DGPS MAX

Reference Manual

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Preface

Welcome to the DGPS MAX Reference Manual 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 DGPS MAX is a complete DGPS receiver, possessing two separate, internal receivers that provide the versatility of this system. Within the DGPS MAX, CSI Wireless has integrated the CSI Wireless SLX receiver, a tri-purpose GPS / WAAS / L-band receiver, and the CSI Wireless 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 DGPS MAX also supports post-processing. You may configure the DGPS MAX for output of binary measurement data for logging with the use of an external device. A conversion utility is available from CSI Wireless for translation from the proprietary binary format into the Receiver Independent Exchange format (RINEX). Consult Appendix E for information on post processing and RINEX.

CSI Wireless has designed this GPS product to function in a wide array of applications and environments. Compact, lightweight, yet rugged, the DGPS MAX will provide you with years of reliable operation.

Organization

This manual contains the following chapters:

Chapter 1: Introduction - provides an introduction to GPS and DGPS technology, the DGPS MAX receiver, and CDA-3 antenna.

Chapter 2: Installation - describes how to install the DGPS MAX receiver and antenna, and provides a foundation for interfacing the DGPS MAX with an external data logging or monitoring device.

Chapter 3: DGPS MAX Overview - provides details on the fundamental operating modes of the internal sensors of the DGPS MAX.

Chapter 4: DGPS MAX Architecture - provides a description of the integration of the DGPS MAX.

Chapter 5: Operation - describes how to configure and operate the DGPS MAX receiver using the keypad-driven menu system. This Chapter also provides a detailed listing of the default parameters.

Chapter 6: Configuration Wizard - introduces the Configuration Wizard feature and describes how it may be used to simplify configuration of the DGPS MAX receiver.

Chapter 7: NMEA 0183 Messages - describes the subset of NMEA 0183 commands and queries used to communicate with the GPS features of the two internal DGPS MAX sensors.

Chapter 8: 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 DGPS MAX receiver and CDA-3 antenna.

Appendix B: DGPS MAX Interface - provides instructions to interface the DGPS MAX 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 DGPS MAX 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 CSI Wireless Customer Service. The contact numbers and e-mail address for CSI Wireless Customer Service are:

Telephone number:	+1-403-259-3311
Fax number:	+1-403-259-8866
E-mail address:	techsupport@csi-wireless.com

Technical Support is available from 8:00 AM to 5:00 PM Mountain Time, Monday to Friday.

To expedite the support process, please have the product model and serial number available when contacting CSI Wireless 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 CSI Wireless Customer Service to obtain a Return Merchandise Authorization (RMA) number before returning any product to CSI Wireless. If you are returning a product for repair, you must also provide a fault description before CSI Wireless will issue an RMA number.

When providing the RMA number, CSI Wireless will provide you with shipping instructions to assist you in returning the equipment.

World Wide Web Site

CSI Wireless maintains a World Wide Web home page at the following address:

www.csi-wireless.com

A corporate profile, product information, application news, GPS and DGPS literature, beacon coverage information, and software 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 DGPS MAX 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 yourself.

1. Introduction

This chapter provides a brief overview of GPS, differential GPS, WAAS, OmniSTAR, and beacon technology, in addition to a description of the DGPS MAX receiver and antenna.

1.1 GPS

The United States Department of Defense (DoD) operates a reliable, 24 hour a day, all weather Global Positioning System (GPS).

Navstar, the original name given to this geographic positioning and navigation tool, includes a constellation of 24 satellites (plus active spares) orbiting the Earth at an altitude of approximately 22,000 km.

1.1.1 How it Works

These satellites transmit coded information to GPS users at UHF (1.575 GHz) frequencies that allows user equipment to calculate a range to each satellite. GPS is essentially a timing system - ranges are calculated by timing how long it takes for the GPS signal to reach the user's GPS antenna.

To calculate a geographic position, the GPS receiver uses a complex algorithm incorporating satellite coordinates and ranges to each satellite. Reception of any four or more of these signals allows a GPS receiver to compute 3D coordinates. Tracking of only three satellites reduces the position fix to 2D coordinates (horizontal with fixed vertical).

The GPS receiver calculates its position with respect to the phase center of the GPS antenna. The latitude, longitude, and altitude of the antenna are referenced according to the WGS-84 ellipsoid. The North American Datum 1983 (NAD-83) is essentially equivalent to this ellipsoid.

1.1.2 GPS Services

The positioning accuracy offered by GPS varies depending upon the type of service and equipment available. For security reasons, two GPS services exist: the Standard Positioning Service (SPS) and the Precise Positioning Service (PPS). The US Department of Defense (DoD) reserves the PPS for use by its personnel and authorized partners. The DoD provides the SPS free of charge, worldwide, to all civilian users.

In order to maintain a strategic advantage, the US DoD used to artificially degrade the performance of the SPS so that the positioning accuracy was limited to 100 meters 95% of the time. This intentional degradation is called Selective Availability (SA). The effect of SA has been turned to zero since mid-2000, however, it has not been officially 'turned off'.

Currently, autonomous GPS is able to provide accuracy on the order of 10 meters, depending on the sophistication of the GPS engine. For many positioning and navigation applications, this level of accuracy is not sufficient, and differential techniques must be employed.

1.2 Differential GPS

The purpose of differential GPS (DGPS) is to remove the effects of SA, atmospheric errors, timing errors, and satellite orbit errors, while enhancing system integrity.

1.2.1 How it Works

DGPS involves setting up a reference GPS receiver at a point of known coordinates. This receiver makes distance measurements, in real-time, to each of the GPS satellites. The measured ranges include the errors present in the system. The base station receiver calculates what the true range, without errors, knowing its coordinates and those of each satellite. The difference between the known and measured range for each satellite is the range error. This error is the amount that needs to be removed from each satellite distance measurement in order to correct for errors present in the system.

1.2.2 Real-Time DGPS

The base station transmits the range error corrections to remote receivers in real-time. The remote receiver corrects its satellite range measurements using these differential corrections, yielding a much more accurate position. This is the predominant DGPS strategy used for a majority of real-time applications. Positioning using corrections generated by DGPS radiobeacons will provide a horizontal accuracy of 1 to 5 meters with a 95% confidence. More sophisticated, short-range DGPS systems (10 to 15 km) can achieve centimeter-level accuracy, but are expensive and often limited to precise survey applications due to technical constraints on their use.

1.3 DGPS Format

For manufacturers of GPS equipment, commonality is essential to maximize the utility and compatibility of a product. The governing standard associated with GPS is the Interface Control Document, ICD-GPS-200, maintained by the US DoD. This document provides the message and signal structure information required to access GPS.

Like GPS, DGPS data and broadcast standards exist to ensure compatibility between DGPS networks, and associated hardware and software. The Radio Technical Commission for Maritime Services Special Committee 104 has developed the primary DGPS standard associated with radiobeacon DGPS, designated RTCM SC-104 V2.2.

Various broadcast standards may exist for the beacon networks installed internationally, controlled by their respective operating authority. The United States Coast Guard maintains a broadcast standard that is referenced in the Further Reading section of this manual.

1.4 Factors Affecting Positioning Accuracy

Many factors affect the positioning accuracy that a user may expect from a DGPS system. The most significant of these influences include:

- Proximity of the remote user to the reference station
- Age of the received differential corrections
- Atmospheric conditions at the beacon and remote user locations
- Satellite geometry, often expressed as a Dilution of Precision (DOP)
- Magnitude of multipath present at the remote station
- Quality of the GPS receiver being used at both the reference and remote stations.

The distance between a remote user and the reference station is often considerable when using 300 kHz DGPS radiobeacons. Broadcast ranges may be as great as 450 km (280 miles) or more, depending primarily upon transmission power and surface conductivity. Consequently, some of the errors associated with GPS at the base station differ somewhat from those at the remote user's location. This spatial decorrelation of errors can result in a relative position offset from the absolute coordinates of the remote receiver. This offset may be as much as one meter for every 100 km (62 miles) between the base station and remote receiver. The WAAS and OmniSTAR services are not as susceptible to this error, as it they use a wide-area correction format. However, when operating away from the reference stations in this network, accuracy may degrade, as correction data may not model errors in your geographic area as thoroughly.

