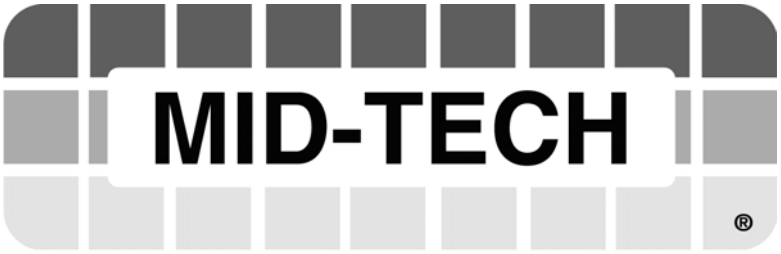

RX 400p
User Guide

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MIDWEST TECHNOLOGIES ILLINOIS, LLC (herein called MID-TECH) warrants to the original purchaser that the product purchased shall be free of defect in material or workmanship. If the product proves to be defective within the warranty period the purchaser must return, freight prepaid, said product to MID-TECH within thirty (30) days after such defect is discovered. Upon inspection and examination by MID-TECH, and at its option, MID-TECH shall repair or replace, with a new or comparable product. No product will be considered defective if it substantially fulfills the performance specifications. Purchaser shall be responsible for all required maintenance service in accordance with procedures outlined in MID-TECH's product operator manual or service bulletins.

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MID-TECH AgLogix Consoles	–	2 ½ years
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MID-TECH does not warrant or guarantee the precision or accuracy of positions obtained when using MID-TECH products. Product accuracy as stated in MID-TECH literature and/or product specifications serves to provide only an estimate of achievable accuracy based on:

- Specifications provided by the US Department of Defense (US DoD) for GPS Positioning,
- GPS OEM Receiver specifications of the appropriate manufacturer (if applicable),
- DGPS service provider performance specifications

MID-TECH reserves the right to modify MID-TECH products without any obligation to notify, supply or install any improvements or alterations to existing products.

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Preface

Welcome to the RX 400p User Guide and congratulations on purchasing this high-performance positioning tool. This is the third generation all-in-one receiver, which incorporates a number of improvements over the previous generation including support of the Wide Area Augmentation System (WAAS) and other Space Based Augmentation Systems (SBAS), and an improved menu system. The purpose of this manual is to familiarize you with the proper installation, configuration, and operation of your new receiver.

The RX 400p is a complete DGPS receiver, possessing two separate, internal receivers that provide the versatility of this system. Within the RX 400p, MID-TECH has integrated the MID-TECH SLX receiver, a tri-purpose GPS / WAAS / L-band receiver, and the MID-TECH SBX, a high performance DGPS beacon receiver. You may use any of the three internal differential correction services, depending which service is available. The beacon receiver obtains free DGPS beacon signals where available, the WAAS demodulator decodes correction data from the Wide Area Augmentation System, and the L-band satellite differential receiver obtains corrections from the OmniSTAR Worldwide DGPS service.

In addition to real-time DGPS, the RX 400p also supports post-processing. You may configure the RX 400p for output of binary measurement data for logging with the use of an external device. A conversion utility is available from MID-TECH for translation from the proprietary binary format into the Receiver Independent Exchange format (RINEX). Consult Appendix E for information on post processing and RINEX.

MID-TECH has designed this GPS product to function in a wide array of applications and environments. Compact, lightweight, yet rugged, the RX 400p will provide you with years of reliable operation.

Organization

This manual contains the following chapters:

Chapter 1: Installation - describes how to install the RX 400p receiver and antenna, and provides a foundation for interfacing the RX 400p with an external data logging or monitoring device.

Chapter 2: RX 400p Overview - provides details on the fundamental operating modes of the internal sensors of the RX 400p.

Chapter 3: RX 400p Architecture - provides a description of the integration of the RX 400p.

Chapter 4: Operation - describes how to configure and operate the RX 400p receiver using the keypad-driven menu system. This Chapter also provides a detailed listing of the default parameters.

Chapter 5: Configuration Wizard - introduces the Configuration Wizard feature and describes how it may be used to simplify configuration of the RX 400p receiver.

Chapter 6: NMEA 0183 Messages - describes the subset of NMEA 0183 commands and queries used to communicate with the GPS features of the two internal RX 400p sensors.

Chapter 7: Troubleshooting - provides you with diagnostic information to aid in determining a source of difficulty for a particular installation.

Appendix A: Specifications - details the technical characteristics of the RX 400p receiver and CDA-2B antenna.

Appendix B: RX 400p Interface - provides instructions to interface the RX 400p with external devices.

Appendix C: Activating OmniSTAR DGPS Service - provides you with information on how to enable an OmniSTAR subscription within your receiver.

Appendix D: Beacon Information - provides a reference for DGPS beacon transmitter sites and general information.

Appendix E: Post-Processing - describes how the RX 400p may be used as a post-processing DGPS tool.

The **Further Reading** section provides a listing of GPS/DGPS sources for further information.

The **Index** provides a listing of the locations of various subjects within this manual.

Customer Service

If you encounter problems during the installation or operation of this product, or cannot find the information you need, please contact your dealer, or MID-TECH Customer Service. The contact numbers and e-mail address for MID-TECH Customer Service are:

Telephone number: 217-753-8424
Fax number: 217-753-8426
E-mail address: custserv@mid-tech.com

Technical Support is available from 7:30 AM to 5:00 PM Central Time, Monday to Friday.

To expedite the support process, please have the product model and serial number available when contacting MID-TECH Customer Service.

In the event that your equipment requires service, we recommend that you contact your dealer directly. However, if this is not possible, you must contact MID-TECH Customer Service to obtain a Return Merchandise Authorization (RMA) number

before returning any product to MID-TECH. If you are returning a product for repair, you must also provide a fault description before MID-TECH will issue an RMA number.

When providing the RMA number, MID-TECH will provide you with shipping instructions to assist you in returning the equipment.

World Wide Web Site

MID-TECH maintains a World Wide Web home page at the following address:

www.mid-tech.com

A corporate profile and product information are available at this site.

Document Conventions

Bold is used to emphasize certain points.

`This font` indicates information presented on the display of the receiver.

This icon indicates that you should press the up arrow button of the receiver keypad.

This icon indicates that you should press the Enter button of the receiver keypad.

This icon indicates that you should press the down arrow button of the receiver keypad.

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings stress important information regarding the installation, configuration, and operation of the RX 400p combination GPS/L-band/Beacon receiver.

Note - Notes outline important information of a general nature.

Cautions - Cautions inform of possible sources of difficulty or situations that may cause damage to the product.

Warning - Warnings inform of situations that may cause harm to you.

1 Installation

This chapter contains instructions and recommendations for the installation of the RX 400p receiver and CDA-2B antenna.

1.1 System Parts List

The following list of standard equipment is included with the RX 400p Receiver system:

- RX 400p
- CDA-2B Antenna
- Power Cable
- Antenna Cable
- Data Cable
- Magnetic Mount Kit
- User Guide

1.2 Receiver Layout and Connections

The RX 400p receiver is easily installed requiring only power, data, antenna, and ground connections. Figure 2-1 illustrates the cable connections required for the RX 400p receiver.

Caution - The RX 400p receiver provides 5 VDC across the antenna port. Connection to incompatible devices may result in damage to equipment.

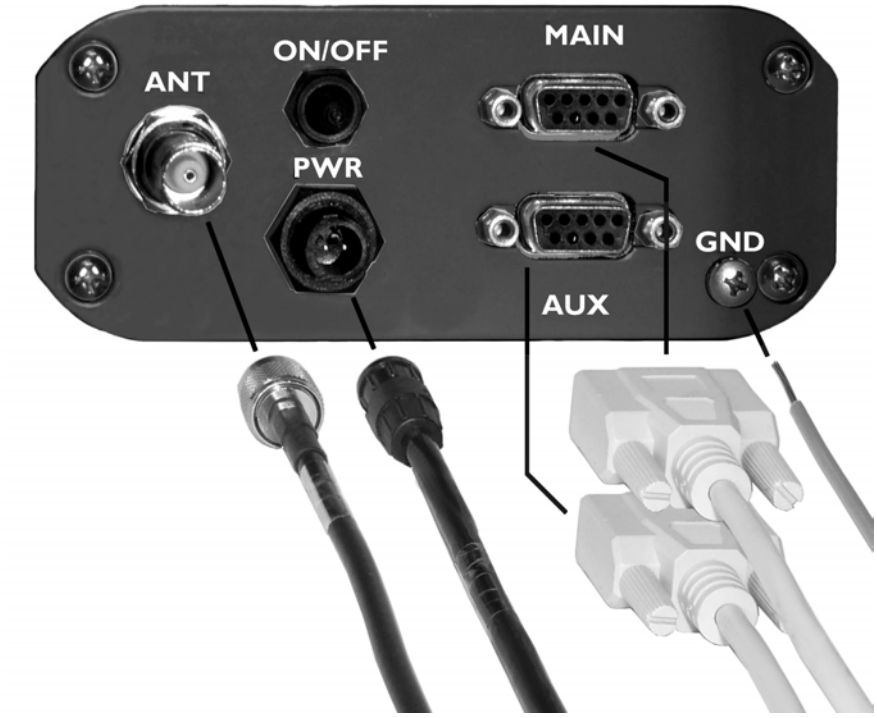


Figure 1-1 Cable Interface

1.3 Installing the RX 400p Receiver

To ensure optimum receiver performance and ease of operation, follow the guidelines presented in the following sections.

1.3.1 Receiver Placement

The flange mounting bracket supplied with the RX 400p is used to secure the receiver to the selected mounting surface. You may install this bracket on the top or

the bottom of the RX 400p. Use the mounting brackets as a template when planning and drilling mounting holes.

When selecting a location to install the receiver, you should ensure that:

- The receiver is within reach of power, data, and antenna cable connections.
- Sufficient room is available at the back of the receiver to connect and disconnect the power, data, antenna, and ground cables.
- Once you have installed the receiver, cables will not be bent excessively or pinched.
- You have a clear view and access to the receiver's front panel, to monitor the receiver status.

1.3.2 Environmental Considerations

The RX 400p is designed to operate in an enclosed environment in which the temperature remains between -32 °C and +74 °C and relative humidity is less than 95% (non-condensing). The receiver may be stored between -40 °C and +85 °C.

The CDA-2B Antenna is designed to operate in an open environment in which the temperature remains between -40 °C and +85 °C and relative humidity is as high as 100%. The antenna may be stored at temperatures between -40 °C and +85 °C.

1.3.3 Power Considerations

The RX 400p uses a 2-conductor, positive locking, circular connector for application of power. The RX 400p accepts an input voltage between 9.2 and 48 VDC. For best performance, the supplied power should be continuous and clean. Table 1-1 details the power specifications of the RX 400p receiver.

The back-lit LCD display of the RX 400p remains illuminated while power is applied to the receiver.

Table 1-1 Power Requirements

Model	Input Voltage	Input Current	Input Power
RX 400p (with CDA-2B)	9 to 48 VDC	<550 mA @ 12 VDC	<6.5 W Nominal

1.3.4 Turning the RX 400p On

When connected to a suitable power source, the RX 400p may be turned on and off using the On/Off switch located on the rear panel.

To turn the RX 400p on:

- Connect the red wire of the supplied power cable to DC positive (+).
- Connect the black wire of the supplied power cable to DC negative (-).
- Connect the keyed, two-conductor socket connector of the power cable to the RX 400p.
- Turn the RX 400p on, by pressing the ON/OFF switch located on the rear panel

You may press the On/Off switch one more time to turn the receiver off. This will save you from having to disconnect the power cable from the receiver.

The RX 400p receiver incorporates reverse polarity protection to prevent damage if the power leads are accidentally reversed.

A 1.5 A slow-blow fuse (or 2.5 A standard blow), situated in-line of the power cable protects the RX 400p receiver from power surges. The fuse container should remain accessible after installation.

Caution - Do not operate the RX 400p with the fuse bypassed. Such a modification will void the product warranty.

1.3.5 Grounding the RX 400p

For best performance, connect the ground screw, labeled 'GND', on the back of the RX 400p to a counterpoise ground (artificial ground). This ground point in most instances will be the chassis of a vehicle. Other grounds may provide acceptable performance. You should minimize the overall length of the ground wire for best performance.

1.3.6 Connecting the RX 400p To External Devices

The RX 400p operates at the RS-232C interface level to communicate with external data loggers, navigation systems, and other devices. It features two data connectors

on the rear panel, labeled ‘MAIN’ and ‘AUX’ to transmit and receive data (refer to Appendix B Interface Information).

MAIN is the primary interface port for differentially corrected GPS data. The AUX port is a secondary port designed for input of external RTCM correction data. In the case that an external differential source is required, you may configure the RX 400p using the menu system to accept the external correction data through the AUX port.

Both data ports are located at the back panel of the RX 400p and are a DB9 socket connector. Table 1-2 and Table 1-3 provide pin-assignment information for the RX 400p MAIN and AUX serial ports respectively.

Table 1-2 MAIN Pin-out, RS-232C Interface Level

Pin #	Signal	Description
2	TXD	RX 400p NMEA 0183 and binary output
3	RXD	RX 400p NMEA 0183 and binary input
5	Sig. Ground	Signal return
9	1 PPS	1 Pulse per second timing output (HCMOS, rising edge synch, 10 kΩ, 10 pF load)

Table 1-3 AUX Port Pin-out, RS-232C Interface Level

Pin #	Signal	Description
3	RXD	RTCM Input (Extrnl RTCM mode only)
5	Sig. Ground	Signal Return
6	Event Marker	HCMOS, active low, falling edge sync, 10 kΩ, 10 pF load
9	1 PPS	1 Pulse per second timing output (HCMOS, rising edge synch, 10 kΩ, 10 pF load)

Figure 1-2 displays the numbering scheme for a DB9 socket connector (female), as located on the rear panel of the RX 400p receiver. The associated numbering for the plug connector (male) is a mirror reflection of scheme showed in this figure.

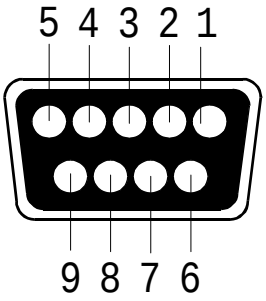


Figure 1-2 RX 400p Socket Connector Pin Numbering

Figure 1-3 illustrates the standard interface for the RX 400p when interfaced to an external device:

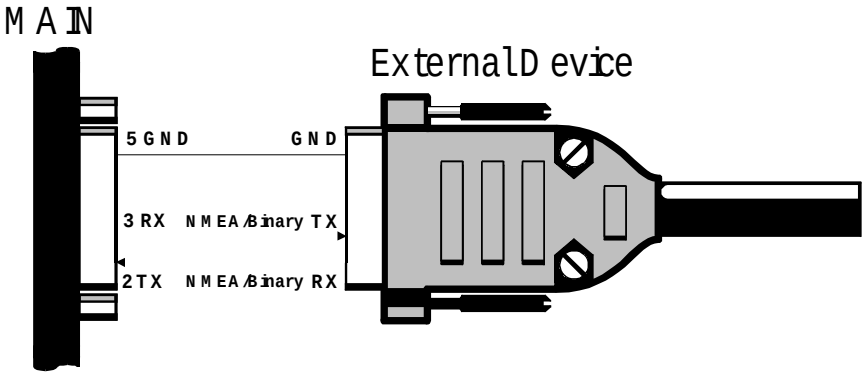


Figure 1-3 RX 400p Interface

Refer to Appendix B for further interface information when operating in the RX 400p with various correction sources.

For successful communications, the baud rate of the RX 400p serial ports must be set to match that of the devices to which they are connected. Refer to Section 4.15.3 and Section 4.16.3 for instructions related to setting the RX 400p baud rates.

1.4 Installing the CDA-2B Antenna

The location chosen for installation of the CDA-2B antenna will influence the overall performance of the RX 400p receiver. When installing the antenna:

- Choose a location with a clear, unobstructed view of the sky. This is important for GPS, WAAS, and OmniSTAR signal reception.
- Choose a location that is at least three feet away from all forms of transmitting antennas, communications, and electronic equipment. This will reduce the amount of noise present at the antenna, improving beacon receiver performance.
- The position calculated by the RX 400p is measured to the center of the CDA-2B antenna. Install the antenna in the best location for your application, such as the centerline of your vehicle or vessel.
- Do not locate the antenna where environmental conditions exceed those specified in Section 1.3.2.

