a receiver file that contains waypoints and edit them. To do this, press the <F3> key. This downloads all ninety-nine waypoints and displays them on the Route and Waypoint Line. Unused waypoints have underscores or zero fill.

These functions allow you to edit the waypoint lines:

Table C.2: Waypoint Functions

Field	Description
<CTRL-A>	Adds a waypoint line.
<CTRL-D>	Deletes a waypoint line.
<CTRL-P>	Specifies a position in earth-centered cartesian coordinates.
<CTRL-C>	Clears the current file.
<TAB>	Moves the cursor to the next field.

When the first line has been entered, press <CTRL-A> to add another waypoint line for editing as shown below. Continue until all new waypoints have been entered:

```
        Choose Way-Point File To Download.
      WAY-POINT FILENAME: DEMO.WAY
                 C:\GPPS\TUTOR.001
ROUTE  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
 01  ONE___   N 37 15 20.000  W 122  10  5.0000   0.000
 02  ______   N  0  0  0.000  E   0   0  0.0000   0.000
<F1> DOS   <F3> DOWNLOAD   <F5> CREATE   <F7> UPLOAD   <F10> SAVE
                                                          PC0065
```

Figure C.13: Editing Waypoint

To delete a line, move the cursor to the line you want to delete and press **<CTRL-D>**. To clear all waypoints in a file, press **<CTRL-C>**.

Press **<CTRL-P>** to see a pop-up screen where you enter a waypoint in earth-centered fixed-cartesian coordinates or in degrees and decimal minutes:

```
        Choose Way-Point File To Download.
      WAY-POINT FILENAME: DEMO.WAY
                 C:\GPPS\TUTOR.001
ROUTE  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
 01  ONE___   N 37 15 20.000  W 122  10  5.0000   0.000
 02  ______   N  0  0  0.000  E   0   0  0.0000   0.000

         001 ONE
      Lat  N  37 15.333333
      Long W 122 10.083333
      ECF X -2706144.6645
          Y -4302602.8901
          Z  3840005.5734

<ESC> - ABORT                <F10> - SAVE
                                                          PC0066
```

Figure C.14: Clearing Waypoints

After you enter the XYZ coordinates and press **<F10>**, HOSE converts them to latitude, longitude, and ellipsoidal height. It closes the pop-up screen and automatically updates the Route and Waypoint Line.

1. When you are finished editing the waypoint file, press **<F7>** to upload the new waypoints to the receiver.
2. Press **<Esc>** to exit HOSE and return to the GPPS main menu.
3. Disconnect the receiver from the computer.

Quit/Execute Section

Normal Program Termination

Pressing the **<Esc>** key from the main menu will cause HOSE to terminate normally and exit to either the **GPPS** program or DOS.

Troubleshooting

If at any time during the execution of the program the receiver does not respond to a command, the screen is cleared and a message similar to the following is displayed:

ERROR: Receive problem

- Receiver has not responded to most recent command.
- Simply toggle the power on the receiver and run
- HOSE again.

Status Registers:

- Modem Status Register:
- Clear To Send Change
- Line Status Register: Normal Status.

Press any key to continue...

If this occurs, follow the instructions provided.

When data will not download normally from the receiver, it may often be recovered by the RAMDUMP procedure. To do this, connect the receiver to the PC, power the receiver on, start HOSE, and from the HOSE main menu, press the F5 key three times. HOSE will download to a file named "RAMDUMP" (an image of the receiver memory). After this is done, exit to DOS, disconnect the receiver, then from the directory with the RAMDUMP file, use the command HOSE-R RAMDUMP. From the HOSE main menu, download as if performing a normal receiver download. HOSE will read the RAMDUMP file as if it were in a receiver, and write the B-, E-, and S-files to disk. If it is necessary to perform a RAMDUMP on more than one receiver, use a separate subdirectory for each one, then combine the data files and process.