The latency of differential corrections to a lesser extent affects the achievable positioning accuracy at the remote receiver since the magnitude of SA was turned to zero in year 2000. Latency is a function of the following:

- The time it takes the base station to calculate corrections
- The data rate of the radio link
- The time it takes the signal to reach the user
- The time required for the remote differential receiver to demodulate the signal and communicate it to the GPS receiver.
- Any data loss that occurs through reception problems

Most of these delays require less than a second, though in some instances, depending upon the amount of information being transferred, overall delays of three to five seconds may occur. The effect of latency is mitigated by new COAST™ technology within the SLX. This technology is especially valuable in conditions of DGPS signal loss where the age of corrections increases for each second of signal loss. Consult Section 1.7 for further information.

Although ionospheric errors are normally removed through differential positioning, the state of the ionosphere can differ between the base station and remote user over large distances. As the base station calculates corrections based on local ionospheric conditions, they may not completely account for the errors observed at the remote user's location. This causes part of the spatial decorrelation that may be observed over large distances between base station and remote receivers. WAAS models the state of the ionosphere, providing Ionospheric errors are minimized by the Virtual Base Station process of the OmniSTAR systems by utilizing a wide are data format.

The number of satellites visible and their geometry in the sky influences positioning accuracy. The Dilution of Precision (DOP) describes the strength of location and number of satellites in view of the receiver. A low DOP indicates a strong potential for better accuracy than a high

DOP. Generally, more satellites visible to both the reference and remote receivers provides a lower DOP. Additionally, if the satellites are evenly spread around the receiver, rather than grouped in a few regions of the sky, a lower DOP (stronger solution) will result.

Satellite signals received by the GPS receiver by a reflection from an object can decrease positioning accuracy. These multipath signals increase the measured range to a satellite as the signal takes a longer route to the GPS antenna. Certain precautions will minimize GPS antenna sensitivity to these reflected signals. Operating away from large reflective structures such as buildings or using special antennas and GPS equipment can help to reduce the impact of multipath. For most consumer-level applications, a small amount of multipath is tolerable.

The quality of a GPS receiver has a dramatic influence on positioning accuracy. Consumer-based GPS products, such as many affordable handheld and fixed-mount receivers, typically operate with an accuracy of 3 to 5 meters horizontally 95% of the time. The accuracy of a particular product depends on the specific receiver's performance characteristics. Higher accuracy GPS receivers are able to achieve up to 1 meter of horizontal accuracy 95% of the time using real-time DGPS transmissions.

1.5 DGPS MAX DGPS Services

The DGPS MAX receiver is able to use differential corrections received through the internal WAAS demodulator, beacon receiver, or the OmniSTAR DGPS Service. This section describes the signal and data content of all three DGPS services available for use with the DGPS MAX receiver.

1.5.1 Wide Area Augmentation System (WAAS)

The US Federal Aviation Administration is in the process of developing a Wide Area Augmentation System (WAAS) for the purpose of providing accurate positioning to the aviation industry. In addition to providing a high quality, accurate service for this industry, this service is available free of charge to all other civilian users and markets in North America.

Other government agencies are in the process of developing similar, compatible systems for their respective geographic regions. In Europe, the European Space Agency, the European Commission, and EUROCONTROL are jointly developing the European Geostationary Overlay System (EGNOS). In Japan, the MTSAT Satellite-based Augmentation System (MSAS) is in progress of development by the Japan Civil Aviation Bureau (JCAB). These compatible augmentation systems fall into a broader category often referred to as Space Based Augmentation Systems (SBAS). The DGPS MAX is capable of receiving correction data from all WAAS-compatible SBAS.

Upon the successful completion of a 21-day test on August 24, 2000, the FAA announced that WAAS would be running 24 hours per day, seven days per week from then on. Testing has shown since that this signal is accurate and reliable, however, since no official statement on it's Initial Operating Capability has been issued, this signal is to used at your risk.

EGNOS has yet to begin broadcasting a tentative signal, however, is broadcasting signals publicly for test purposes. EGNOS should be used at your risk only. MSAS has yet to begin transmitting data publicly.

Warning – Although WAAS has successfully passed a 21-day test, and is publicly available, its use is at your risk and discretion. EGNOS is not currently broadcasting with any form of certification and its use is at your risk and discretion.

1.5.1.1 WAAS DGPS

WAAS differential, and other compatible SBAS, use a state-based approach in their software architecture. These services take in reference data from a network of base stations and endeavor to model the sources of error directly, rather than computing the sum impact of errors upon observed ranges. The advantage of this approach is that the error sources can be more specifically accounted during the correction process.

Specifically, WAAS calculates separate errors for the following:

- The ionospheric error
- GPS satellite timing errors
- GPS satellite orbit errors

Provided that a GPS satellite is available to the WAAS reference station network for tracking purposes, orbit and timing error corrections will be available for that satellite. Ionospheric corrections for that satellite are only available if the signal passes through the ionospheric map provided by WAAS, which covers the majority of North America.

To improve upon the ionospheric map provided by WAAS, the DGPS MAX extrapolates information from the broadcast ionospheric coverage map, extending its effective coverage. This allows the DGPS MAX to be used successfully in regions that competitive products may not. This is especially important in Canada for regions north of approximately 54° N latitude and east of 110° W longitude. Please note that the process of estimating ionospheric corrections beyond the WAAS broadcast map would not be as good as having an extended WAAS map in the first place. This difference may lead to minor accuracy degradation.

Figures 1-1 and 1-2 depict the broadcast WAAS ionospheric map extent and the CSI Wireless extrapolated version, respectively. As can be seen from Figure 1-2, the coverage compared to Figure 1-1 extends further in all directions, enhancing usable coverage.

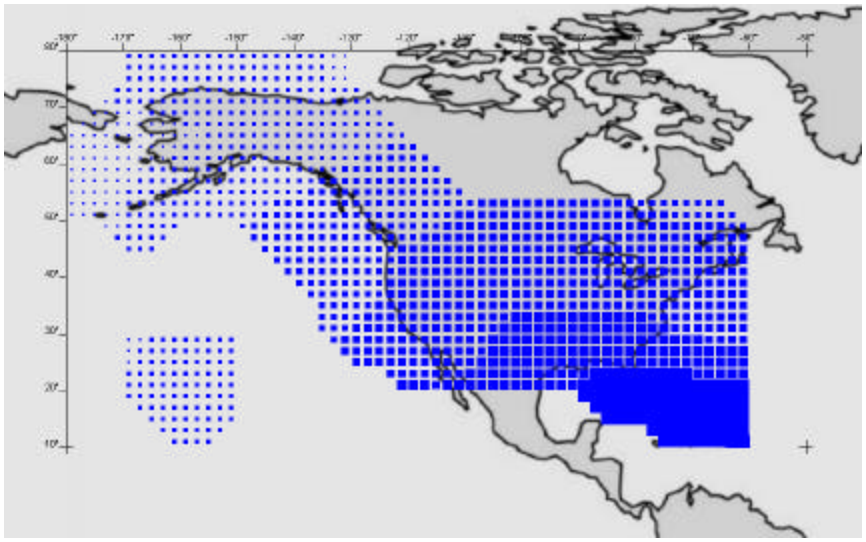


Figure 1-1 Broadcast WAAS Ionospheric Correction Map

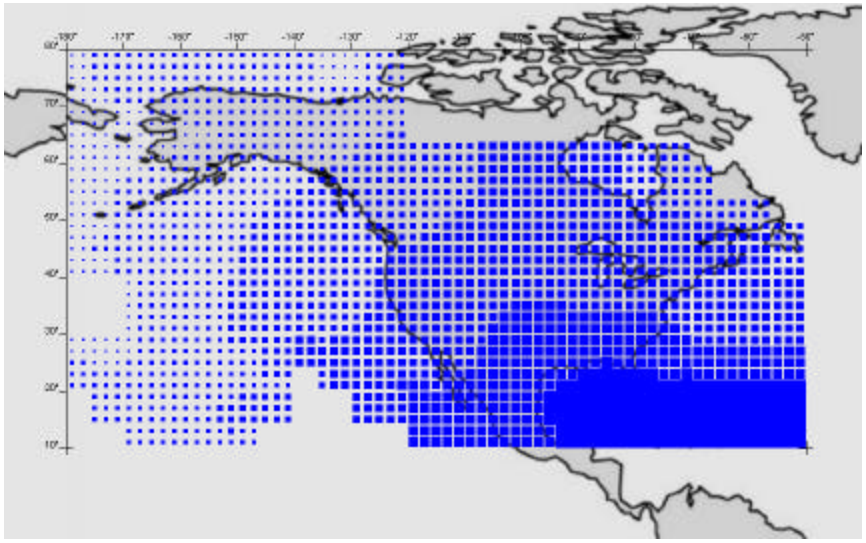


Figure 1-2 Extrapolated WAAS Ionospheric Correction Map

1.5.1.2 WAAS Signal Information

WAAS and other SBAS transmit correction data on the same frequency as GPS, allowing the use of the same receiver equipment used for GPS. Another advantage of having WAAS transmit on the same frequency as GPS is that only one antenna element is required.