1.4.1 Antenna Placement To Optimize Beacon Reception

When using the internal beacon receiver as the correction source, selecting an appropriate location for installation of the antenna will influence the performance of the internal beacon receiver of the RX 400p. The following list provides some general guidelines for deciding upon an antenna location:

- Ensure that the antenna is as far as possible from all other equipment that emits Electromagnetic Interference (EMI), including DC motors, alternators, solenoids, radios, power cables, display units, and other electronic devices.
- If you are installing the antenna on a vessel (using DGPS beacon corrections), mount the antenna as high as possible, considering maintenance and accessibility. In addition, ensure that the antenna is lower than the highest metal object on the vessel.
- If a radar system is present, mount the antenna outside the path of the radar beam.

Your beacon receiver calculates a Signal to Noise Ratio (SNR), measured in dB (Decibels) that indicates the receiver's performance. The SNR is height of the signal above the noise floor. The higher the SNR, the better your beacon receiver is demodulating the signal. The optimum antenna location will be a position where your average SNR is highest. You should turn on all accessories that you intend to use during normal operation when locating the best position for the antenna.

1.4.2 Antenna Installation – 1-14-UNS Threaded Mount

The CDA-2B uses a 1-14-UNS-2B thread for mounting, which is not compatible with ¾ NPT or pipe threads. A magnetic mount accompanies the standard RX 400p system. An adapter to convert the 1-14-UNS thread to a 5/8th inch survey-style thread is available from MID-TECH, discussed in Section 1.5.3.

Thread the CDA-2B Antenna onto the mount, tightening by hand only. Do not use any tools for tightening, and do not over-tighten.

Caution - A ¾ NPT or pipe thread is not compatible with the thread of the CDA-2B. Use only a 1-14-UNS threaded mount to prevent damage to the antenna enclosure. This type of damage is not covered under warranty.

Caution - Install the antenna only hand-tight. Damage resulting from over-tightening the antenna is not covered by warranty.

1.4.3 Antenna Installation – Surface Mount

The CDA-2B antenna comes with a PVC base pre-installed for mounting on a 1-14-UNS threaded mount installed. This base may be removed for surface mounting the CDA-2B, if desired.

To mount the CDA-2B in this fashion, you must use four 4-40 screws in order to secure the antenna to the mounting surface. Their length will be dependant upon the thickness of the mounting surface used. To determine the location of the screw holes, use the PVC base as a template.

Note - The screw holes are not symmetric so that the PVC base cannot be improperly installed on the antenna. As such, you will have to place the base on the bottom face of the mounting surface when marking the screw holes, before drilling. Do not place the base upside down on the top face of the mounting surface, as the resulting screw holes will not line up correctly.

1.4.4 Routing and Securing the Antenna Cable

The CDA-2B requires a 50 Ω impedance antenna extension cable such as RG-58U (up to a maximum of 10 m (33 ft) in length) for proper operation. For more information on cable length or low-loss cable, please contact your MID-TECH dealer or MID-TECH Customer Service.

When choosing a route for the antenna extension cable:

- Avoid running cables in areas of excessive heat.
- Keep antenna cables away from corrosive chemicals.
- Do not run the extension cable through door or window jams.
- Keep the antenna cable away from rotating machinery.
- Do not bend excessively or crimp the antenna extension cable.
- Avoid placing tension on the cable.
- Remove unwanted slack from the antenna extension cable at the receiver end.
- Secure along the cable route using plastic tie wraps.

Caution - The RX 400p receiver provides 5 VDC across the antenna port. Connection to incompatible devices may result in damage to equipment.

Warning - Improperly installed cables near machinery can be dangerous

1.4.5 Connecting the CDA-2B Antenna

The CDA-2B Antenna connects to the RX 400p receiver using the supplied TNC-male to TNC-male antenna cable. To connect the CDA-2B Antenna to the RX 400p:

- Thread one end of the TNC to TNC antenna extension cable onto the TNC socket present on the CDA-2B

- Thread the other end of the antenna extension cable to the TNC socket connector on the rear panel of the RX 400p, labeled CDA-2B.

Caution - Be sure to always connect the antenna to the RX 400p before you turn the receiver on.

1.5 Mounting Accessories

MID-TECH offers various mounting accessories as discussed in the following sections.

1.5.1 Magnetic Mount

Included with a standard system, the magnetic mount (PN 725-0007-012) can be used to install the CDA-2B antenna on any ferrous surface including the roof of a vehicle. It consists of a mounting extension two inches long, attached to a circular metal disk, housing a magnet. A protective membrane covers the bottom of the mount protects the mounting surface from abrasion.

A three inch diameter zinc plated steel disc and a double sided adhesive foam pad are included with the magnetic mount to attach the magnetic mount to non-ferrous surfaces, such as fiberglass rooftops. For such an installation, remove the protective backing from both sides of the adhesive foam pad, and affix the foam pad to the non-ferrous surface. Place the disc on top of the foam pad. You can then place the magnetic mount securely on the metal plate, and remove as necessary.

The threaded shaft of the mount may be removed from the magnetic disk and used as a threaded insert for survey applications that use the common 5/8th-inch thread. The MID-TECH part number for the threaded shaft is 78-50069.

1.5.2 Survey Adapter

The optional Survey Adapter is a threaded insert available for use with the CDA-2B antenna. It converts the standard 1-14-UNS-2B thread to a 5/8th-inch thread, frequently used with survey equipment (MID-TECH PN 78-50069). This survey adapter is the same part as used for the shaft of the magnetic mount

2 RX 400p Overview

For your convenience, all internal sensors within the RX 400p feature automatic tuning algorithms, which are in operation by default.

When powered for the first time, the RX 400p receiver will perform a 'cold start', which involves acquiring the available GPS satellites in view and the WAAS differential service.

If WAAS is not available in your area, either of the other two internal differential sensors, the beacon or L-band receiver, may be used. The beacon receiver will scan the beacon spectrum for the best signal, and maintain an acquisition on the best station at all times. Should a superior station become available as you navigate with your positioning system, the beacon sensor will automatically acquire that station.

This chapter describes the various modes of operation and features of your RX 400p receiver and its internal sensors.

2.1 GPS Operation

The GPS engine is always operating, regardless of the DGPS mode of operation. The following sections describe the general operation of the RX 400p's internal GPS engine.

2.1.1 Automatic Tracking

The GPS engine within the RX 400p automatically searches for GPS satellites, acquires the signal, and manages the associated navigation information required positioning and tracking. This is a hands-free mode of operation.

2.1.2 Receiver Performance

There are two main aspects of GPS receiver performance - positioning accuracy and satellite acquisition quality.

The estimated positioning precision is accessible through the menu system of the RX 400p receiver. Although this feature is intended for advanced users, it will provide the real-time estimates of precision. As the receiver is not able to determine accuracy with respect to a known location in real time (this is traditionally performed in post-mission analyses), the precision numbers are relative in nature. More about this feature is discussed in Section 4.9.1.1.

Satellite acquisition quality is described as a signal to noise ratio (SNR). A higher SNR is indicative of better quality signal reception. SNR information is provided by the RX 400p via its menu system on a per channel basis numerically as well as presenting this information symbolically in a bar chart. More about this feature is discussed in Sections 4.7 and 4.9.2.

2.2 WAAS Operation

The following sections describe the general operation and performance monitoring of the WAAS demodulator within the RX 400p.

2.2.1 Automatic Tracking

The WAAS demodulator featured within the RX 400p will automatically scan and track the WAAS satellite signals. This automatic tracking allows you to focus on other aspects of receiver operation without the need to tune the receiver.

The WAAS demodulator features two-channel tracking that provides an enhanced ability to maintain acquisition on a WAAS satellite in regions where more than one satellite is in view. This redundant tracking approach will result in more consistent acquisition of a signal when in an area where signal blockage of either satellite is possible.

2.2.2 Receiver Performance

The performance of the WAAS receiver is described in terms of lock icon and a bit error rate (BER). WAAS requires a line of sight to the WAAS satellites in order to acquire the signal.

The BER number indicates the number of unsuccessfully decoded symbols in a moving window of 2048 symbols. Due to the use of forward error correction algorithms, one symbol is composed of two bits.

A lower BER indicates that data is being successfully decoded with fewer errors, providing more consistent throughput. The BER numbers for both satellites, if available in your region, are presented in the menu system of the RX 400p. The bit error rate has a default, no-lock value of 500 or more. As the receiver begins to successfully acquire the signal, it will result in a lower bit error rate. For best operation, this value should be less than 150 and ideally less than 20.

Section 4.10.1 provides more information on the display of the BER. A graphical presentation of the reception quality is provided in the signal tracking bar chart. Refer to Section 4.7 for further information.

2.3 OmniSTAR Operation

The following sections describe the general operation and performance monitoring of the OmniSTAR sensor within the RX 400p.

2.3.1 Automatic Tracking

The RX 400p features an Automatic mode that allows the receiver to locate the best L-band spot beam if more than one is available in a particular region. This function frees you from having to adjust the frequency of the L-band DGPS receiver. For flexibility, the OmniSTAR receiver also features a manual tune mode.

2.3.2 Receiver Performance

The internal OmniSTAR receiver provides both a lock icon and a bit error rate to describe the lock status and reception quality. Both of these features depend on a line-of-sight between the CDA-2B antenna and the geostationary communications satellite broadcasting OmniSTAR correction information.

The CDA-2B Antenna is designed with sufficient gain at low elevation angles to perform well at higher latitudes where the signal power is lower and the satellite appears lower on the horizon.

The BER number indicates the number of unsuccessfully decoded symbols in a moving window of 2048 symbols. Due to the use of forward error correction algorithms, one symbol is composed of two bits.

The bit error rate has a default, no-lock value of 500. As the receiver begins to successfully acquire the signal, it will result in a lower bit error rate. For best operation, this value should be less than 150 and ideally less than 20.

Section 4.11.1 provides more information on this feature. A graphical presentation of the reception quality is provided in the signal tracking bar chart. Refer to Section 4.7 for further information.

2.4 Beacon Operation

The following sections describe the general operation and performance monitoring of the beacon engine within the RX 400p.

2.4.1 Tune Modes

The RX 400p may be operated in either Automatic or Manual Beacon tune modes. In Automatic Beacon Search (ABS) mode, the receiver will identify and tune to the station providing the strongest DGPS signal. In Manual Tune mode, you specify the frequency to which the receiver will tune, or select the desired beacon by name from the built-in global listing.

Refer to Figure 5-12 and Section 4.16.5.3 to switch between Automatic and Manual Tune modes using the display and keypad.

2.4.1.1 Automatic Beacon Search (ABS) Mode

When operating using the internal beacon sensor as the source of DGPS correction information, the RX 400p operates in Automatic Beacon Search (ABS) mode by

default, selecting and tuning to the most appropriate beacon without operator intervention. The RX 400p's internal beacon receiver uses its two independent beacon channels to identify and lock to DGPS beacons without interrupting the continuous flow of RTCM data to the GPS receiver.

ABS mode is ideal for navigation applications over considerable areas, eliminating the need for operator intervention when transitioning from one beacon coverage zone to another.

When desired, you may also tune the beacon receiver manually by using the menu system. This is discussed in Section 4.12.2.

2.4.1.2 ABS Global Beacon Search

When powered for the first time in ABS mode, the RX 400p initiates a Global Search using, examining each available DGPS beacon frequency, and recording Signal Strength (SS) measurements in units of dBμV/m to the Global Search Table. The receiver uses these measured values to compute an average SS, and noise floor, to sort the frequencies in descending order of SS. The beacon receiver's two channels cooperatively examine the frequencies with the highest SS measurements, above the computed noise floor, to determine the station providing the strongest RTCM signal. The receiver's primary channel locks to the first identified DGPS broadcast, while the second channel continues searching in the background for superior beacon signals. If no signal is available, the RX 400p will initiate a fresh Global Search, continuing this cycle until it finds a valid station.

2.4.1.3 ABS Background Beacon Search

During the Background Search, the second beacon channel examines all frequencies at both 100 and 200 bps MSK bit rates to identify beacons possessing superior signal quality. If a DGPS broadcast is identified that exhibits a 2 dB greater signal strength than that of the primary station, the receiver will automatically switch to this beacon. No loss of lock occurs on the primary station during the background scan.

The RX 400p stores the current primary beacon in memory so that it is available upon subsequent power-up. You may force a new Global Search at any time using the display and keypad by selecting the Auto Tune menu item as discussed in Section 4.12.2.

2.4.1.4 Manual Tracking

In Manual tune mode, you may select a specific frequency and bit rate for the receiver to tune, or specify the frequency only, allowing the RX 400p to identify the correct MSK bit rate on its own. This mode of operation is most useful when working in an area where you know the frequency though not necessarily the MSK bit rate of the closest beacon.

The RX 400p also provides the capability to select a beacon by name from the World Beacon Table stored within receiver memory. This feature is discussed in more detail in Section 4.12.2 and 4.12.2.1.

2.4.2 Receiver Performance

The Signal to Noise Ratio (SNR) best describes the internal SBX-2 beacon receiver performance. The SNR, measured in dB, is the height of the signal above the noise floor. The higher the SNR, the more successfully the beacon receiver is demodulating the signal. You can easily monitor the SNR in the Beacon Status menu.

Table 2-1 describes the beacon receiver quality of reception with respect to the SNR reading.

Table 2-1 Beacon Receiver Performance - SNR Reading

SNR	Reception Description	Approximate Data Throughput
>25	Excellent	100% data throughput
20 to 25	Very Good	100% data throughput
15 to 20	Good	Good data throughput up to 100%
10 to 15	Stable	Moderate to good data throughput
7 to 10	Intermittent	Low data throughput
<7	No Lock	No data throughput

A graphical presentation of the reception quality is provided in the signal tracking bar chart. Refer to Section 4.7 for further information.

2.5 Factory Default Parameters

Tables 2-2, 2-3, and 2-4 identify the default RX 400p configuration settings of the various RX 400p Series receivers.

Caution - The changes you make to the RX 400p configuration are saved in memory for subsequent power-up.

Table 2-2 Preset DGPS Mode

DGPS Mode
WAAS

Table 2-3 Preset Port Settings

Serial Port	Baud Rate	Data Bits	Parity	Stop Bit	Interface Level
MAIN	9600	8	None	1	RS-232C
AUX	9600	8	None	1	RS-232C

Table 2-4 Preset GPS NMEA Message Output

GPS NMEA Messages	Update Rate	Max DGPS Age	Elevation Mask
GGA, GSV, VTG, ZDA	1 Hz	1800 seconds	5°

3 RX 400p Architecture

The RX 400p receiver is comprised of two main components – hardware and software. This chapter provides an overview of the hardware and software architecture of the RX 400p receiver in order to provide further insight into the operation of the product.

As the RX 400p receiver supports the following services, it requires receiving capability for each:

- GPS
- WAAS
- OmniSTAR
- Beacon

3.1 Hardware

The SLX receiver inside the RX 400p drives the menu system and provides receiving capability for GPS, WAAS, and OmniSTAR. This platform comprises the main portion of the RX 400p receiver.

The SLX is designed to process GPS and L-band signals simultaneous, using specific hardware and software. A built-in WAAS demodulator uses the same hardware as the GPS receiver, as it does not require its own specific circuitry.

Onboard the SLX is an SBX beacon receiver engine that demodulates beacon signals and communicates them to the SLX GPS through an internal serial port.

3.2 Firmware

As the software that operates the internal components of the RX 400p operates at a low level, it is often referred to as firmware.

There are three types of firmware within the SLX - DSP, ARM, and menu system firmware. Each of these types of firmware may be upgraded in the field through the MAIN serial port, as new revisions become available.

The SBX beacon receiver that resides on-board the SLX incorporates its own version of firmware. The firmware of the SBX may also be upgraded through the MAIN serial port.

3.3 Applications

The ARM of the SLX inside the RX 400p supports two simultaneous versions of firmware. Only one of them is in operation at a given time. These two versions of firmware may have different functionality, and are also referred to as applications. The RX 400p ships with two resident applications - WAAS and OmniSTAR. Switching between the WAAS and OmniSTAR DGPS mode effectively changes the current application. The receiver is automatically rebooted during this operation. No operator intervention is required.

4 Operation

This chapter introduces the display and keypad features of the RX 400p, operating modes, menu structure, and receiver default operating parameters.