Advanced Program Options

Command Line Parameters

HOSE accepts the following command line parameters:

Table C.3: HOSE Command Line Parameters

Field	Description
b	To set communication rate (BAUD)
c	To set communication port
?	List options
a	Auto download (use with caution!)
r	Convert image files downloaded by remote program; convert ramdump file
e	Executive overlay
i	Ignore status (**use with caution!**)
z	Exit program if data type from receiver is incorrect

These parameters can exist in any order, but their related parameters must follow them in the same order; see examples.

HOSE, in its default configuration, attempts to communicate via COM1 at 38400 baud. The default start-up configuration can also be set via these command line parameters. To force HOSE to utilize COM2 at 38400 Baud, enter the following at the DOS prompt:

HOSE -c 2 <CR>

To initialize HOSE on COM1 at 9600 Baud, enter the following command:

HOSE -b 9600 <CR>

To start HOSE on COM2 at 9600 Baud, enter either of the following commands:

HOSE -cb 2 9600 <CR> or HOSE -bc 9600 2 <CR>

The command line parameters are order-specific and must follow the order of the switches as shown above.

The executive overlay option is for those who wish to call Ashtech programs from their own software. In general, most programs can call HOSE directly without using it. Use -e only if the calling program is using too much memory to load HOSE at a higher memory address.

This option informs HOSE that it was loaded over the space occupied by the calling program and must therefore ensure that the calling program is restarted in the same address space. When using this option it is VERY IMPORTANT that the calling program be able to save and restore its state. Ashtech recommends that users who are unfamiliar with this type of calling sequence NOT utilize this option. Misuse of this option can cause undesirable effects.

To invoke the executive overlay option you must follow the -e option with the name of the calling program (provide complete path if the program is not in the current working directory or DOS search path). For example,

HOSE -e MYPROG <CR>

Additional Information

Position Determination with GPS

There are three methods of determining position using GPS receivers. These are **pseudo-kinematic**, **kinematic** and **static**, collectively described as relative or **differential** positioning. The **pseudo-kinematic** and **kinematic** methods are not applicable to DGPS reference station operation and are not explained in this manual.

The **static** survey measures the phase differences from two GPS receivers which are simultaneously locked on several common satellites. One receiver gathers data from a known position, the other from an unknown position.

The static method minimizes errors associated with satellite information and receiver biases, and is the most reliable and accurate method, producing coordinate accuracies to the millimeter level. The disadvantage is that the receiver must remain at a site for a relatively long time to get redundant observations, but this is of little consequence for a fixed reference station.

Doing a Static Survey

The following procedure describes a static survey to show how to use the Z-12R receiver to determine the exact location of the DGPS reference station. The operations are:

- Set up the receivers and the antennas.
- Measure antenna height.
- Operate the receiver to collect data.
- Enter the site name.
- Terminate the survey properly.
- Connect the receiver to a computer for down loading the data.

A static survey uses at least two stationary GPS antennas that simultaneously observe the range and carrier phase of several common satellites over a specific time period. One antenna is centered over a known point, while the other antennas occupy unknown stations.

By occupying more than one station, a number of common errors cancel so the accuracy can be greatly improved. To compute accurate baselines and establish accurate positions on the unknown points, the data collected by the receivers is post-processed later with a PC (personal computer). The necessary receiver operations for collecting data necessary for the post-processed solution are discussed

System Set Up

Two receivers are required to do a static survey with GPS.

1. Set up and level an antenna over a survey mark. The survey point must provide line-of-sight reception of the GPS signals. You should already know the WGS-84 or NAD-83 coordinates of one survey mark in the session. To set up the antenna over the survey mark, a tripod and centering device such as a tribrach with an optical plummet is required. When the tribrach is in level, put the antenna platform on it.
2. Connect the antenna through the pre-amplifier to the receiver with an antenna cable.
3. Measure the antenna height. Use the Ashtech sectioned precision rod or any other accurate method.
4. Connect an external battery or power source to one of the POWER sockets on the receiver's back panel, making sure to align the red dot of the connector with the red dot of the socket.
5. Repeat these steps for all receivers participating in the survey. For each, set up an antenna over a mark for which you will determine the coordinates. Measure its antenna height and connect it to its receiver.
6. Set the receivers' power switches to ON.