In the case of the CDA-3 antenna, a second antenna element is required internally for the beacon sensor within the DGPS MAX receiver. Further, the internal GPS / WAAS antenna has been designed for reception of OmniSTAR signals, which also broadcast in the L-band. More about the CDA-3 antenna is provided in Section 1.8.

1.5.1.3 WAAS Reception

Since WAAS broadcasts in the L-band, the signal requires a line of sight in the same manner as GPS to maintain signal acquisition.

Currently, two commercial satellites are transmitting WAAS data for public use, and one each is located above both the Pacific and Atlantic oceans. Due to their location away over the oceans, these satellites may appear lower on the horizon, depending on your geographic position on land. When using WAAS correction data, the DGPS MAX is able to provide you with the azimuth and elevation of both satellites to aid in determining their position with respect to the CDA-3 antenna. More about this feature is described in Section 5.10.1.

1.5.1.4 WAAS Coverage

Figure 1-3 depicts the current WAAS coverage as provided by the currently leased Inmarsat Atlantic Ocean Region - West (AOR-W) and Pacific Ocean Region (POR) geostationary satellites. This figure approximates the coverage of these satellites by depicting coverage within the white shaded region. Within the white shaded coverage area, at least one of the two satellites is available by line of sight. Within the overlap area, both satellites may be accessible.

Please note that signal coverage may be present in some areas without either sufficient ionospheric map coverage or satellites with valid orbit and clock correctors. In such a case, differential positioning with WAAS may not be possible, as four or greater satellites (with correctors) must be available to compute a DGPS position.

Although EGNOS is not yet broadcasting an official signal, Figure 1-4 presents approximate EGNOS test-bed coverage provided by the leased Inmarsat Atlantic Ocean Region - East (AOR-E) and Indian Ocean Region (IOR) satellites. This figure approximates coverage of with white shading. Virtually all of Europe, part of northern Africa, and into the Middle East is covered.

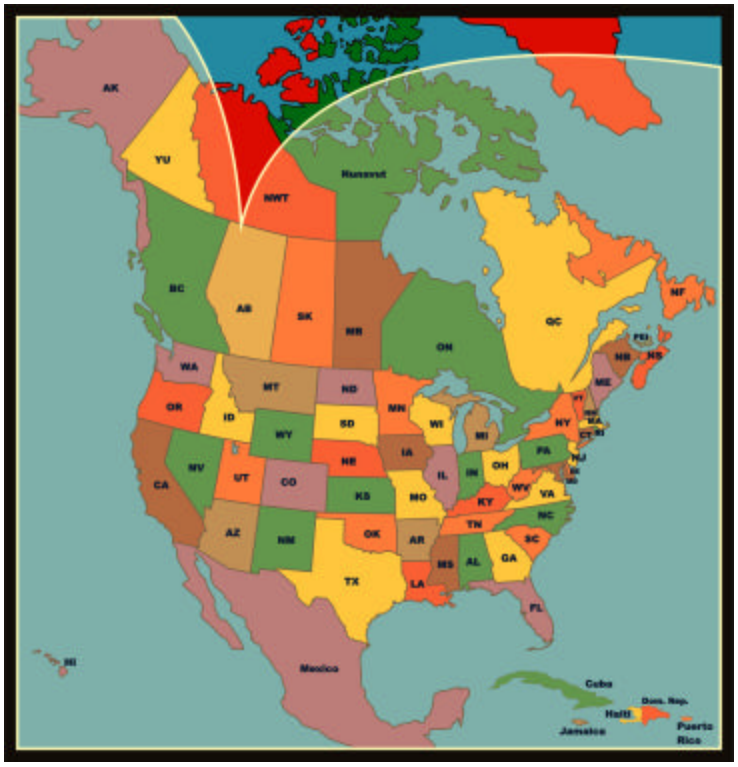


Figure 1-3 WAAS Coverage

Figure 1-4 EGNOS Coverage

1.5.2 OmniSTAR Worldwide DGPS Service

OmniSTAR is a worldwide terrestrial DGPS service that provides correction data to subscribers of the system with the use of a geostationary transponder.

1.5.2.1 OmniSTAR DGPS

OmniSTAR is a wide area DGPS service. The information broadcast by this service is based upon a network of reference stations placed at geographically strategic locations. The network stations communicate GPS correction data to control centers where it is decoded, checked, and repackaged into a proprietary format for transmission to a geostationary L-band communications satellite. The satellite re-broadcasts the correction information back to Earth over a large signal footprint where the DGPS MAX's L-band differential satellite receiver demodulates the data.

The OmniSTAR signal content is not RTCM SC-104, but a proprietary wide-area signal that is geographically independent. With this service, the positioning accuracy does not degrade as a function of distance to a base station, as the data content is not composed of a single base station's information, but an entire network's. When The DGPS MAX L-band DGPS receiver demodulates the proprietary signal, it converts it into a local-area format for input to the GPS receiver (standard RTCM SC-104, message Type 1).

The L-band DGPS receiver within the DGPS MAX interpolates corrections from the wide-area signal, specific to your location using Virtual Base Station (VBS) processing algorithms. The resulting RTCM corrections are those that would be calculated if a reference station were set up at your present location. This type of solution ensures a consistent level of accuracy across the entire coverage area. The GPS receiver inside the DGPS MAX provides position information to the L-band DGPS receiver for VBS calculations.

1.5.2.2 OmniSTAR Signal Information

The OmniSTAR L-band signal is a line-of-sight UHF signal similar to that of GPS. There must be a line of sight between the DGPS MAX's antenna and the geostationary communications satellite in order for the L-band differential receiver inside the DGPS MAX to acquire the signal.

Various L-band communications satellites are used for transmitting the correction data to OmniSTAR users around the world. When the DGPS MAX has acquired an OmniSTAR signal, the elevation and azimuth are available in the menu system in order for you to troubleshoot line of sight problems. Contact OmniSTAR for further information on this service. OmniSTAR contact information is provided in Appendix C of this manual.

1.5.2.3 OmniSTAR Reception

The OmniSTAR service broadcasts at a similar frequency to GPS, and as a result, is a line of sight system. There must be a line of sight between the antenna and the OmniSTAR satellite for reception of the service.

The OmniSTAR service uses geostationary satellites for communication. The elevation angle to these satellites is dependent upon latitude. For latitudes higher than approximately 55° North or South, the OmniSTAR signal may be blocked more easily by obstructions such as trees, buildings, terrain, or other objects.

1.5.2.4 OmniSTAR Coverage

Figure 1-5 shows approximate OmniSTAR service coverage. Regions without coverage, or with poor coverage are shown with dark shading.

Please note that signal coverage may be present in some areas without reference stations within the region. Operating outside of the reference station network may cause the applicability of the correction data to be less, resulting in a lower degree of positioning accuracy due to spatial decorrelation.