4.1 Front Display and Keypad

The RX 400p features a 2-line by 16-character LCD and 3-button keypad. The keypad is composed of an up arrow, enter, and down arrow key. Figure 4-1 shows the display and keypad of the RX 400p receiver.

Figure 4-1 RX 400p Display and Keypad

4.2 Navigating the Menu System

The keypad on the front of the RX 400p allows you to navigate through the intuitive menu system, configuring operating parameters and viewing status information. The top line of the display is the active Focus Line for keypad operations. Menu items that are being accessed must be on the top line of the display for the desired effect to occur.

Note - The top line of the RX 400p display is the Focus Line. The field of interest must be 'in focus' for keystrokes to have the desired effect.

4.3 Menu Access Icon

The icon shown in Figure 4-2 indicates that you may access the current item in focus by pressing the ENTER key.

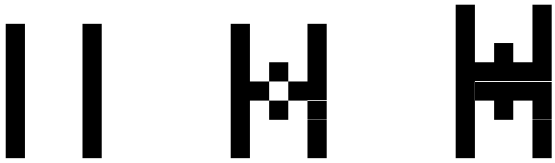
Figure 4-2 Menu Access Icon

4.4 Receiver Status Icons

The following sections describe the status icons of the RX 400p receiver. The icons displayed by the RX 400p depend on the current operating mode of the receiver and its current lock status.

4.4.1 Position Fix Status Icon

The RX 400p provides an indication of the GPS lock status, as contained within the **GPGGA** data message string output from the data port of the receiver. This indicator is located in the lower right hand corner of the RX 400p display. Figure 4-3, illustrates the three states of the GPS status icon.



No GPS Fix GPS Position DGPS Position

Figure 4-3 GPS Position Fix Icon

In the first state, the two parallel vertical lines indicate that no position fix is available. The second state, denoted by the hollow circle between the two parallel vertical lines, indicates that the receiver is tracking four satellites or more, and is computing an uncorrected position. This indicator is a symbol representing a GPS satellite. The third state, denoted by the solid circle between the two parallel vertical lines, indicates that the GPS receiver is computing differentially corrected position solutions.

4.4.2 WAAS Lock Icon

When the RX 400p is configured to use WAAS correction information, The RX 400p receiver will display the lock status on at the far right of the top line of the display. The lock symbol illustrated in the following figure remains in the 'No WAAS Lock' position until the receiver has acquired the signal, at which point the receiver will display the 'WAAS Lock' icon.

No WAAS Lock WAAS Lock

Figure 4-4 WAAS Lock Icon

4.4.3 OmniSTAR Lock Icon

When operating using the internal L-band receiver as the differential source, the RX 400p receiver indicates the OmniSTAR DGPS lock status in the upper right corner of the display. The lock symbol, illustrated in Figure 4-5, remains in the 'No L-band' DGPS Lock state until the receiver has acquired the DGPS satellite transmission at which point the symbol changes to the 'L-band Lock' icon. The L-band DGPS receiver will lock to the satellite signal although a valid subscription is not present within the receiver in order to provide the facility to subscribe the receiver over the air.

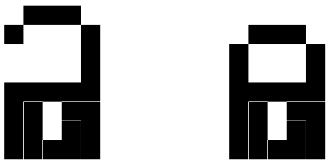
No L-band Lock L-band Lock

Figure 4-5 L-band Lock Icon

Note - When using corrections from the OmniSTAR service, the GPS output of the RX 400p will not be differentially corrected until lock has been attained on an OmniSTAR broadcast with a subscribed receiver.

4.4.4 Beacon Lock Icon

When using the internal beacon sensor as the differential source, the RX 400p indicates beacon lock status in the upper right hand corner of the display. The lock symbol, illustrated in Figure 4-6, remains in the closed position when the RX 400p is locked to a valid beacon signal, and open, when no broadcast is available for the specified frequency and/or MSK bit rate.



No Beacon Lock Beacon Lock

Figure 4-6 Beacon Lock Icon

Note – When using beacon corrections, the GPS output of the RX 400p will not be differentially corrected until the beacon receiver locks to a valid RTCM broadcast.

4.4.5 External DGPS Correction Source Icon

The icon shown in Figure 4-7 indicates that the RX 400p receiver is currently operating with corrections input from an external source. This icon symbolizes external correction input to a DB9 connector.

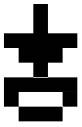


Figure 4-7 External DGPS Source Icon

4.4.6 Autonomous Mode Icon

The Icon shown in the following figure indicates that the receiver is configured to position autonomously, with no DGPS correction source.

Figure 4-8 Autonomous Mode Icon

4.5 RX 400p Menu System Overview

This section shows you how to navigate through the menu system of the RX 400p receiver, change operating modes, monitor position and status information, and change receiver configuration. Figures 4-9 to 4-15 illustrate the various menus in the menu system.

The root, or main menu, contains main parent menus - a GPS menu, a differential menu, a Configuration Wizard menu, and a System Setup menu.

The GPS, Configuration Wizard, and System Setup menus remain the same regardless of the operating settings of the RX 400p receiver. However, the name and content of the differential menu depends on the differential correction source currently in use. Available DGPS operating modes include WAAS, OmniSTAR, Beacon, Autonomous, and External RTCM Input mode.

In Figures 4-9 to 4-15, the root menu is displayed on the left, with associated submenus displayed progressively towards the right. Each of the figures is described in the following sections in detail.

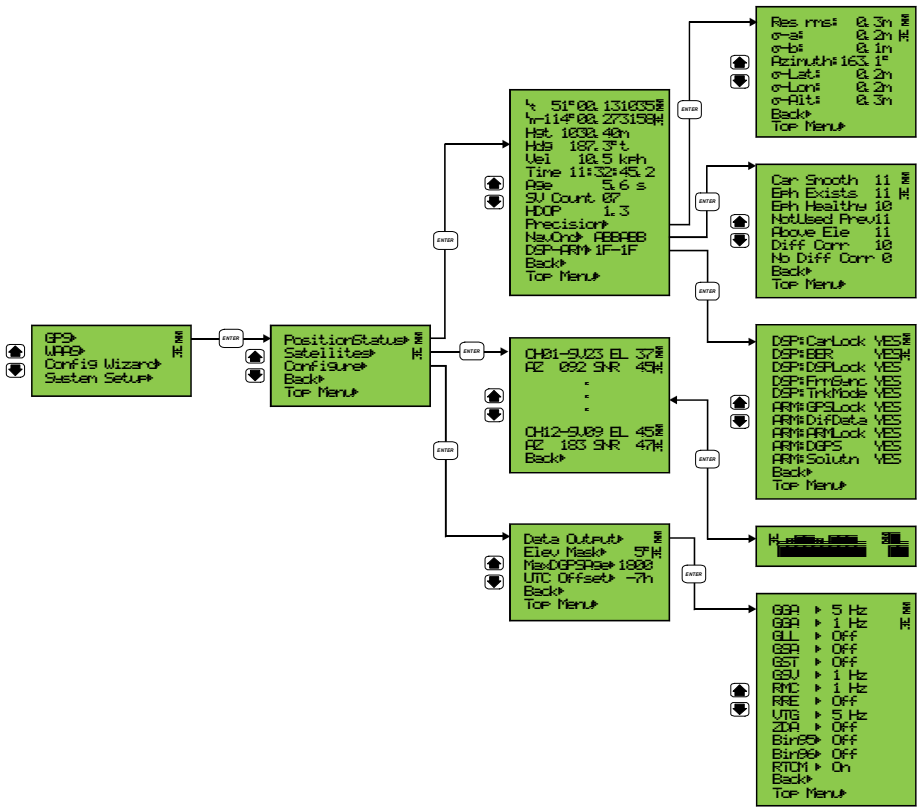


Figure 4-9 GPS Menu

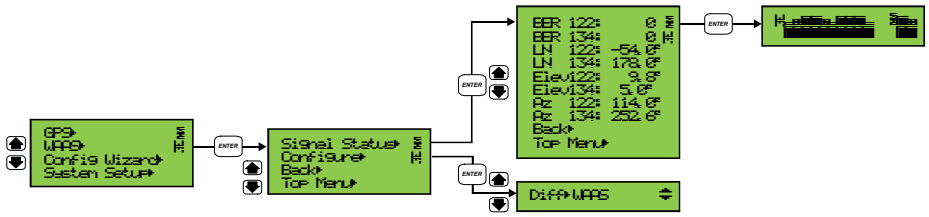


Figure 4-10 WAAS Menu

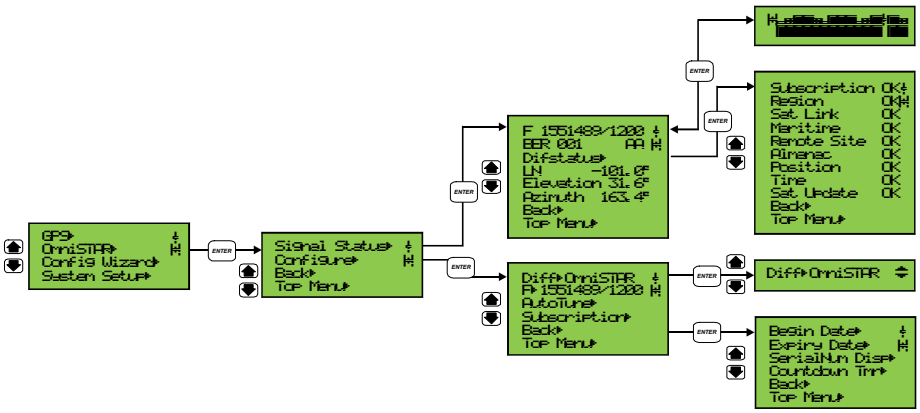


Figure 4-11 OmniSTAR Menu

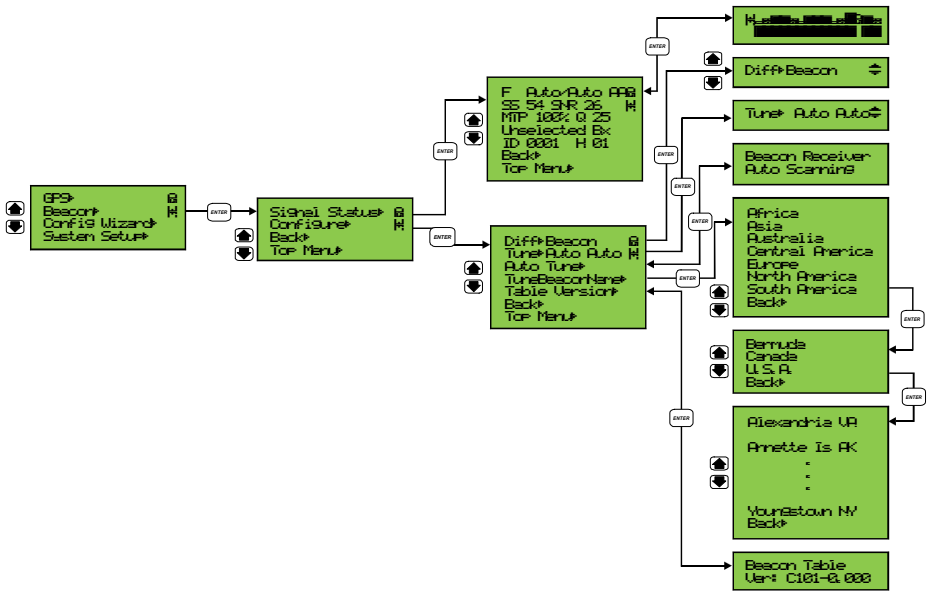


Figure 4-12 Beacon Menu

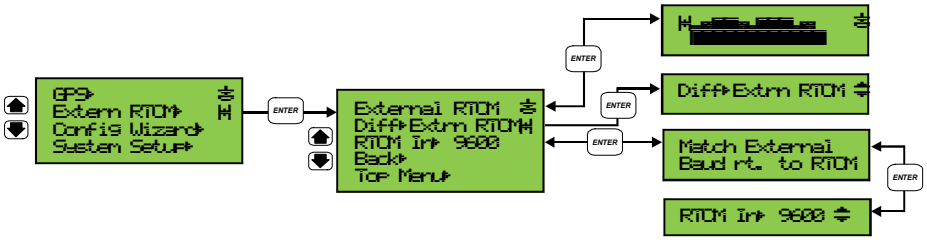


Figure 4-13 External RTCM Input Menu

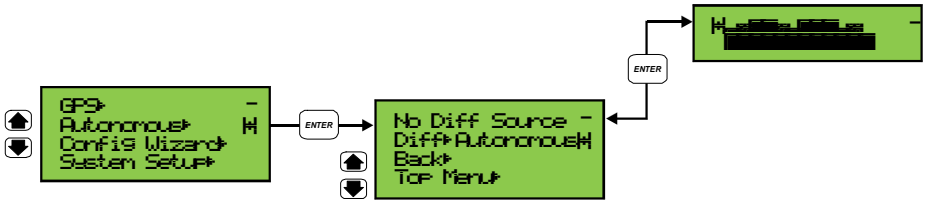


Figure 4-14 Autonomous Menu

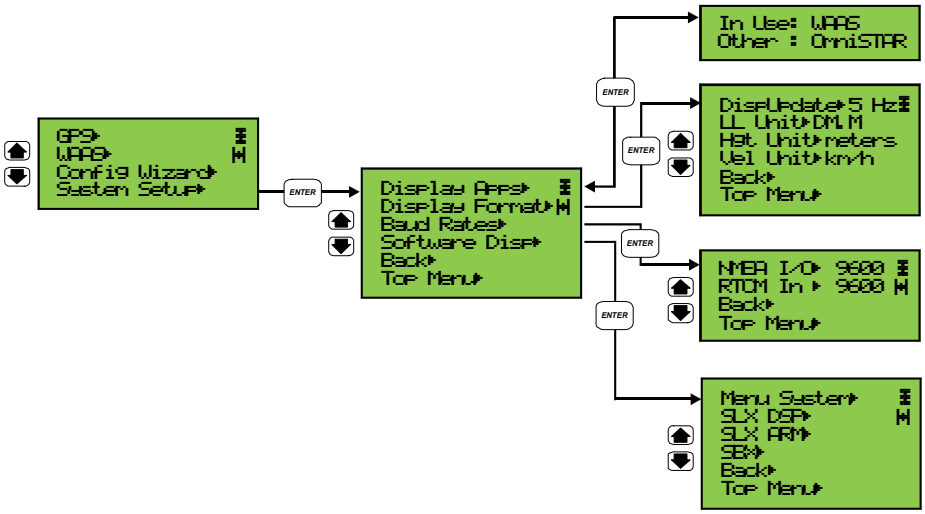


Figure 4-15 Setup Menu

4.6 Start-Up Sequence

When you turn the RX 400p on, it will sequence through a startup screen followed by a prompt asking if you'd like to use the Configuration Wizard. This prompt has a 3-second timeout where the receiver will proceed to the Position Status menu unless the ENTER button is pressed. If ENTER is pressed, the menu system will begin the Configuration Wizard. Consult Chapter 6 for further information on the Configuration Wizard.

4.7 Signal Tracking Bar Chart

When you press the button with a menu item in focus that does not have the menu access indicator, ▸ , a bar chart is displayed that provides signal tracking information.

The bar chart consists of two main parts, provides an indication of the GPS satellite signal quality per receiver channel and the signal quality of the differential source. For each bar, the higher the bar, the greater the signal quality.

The first portion of the chart, denoted by the GPS icon, , indicates the GPS satellite receiving quality on a per channel basis. The second portion, denoted by the DGPS icon (, , , , or) of the current mode of operation, provides the signal tracking information for that correction source, if appropriate. If the external correction input or the autonomous mode of differential operation is selected, the receiver will not display status information for a correction source.

4.7.1 WAAS Mode Bar Chart

When operating the RX 400p receiver in WAAS mode, the portion of the bar chart to the right of the WAAS mode indicator, , reflects WAAS tracking performance. The WAAS bar chart will reflect the quality of the bit error rate (BER) for WAAS signal reception. A higher bar is indicative of a better BER.

A good BER is zero and no lock is 500 or greater. A full height bar (16 pixels tall, including both the top and bottom rows of the display) represents a BER of zero as shown below. A BER of 500 or greater will be displayed with minimum bar height, and will be only 2 pixels tall. Intermediate quality signals are shown with a bar height relative to the reception quality.

In the case of WAAS, since there are two WAAS satellites available, two BER's are provided. The first bar is for WAAS PRN 122 and the second for WAAS PRN 134.