Measuring Antenna Height

In any GPS observation, the measurements are made at the phase center of the top of the antenna receiving the signal. To reduce them to the ground level to serve as a survey control point, you must accurately measure the distance from the antenna to the survey mark. This distance is referred to as the antenna height or **height of the instrument (HI)**.

1. Using the precision HI rod, direct the rod through one of the dog-legged holes around the edge of the antenna platform. The holes (marked A to H) are situated so that the rod will not be blocked by a tripod leg.
2. Put the rod's point at the center of the mark and read the engraved markings.

Measure three different holes to confirm the HI and check that the tribrach is in adjustment and indeed over the point. All three measurements should be within 1 mm of each other.

If a nongraduated measuring rod is used, lift it up about a ½ inch and place a strip of masking tape on it. Reposition the rod and mark the tape. Measure from two other holes for redundancy. Then measure the marked rod to obtain the HI.

To assure that the HI is correct, measure it several times and preferably in two systems: feet and meters. It is necessary only to measure the distance from the mark to the top **outside** edge of the dog-legged hole on the antenna platform. (Later the processing software corrects this diagonal measurement to vertical.) Measure the HI before and after the observation to check that no settling is experienced during the survey.

Operating the Receiver

1. Connect one end of the power cable to a power source (generally a battery pack) and the other end to either of the POWER connectors on the back of the receiver as shown in Figure 2.2.
2. Connect one end of the antenna cable to the antenna and the other end to the ANTENNA connector on the back of the receiver as shown in Figure 2.2.
3. Check that the antenna height (HI) has been measured.
4. To start data collection, turn on the receiver. Set the POWER switch on the back of the receiver to ON.
5. Turning on the power initiates a self-test and momentarily displays the following messages:
   - EPROM checksum OK
   - XRAM installed
   - Mag var checksum OK
   - Downloading channel

If the receiver finds a problem, during self-test, it displays an error message and stops. When there are no problems, the receiver briefly displays the Ashtech copyright before displaying Screen 0, (Figure 4.1).

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

- Searches and locks on all satellites available.
- 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 closes the file .

There are two primary screens for specifying information for a survey. These are Screen 4, (Figure D.1) and Screen 9, (Figure D.3) described later. To operate the receiver after it has been turned on, do the following:

1. On Screen 0 (Figure 4.1), adjust contrast by pressing the ▲ or ▼ key. You do not have to enter any information for the survey if the default parameters are

suitable. For a static survey, Ashtech recommends that you accept the defaults and go directly to Screen 9, (Figure D.3) (step 3).

2. Go to Screen 4, (Figure D.1) Mode Control, to change operational parameters. To do this, press the **[4]** key.

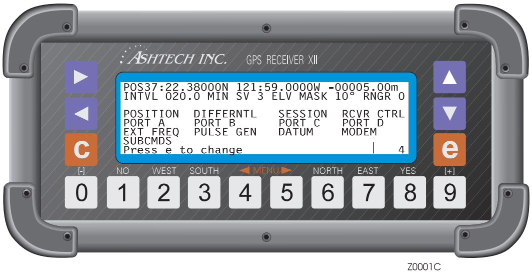


Figure D.1: Screen 4, Mode Control

The default values work very well for static surveys. However 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 **[c]** to abandon changes.

3. Go to Screen 9, (Figure D.3) Site and Session Control: press **[9]**. Like Screen 4, you do not have to alter information to successfully conduct a static survey. However, Ashtech recommends at least a four-character site name to assist in automatic processing. For further information, read the detailed information under Screen 9, (Figure D.3).

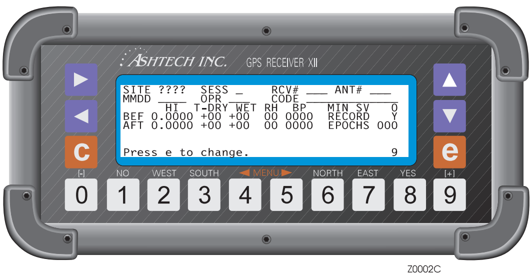


Figure D.2: Screen 1, Site Information

Site information can be entered during data collection and will not affect or interrupt the collection process. It is output as an ASCII file when the data is downloaded from the receiver. Be aware that external memory, not included with the Z-12Rw, is required to perform these functions.