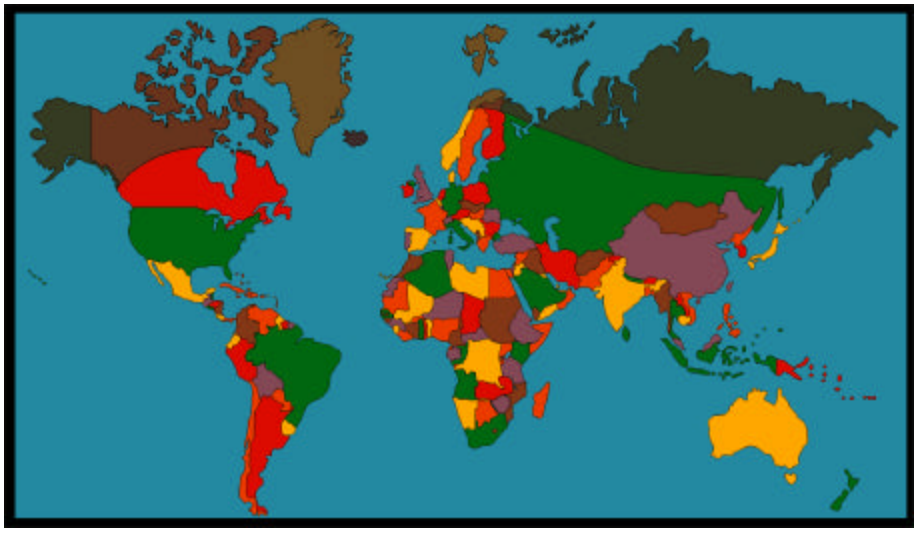


Figure 1-5 Worldwide OmniSTAR Coverage

Note - OmniSTAR is a terrestrial-only service.

1.5.3 Radiobeacon DGPS

Many Marine authorities, such as Coast Guards, have installed networks of radiobeacons that broadcast DGPS corrections to users of this system. With the increasing utility of these networks for terrestrial applications, there is an increasing trend towards densification of these networks inland.

1.5.3.1 Radiobeacon Range

The broadcasting range of a 300 kHz beacon is dependent upon a number of factors including transmission power, free space loss, ionospheric state, surface conductivity, ambient noise, and atmospheric losses.

The strength of a signal decreases with distance from the transmitting station, due in large part to spreading loss. This loss is a result of the signal's power being distributed over an increasing surface area as the signal radiates away from the transmitting antenna.

The expected range of a broadcast also depends upon the conductivity of the surface over which it travels. A signal will propagate further over a surface with high conductivity than over a surface with low conductivity. Lower conductivity surfaces such as dry, infertile soil, absorb

the power of the transmission more than higher conductivity surfaces, such as sea water or arable land.

A radiobeacon transmission has three components: a direct line of sight wave, a ground wave, and a sky wave. The line of sight wave is not significant beyond visual range of the transmitting tower, and does not have a substantial impact upon signal reception.

The ground wave portion of the signal propagates along the surface of the earth, losing strength due to spreading loss, atmospheric refraction and diffraction, and attenuation by the surface over which it travels (dependent upon conductivity).

The portion of the beacon signal broadcast skywards is known as the sky wave. Depending on its reflectance, the sky wave may bounce off the ionosphere and back to Earth causing reception of the ground wave to fade. Fading occurs when the ground and sky waves interfere with each other. The effect of fading is that reception may fade in and out. However, this problem usually occurs in the evening when the ionosphere becomes more reflective and usually on the edge of coverage areas. Fading is not usually an issue with overlapping coverage areas of beacons and their large overall range.

Atmospheric attenuation plays a minor part in signal transmission range, as it absorbs and scatters the signal. This type of loss is the least significant of those described.

1.5.3.2 Radiobeacon Reception

Various sources of noise affect beacon reception, and include:

- Engine noise
- Alternator noise
- Noise from Power lines
- DC to AC inverting equipment
- Electric devices such as CRT's electric motors, and solenoids

Noise generated by this type of equipment can mask the beacon signal, reducing or impairing reception. Section 2.4.1 presents an effective procedure to minimize impact of local noise on beacon reception when using this correction service.

1.5.3.3 Radiobeacon Coverage

Figure 1-6 shows the approximate radiobeacon coverage throughout the world. In this figure, light shaded regions note current coverage, with beacon stations symbolized as white circles.

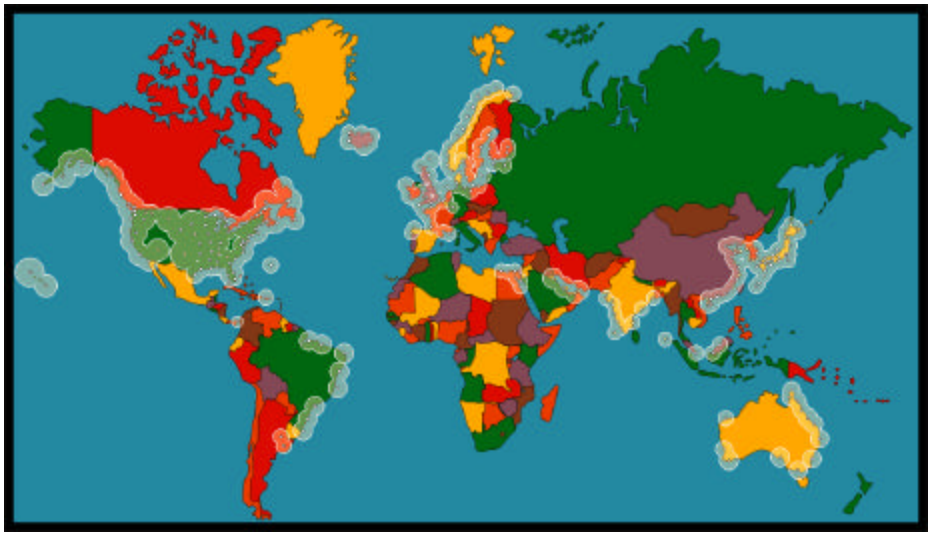


Figure 1-6 World DGPS Radiobeacon Coverage

The world beacon networks continue to expand. For more current coverage, consult the CSI Wireless Web site at www.csi-wireless.com.

1.6 DGPS Service Comparison

As the DGPS MAX offers the use multiple differential services, questions have been raised in regards to which correction source to use when more than one is available. Ultimately, this is a personal choice, however, this section provides some information that may help you choose which service is most appropriate for you. In the end, it may be best to try each, if possible, to determine which is most appropriate.

There are four scenarios that may occur for multiple DGPS service availability:

- WAAS, OmniSTAR, and beacon are each available
- WAAS and OmniSTAR are available
- WAAS and beacon are available
- OmniSTAR and beacon are available

Beacon signals are not affected by a line of sight. In situations where there are tall obstacles that may block the line of sight DGPS signal (both WAAS and OmniSTAR), such as buildings or trees, a beacon signal may be more desirable. However, the value of our new COAST™ technology, discussed in Section 1.8, is that outages of the DGPS signal are less of an influence on reception. This improves the robustness of using a line of sight signal in areas of potential blockage. If robustness to signal acquisition due to line of sight is considered a significant issue, beacon DGPS should be considered in replace of WAAS or OmniSTAR services.

All three services use base stations to calculate GPS correction data. Beacons use a single, local base station for corrections, while WAAS and OmniSTAR use a wide area network of stations. If there is a significant distance to the closest beacon (greater than a 200 - 300 hundred miles), this will have an effect on positioning accuracy due to differing environmental conditions between the remote receiver and base station (spatial decorrelation). In such a

case, if the accuracy degradation is not tolerable, WAAS or OmniSTAR should be considered. Both WAAS and OmniSTAR use a network of stations, and for best results, a user should be within or near the network to achieve best positioning results. When operating at distances significantly away from the network, the same issue of spatial decorrelation can occur.

Beacon signals are more susceptible to radio frequency interference than either WAAS or OmniSTAR signals, however, the state of CSI Wireless beacon technology has progressed such that beacon systems provide very good immunity to environmental noise. If RF noise presents a continuing problem, WAAS or OmniSTAR should be considered.

Both WAAS and beacon services are free, so it's possible to use both for a period of time, to determine which satisfies your needs best. Once this has been determined, it's a good idea to continue using one of the two services from then on, and not switch from between the services frequently. This will help to ensure consistent positioning from day to day. For information relating to locations of DGPS beacons, please consult Appendix D.

As the OmniSTAR service requires a subscription, you may wish to learn more about this service by speaking with OmniSTAR directly to determine if this system will best satisfy your needs. Please consult Appendix C for contact information and subscription details.

1.7 DGPS MAX Receiver Information

The DGPS MAX DGPS receiver incorporates the CSI Wireless SLX GPS / WAAS / L-band receiver and the SBX-3 beacon receiver internally with a sophisticated menu system.