4.7.2 OmniSTAR Mode Bar Chart

When operating the RX 400p receiver in OmniSTAR mode, the portion of the bar chart to the right of the OmniSTAR mode indicator, , reflects OmniSTAR tracking performance. The OmniSTAR bar chart will reflect the quality of the bit error rate (BER) for OmniSTAR signal reception. A higher bar is indicative of a better BER.

A good BER is zero and no lock is 500. A full height bar (16 pixels tall, including both the top and bottom rows of the display) represents a BER of zero as shown below. A BER of 500 will be displayed with minimum bar height, and will be only 2 pixels tall. Intermediate quality signals are shown with a bar height relative to the reception quality.

4.7.3 Beacon Mode Bar Chart

When operating the RX 400p receiver in beacon mode, the portion of the bar chart to the right of the beacon mode indicator, , reflects tracking performance. The beacon bar chart will reflect the quality of the signal strength (SS) and the signal to noise ration (SNR) for beacon signal reception. A higher bar is indicative of better signal variables.

A full height bar (16 pixels tall, including both the top and bottom rows of the display) represents an SS of 35 or greater and an SNR of 24 or greater. SS and SNR values of zero will be displayed with minimum bar height, and will be only 2 pixels tall. Intermediate quality signals are shown with a bar height relative to the reception quality.

In the case of Beacon, there are two signal figures, the SS and SNR reading. The first bar indicates the SS value and the second the SNR reading.

4.7.4 External RTCM Input Bar Chart

When operating the RX 400p receiver in External RTCM Input mode, the portion of the bar chart to the right will display the external RTCM input icon . No associated status data is provided for the external correction source.

4.7.5 Autonomous Mode Bar Chart

When operating the RX 400p receiver in autonomous mode, the portion of the bar chart to the right will display the autonomous icon -. No associated status data is provided for this mode of operation.

4.8 Main Menu

The RX 400p will display the following menu when the boot sequence has been completed upon startup. This is the top, or Main menu.

Pressing the ▲ and ▼ keys allows you to scroll through the available menu items. Pressing the ENTER button with any item in focus (on the top line) will take the menu system to that submenu.

GPS▸	When this menu is accessed using the ENTER button, the menu system displays the contents of the GPS menu, providing access to position and satellite information, and access to GPS setup parameters.
WAAS▸	When this menu is accessed using the ENTER button, the RX 400p menu displays the contents of the DGPS menu. Depending on the differential mode of operation, this menu will be named WAAS, OmniSTAR, Beacon, Extern RTCM, or Autonomous. Inside this menu will be status-related information and configuration parameters. The structure of this menu differs from one DGPS mode to another.
Config Wizard▸	When this menu item is accessed using the ENTER button, the Configuration Wizard will begin. This feature allows you to easily configure the RX 400p step-by-step. This feature is described in detail in Chapter 5.
System Setup▸	When this menu is accessed, the menu system will display the contents of the System Setup menu. Inside this menu, you'll have the ability to change baud rates, view the current applications in memory, customize the display parameters, and monitor the versions of firmware installed in the RX 400p receiver.

4.9 GPS Menu

The GPS▸ menu contains sub-menus that provide access to position and satellite status information, and GPS receiver configuration parameters. Please note that the icon in the lower corner of the display will change according to the GPS fix as shown in Figure 4-3. This portion of the menu system, including submenus, is detailed in Figure 4-9.

Pressing the ▲ and ▼ keys in this menu allows you to scroll through the available menu items. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

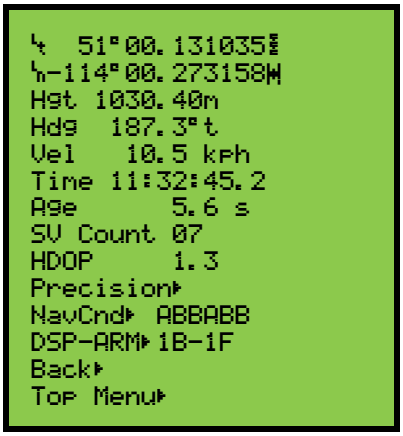
Accessing this menu item using the ENTER button allows you to monitor position-related information, such as latitude, longitude, altitude, and time. Other useful information is also presented in this menu.

When this menu item is accessed using the ENTER button, the menu system will display the GPS satellite tracking status on a channel-by-channel basis.

Configure▸	Entering this menu using the ENTER button will allow you to change various configuration parameters related to the GPS receiver inside the RX 400p. This includes NMEA message output settings, elevation cut-off mask, differential time-out, and UTC offset.
Back▸	When accessed using the e button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.1 GPS Position Status Menu

The PositionStatus▸ section of the menu tree provides access to GPS position and navigation status information. This portion of the menu system, including submenus, is detailed in Figure 4-9.



Pressing the ↑ and ↓ keys allows you to scroll through the available menu items. Pressing the ENTER button anywhere in this menu will provide a bar chart of signal tracking information. Pressing the ENTER button with the Back or Top Menu item in focus will take the menu system to the previous menu or the Main menu, respectively

This menu item displays the current antenna latitude in degrees / minutes / decimal minutes (DM.M) by default. Other display formats are possible, including degrees / decimal degrees (D.D) and degrees / minutes / seconds (DMS). These other display formats are discussed in further detail in Section 4.15.2.

Latitude information is parsed from the **GPGGA** NMEA message. The latitude, measured to the phase center of the antenna, is usually referenced to the WGS-84 ellipsoid, however, some DGPS services result in a position relating to the North American Datum 1983 (NAD-83). This datum is essentially equivalent to this ellipsoid, considering the level of accuracy of this product.

This menu item displays the current antenna longitude in degrees / minutes / decimal minutes (DM.M) by default. Other display formats are possible, including degrees / decimal degrees (D.D) and degrees / minutes / seconds (DMS). These other display formats are discussed in further detail in Section 4.15.2.

Longitude information is parsed from the **GPGGA** NMEA message. The longitude, measured to the phase center of the antenna, is usually referenced to the WGS-84 ellipsoid, however, some DGPS services result in a position relating to the North American Datum 1983 (NAD-83). This datum is essentially equivalent to this ellipsoid, considering the level of accuracy of this product.

This menu item displays the current antenna height in either meters or feet depending on the units selected (See Section 4.15.2). The default unit is meters. This information is parsed from the NMEA **GPGGA** message.

The altitude, measured to the phase center of the antenna, is usually referenced to the WGS-84 ellipsoid, however, some DGPS services result in a position relating to the North American Datum 1983 (NAD-83). This datum is essentially equivalent to this ellipsoid, considering the level of accuracy of this product.

This item displays the horizontal heading clockwise from True North in degrees. This information is parsed from the **GPVTG** NMEA message string.

This item displays the horizontal speed in KPH by default. The units may be changed to MPH or knots if desired (See Section 5.15.2 for details on configuring the units of this item). This information is parsed from the **GPVTG** NMEA message.

This item displays the current UTC Time. If a local offset has been specified, the time will reflect your local time instead. See Section 5.15.2 for further details on setting a UTC offset. This information is parsed from the **GPZDA** NMEA message.

This item displays the current DGPS age of corrections in seconds. This information is parsed from the **GPGGA** NMEA message.

This item displays the current number of satellites being used by the GPS receiver in computing its position. If this value is 4 or greater, then the computed position is 3D, and includes a valid height solution. If less than four, then the solution is 2D, holding the height parameter constant at either 0, or its last measured value. This information is parsed from the **GPGGA** NMEA message

This menu item displays the Horizontal Dilution of Precision (HDOP), which describes the quality of the satellite geometry. A lower value is better than a higher number. An HDOP of less than 1.0 indicates strong satellite geometry, which promotes good positioning accuracy. A value of over 3.0 indicates weaker satellite geometry and accuracy may become affected. This information is parsed from the **GPGGA** NMEA message.

Accessing this menu by pressing the ENTER button with this item in focus will provide access to estimated real-time precision values of computed positions. The contents of this menu are described in Section 4.9.1.1.

This menu item displays satellite tracking information and is called the navigation condition. Each character following the NavCnd▸ prompt is the number of satellites that meet certain criteria. Each character space is a hexadecimal value of between 0 and 12 (B in hexadecimal).

by pressing the ENTER button with this item in focus, an intuitive summary of the navigation condition is displayed. This is discussed in further detail in Section 4.9.1.2.

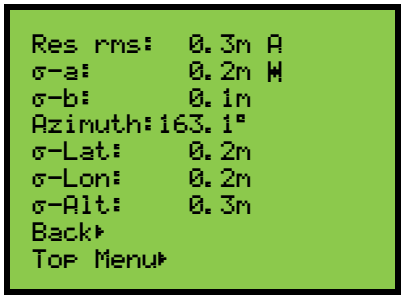
This menu item displays the internal status of the on-board DSP and ARM processor of the SLX. By pressing the ENTER button with this item in focus, a menu will display that decodes the raw DSP-ARM status into an intuitive format described in Section 4.9.1.3.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.1.1 Precision Menu

The Precision▸ menu provides information relating to the estimated real-time precision of position computations. Please note that these are not absolute accuracy estimates, but only relative measures. This menu is detailed in Figure 4-9.



Pressing the ▲ and ▼ keys allows you to scroll through the available menu items. Pressing the ENTER button anywhere in this menu will provide a bar chart of signal tracking information. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

This menu item displays the root mean square of the residuals that result from a position computation. This value provides an estimate of the position accuracy, and approximates one standard deviation of horizontal precision.

This menu item indicates the length of the semi-major axis of the horizontal position's error ellipse, to a confidence of one standard deviation.

This menu item indicates the length of the semi-minor axis of the horizontal position's error ellipse, to a confidence of one standard deviation.

This menu item indicates the azimuth of the semi-major axis of the horizontal position's error ellipse.

This menu item indicates length of the latitude component of the horizontal error ellipse to a confidence of one standard deviation.

This menu item indicates length of the longitude component of the horizontal error ellipse to a confidence of one standard deviation.

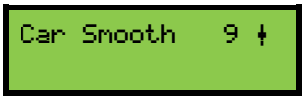
σ-Alt: 0.3m	This menu item indicates height of the altitude component of a 3D error ellipse to a confidence of one standard deviation.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.1.2 NavCnd Menu

In order to be added to the position computation, a satellite must have a healthy ephemeris, be above the elevation cut-off mask angle, and have differential corrections. This menu indicates how many satellites meet each of these criteria. This menu is detailed in Figure 4-9.

Pressing the ▲ and ▼ keys allows you to scroll through the available menu items. Pressing the ENTER button anywhere in this menu will provide a bar chart of signal tracking information. Pressing the ENTER button with the Back▸ or Top Menu▸ item

in focus will take the menu system to the previous menu or the Main menu, respectively.

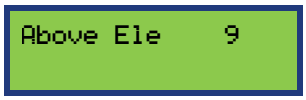


This menu item displays the number of satellites currently being tracked that have carrier phase smoothing active. Carrier phase smoothing uses the instantaneous carrier phase to smooth the code measurements to remove measurement noise and improving the consistency and accuracy of the position solution. This feature is automatic in nature.

This menu item shows how many satellites have a healthy ephemeris (orbit information). A satellite must have a healthy ephemeris in order to be added to the position solution.

This menu items displays the number of satellites that have an ephemeris and the ephemeris is deemed to be healthy. If an ephemeris is not considered to be healthy, that satellite will not be considered in the position computation.

This menu item is the number of satellites that are currently being tracked by the GPS engine, have an ephemeris, are healthy, and are above the elevation mask.



This menu item indicates how many satellites are above the current elevation mask setting. An elevation mask is used to ignore satellites that are low on the horizon, but still usable, as they will have more significant tropospheric refraction errors. A satellite below the elevation mask is ignored from the position solution. See Section 4.9.3 for further details on setting the mask angle.

This menu item indicates the number of satellites that have valid differential correctors in use. The number of correctors present will depend on the information broadcast by the differential service in use. There will not be correction information for satellites tracked by the remote receiver but not the base station. As a consequence, these satellites are not used in the position calculation.

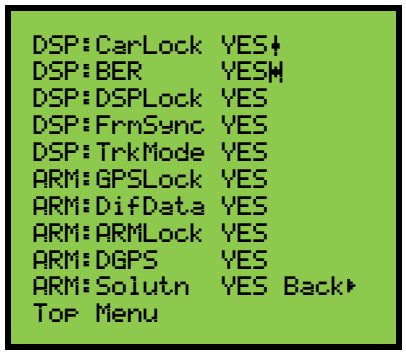
This menu item indicates the number of satellites that have no differential correctors present and are ignored in the position solution, until correction information becomes available.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.1.3 DSP-ARM Menu

The DSP-ARM status menu provides information relating to the status of the internal DSP and ARM processors of the internal SLX receiver of the RX 400p. This menu is detailed in Figure 4-9.



Pressing the ↑ and ↓ keys allows you to scroll through the available menu items. Pressing the ENTER button anywhere in this menu will provide a bar chart of signal tracking information. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

The DSP:CarLock is a description of the L-band carrier lock. Under normal operation, this field should indicate YES.

This is an indication of whether or not the internal L-band receiver has acquired a Viterbi lock (signal lock). Under normal operation, this field should indicate YES.

This is an indication of whether or not the internal L-band receiver has a valid internal tracking frequency. Under normal operation, this field should indicate YES.

This is an indication of whether or not the internal OmniSTAR receiver or WAAS demodulator has acquired frame synchronization. Under normal circumstances, this lock condition should indicate YES.

This has the same meaning as the CarLock. Under normal operation, this field should indicate YES.

This menu item provides the status of a GPS lock. Four valid satellites must be acquired before a GPS lock may be indicated. Under normal operation, this field should indicate YES.

This menu item indicates if differential data is being successfully decoded by the GPS receiver. Under normal operation, this field should indicate YES.

Under normal operation, this field should indicate YES.

Under normal operation, this field should indicate YES.

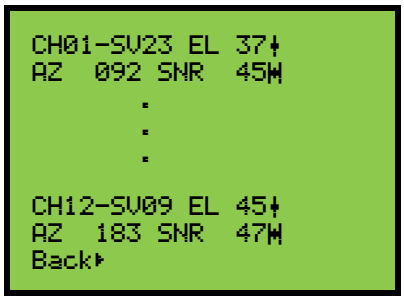
This menu item indicates if the GPS solution is deemed correct by the processor. Under normal operation, this field should indicate YES

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.2 GPS Satellites Menu

This section of the menu tree provides access to GPS satellite tracking information on a channel-by-channel basis. This menu is detailed in Figure 4-9.



Pressing the ↑ and ↓ keys allows you to scroll through the available GPS receiver channels, numbered Ch01 through Ch12. Pressing the ENTER button with any item in focus that does not have the menu access indicator, ▸, will display a signal tracking bar chart. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

This is the receiver channel (0 to 12) and the satellite number being tracked by that channel. This information is parsed from the **GPGSV** NMEA message.

This is the elevation (0° - horizon to 90°- vertical) of the satellite for the particular receiver channel referenced on the top line of the display. This information is parsed from the **GPGSV** NMEA message.

This figure is the azimuth of the satellite, referenced to North (0° = 360° = North), for the particular receiver channel noted on the top line of the display. An azimuth of 90° is directly East. This information is parsed from the **GPGSV** NMEA message.

This is the signal-to-noise ratio (carrier to noise ratio) of the GPS satellite signal, per receiver channel of the internal GPS engine. The value of the SNR per satellite depends on the gain of the antenna used, length of coaxial cable, elevation of the satellite, and also if there are any minor obstructions between the satellite and the receiver's antenna, such as foliage. A higher SNR reading is desirable. For best channel tracking performance, the RX 400p requires an SNR of above approximately 40. This information is parsed from the **GPGSV** NMEA message.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.3 GPS Configure Menu

This menu provides access to various configurable GPS parameters. This portion of the menu system, including submenus, is detailed in Figure 4-9.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

NMEA Output▸	When accessed using the ENTER button, this menu item will take the menu system of the RX 400p to the NMEA Output menu for configuration of the messages output by the receiver.

When accessed, this menu allows you to adjust the elevation cutoff mask of the internal GPS receiver, from 0° to 45°, using the ↑ and ↓ keys, followed by pressing ENTER.

When accessed, this menu allows you to adjust the maximum age that the GPS receiver will accept of differential corrections before leaving differential mode and entering standalone mode. Simply adjust the maximum age to the value that you desire by adjusting the leftmost number using the ↑ and ↓ keys, followed by pressing ENTER. This will allow you to adjust the subsequent number and so on.