To conclude data collection, turn off the receiver. The receiver automatically closes the data file.

Entering Site Name

To type in text, that is, a site name Screen 9, (Figure D.3):

1. Press **[e]** to switch to data-entry mode. The following alphanumeric conversion table appears:

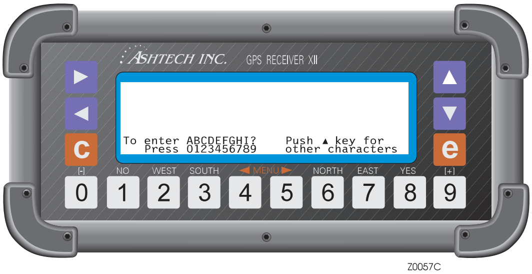


Figure D.3: Screen 9, Data Entry Mode

1. Type in the site name, one number at a time, where each number corresponds to a desired letter.
2. To see another bank of alphanumeric characters, press the ▲ key to cycle through the five displays.
3. If the cursor is in the wrong character position, use the ▶ and ◀ keys to line it up again.

After the fourth character of the name, the cursor jumps to the session identifier field.

To change an entry, move the cursor to the desired field and re-enter the information. When the entries are acceptable, press **[e]** again to save the changes in memory and return to display mode. To cancel the changes before saving them, press **[c]**.

Ionosphere Information

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

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

Reference Documents

Two excellent general reference books on GPS are shown below:

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

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

The books shown below provide a heavy mathematical treatment on GPS:

- **Leick**: *GPS Satellite Surveying* ISBN 0-471-81990-5
  Wiley Interscience, 605 3rd Avenue, New York NY 10158-0012
  Excellent overview of geodesy:
- **Smith**: *Basic Geodesy - An Introduction to the History and Concepts of Modern Geodesy without Mathematics* ISBN 0-910845-33-6
  Landmark Enterprises, 10324 Newton Way, Rancho Cordova CA 95670

Sources of GPS Information

- International GPS Service for Geodynamics (IGS)
  Jet Propulsion Laboratory, MS 238-540, Pasadena CA 91109
  Tel 818-393-6686   Fax 818-354-8330 or -5072
  Internet ren@logos.jpl.nasa.gov.
- National Geodetic Information Center, NOAA
  11400 Rockville Pike, Rockville MD 20852 Tel 301-443-8631
- Institute of Navigation
  1626 16th St. NW, Washington DC 20036
- Scripps Orbit and Permanent Array Center (SOPAC)
  High-Precision GPS BBS Service
  Subscription $7500/year and $3000/year
  SOPAC Coordinator   IGPP-UCSD
  9500 Gilman Drive, La Jolla CA 92093-0225
  Tel 619-534-0229   Fax 619-534-8090

Common GPS Acronyms

ALT	Altitude
ALM	Almanac
AFT	After
AGE	Age of Data
ANT	Antenna
ASCII	American Standard Code for Information Interchange
AZM	Azimuth
BEF	Before
BIN	Binary Index (file)
BM	Bench Mark
BP	Barometric Pressure
C/A	Coarse/Acquisition
	Clear/Access
COG	Course Over Ground
CTD	Course To Destination