The WAAS signal is available in the majority of North America and is free of charge to the public, however, beacon and OmniSTAR services may be used where the WAAS signal has shown not to be sufficient. Beacon signals are another free service, where available. To use the OmniSTAR DGPS service, you must purchase a user subscription. Refer to Appendix C for further information on activating an OmniSTAR subscription within your DGPS MAX receiver

The GPS engine of the internal SLX receiver provides high performance positioning for a variety of markets. This design is capable of providing up to 5 Hz position output with an accuracy of less than 1.2 m 95% confidence.

The SLX receiver inside the DGPS MAX features a built-in WAAS demodulator that provides free access to this service. The WAAS engine decodes the WAAS signal and localizes the wide-area correction data for use at the current location. Operation of the WAAS receiver is fully automatic, requiring no operator intervention.

The MAX's internal L-band differential satellite receiver features an auto-scanning mode where it will reacquire a valid signal if the current one becomes unavailable. The L-band DGPS receiver generates Virtual Base Station GPS corrections by localizing the wide-area data using position input from the GPS receiver inside the DGPS MAX.

The beacon receiver embedded within the DGPS MAX is CSI Wireless's SBX dual channel, minimum shift keying (MSK), demodulator. It receives GPS correction information broadcast by medium frequency DGPS radiobeacons. The SBX passes these corrections to the internal GPS engine that computes DGPS positions. CSI Wireless's web site at www.csi-

wireless.com provides current DGPS radiobeacon coverage and site information. This receiver operates automatically by default, however, an option is available to tune this engine manually.

The 2-line by 16-character liquid crystal display (LCD) and menu system provide access to all three internal sensors. The DGPS MAX uses a 3-button keypad for menu system navigation. The menu system allows you to operate each internal sensor and monitor signal status.

1.8 COAST™ Technology

The DGPS MAX receiver incorporates new technology referred to as COAST™ that allows the DGPS MAX receiver to operate with old correction data for up to 30 minutes without significant accuracy degradation. The ability of the DGPS MAX to perform such as this is attributed to sophisticated algorithms that are able to anticipate how errors will change during a period of correction loss.

Traditional receiver technology would experience an increasing degradation with increasing age of corrections. COAST™ technology provides consistent positioning during periods where loss of signal occur, thus bridging the gap to when signal reacquisition occurs. This means that the DGPS MAX is more tolerant to data loss when a correction signal is masked due to noise or line of sight issues than competing products.

1.9 CDA-3 Antenna Information

The antenna supplied with the DGPS MAX provides radio frequency signals to all three internal receivers. Inside the CDA-3's enclosure are an L-band antenna for reception of GPS, WAAS, and L-band satellite signals, and an H-field beacon loop antenna for reception of beacon signals. Both of these antenna elements are active and draw their power from the DGPS MAX receiver. The CDA-3 outputs all three signals through its TNC connector to the DGPS MAX's TNC-S antenna input port labeled 'ANT'. Internally, the DGPS MAX separates the three signals are and routes them to the appropriate internal sensor.

The L-band antenna element is designed for reception of both GPS and L-band satellite DGPS transmissions. The gain pattern of the antenna is designed so that the system will function well at higher latitudes where the OmniSTAR and WAAS satellites appear lower on the horizon. The L-band antenna features a low noise amplifier, allowing the use of antenna cable lengths up to 10 meters (RG-58U). If longer cable runs are required for your application, please contact CSI Wireless for a low-loss antenna cable.

The H-field Loop antenna within the CDA-3 is sensitive to the magnetic field of the medium frequency radiobeacon broadcast. It receives beacon signals that are band-pass filtered and amplified. This ensures that only radiobeacon frequencies to passed to the beacon receiver.

Appendix A details the technical specifications for the CDA-3 antenna. Refer to Section 2.4 for instructions regarding antenna installation.

2. Installation

This chapter contains instructions and recommendations for the installation of the DGPS MAX receiver and CDA-3 antenna.

2.1 System Parts List

The following list of standard equipment is included with the DGPS MAX Receiver system:

- DGPS MAX (part number 803-0025-xxx)
- CDA-3 Antenna (part number 804-3023-xxx)
- Power Cable (various available)
- Antenna Cable (various available)
- Data Cable (part number 050-0011-022)
- Magnetic Mount Kit (part number 725-0007-012)
- Reference Manual (part number 875-0034-000)

2.2 Receiver Layout and Connections

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

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

Figure 2-1 Cable Interface

2.3 Installing the DGPS MAX Receiver

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

2.3.1 Receiver Placement

The flange mounting bracket supplied with the DGPS MAX is used to secure the receiver to the selected mounting surface. You may install this bracket on the top or the bottom of the DGPS MAX. 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.

2.3.2 Environmental Considerations

The DGPS MAX 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-3 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.

2.3.3 Power Considerations

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

The back-lit LCD display of the DGPS MAX remains illuminated while power is applied to the receiver.

Table 2-1 Power Requirements

Model	Input Voltage	Input Current	Input Power
DGPS MAX (with CDA-3)	9 to 48 VDC	<550 mA @ 12 VDC	<6.5 W Nominal

2.3.4 Turning the DGPS MAX On

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

To turn the DGPS MAX 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 DGPS MAX.
- Turn the DGPS MAX 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 DGPS MAX 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 DGPS MAX receiver from power surges. The fuse container should remain accessible after installation.

Caution - Do not operate the DGPS MAX with the fuse bypassed. Such a modification will void the product warranty.

2.3.5 Grounding the DGPS MAX

For best performance, connect the ground screw, labeled 'GND', on the back of the DGPS MAX 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.

2.3.6 Connecting the DGPS MAX To External Devices

The DGPS MAX 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 DGPS MAX 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 DGPS MAX and are a DB9 socket connector. Table 2-2 and Table 2-3 provide pin-assignment information for the DGPS MAX MAIN and AUX serial ports respectively.

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

Pin #	Signal	Description
2	TXD	DGPS MAX NMEA 0183 and binary output
3	RXD	DGPS MAX 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 2-3 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 2-2 displays the numbering scheme for a DB9 socket connector (female), as located on the rear panel of the DGPS MAX receiver. The associated numbering for the plug connector (male) is a mirror reflection of scheme showed in this figure.

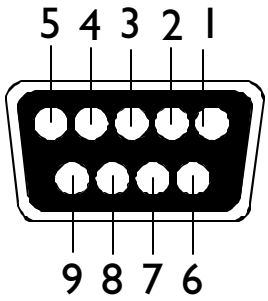


Figure 2-2 DGPS MAX Socket Connector Pin Numbering

Figure 2-3 illustrates the standard interface for the DGPS MAX when interfaced to an external device:

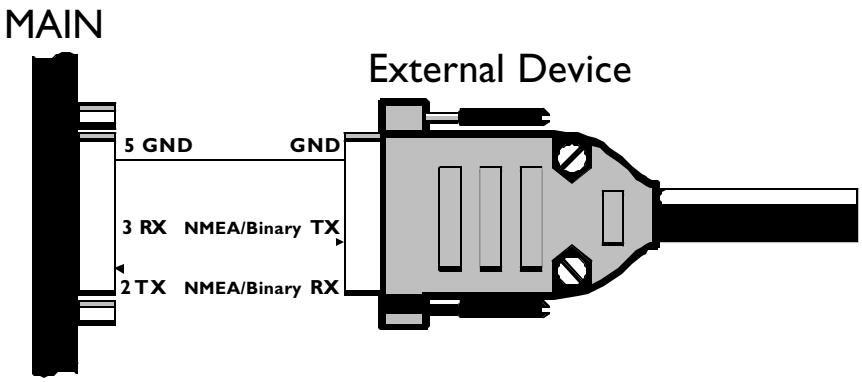


Figure 2-3 DGPS MAX Interface

Refer to Appendix B for further interface information when operating in the DGPS MAX with various correction sources.

For successful communications, the baud rate of the DGPS MAX serial ports must be set to match that of the devices to which they are connected. Refer to Section 4.6.7.1 and Section 4.7.2 for instructions related to setting the DGPS MAX baud rates.

2.4 Installing the CDA-3 Antenna

The location chosen for installation of the CDA-3 antenna will influence the overall performance of the DGPS MAX 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 DGPS MAX is measured to the center of the CDA-3 antenna. Install the antenna in the best location for your application, such as the center line of your vehicle or vessel.
- Do not locate the antenna where environmental conditions exceed those specified in Section 2.3.2.