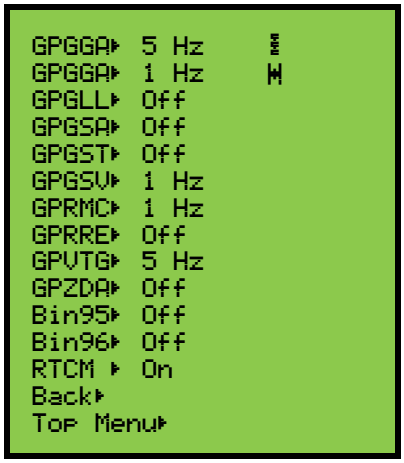
When accessed, this menu allows you to adjust the offset needed to reference your local time rather than UTC time from -12 to +12 hours. You may change the offset used by the receiver in the display of time, using the ↑ and ↓ keys, followed by pressing ENTER.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.9.3.1 NMEA Output Menu

This menu allows you to toggle the output of various NMEA messages that are output from the MAIN port of the RX 400p. This menu is detailed in Figure 4-9. The NMEA messages within this menu are described in detail within Chapter 7.



Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the `Back▸` or `Top Menu▸` item in focus will take the menu system to the previous menu or the Main menu, respectively.

This menu item allows you to toggle the output of the GPGGA message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

This menu item allows you to toggle the output of the GPGLL message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

This menu item allows you to toggle the output of the GPGSA message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 1 Hz only.

This menu item allows you to toggle the output of the GPGST message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 1 Hz only.

This menu item allows you to toggle the output of the GPGSV message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 1 Hz only.

This menu item allows you to toggle the output of the GPRMC message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

This menu item allows you to toggle the output of the GPRRE message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 1 Hz only.

This menu item allows you to toggle the output of the GPVTG message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

This menu item allows you to toggle the output of the ZDA message through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

This menu item allows you to toggle the output of the Binary 95 message (contains GPS ephemeris data) through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ↑ or ↓ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

This menu item allows you to toggle the output of the Binary 96 message (contains raw measurement data) through the MAIN port of the RX 400p receiver. To change the current update rate, press the ENTER button followed by adjusting the rate using the ▲ or ▼ key, then press ENTER. This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.

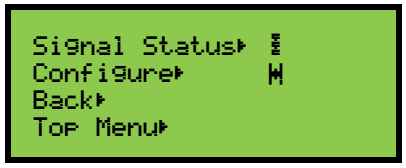
This menu item allows you to toggle the output of the RTCM data through the MAIN port of the RX 400p receiver. When set to output RTCM, this data comes from the current DGPS source in use. To toggle its output, press the ENTER button followed by adjusting the rate using the ▲ or ▼ key, then press ENTER. This data may be turn on or off.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.10 WAAS Menu

This menu provides access to the WAAS signal status menu and a menu to choose the DGPS source. Please note that the icon in the upper right corner of the display will change to a vertical satellite symbol as shown in Figure 4-4 when using corrections from the internal WAAS receiver. This portion of the menu system, including submenus, is detailed in Figure 4-10.



Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back or Top Menu item in focus will take the menu system to the previous menu or the Main menu, respectively.

Pressing the ENTER button with this menu item in focus will take the menu system to the WAAS signal status menu.

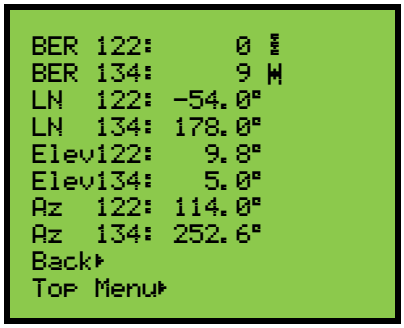
Pressing the ENTER button with this menu item in focus will take the menu system to the WAAS configuration menu. Since the WAAS demodulator is fully automatic in nature, this submenu allows you to only change the current DGPS mode.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.10.1 WAAS Signal Status Menu

This menu provides various information regarding the status and operation of the WAAS demodulator. This portion of the menu system, including submenus, is detailed in Figure 4-10.



Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any status information in focus will display the signal tracking bar chart. Pressing the ENTER button with the Back or Top Menu item in focus will take the menu system to the previous menu or the Main menu, respectively.

This menu item displays the bit error rate of PRN 122 AOR-W (Atlantic Ocean Region – West) WAAS satellite signal. The bit error rate, as discussed in Section 2.3.2 is an indication of the signal acquisition quality. Good reception is characterized by a rate of less than 20, a tolerable rate is less than 150, and a no-lock condition is 500 or greater.

This menu item displays the bit error rate of PRN 134 POR (Pacific Ocean Region) WAAS satellite signal. The bit error rate, as discussed in Section 2.3.2 is an indication of the signal acquisition quality. Good reception is characterized by a rate of less than 20, a tolerable rate is less than 150, and a no-lock condition is 500 or greater.

This menu item provides the longitude of the PRN 122 AOR-W (Atlantic Ocean Region - West) WAAS satellite. As the satellite is geosynchronous, this value will not change.

This menu item provides the longitude of the PRN 134 POR (Pacific Ocean Region - West) WAAS satellite. As the satellite is geosynchronous, this value will not change.

This menu item provides the current elevation angle, referenced to the horizon, of the PRN 122 AOR-W (Atlantic Ocean Region - West) WAAS satellite. This value is dependent upon your latitude and longitude in relation to the satellite's longitude and the equator. Increasing distance from the equator will result in the satellite appearing lower on the horizon.

This menu item provides the current elevation angle, referenced to the horizon, of the PRN 134 POR (Pacific Ocean Region) WAAS satellite. This value is dependent upon your latitude and longitude in relation to the satellite's longitude and the equator. Increasing distance from the equator will result in the satellite appearing lower on the horizon.

This menu item provides you with the current azimuth, referenced to North, of the PRN 122 AOR-W (Atlantic Ocean Region - West) WAAS satellite. The azimuth value depends on your current latitude and longitude in relation to the satellite's longitude. If the satellite is directly South of your current location, the satellite will have an azimuth of 180°.

Az 134: 252.6°	This menu item provides you with the current azimuth, referenced to North, of the PRN 134 POR (Pacific Ocean Region) WAAS satellite. The azimuth value depends on your current latitude and longitude in relation to the satellite's longitude. If the satellite is directly South of your current location, the satellite will have an azimuth of 180°.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

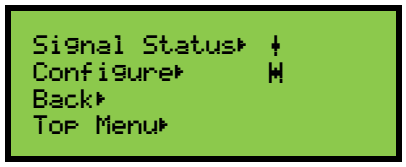
4.10.2 WAAS Configure Menu

This menu allows you to change from the current WAAS mode to a different DGPS mode. This portion of the menu system is detailed in Figure 4-10.

Pressing the ↑ and ↓ keys allows you to scroll through the differential options. Pressing the ENTER button will change to the specified mode. If you do not wish to change from the current differential mode, simply select WAAS and press the ENTER button.

4.11 OmniSTAR Menu

This menu provides access to the signal status and configuration parameters of the internal L-band receiver inside the RX 400p. Please note that the icon in the upper right corner of the display will change to a vertical satellite symbol as shown in Figure 4-5 when using corrections from the internal OmniSTAR receiver. This portion of the menu system, including submenus, is detailed in Figure 4-11.

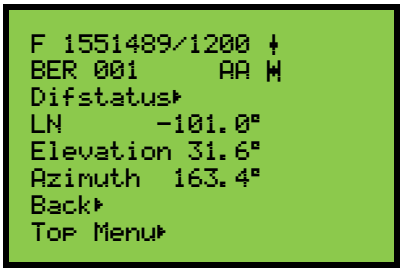


Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Signal Status▸	Accessing this submenu by pressing the ENTER button with this item in focus allows you to monitor signal status information from the internal OmniSTAR DGPS receiver.
Configure▸	When in focus, accessing this menu using ENTER button allows you to configure the internal OmniSTAR receiver.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.11.1 OmniSTAR Signal Status Menu

This menu provides information related to the signal quality of the built-in OmniSTAR DGPS receiver. Included in this menu are the elevation and azimuth to the L-band satellite specific to your current location. These two values will be useful for you to help troubleshoot signal blockages, if present. This portion of the menu system, including submenus, is detailed in Figure 4-11.



Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any status information in focus will display the signal tracking bar chart. Pressing the ENTER button with the **Back** or **Top Menu** item in focus will take the menu system to the previous menu or the Main menu, respectively.

This menu item displays the current tracking frequency of the L-band DGPS receiver (in kHz) and the modulation rate (in bps).

This menu item displays the bit error rate of the OmniSTAR receiver and the tuning mode. AA indicates that the receiver is currently operating in automatic mode for both frequency and modulation rate. MM indicates manual frequency and modulation rate selection.

The bit error rate, as discussed in Section 2.3.2 is an indication of the signal acquisition quality. Good reception is characterized by a rate of less than 20, a tolerable rate is less than 150, and a no-lock condition is 500.

The differential status menu provides an indication of the status of the L-band DGPS receiver. This value is in hexadecimal, however, the submenu that may be accessed by pressing the ENTER button, when this item is focus, decodes this into more intuitive information.

This menu item provides the longitude of the currently acquired OmniSTAR DGPS communication satellite. As the satellite is geosynchronous, this value will not change.

This menu item provides the current elevation angle, referenced to the horizon, of the OmniSTAR satellite. This value is dependent upon your latitude and longitude in relation to the satellite's longitude and the equator. The further North or South from the equator, the lower the satellite will appear on the horizon. The further East or West of the satellite's longitude, again, the satellite will appear lower on the horizon.

This menu item provides you with the current azimuth, referenced to North, of the OmniSTAR satellite. The azimuth value depends on your current latitude and longitude in relation to the satellite's longitude. If the satellite is directly South of your current location, the satellite will have an azimuth of 180°. If the satellite appears directly North of your current location, it will have an azimuth of 0°. If you are on the equator with the satellite East of you, it will have an azimuth of 90°.

Back▸ When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

Top Menu▸ When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.11.1.1 Difstatus Menu

This menu provides details on the OmniSTAR differential service. This menu is detailed in Figure 4-11.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any status information in focus will display the signal tracking bar chart. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Subscription This menu item indicates if the current subscription is valid by displaying 'OK'. If a subscription is not currently present or has expired, it will display 'BAD'.

This menu item indicates if the receiver is currently operating within the intended region. If the receiver is operating in the subscribed region, this item will display ‘OK’, otherwise it will display ‘BAD’.

This menu item indicates if the OmniSTAR satellite uplink is operating correctly. If the link is operating correctly, this item will display ‘OK’, otherwise it will display ‘BAD’.

This menu item indicates if the currently enabled OmniSTAR subscription is valid for maritime use. For land use, it’s acceptable if this is item displays ‘BAD’.

When the RX 400p displays ‘OK’, this menu item indicates that the remote site in use as part of the DGPS correction source is operating correctly. If the site is not operating correctly, the receiver will display ‘BAD’.

This menu item indicates if the almanac provided by the OmniSTAR services has been downloaded successfully. If a valid almanac is present with the RX 400p, it will display ‘OK’, otherwise the receiver will display ‘BAD’. A valid almanac is required to decode DGPS data. It may take up to 20 minutes to obtain a valid almanac if the current one is invalid or out of date. A valid almanac is present from factory.

This menu item indicates if the internal L-band receiver has received a position from the GPS sensor. If a valid position is present, the RX 400p will display ‘OK’, otherwise the receiver will indicate ‘BAD’.

This menu item indicates if GPS time is currently available to the internal L-band sensor. If time is available, the RX 400p will display ‘OK’, otherwise the receiver will display ‘BAD’.

This menu item indicates if the current satellite update is correct. If the current update is acceptable, the RX 400p will display ‘OK’, otherwise the receiver will display ‘BAD’.

Back▸ When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

Top Menu▸ When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.11.2 OmniSTAR Configure Menu

This menu contains two menus related to the selection of the differential source, OmniSTAR receiver tuning, and a facility to monitor the subscription status of the OmniSTAR receiver inside the RX 400p. This menu is detailed in Figure 4-11.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Diff▸OmniSTAR ↓ This menu item allows you to choose the source of differential corrections. Correction source options include the internal WAAS, OmniSTAR, beacon, autonomous, or external corrections. When using an external source, be sure that the source is providing RTCM SC-104 compliant corrections, and not a proprietary binary format.

When accessed using the ENTER button, you will be able to tune the OmniSTAR receiver manually. A screen will confirm that you wish to proceed with the manual tune. If you do, adjust this to read 'Yes' and press the ENTER button.

When prompted to tune the frequency, adjust each character using the ▲ and ▼ keys, followed by pressing the ENTER button to advance the cursor to the next position. Continue unit you have entered the desired frequency.

You will then be prompted to select the correct modulation rate. Simply adjust to the correct modulation rate using the ▲ and ▼ keys and press the ENTER button to complete the process.

When accessed using the ENTER button, the OmniSTAR receiver will be tuned in automatic mode. A screen will indicate that the receiver is in automatic mode.

When accessed using the ENTER button, this menu item will take the menu system to the Subscription menu where the subscription expiry date and serial numbers may be viewed.

Back▸ When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

Top Menu▸ When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.11.2.1 Subscription Menu

When operating the RX 400p with an OmniSTAR subscription, this menu provides information relating to the expiry of the subscription. Additionally, the OmniSTAR unit number is provided in this menu, which is required by OmniSTAR for subscribing to their service. This menu is detailed in Figure 4-11.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Begin Date▸ When accessed using the ENTER button, this menu will provide you with the beginning date of your subscription.

Expiry Date▸ When accessed using the ENTER button, this menu will provide you with the expiry date for your subscription.

SerialNum Disp▸	When accessed using the ENTER button, this menu will provide you with the OmniSTAR unit number for your RX 400p. OmniSTAR uses this number for subscription purposes. Please have it ready when subscribing your receiver when contacting OmniSTAR.
Countdown Tmr▸	When accessed using the ENTER button, this menu item will display the time left, if a countdown timer has been subscribed to your receiver.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.12 Beacon Menu

This menu provides access to the signal status and configuration parameters of the internal SBX beacon receiver inside the RX 400p. Please note that the icon in the upper right corner of the display will be a padlock symbol as shown in Figure 4-6 when operating in beacon DGPS mode. This portion of the menu system, including submenus, is detailed in Figure 4-12.

Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Using the ENTER button, this menu item allows you to access a menu that provides Signal Status information from the internal beacon DGPS receiver.

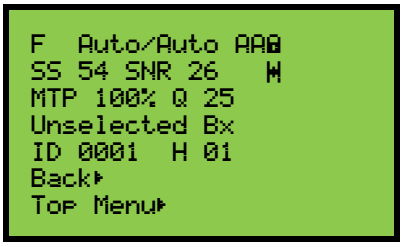
Accessing this menu using the ENTER button allows you to configure the internal SBX beacon receiver.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.12.1 Beacon Signal Status Menu

This section of the menu tree provides access to information related to the status of the beacon receiver primary channel. This submenu is detailed in Figure 4-12.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any status information in focus will display the signal tracking bar chart. Pressing the ENTER button with the Back or Top Menu item in focus will take the menu system to the previous menu or the Main menu, respectively.

F Auto/Auto AAB

This menu displays the currently tuned frequency (kHz) and modulation rate (bps) for the receiver's primary channel.

SS 54 SNR 26 M

This menu item provides the signal strength(SS) and signal to noise ratio (SNR).

There is a direct correlation of signal strength and signal quality, however, high signal strength may not translate into good reception if there is significant noise present. The SNR value is more representative of signal quality.

The SNR is the height of the signal above the noise

floor, measured in decibels (dB). This value effectively describes the reception quality, as a signal is 'louder' if it is higher above the noise floor. Interpretation of the SNR reading is discussed further in Section 2.4.2.

The menu item provides an indication of the amount of successfully decoded differential data. Two figures are provided – message throughput (MTP) and quality (Q).

If reception is strong, all data will be decoded, providing a 100% MTP. As reception becomes weaker due to data errors caused by a weaker signal or the introduction of radio frequency (RF) noise, the MTP value will decrease. A 0% MTP reading indicates that the beacon receiver is not successfully demodulating any differential correction data.