DGPS	Differential GPS
DIFF	Differential
DMS	Degrees, Minutes, Seconds
DOP	Dilution Of Precision
DOS	Disk Operating System
DTD	Distance To Destination
EDOP	Elevation Dilution Of Precision
ELEV	Elevation
ELIP	Ellipsoid
ELLIP	Ellipsoid
ELP	Ellipsoid
ELV	Elevation
EMI	Electromagnetic Interference
ENU	East, North, Up
EPHM	Ephemeris
FCC	Federal Communications Commission
FREQ	Frequency
GH	Geoid Height
GLL	Latitude/Longitude for Position
GMST	Greenwich Mean Sidereal Time
GMT	Greenwich Mean Time
GPPS	GPS Post-Processing Software
GPS	Global Positioning System
GPSIC	GPS Information Center • 7323 Telegraph Road • Alexandria VA 22310-3998 • 703-313-5900
HDOP	Horizontal Dilution Of Position
HEL	Health
HI	Height of Instrument
HTDOP	Horizontal/Time Dilution Of Precision
ID	Identification, Integrated Doppler
LAT	Latitude
LAD	Liquid Crystal Display

LNA	Low-Noise Amplifier
LNG	Longitude
LON	Longitude
MMDD	Date format - Month, Date
MSG	RTCM Message
MSL	Mean Sea Level
N	Geodetic Undulation
NAD	North American Datum
NMEA	National Marine Electronics Assoc.
NV	Non-Volatile
PDOP	Position Dilution of Precision
PE	Precise Ephemeris
POS	Position
RAM	Random-Access Memory
RF	Radio Frequency
RFI	Radio Frequency Interference
RH	Relative Humidity
RMS	Root Mean Square
RTCM	Radio Technical Commission for Maritime Services • P.O. Box 19087 • Washington DC 20036-9087
SE	Site Editor
	Standard Error
SESS	Session
SOG	Speed Over Ground
SS	Static Survey
SV	Satellite Visibility
	Space Vehicle
T-DRY	Temperature - Dry (Celsius)
T-WET	Temperature - Wet (Celsius)
TDOP	Time Dilution Of Precision
UT	Universal Time
UTC	Universal Time Coordinated
VDC	Volts Direct Current

VDOP	Vertical Dilution of Precision
WGS	World Geodetic System
WGS-84	Reference Ellipsoid
WP	Waypoint

Global Product Support

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

- telephone
- email
- internet

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

Ashtech customer support:

471 El Camino Real

Santa Clara, California,

USA, 95050-4300

800 Number: 1-800-229-2400

Local Voice Line: (408) 615-5100

FAX Line: (408) 615-5200

Email: support@ashtech.com

Internet: www.ashtech.com

Ashtech Europe Ltd. Berkshire, UK

TEL: 44 1753 835 700

FAX: 44 1753 835 710

Solutions for Common Problems

- Check cables and power supplies. Many hardware problems are related to these simple problems.
- If the problem seems to be with your computer or handheld data collector, re-boot it to clear the system's RAM memory.
- If you are experiencing receiver problems, power cycle the receiver or try a different port.
- Verify that the batteries are charged.

If none of these suggestions solves the problem, contact the Customer Support team. To assist the Customer Support team, please have the following information available:

Table B.1: GPS Product Information

Information Category	Your Actual Numbers
Receiver model	
Receiver serial #	
Software version #	
Software key serial #	
Firmware version #	
Options*	
A clear, concise description of the problem.	
* The firmware version # and options can be obtained using the $PASHQ,RID (receiver identification) command.	

Corporate Web Page

You can obtain data sheets, GPS information, application notes, and other useful information from the Ashtech and Magellan internet web pages. You can also locate additional support areas such as frequently asked questions, training previews, and the Customer Support email form. Use the following Internet address:

http://www.ashtech.com

http://www.magellangps.com

Training Courses

Ashtech provides a complete range of GPS training courses for novice and advanced users. Arrangements can be made for customized, on-site training to fit your specific needs.

Ashtech's standard training courses are listed below:

- Conventional GPS Surveying
- Resolving Problem Data Sets
- Real-Time Z Applications
- Reliance for GPS/GIS

For detailed information, call or email Ashtech, or contact your local Ashtech dealer. You can also find information on course dates, costs, and content in the Ashtech website.

Repair Centers

In addition to repair centers in California and England, authorized distributors in 27 countries can assist you with your service needs. Please contact Ashtech Customer Support for more information.

Index

Index

D

E

F

S

T

U

V

W

X

Z