2.4.1 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 DGPS MAX. 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.

2.4.2 Antenna Installation – 1-14-UNS Threaded Mount

The CDA-3 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 DGPS MAX system. An adapter

to convert the 1-14-UNS thread to a 5/8th inch survey-style thread is available from CSI Wireless, discussed in Section 2.5.3.

Thread the CDA-3 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-3. 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.

2.4.3 Antenna Installation – Surface Mount

The CDA-3 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-3, if desired.

To mount the CDA-3 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.

2.4.4 Routing and Securing the Antenna Cable

The CDA-3 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 CSI Wireless dealer or CSI Wireless Technical Support.

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 DGPS MAX 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

2.4.5 Connecting the CDA-3 Antenna

The CDA-3 Antenna connects to the DGPS MAX receiver using the supplied TNC-male to TNC-male antenna cable. To connect the CDA-3 Antenna to the DGPS MAX:

- Thread one end of the TNC to TNC antenna extension cable onto the TNC socket present on the CDA-3
- Thread the other end of the antenna extension cable to the TNC socket connector on the rear panel of the DGPS MAX, labeled CDA-3.

Caution - Be sure to always connect the antenna to the DGPS MAX before you turn the receiver on.

2.5 Mounting Accessories

CSI Wireless offers various mounting accessories as discussed in the following sections.

2.5.1 Magnetic Mount

Included with a standard system, the magnetic mount (PN 725-0007-012) can be used to install the CDA-3 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 this 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 CSI Wireless part number for the threaded shaft is 676-0005-000.

2.5.2 Permanent Mount

An optional stainless steel permanent mount is available for installation of the CDA-3 antenna. It consists of a hollow threaded post on a circular base. Three screws are required to secure this mount to a mounting surface. (CSI Wireless PN 604-0002-000)

2.5.3 Survey Adapter

The optional Survey Adapter is a threaded insert available for use with the CDA-3 antenna. It converts the standard 1-14-UNS-2B thread to a 5/8th-inch thread, frequently used with survey

equipment (CSI Wireless PN 676-0005-000). This survey adapter is the same part as used for the shaft of the magnetic mount

3. DGPS MAX Overview

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

When powered for the first time, the DGPS MAX 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 DGPS MAX receiver and its internal sensors.

3.1 GPS Operation

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

3.1.1 Automatic Tracking

The GPS engine within the DGPS MAX 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.

3.1.2 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 DGPS MAX 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 5.9.1.1.

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 DGPS MAX 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 5.7 and 5.9.2.

3.2 WAAS Operation

The following sections describe the general operation and performance monitoring of the WAAS demodulator within the DGPS MAX.

3.2.1 Automatic Tracking

The WAAS demodulator featured within the DGPS MAX 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.

3.2.2 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 DGPS MAX. 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 5.10.1 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 5.7 for further information.

3.3 OmniSTAR Operation

The following sections describe the general operation and performance monitoring of the OmniSTAR sensor within the DGPS MAX.

3.3.1 Automatic Tracking

The DGPS MAX 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.

3.3.2 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-3 antenna and the geostationary communications satellite broadcasting OmniSTAR correction information.

The CDA-3 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 5.11.1 provides more information on this feature. A graphical presentation of the reception quality is provided in the signal tracking bar chart. Refer to Section 5.7 for further information.

3.4 Beacon Operation

The following sections describe the general operation and performance monitoring of the beacon engine within the DGPS MAX.

3.4.1 Tune Modes

The DGPS MAX 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 5.5 to switch between Automatic and Manual Tune modes using the display and keypad.

3.4.1.1 Automatic Beacon Search (ABS) Mode

When operating using the internal beacon sensor as the source of DGPS correction information, the DGPS MAX operates in Automatic Beacon Search (ABS) mode by default, selecting and tuning to the most appropriate beacon without operator intervention. The DGPS MAX'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 5.12.2.

3.4.1.2 ABS Global Beacon Search

When powered for the first time in ABS mode, the DGPS MAX 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 DGPS MAX will initiate a fresh Global Search, continuing this cycle until it finds a valid station.

3.4.1.3 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 DGPS MAX 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 5.12.2.

3.4.1.4 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 DGPS MAX 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 DGPS MAX 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 5.12.2 and 5.12.2.1.

3.4.2 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 3-1 describes the beacon receiver quality of reception with respect to the SNR reading.

Table 3-1 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 5.7 for further information.

3.5 Factory Default Parameters

Tables 3-2, 3-3, and 3-4 identify the default DGPS MAX configuration settings of the various DGPS MAX Series receivers.

Caution - The changes you make to the DGPS MAX configuration are saved in memory for subsequent power-up.

Table 3-2 Preset DGPS Mode

DGPS Mode
WAAS

Table 3-3 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 3-4 Preset GPS NMEA Message Output

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

4. DGPS MAX Architecture

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

As the DGPS MAX receiver supports the following services, it requires receiving capability for each:

- GPS
- WAAS
- OmniSTAR
- Beacon

4.1 Hardware

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

4.2 Firmware

As the software that operates the internal components of the DGPS MAX 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.

4.3 Applications

The ARM of the SLX inside the DGPS MAX 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 DGPS MAX 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.

5. Operation

This chapter introduces the display and keypad features of the DGPS MAX, operating modes, menu structure, and receiver default operating parameters.

5.1 Front Display and Keypad

The DGPS MAX 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 5-1 shows the display and keypad of the DGPS MAX receiver.

Figure 5-1 DGPS MAX Display and Keypad

5.2 Navigating the Menu System

The keypad on the front of the DGPS MAX 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, which is denoted by the opposing arrows ▶◀. 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 DGPS MAX display is the Focus Line. The field of interest must be 'in focus' for keystrokes to have the desired effect.

5.3 Menu Access Icon

The icon shown in Figure 5-2 indicates that you may access the current item in focus by pressing the ⓔ key.

Figure 5-2 Menu Access Icon

5.4 Receiver Status Icons

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

5.4.1 Position Fix Status Icon

The DGPS MAX 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 DGPS MAX display. Figure 5-3, illustrates the three states of the GPS status icon.

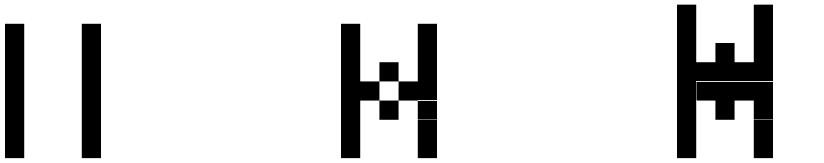
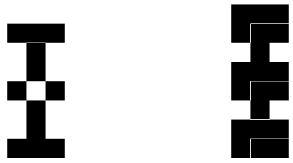


Figure 5-3 GPS Position Fix Icon

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.

5.4.2 WAAS Lock Icon

When the DGPS MAX is configured to use WAAS correction information, The DGPS MAX 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 5-4 WAAS Lock Icon

5.4.3 OmniSTAR Lock Icon

When operating using the internal L-band receiver as the differential source, the DGPS MAX receiver indicates the OmniSTAR DGPS lock status in the upper right corner of the display. The lock symbol, illustrated in Figure 5-5, 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.

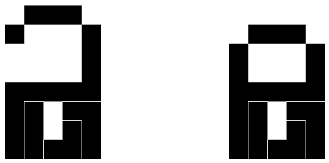
No L-band Lock L-band Lock

Figure 5-5 L-band Lock Icon

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

5.4.4 Beacon Lock Icon

When using the internal beacon sensor as the differential source, the DGPS MAX indicates beacon lock status in the upper right hand corner of the display. The lock symbol, illustrated in Figure 5-6, remains in the closed position when the DGPS MAX 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 5-6 Beacon Lock Icon

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

5.4.5 External DGPS Correction Source Icon

The icon shown in Figure 5-7 indicates that the DGPS MAX receiver is currently operating with corrections input from an external source. This icon symbolizes external correction input to a DB9 connector.