The Q value indicates the number of consecutive 30 bit RTCM words received successfully, to a maximum count of 25. The Q value changes rapidly, but the menu is updated at 1 Hz. As such, its value may not appear to update in an intuitive manner. Each RTCM word is 30 bits in length. For a 200 bps modulation rate, assuming a 100% MTP, approximately 7 words will be decoded per second, resulting in quick changes of Q.

This menu item provides the name of the beacon to which the receiver is tuned. This field will display the beacon's name only if it has been tuned by selecting it from the receiver's internal Global Beacon Table. If the receiver is in automatic mode or if it has been tuned manually by frequency, 'Unselected Bx' will be shown.

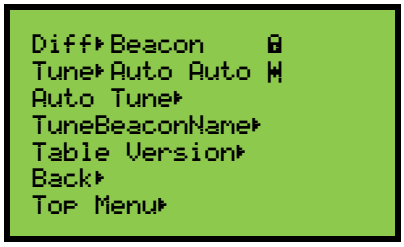
ID 0001 H 01	This menu item displays the identification number of the reference Station as contained within the RTCM header words of the correction data. Usually, beacon sites have redundant base stations, so it the number displayed will be one of two that identify the beacon. The identification number that is being transmitted will identify which base station is currently transmitting correction data. Station identification numbers are listing in MID-TECH's World Beacon Listing, located on our Web site at **www.csi-wireless.com**. This menu item also provides the health of the transmitting beacon as included within all RTCM messages broadcast by the beacon. Table 5-1 defines the range and interpretations of health values. Please note that the RTCM specification leaves the definition of some states of the heath bit up to the service provider. Please contact the authority responsible for your DGPS beacon network for further information.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

Table 4-1 Beacon Health Status Values

Health Code	Indication
0 - 5	Reference Station Transmission Broadcast – Monitored
6	Reference Station Transmission Broadcast – Unmonitored
7	Reference Station Not Working

4.12.2 Beacon Configure Menu

This menu provides access to the various methods to tune the internal SBX beacon sensor inside the RX 400p. This submenu is detailed in Figure 4-12.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the `Back▸` or `Top Menu▸` item in focus will take the menu system to the previous menu or the Main menu, respectively.

Using the ENTER button, this menu item allows you to choose the source of differential corrections. Correction source options include the WAAS demodulator, internal OmniSTAR receiver, the internal beacon receiver, use of external corrections, or autonomous operation.

When using an external source, be sure that it is providing RTCM SC-104 compliant data and not a proprietary binary format.

When accessed using the ENTER button, this menu item allows you to manually tune the beacon receiver using the ↑ or ↓ key. When manually selecting a tuning frequency, you will need to specify the MSK modulation rate. You may choose 100 bps, 200 bps, or automatic MSK rate detection.

When this menu item is selected using the ENTER button, it will instruct the internal beacon receiver to enter automatic tracking mode and perform a new Global Search, erasing any previous search information.

When accessed using the ENTER button, this menu item allows you to choose a beacon, by name, from an internal listing of beacons. The beacon that you select is chosen initially from a listing of continents, then by country, and finally from a listing of beacons for that chose country. This is discussed further in Section 4.12.2.1

When accessed using the ENTER button, this menu will identify the version of the current beacon table in memory.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.12.2.1 TuneBeaconName Menu

This menu allows you to tune the beacon receiver inside the RX 400p by selecting the desired station from a global list. When this menu item is accessed using the button, the menu allows you to choose the beacon from a list by continent, country, and finally by beacon name. When you have placed the desired station into the focus line and have pressed the ENTER button, the beacon receiver will manually tune to that beacon.

4.13 External RTCM Menu

The following menu appears when accessing the DGPS menu when using correction supplied from an external source. Please note that the upper right icon will change to the external RTCM icon, ⸸, as shown in Figure 4-7 when operating the RX 400p with external corrections. This portion of the menu system, including submenus, is detailed in Figure 4-13.

Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any status information (items without the menu access indicator, ▸) in focus will display the signal tracking bar chart. Pressing the ENTER button on any item in focus with the menu access indicator will take the menu system to that submenu. Pressing the ENTER button with the `Back▸` or `Top Menu▸` item in focus will take the menu system to the previous menu or the Main menu, respectively.

This menu item indicates that the current correction source comes from an external device. Pressing the ENTER button on this menu item will display the signal tracking bar chart.

Accessing this menu item using the ENTER button allows you to choose the source of differential corrections. Correction source options include the WAAS demodulator, internal OmniSTAR receiver, the internal beacon receiver, the use of external corrections, or autonomous operation. When using an external source, be sure that the source is providing RTCM SC-104 compliant corrections, and not a proprietary binary format.

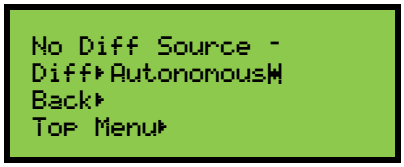
When accessed using the ENTER button, this menu item allows you to change the baud rate of the AUX port to match that of the external RTCM source. Available baud rates are 4800, 9600, and 19200.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.14 Autonomous Menu

This menu displays the current mode of operation and a menu item to change the current DGPS mode. This submenu is detailed in Figure 4-14.



Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any status information (items without the menu access indicator, ▸) in focus will display the signal tracking bar chart. Pressing the ENTER button on any item in focus with the menu access indicator will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

When accessed using the ENTER button, the signal tracking bar chart will be displayed.

Diff▸Autonomous	Accessing this menu item using the ENTER button allows you to choose the source of differential corrections. Correction source options include the WAAS demodulator, internal OmniSTAR receiver, the internal beacon receiver, the use of external corrections, or autonomous operation. Autonomous operation uses no differential corrections.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.15 System Setup Menu

This menu provides access to RX 400p configuration menus. This portion of the menu system, including submenus, is detailed in Figure 4-15.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

When accessed using the ENTER button, this menu item will display the current application in use and the other application not in use.

The current applications present for the SLX are WAAS and OmniSTAR. Both the WAAS and OmniSTAR applications support Beacon DGPS mode, external RTCM input, or autonomous operation. It does not matter if which of OmniSTAR or WAAS is currently in use when choosing to use one of the other DGPS modes.

When accessed using the ENTER button, this menu item provides a submenu that allows you to change the display properties, including the update rate of the display and the units associated with on-screen variables.

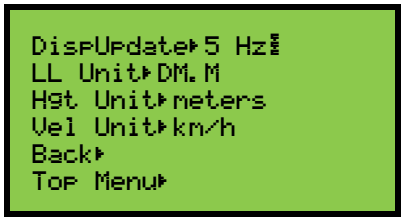
Baud Rates▸	When accessed using the ENTER button, this menu will provide access to the baud rates submenu where the speed of the external MAIN and AUX ports may be changed.
Software Disp▸	When accessed using the ENTER button, this menu will provide access to a submenu that allows you to query the RX 400p for each version of firmware.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.15.1 Display Applications Menu

This menu displays the current application in use and the other application not in use. This menu system is detailed in Figure 4-15.

4.15.2 Display Format Menu

This menu provides access to RX 400p configuration information and sub-menus. This menu system is detailed in Figure 4-15.



Pressing the ↑ and ↓ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the `Back▸` or `Top Menu▸` item in focus will take the menu system to the previous menu or the Main menu, respectively.

Accessing this menu using the ENTER button allows you to change the update rate of certain information on the display. The display update options are 1 Hz or 5 Hz. Selecting the 5 Hz mode will update the contents of the Position Status menu at a rate of 5 Hz. Satellite data will continue to be updated at 1 Hz in this mode.

When set to 1 Hz, this mode will display all information at 1 Hz.

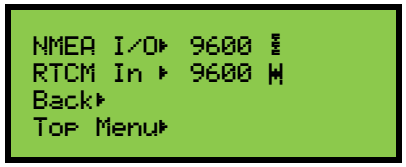
Accessing this menu using the ENTER button allows you to adjust the units used to display the latitude and longitude. Three formats are available:

- Degrees, minutes, decimal minutes (DM.M)
- Degrees, decimal degrees (D.D)
- Degrees, minutes, seconds (DMS)

Hgt Unit▸meters	Accessing this menu using the ENTER button allows you to adjust the height units used to display the antenna altitude. Two formats are available: meters and feet.
Vel Unit▸km/h	Accessing this menu using the ENTER button allows you to adjust the velocity units used to display the speed of the antenna. Three formats are available: km/h, mph, and knots.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.15.3 Baud Rates Menu

This menu allows you to change the data rates of the external MAIN and AUX serial ports of the RX 400p receiver. These ports are referred to as the NMEA I/O and RTCM In ports, respectively, within the menu system for clarification of their purpose. This menu system is detailed in Figure 4-15.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

NMEA I/O▸ 9600	Accessing this using the ENTER button allows you to adjust the baud rate of the external MAIN port, referred to as the NMEA I/O port within the menu system due to its primary functionality. Available baud rates are 4800, 9600, and 19200.
RTCM In ▸ 9600	Accessing this using the ENTER button allows you to adjust the baud rate of the external AUX port, referred to as the RTCM In port within the menu system due to its primary functionality. Available baud rates are 4800, 9600, and 19200. This baud rate must match the rate of an external RTCM source if using the external RTCM input mode.
Back▸	When accessed using the ENTER button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.15.4 Software Display Menu

This menu provides access to version of firmware installed within the RX 400p receiver. There are four types of firmware described below. This menu system is detailed in Figure 4-15.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ENTER button with any item in focus will take the menu system to that submenu. Pressing the ENTER button with the B Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Accessing this menu item using the ENTER button will display the version of firmware for the menu system.

Accessing this menu item using the ENTER button will display the version of firmware for the SLX's DSP.

Accessing this menu item using the ENTER button will display the version of firmware for the ARM processor on the SLX.

Accessing this menu item using the ENTER button will display the version of firmware for the SBX beacon receiver.

When accessed using the ENTER button, this menu item returns the menu system to the previous menu.

When accessed using the ENTER button, this menu item returns the menu system to the main menu.

4.16 Configuring the Receiver

The following subsections provide detailed instructions for you to configure important operating parameters of the RX 400p.

4.16.1 Changing the Source of DGPS Corrections

To change the source of corrections used by the internal GPS sensor within the RX 400p receiver:

- Using the ↑ or ↓ key, move the DGPS menu, located in the root menu, into focus and press ENTER. For example, when in WAAS mode, this menu will be called WAAS▸ .
- Press ↓ to move the Configure▸ menu item in focus and press ENTER.
- If required, press ↓ to move the Diff▸ menu item into focus and press ENTER.
- Select the desired differential correction source (WAAS, OmniSTAR, beacon, Extern RTCM, or Autonomous) using the ↑ or ↓ keys and press ENTER.

4.16.2 Changing the Output Data Messages

To change data messages output by the RX 400p receiver:

- Using the ↑ or ↓ key, move the GPS▸ menu, located in the root menu, into focus and press ENTER.
- Press ↓ to move the Configure▸ menu item in focus and press ENTER.
- Press ENTER to access the NMEA I/O▸ menu.
- Adjust the message output as necessary by moving the desired message into focus using the ↑ or ↓ key and press ENTER.
- Adjust the output rate to that desired using the ↑ or ↓ key and pressing the ENTER button.
- Continue for each data message as required.

4.16.3 Changing the Baud Rates

To modify the baud rate of the RX 400p data ports:

- Using the ↑ or ↓ key, move the Setup▸ menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the Baud Rates▸ menu into focus and press ENTER.

- Depending on which baud rate you with to change, Use the ↑ or ↓ key to move either the DATA 1▸ or DATA 2▸ menu into focus and press ENTER.
- Scroll with the ↑ or ↓ keys to the required baud rate and press ENTER.

4.16.4 Monitoring the OmniSTAR Subscription Status

When in OmniSTAR DGPS mode, to view the subscription status of the OmniSTAR engine inside the RX 400p receiver:

- Using the ↑ or ↓ key, move the OmniSTAR▸ menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the Configure▸ menu into focus and press ENTER.
- Use the ↑ or ↓ key to move the Subscription▸ menu into focus and press ENTER.
- Press ENTER to access the Expiry Date▸ menu that provides the current expiration date of the internal subscription. If the subscription date provided is older than your current date, the subscription has expired or is not present.

4.16.5 Tuning the Internal Beacon Sensor

When operating in beacon DGPS mode, there are a few different ways to tune the beacon engine within the RX 400p.

4.16.5.1 Change Beacon Frequency and MSK Rate

To modify the frequency and MSK rate to which the receiver is manually tuned:

- Using the ↑ or ↓ key, move the Beacon▸ menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the Configure▸ menu into focus and press ENTER. Use the ↑ or ↓ key to move the Tune▸ menu into focus and press ENTER.
- Using the ↑ or ↓ keys, adjust the frequency and MSK bit rate to the values that you desire and press ENTER. You may select a beacon within the 283.5/100 to Auto/Auto range of values.

4.16.5.2 Select a Beacon By Name

To tune to a specific beacon by name:

- Using the ↑ or ↓ key, move the Beacon▸ menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the Configure▸ menu into focus and press ENTER.
- Using the ↑ or ↓ key, move the TuneBeaconName▸ menu into focus and press ENTER.
- Scroll with the ↑ or ↓ keys until the desired continent is displayed on the focus line and press ENTER.
- Scroll with the ↑ or ↓ keys until the desired country is displayed on the focus line and press ENTER.
- Scroll with the ↑ or ↓ keys until the name of the specific beacon is displayed on the focus line and press ENTER.

4.16.5.3 Set to Automatic Beacon Search Mode

To set the receiver to ABS:

- Using the ↑ or ↓ key, move the Beacon▸ menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the Configure▸ menu into focus and press ENTER.
- Using the ↑ or ↓ key, move the Auto Tune▸ menu into focus and press ENTER.

-or-

- Using the ↑ or ↓ key, move the Beacon▸ menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the Configure▸ menu into focus and press ENTER.
- Use the ↑ or ↓ key to move the Tune▸ menu into focus and press ENTER.
- Using the ↑ or ↓ keys, adjust the frequency and MSK bit rate to read **Auto/Auto**.

The first method erases any previous search information and performs a new Global Search. The second method will resume from where the last automatic search algorithm left off.

4.17 Firmware Updates

Please contact MID-TECH Customer Service for the latest firmware update for your RX 400p receiver. Firmware releases include a Field Upgrade Program, installation instructions, and release notes.

5 Configuration Wizard

The Configuration Wizard is an easy, efficient way of configuring your receiver. Using the Wizard, you may configure your receiver in just a few keystrokes by selecting from a list of previously saved configurations.

The Configuration Wizard is composed of two main parts - a step-by-step process of configuration, plus the ability to store a new configuration in one of five memory locations for future use. This will provide you with the quickest method of configuring your receiver for different applications.

Additionally, when a number of receivers are used for various operations in the field, it's an advantage to have the same configurations in each. To accomplish this, it's possible to define the configurations either using the menu system or serial commands. This ensures that each of the receivers can be set up with the same configuration with just a few keystrokes after startup. This removes some of the guesswork from receiver operation in the field, especially since your main priority is likely the application at hand and not operating the receiver.

Figure 5-1 presents the Configuration Wizard menu layout.

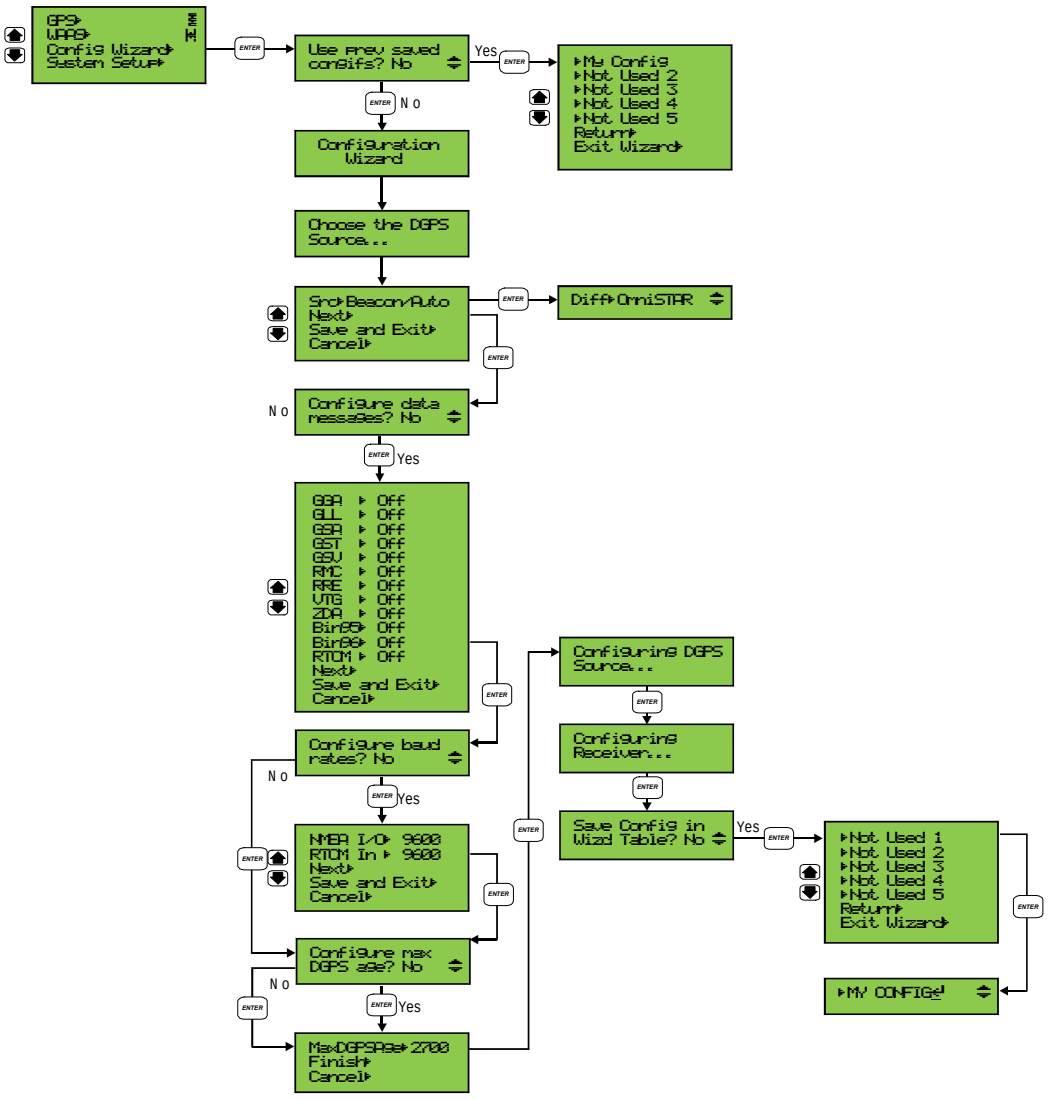


Figure 5-1 Configuration Wizard Menu

5.1 Start-up Sequence

When you turn the RX 400p on, it will sequence through a startup screen followed by a prompt asking if you'd like to use the Configuration Wizard. To access the Configuration Wizard, press the ENTER button within the 3-second timeout period.

Once the menu system enters into the Configuration Wizard mode, the following prompts will be presented, starting with the more important settings followed by settings of decreasing importance. This allows you to immediately set the critical settings and quit the Wizard early, if you are comfortable with the current settings that follow.

- Use a previously saved configuration
- Choose and tune (if desired) the DGPS source
- Set the output data messages
- Set the baud rates
- Set the maximum DGPS age

You may cancel the Wizard at any time, without making any changes to your current configuration by selecting `Cancel►`. You may quit the Wizard early, while saving the changes that you've made by selecting `Save and Exit►`. When the Wizard is complete and you are comfortable with the new settings, choose `Finish►`.

5.2 Using the Configuration Wizard After Start-up

At any time after start-up, you may use the Configuration Wizard by navigating to the Main menu and pressing the ENTER button when `Configuration Wizard►` is in focus. This will immediately begin the Wizard process.

5.3 Selecting a Previously Saved Configuration

The beginning of the Configuration Wizard starts with a prompt to ask if you wish to use a previously saved configuration. If you do not wish to, simply choose 'No'. If you have created a configuration previously, saved it to one of the five memory locations, and wish to recall that configuration, choose 'Yes'.

When choosing ‘Yes’, the menu system will display the five memory locations and allow you to choose one configuration, or exit the Wizard with no changes to the current configuration.

5.4 Bypassing a Configuration Step

The Wizard process prompts you for each step by asking if you wish to configure the specific parameter mentioned. You may choose ‘No’ and go on to the next step, thus bypassing the current step.

When bypassing the current step, the parameter that was bypassed will remain unchanged from your current configuration. For example, if the RX 400p is operating in WAAS mode, and during the Wizard step-by-step process you are prompted to choose the DGPS source, if you are happy with the current WAAS mode, select ‘No’. This will maintain WAAS mode and allow you to proceed on to the subsequent configuration parameters in the Wizard.

5.5 Completing the Step-by-Step Process

When completing the Configuration Wizard, by pressing the ENTER button with Finish▸ in focus, the Wizard will indicate that it’s configuring the DGPS source, followed by configuring the receiver. This will complete the step-by-step process and takes a few seconds. You will then be prompted to save the new configuration for later use, if desirable.

5.6 Saving a Configuration

When completing the Configuration Wizard, you will be prompted to save your new configuration or simply proceed with the new configuration. If you wish to save the new configuration for future use in the Wizard Table, you will be prompted to select one of the five memory locations for saving.

Within this stage of the Configuration Wizard, you may continue without saving the new configuration by selecting Exit Wizard▸ .

If you wish to save the configuration, simply move the memory location to which you would like to save it, into focus and press the ENTER button. You will then be prompted to enter in each alpha-numeric character of the new configuration's name. The name may be up to 14-characters long. Simply adjust the current character using the ▲ or ▼ button, followed by pressing the ENTER button. The character choices are alphanumeric, including only capitalized letters. You do not need to enter all 14 characters.

To erase a character, use the ▲ or ▼ button to locate the ← character and press the ENTER button. To complete the new name of the configuration, adjust the current character to ↵ and press the ENTER button. Pressing the ENTER button on the last of a full 14-character name will complete the naming process.

Once the name of the new configuration has been entered to your satisfaction and you have completed the name by entering the character, the Wizard will finish and the menu system will return to the main menu. You may, at any time, select your new configuration by beginning the Configuration Wizard again. The first step allows you to select a previously saved configuration. If you wish to choose a saved configuration, simply choose 'Yes', otherwise the step-by-step Wizard process will begin.

6 NMEA 0183 Messages

This chapter identifies the selection of valid NMEA 0183 output messages for the RX 400p receiver.

6.1 Description of NMEA 0183

NMEA 0183 is a communications standard established by the marine industry. It has found use in a variety of electronic devices, including GPS and beacon receivers.

The National Marine Electronics Association publishes updates to the NMEA 0183 message standard. The latest NMEA 0183 standard is available through:

National Marine Electronics Association
NMEA Executive Director
P. O. Box 50040, Mobile, Alabama 36605, USA
Tel (205) 473-1793 Fax (205) 473-1669

6.2 NMEA Message Elements

NMEA 0183 messages have a common structure, consisting of a message header, data fields, and carriage return/line feed message terminator.

Example: $XXYYY,zzz,zzz,zzz…<CR><LF>

The components of this generic NMEA message example are displayed in Table 6-1.

Table 6-1 NMEA Message Elements

Element	Description
$	Message header character
XX	NMEA Talker field. GP indicates a GPS talker
YYY	Type of GPS NMEA Message
zzz	Variable Length Message Fields
<CR>	Carriage Return
<LF>	Line Feed

Null, or empty fields occur when no information is available for that field.

6.3 RX 400p Serial Port Configuration

The RX 400p may be configured using a selection of NMEA commands, however, these commands are beyond the scope of this document. Intended for advanced users, these messages allow the RX 400p to be configured and monitored remotely. A separate RX 400p Programming Manual is available that goes into detail on how to use these extended commands. Please contact MID-TECH for further information on programming the RX 400p through its serial port.

6.4 SLXMon

MID-TECH offers a configuration utility for the SLX and SBX within the RX 400p receiver. This utility runs on PC computers running the Microsoft Windows 95 or higher operating system. Please contact MID-TECH for further information on this utility.

6.5 GPS NMEA Data Messages

The following subsections describe the data messages listed in Table 6-2 in detail.

Table 6-2 GPS NMEA Messages

Message	Description
GPGGA	Global Positioning System Fix Data
GPGLL	Geographic Position – Latitude/Longitude
GPGSA	GNSS (Global Navigation Satellite System) DOP and Active Satellites
GPGST	GNSS Pseudorange Error Statistics
GPGSV	GNSS Satellites in View
GPRMC	Recommended Minimum Specific GNSS Data
GPRRE	Range residual message
GPVTG	Course Over Ground and Ground Speed
GPZDA	Time and Date

6.5.1 GGA Data Message

The GGA message contains detailed GPS position information, and is the most frequently used NMEA data message. In Table 6-3, the GGA data message is broken down into its components. This message takes the following form:

$GPGGA,hhmmss.ss,ddmm.mmmm,s,dddmm.mmmm,s,n,qq,pp.p,saaaa.aa,M,±xxxx.xx,M,sss,aaaa*cc<CR><LF>

Table 6-3 GGA Data Message Defined

Field	Description
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
s	s = N or s = S, for North or South latitude
dddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
s	s =E or s = W, for East or West longitude
n	Quality indicator, 0 = no position, 1 = undifferentially corrected position, 2 = differentially corrected position, 9= position computed using almanac
qq	Number of satellites used in position computation
pp.p	HDOP =0.0 to 9.9
saaaa.aa	Antenna altitude
M	Altitude units, M = meters
±xxxx.xx	Geoidal separation (needs geoidal height option)
M	Geoidal separation units, M = meters
sss	Age of differential corrections in seconds
aaa	Reference station identification
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.2 GLL Data Message

The GLL message contains Latitude and Longitude. In Table 6-4, the GLL data message is broken down into its components. This message has the following format:

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

Table 6-4 GLL Data Message Defined

Field	Description
ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
s	s = N or s = S, for North or South latitude
dddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
s	s = E or s = W, for East or West longitude
hhmmss.ss	UTC time in hours, minutes, and seconds of GPS position
s	Status, s = A = valid, s = V = invalid
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.3 GSA Data Message

The GSA message contains GPS DOP and active satellite information. Only satellites used in the position computation are present in this message. Null fields are present when data is unavailable due to the number of satellites tracked. Table 6-5, breaks down the GSA message into its components. This message has the following format:

$GPGSA,a,b,cc,dd,ee,ff,gg,hh,ii,jj,kk,mm,nn,oo,p.p,q.q,r.r *cc<CR><LF>

Table 6-5 GSA Data Message Defined

Field	Description
a	Satellite acquisition mode M = manually forced to 2D or 3D, A = automatic swap between 2D and 3D
b	Position mode, 1 = fix not available, 2 = 2D fix, 3 = 3D fix
cc to oo	Satellites used in the position solution, a null field occurs if a channel is unused
p.p	Position Dilution of Precision (PDOP) = 1.0 to 9.9
q.q	Horizontal Dilution of Precision (HDOP) = 1.0 to 9.9
r.r	Vertical Dilution of Precision (VDOP) = 1.0 to 9.9
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.4 GST Data Message

The GST message contains Global Navigation Satellite System (GNSS) psuedorange error statistics. Table 6-6, breaks down the GST message into its components. This message has the following format:

$GPGST,hhmmss.ss,a.a,b.b,c.c,d.d,e.e,f.f,g.g *cc<CR><LF>

Table 6-6 GST Data Message Defined

Field	Description
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
a.a	Root mean square (rms) value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudoranges and differential GNSS (DGNSS) corrections
b.b	Standard deviation of semi-major axis of error ellipse (meters)
c.c	Standard deviation of semi-minor axis of error ellipse (meters)
d.d	Orientation of semi-major axis of error ellipse (meters)
e.e	Standard deviation of latitude error (meteers)
f.f	Standard deviation of longitude error (meters)
g.g	Standard deviation of altitude error (meters)
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.5 GSV Data Message

The GSV message contains GPS satellite information. Null fields occur where data is not available due to the number of satellites tracked. Table 6-7 breaks down the GSV data message into its components. This message has the following format:

$GPGSV,t,m,n,ii,ee,aaa,ss,…ii,ee,aaa,ss,*cc<CR><LF>

Table 6-7 GSV Data Message Defined

Field	Description
t	Total number of messages
m	Message number, m = 1 to 3
n	Total number of satellites in view
ii	Satellite number
ee	Elevation in degrees, ee = 0 to 90
aaa	Azimuth (true) in degrees, aaa = 0 to 359
ss	SNR (dB), ss = 0 to 99
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.6 RMC Data Message

The RMC message contains recommended minimum specific GPS data. Table 6-8 breaks down the RMC data message into its components. This message has the following format:

$GPRMC,hhmmss.ss,a,ddmm.mmm,n,dddmm.mmm,w,z.z,y.y,ddmmyy, d.d,v *cc<CR><LF>

Table 6-8 RMC Data Message Defined

Field	Description
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
a	Status is valid if a = A, status is invalid if a = V
ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
n	S = N or s = S, for North or South latitude
dddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
w	S = E or s = W, for East or West longitude
z.z	Ground speed in knots
y.y	Track made good, referenced to true north
ddmmyy	UTC date of position fix in day, month, year
d.d	Magnetic Variation in degrees
v	Variation sense v = E = East, v = W = West
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.7 RRE Data Message

The RRE message contains the satellite range residuals and estimated position error. Table 6-9 breaks down the RRE data message into its components. This message has the following format:

$GPRRE,n,ii,rr…ii,rr,hhh.h,vvv.v *cc<CR><LF>

Table 6-9 RRE Data Message Defined

Field	Description
n	Number of satellites used in position computation
ii	Satellite number
rr	Range residual in meters
hhh.h	Horizontal position error estimate in meters
vvv.v	Vertical position error estimate in meters
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.8 VTG Data Message

The VTG message contains velocity and course information. Table 6-10 breaks down the VTG data message into its components. This message has the following format:

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

Table 6-10 VTG Data Message Defined

Field	Description
ttt	True course over ground, ttt = 000 to 359, in degrees
c	True course over ground indicator, c = T always
ttt	Magnetic course over ground, ttt = 000 to 359, in degrees (output with magnetic model option only)
c	Magnetic course over ground Indicator, always c = M
ggg.gg	Speed over ground, 000 to 999 knots
u	Speed over ground units, u = N = Nautical mile/h
ggg.gg	Speed over ground, 000 to 999 km/h
u	Speed over ground units, u = K = kilometer/h
*cc	Checksum
<CR><LF>	Carriage return and line feed

6.5.9 ZDA Data Message

The ZDA message contains Universal Time information. Table 6-11 breaks down the ZDA data message into its components. This message has the following format:

$GPZDA,hhmmss.ss,dd,mm,yyyy,xx,yy*cc<CR><LF>

Table 6-11 ZDA Data Message Defined

Field	Description
hh	UTC time in hours, minutes, seconds of the GPS position
mmss.ss	
dd	Day, dd = 0 to 31
mm	Month, mm = 1 to 12
yyyy	Year
xx	Local zone description in hours, xx = -13 to 13
yy	Local zone description in minutes, yy = 0 to 59
*cc	Checksum
<CR><LF>	Carriage return and line feed

7 Troubleshooting

Use the following checklist to troubleshoot erroneous RX 400p receiver operation. Table 7-1 provides a problem symptom, followed by a list of possible solutions.