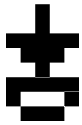


Figure 5-7 External DGPS Source Icon

5.4.6 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 5-8 Autonomous Mode Icon

5.5 DGPS MAX Menu System Overview

This section shows you how to navigate through the menu system of the DGPS MAX receiver, change operating modes, monitor position and status information, and change receiver configuration. Figures 5-9 to 5-15 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 DGPS MAX 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 5-9 to 5-15, the root menu is displayed on the left, with associated submenus displayed progressively towards the right. Each of the figures are described in the following sections in detail.

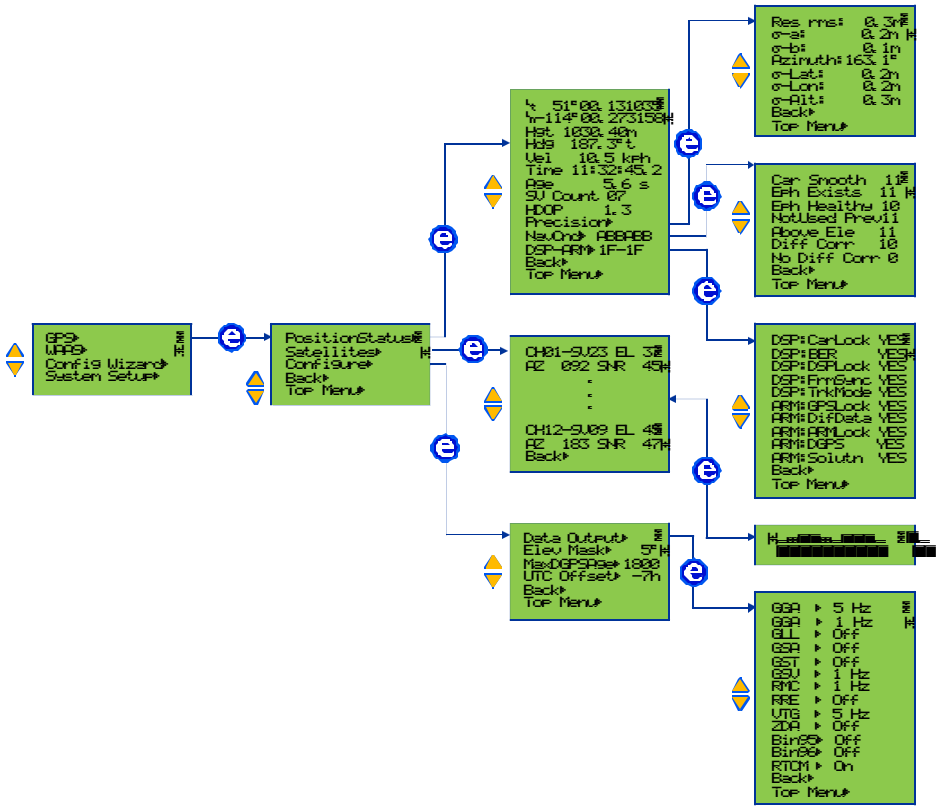


Figure 5-9 GPS Menu

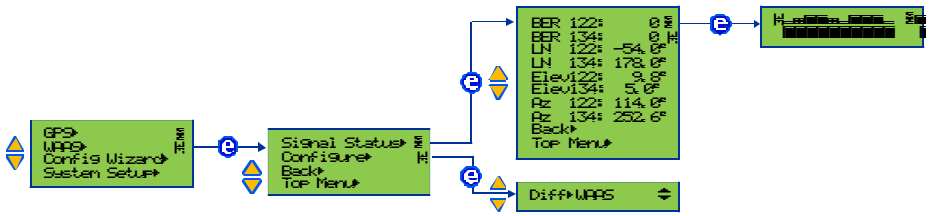


Figure 5-10 WAAS Menu

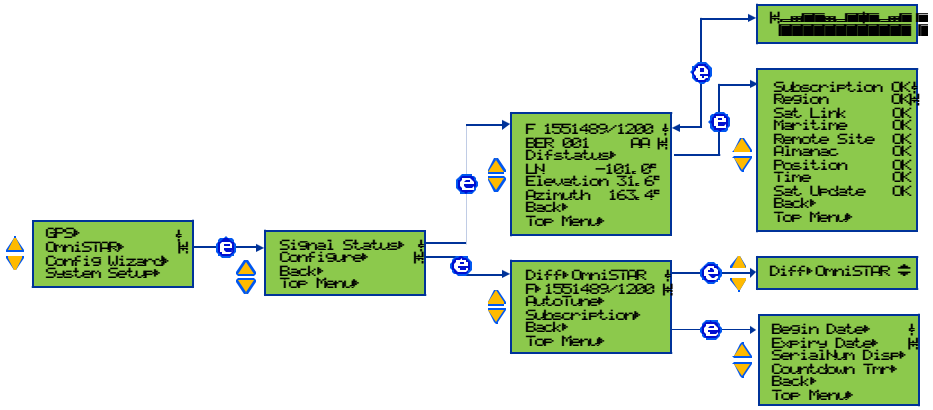


Figure 5-11 OmniSTAR Menu

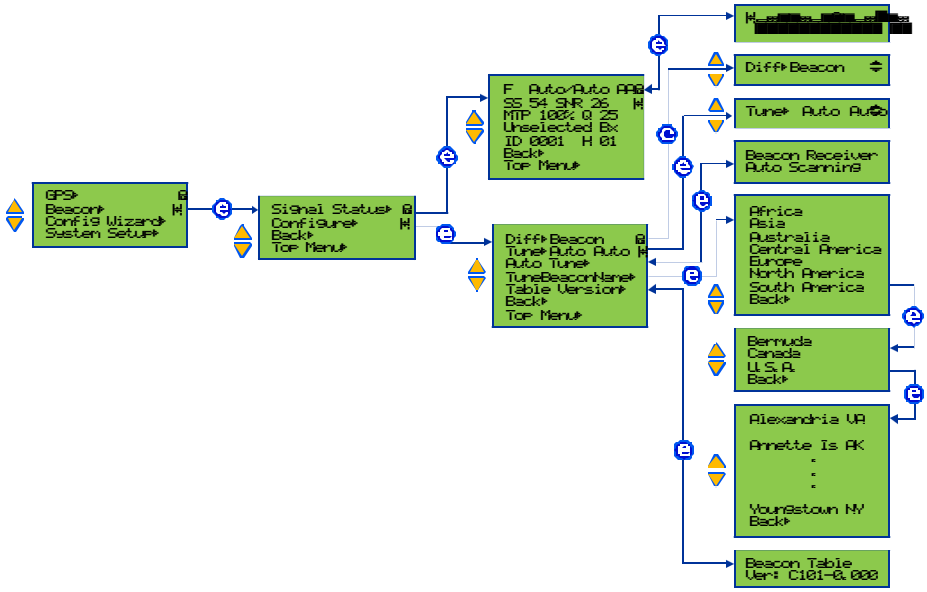


Figure 5-12 Beacon Menu

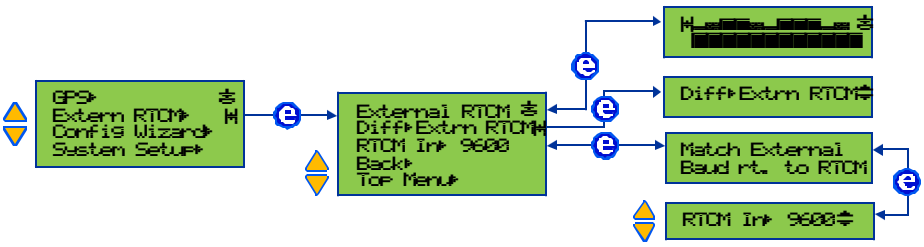


Figure 5-13 External RTCM Input Menu

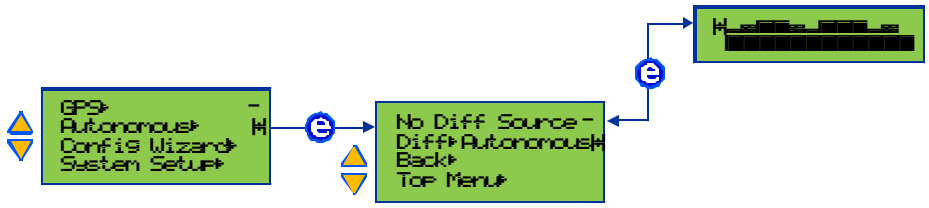


Figure 5-14 Autonomous Menu

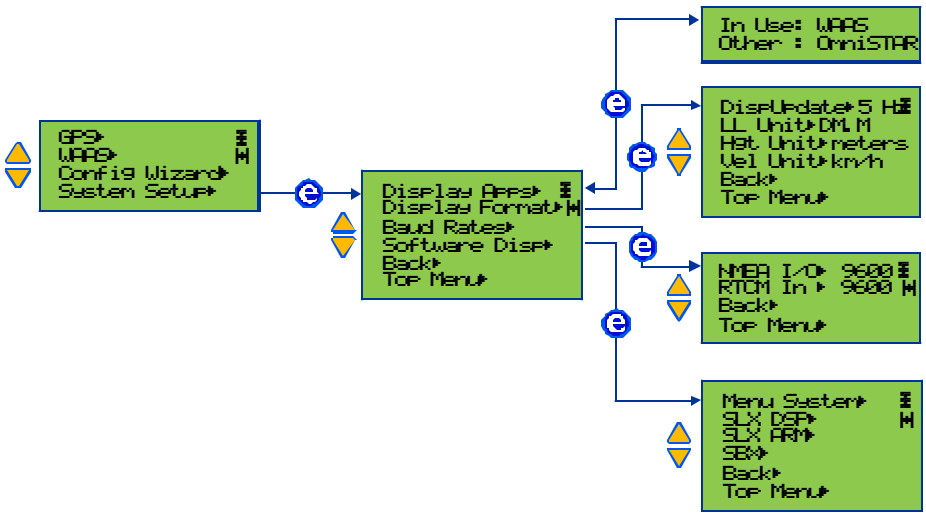


Figure 5-15 Setup Menu

5.6 Start-Up Sequence

When you turn the DGPS MAX 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 ⓔ button is pressed. If ⓔ is pressed, the menu system will begin the Configuration Wizard. Consult Chapter 6 for further information on the Configuration Wizard.

5.7 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.

5.7.1 WAAS Mode Bar Chart

When operating the DGPS MAX 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.

5.7.2 OmniSTAR Mode Bar Chart

When operating the DGPS MAX 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.

5.7.3 Beacon Mode Bar Chart

When operating the DGPS MAX 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.

5.7.4 External RTCM Input Bar Chart

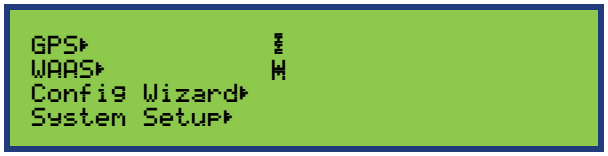
When operating the DGPS MAX receiver in External RTCM Input mode, the portion of the bar chart to the right will display the external RTCM input icon . No associated status data is provided for the external correction source.

5.7.5 Autonomous Mode Bar Chart

When operating the DGPS MAX 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.

5.8 Main Menu

The DGPS MAX 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 ⓔ 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 ⓔ 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 ⓔ button, the DGPS MAX 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▸

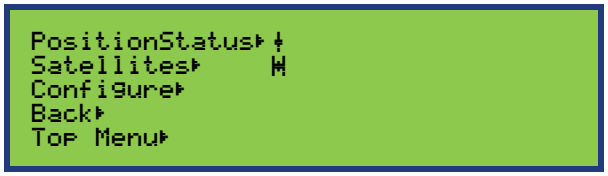
When this menu item is accessed using the ⓔ button, the Configuration Wizard will begin. This feature allows you to easily configure the DGPS MAX step-by-step. This feature is described in detail in Chapter 6.

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 DGPS MAX receiver.

5.9 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 5-3. This portion of the menu system, including submenus, is detailed in Figure 5-9.



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

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

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

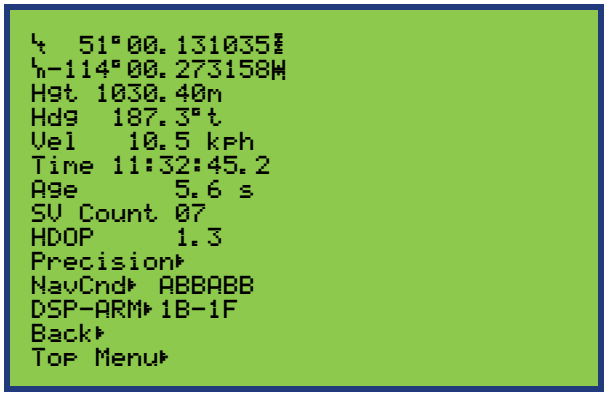