Table 7-1 Troubleshooting

Symptom	Possible Solution
Receiver fails to power	• Verify polarity of power leads • Check 1.5 A in-line power cable fuse • Check integrity of power cable connections • Check power input voltage (9.2-48 VDC) • Check current restrictions imposed by power source (maximum > 1.0 A)
No data from RX 400p	• Check receiver power status (display illuminated?) • Verify that RX 400p is locked to a valid DGPS signal (DGPS lock symbol engaged) • Verify that RX 400p is locked to GPS satellites (GPS Lock symbol engaged) • Check integrity and connectivity of power and data cable connections • Verify RX 400p Mode of operation
Random data from RX 400p	• Verify that the RTCM or the Bin95 and Bin96 messages are not being output accidentally (check the NMEA Output@ menu) • Verify baud rate settings of RX 400p and remote device • Potentially, the volume of data requested to be output by the RX 400p could be higher than the current baud rate supports. Try using 19,200 as the baud rate for all devices.
No GPS lock	• Check integrity of antenna cable • Verify RX 400p antenna port output voltage (5 DC) • Verify CDA-2B's unobstructed view of the sky • Verify antenna cable length < 10 meters
No WAAS lock	• Check antenna connections • Verify 5 VDC across antenna cable connector • Verify CDA-2B's unobstructed view of the sky
No OmniSTAR lock	• Subscription Activated and not expired? • Check antenna connections • Verify 5 VDC across antenna cable connector • Verify CDA-2B's unobstructed view of the sky

No Beacon lock	• Check antenna connections • Verify MSK rate is set correctly or choose Auto MSK rate (100 200, or Auto) • Verify frequency of transmitting beacon, or choose **Auto?Tune@** • Verify RX 400p antenna port output voltage (5 VDC)
No DGPS position in external RTCM mode	• Verify that the baud rate of the RTCM In (AUX) port matches the baud rate of the external source • Verify the pin-out between the RTCM source and the AUX port (transmit from the source must go to receive of AUX and grounds must be connected - Refer to Appendix B)
Low beacon SNR	• Check integrity of antenna connections • Are other electronics interfering with reception? • Select alternate antenna position
Non-differential GPS output	• Verify RX 400p lock status • Verify matched beacon output and GPS RTCM input baud rates if using external source

8 Appendix A - Specifications

This appendix provides the operational, mechanical, electrical, physical, and environmental specifications for the RX 400p receiver and CDA-2B antenna.

Table A-1 RX 400p Specifications

Internal GPS Engine Operational Specifications	
Item	**Specification**
Frequency	1.575 GHz
Channels	12 parallel tracking
Horizontal Accuracy	< 1.2 meter
Max Position Update Rate	Up to 5 Hz

Internal OmniSTAR Engine Operational Specifications	
Item	**Specification**
Frequency	1.525 - 1.559GHz
Frequency Tuning Modes	Automatic scanning

Internal Beacon Engine Operational Specifications	
Item	**Specification**
Frequency Range	283.5 - 325 kHz
Channels	2
Input Sensitivity	2.5 μV for 6 dB SNR @ 200 bps MSK Rate
Acquisition Time	< 1 Second Typical
MSK Bit Rate	100, 200, or Automatic
Frequency Selection	Manual or Automatic
Frequency Offset	± 5 Hz
Dynamic Range	100 dB
Adjacent Channel Rejection	61 dB ±1 @ f_0 ± 400 Hz
Decoding	RTCM 6/8
Demodulation	MSK

Serial Interface Specifications	
Item	**Specification**
Serial Port Interface Level	RS-232C
MAIN Connector	DB9 Socket
AUX Connector	DB9 Socket
MAIN Baud Rate	4800, 9600, or 19200 Baud
AUX Baud Rate	4800, 9600, or 19200 Baud
MAIN Output Protocol	NMEA 0183
MAIN Input Protocol	NMEA 0183
AUX Input Protocol	RTCM SC-104 (Extrnl mode only)

Power Specifications	
Item	**Specification**
Input Voltage	9.2-48 VDC
Power Consumption with CDA-2B	<6.5 W Nominal
Power Connector	Circular 2-pin Locking Plug

Mechanical Characteristics	
Item	**Specification**
Enclosure	Extruded aluminum with aluminum front and back plates.
Length	203 mm (8.0”)
Width	125 mm (4.9”)
Height	53 mm (2.0”)
Weight	0.8 kg (1.76 lb.)
Antenna Connector	TNC Socket

Environmental Specifications	
Item	**Specification**
Storage Temperature	-40°C to 85°C
Operating Temperature	-32°C to 74°C
Humidity	95% Non-Condensing

Table A-2 CDA-2B Specifications

Operational Specifications	
Item	**Specification**
Frequency Range, Beacon	283.5 - 325 kHz
LNA Gain, Beacon	34 dB
Frequency Range, L-band	1.525 - 1.575 GHz
LNA Gain, L-band	28 dB

Power Specifications	
Item	**Specification**
Input Voltage	3.6-15 VDC Supplied by Receiver
Input Current	50-60 mA

Mechanical Characteristics	
Item	**Specification**
Enclosure	Aluminum Base, Polycarbonate Top
Mounting Thread	1-14-UNS-2B
Diameter	129 mm (5.08”)
Height	98 mm (3.85”)
Weight	456 g (1.0 lb.)
Antenna Connector	TNC-S
Antenna Extension Cable	RG-58U, < 10 m (33 ft) in Length

Environmental Specifications	
Item	**Specification**
Storage Temperature	-40°C to 85°C
Operating Temperature	-40°C to 85°C
Humidity	100% Condensing

9 Appendix B - Interface

This appendix provides information on interfacing the various aspects of your RX 400p receiver.

The main purpose of the RX 400p receiver is to provide differentially corrected position and position-related information in the standard NMEA format. In addition to the RX 400p operating as a positioning sensor, you may also have a use for the correction data received by the internal WAAS, OmniSTAR, or beacon.

The following sections detail how to interface your RX 400p depending on your application.

9.1 GPS NMEA Output

The data output from the RX 400p MAIN port is differentially corrected GPS NMEA data.

To establish communications between the RX 400p and your data logging or monitoring device in these modes of operation, you must:

- Connect Pin-2-transmit (TX) of the MAIN port to the receive pin (RX) of the data logging or monitoring device.
- Connect Pin-3-receive (RX) of the MAIN port to transmit pin (TX) of the monitor device if bi-directional communication is required
- Connect Pin-5-Common Ground of the MAIN port to the signal return or common ground of the external device.

This configuration is also valid for the output of RTCM data and the Bin95 and Bin96 binary messages through the MAIN port.

Figure B-1 illustrates the required interface between the RX 400p and an external device:

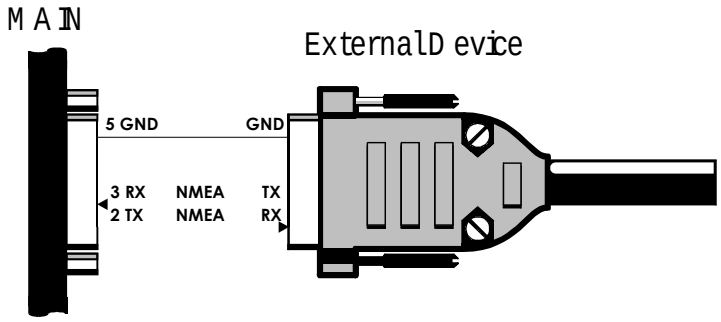


Figure B-1 GPS Data Interface

Note - For successful communications, the baud rate of the RX 400p MAIN port must be set to match that of the data logging or monitoring device. Additionally, you must interface the RX 400p to an RS-232C serial port of the external device. Refer to Section 4.15.3 for instructions related to setting the RX 400p baud rate.

9.2 RTCM Data Output

To output only RTCM correction data from a correction source:

- Choose the desired source of corrections, be it WAAS, OmniSTAR, or beacon
- Turn off all NMEA and binary messages in the NMEA Output menu.
- Turn RTCM on in the NMEA Output menu

To establish communications between the RX 400p and an external GPS receiver, you must:

- Connect Pin-2-transmit (TX) of the MAIN port to the receive pin (RX) of the separate GPS receiver or logging device.
- Connect Pin-5-Common Ground of the MAIN port to the signal return or common ground of the separate GPS receiver.

Figure B-2 illustrates the required interface between the RX 400p and a separate GPS receiver:

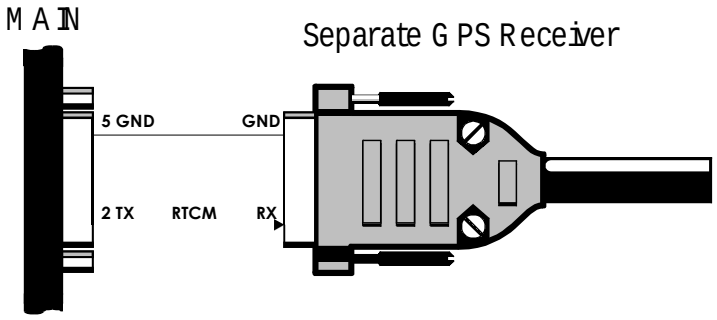


Figure B-2 RTCM Data Interface

Note - For successful communications, the baud rate of the RX 400p MAIN port must be set to match that of the separate GPS receiver. Additionally, you must interface the RX 400p to an RS-232C serial port of the separate GPS receiver. Refer to Section 4.15.3 for instructions related to setting the RX 400p baud rate.

9.3 External Correction Input

In this operating mode, an external correction device inputs RTCM correction data through the RX 400p's RTCM In port (AUX port). In order to accomplish this, the RX 400p must be operating in the external RTCM input DGPS mode.

To establish communications between the RX 400p and an external GPS receiver, you must:

- Connect Pin-3-receive (RX) of the AUX port to transmit pin (TX) of the external correction source
- Connect Pin-5-Common Ground of the AUX port to the signal return or common ground of the external correction source

Figure B-3 illustrates the required interface between the RX 400p and an external GPS receiver:

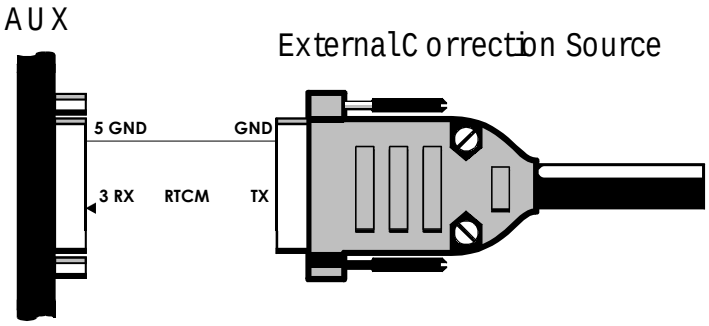


Figure B-3 External Correction Source Interface

Note - For successful communications, the baud rate of the RX 400p AUX port must be set to match that of the external correction source. Additionally, you must interface the RX 400p to an RS-232C serial port of the external source. Refer to Section 4.15.3 for instructions related to setting the RX 400p baud rate.

10 Appendix C - Activating the OmniSTAR DGPS Service

10.1 L-band Receiver Unit Number

To use the OmniSTAR service, your receiver must be operating in OmniSTAR mode with a valid subscription. In order to subscribe your RX 400p receiver's internal OmniSTAR sensor, you must know its unit number.

To determine the unit number of the internal L-band DGPS receiver inside your RX 400p receiver, follow these instructions:

- Turn the RX 400p receiver on
- Once the boot sequence has completed, ensure that the internal OmniSTAR sensor is currently selected as the DGPS source. If the second menu item shows `OmniSTAR▸`, then the L-band sensor is currently being used. If this is not displayed, you must change to the use of the internal L-band receiver. See Section 4.16.1 for information on changing the DGPS source.
- Access the `OmniSTAR▸` menu in the current level of the menu system using either ↑ or ↓ and press ENTER.
- Use either ↑ or ↓ to cycle the menu system so that `Configure▸` is in focus and press ENTER.
- Press ↑ or ↓ until `Subscription▸` is in focus and press ENTER.
- Use either ↑ or ↓ to move the `SerialNum Disp▸` menu item into focus and press ENTER to access this feature.
- The serial number of the internal SLX receiver will be displayed

When you access the `SerialNum Disp▸` menu item, the RX 400p receiver will display the unit number (serial number) of the SLX engine. Please record the unit number so that you may provide it to OmniSTAR when activating your service.

10.2 OmniSTAR Service Activation

You may activate the OmniSTAR DGPS service for your RX 400p receiver by contacting the service provider in your region. Contact OmniSTAR with your unit number and they will activate your subscription over the air. Please be ready to have your receiver ready to receive the OmniSTAR signal for subscription validation.

If you have questions regarding the OmniSTAR service, please contact OmniSTAR for further information. Contact information is provided in Table C-1.

10.2.1 OmniSTAR License Agreement

OmniSTAR requires that you fill out the enclosed license agreement before subscription activation. Please read the agreement thoroughly before filling in the require information. Be ready to fax the completed agreement when contacting OmniSTAR.

Note – The license agreement enclosed is an agreement between yourself and OmniSTAR. MID-TECH is not responsible for this service or this agreement.

10.2.2 Contacting OmniSTAR

Table C-1 provides the contact numbers for the various OmniSTAR offices throughout the world. Please contact the office responsible for subscriptions in your area by consulting Figure C-1.

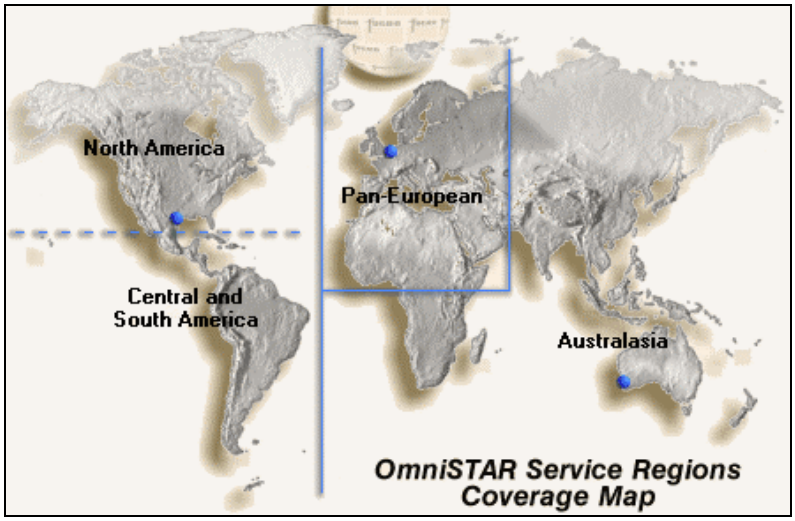


Figure C-1 OmniSTAR Coverage Map

Table C-1 OmniSTAR Contact Information

Location	Telephone Numbers	Fax Numbers
North America	+1-888-883-8476	+1-713-780-9408
Europe and North Africa	+31-70-311-1151	+31-71-581-4719
Asia, Australia, New Zealand, and South Africa	+61-89-322-5295	+61-8-9322-4164
Central America and South America	+1-713-785-5850	+1-713-780-9408

You may visit OmniSTAR's Web site at the following address for further information.

www.omnistar.com

10.3 Over-Air Subscription Activation

OmniSTAR will activate the subscription within your RX 400p receiver over the air. The OmniSTAR L-band DGPS receiver inside your RX 400p will automatically lock onto the OmniSTAR service even if your subscription has not yet been activated. This allows OmniSTAR to activate your subscription over the air.

When you have powered the receiver, you must have the antenna in a location with an unobstructed view of the sky. The subscription activation will be transmitted over the air and received by the internal OmniSTAR receiver. Your L-band DGPS receiver must be locked to the OmniSTAR service during this procedure.

10.4 Subscription Confirmation

To confirm that you have a valid subscription enabled within your L-band receiver:

- Using the ↑ or ↓ key, move the `OmniSTAR▸` menu, located in the root menu, into focus and press ENTER.
- Using the ↑ or ↓ key, move the `Configure▸` menu into focus and press ENTER.
- Use the ↑ or ↓ key to move the `Subscription▸` menu into focus and press ENTER
- Press ENTER to access the `Expiry Date▸` menu that provides the current expiration date of the internal subscription. If the subscription date provided is older than your current date, the subscription has expired or is not present.

11 Appendix D - Beacon Information

You can find an accurate listing of DGPS radiobeacons worldwide on the Internet at:

www.csi-wireless.com

This listing contains the following information regarding currently operating beacons and potential new sites:

- Station name
- Frequency
- MSK rate
- Location
- Transmitting ID
- Reference station ID
- Field Strength
- Operating notes

This document is viewable within your Internet browser, however, if you require a faxed copy of this information, contact your MID-TECH dealer or MID-TECH Sales.

Further Reading

National Marine Electronics Association, **National Marine Electronics Association (NMEA 0183) Standard for Interfacing Marine Electronic Devices**, Version 2.1, October 15, NMEA 1995, PO Box 50040, Mobile Alabama, 36605 USA

Radio Technical Commission for Maritime Services, **RTCM Recommended Standards for Differential NAVSTAR GPS Service**, Version 2.2, Developed by Special Committee No. 104, RTCM 1998, 1800 Diagonal Rd, Suite 600, Alexandria, VA, 22314-2840 USA, Tel: +1-703-684-4481, Fax: +1-703-836-4429

US Department of Transportation, United States Coast Guard, **Broadcast Standard for the USCG DGPS Navigation Service**, COMDTINST M16577.1, April, 1993, 2100 Second St. SW, Washington, D.C., 20593-0001, USA

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