`Configure▸` Entering this menu using the ⓔ button will allow you to change various configuration parameters related to the GPS receiver inside the DGPS MAX. This includes NMEA message output settings, elevation cut-off mask, differential time-out, and UTC offset.

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

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

5.9.1 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 5-9.



Pressing the ▲ and ▼ keys allows you to scroll through the available menu items. Pressing the ⓔ button anywhere in this menu will provide a bar chart of signal tracking information. Pressing the ⓔ 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 5.15.2.

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 4.6.7.

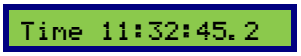
Longitude information is parsed from the GPGGA NMEA message. The longitude, measured to the phase center of the antenna, is usually referenced to the WGS-84 ellipsoid, however, some DGPS services result in a position relating to the North American Datum 1983 (NAD-83). This datum is essentially equivalent 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 4.6.7). 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 referenced to the geoid (or mean sea-level).

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 e 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 5.8.1.1.

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).

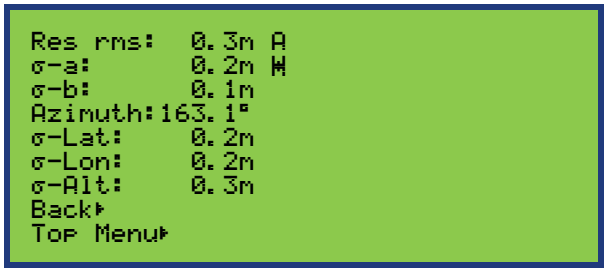
by pressing the e button with this item in focus, an intuitive summary of the navigation condition is displayed. This is discussed in further detail in Section 5.8.1.2.

This menu item displays the internal status of the on-board DSP and ARM processor of the SLX. By pressing the e button with this item in focus, a menu will display that decodes the raw DSP-ARM status into an intuitive format described in Section 5.8.1.3.

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

5.9.1.1 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 5-9.



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

Res rms: 0.3m A	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.
σ-a: 0.2m W	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.
σ-b: 0.1m	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.

azimuth:163.1°

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

σ-Lat: 0.2m

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

σ-Lon: 0.2m

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▸

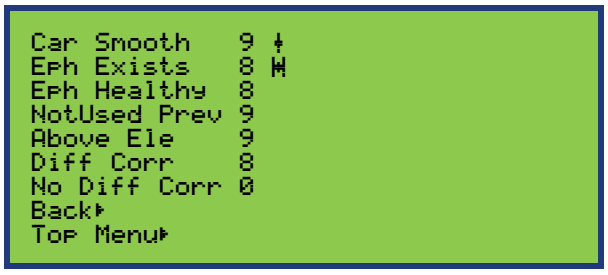
When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.

Top Menu▸

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

5.9.1.2 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 5-9.



Pressing the △ and ▽ keys allows you to scroll through the available menu items. Pressing the ⓔ button anywhere in this menu will provide a bar chart of signal tracking information. Pressing the ⓔ 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.

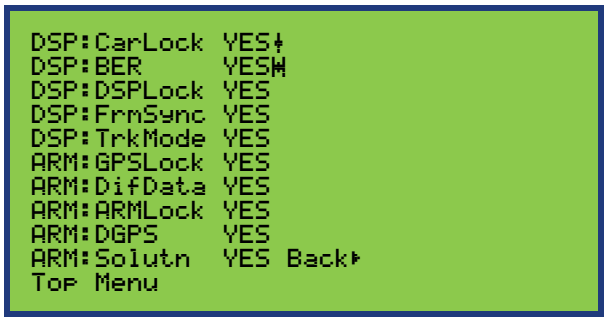
This menu item indicates how many satellites are above the current elevation mask setting. An elevation mask is used to ignore satellites that are low on the horizon, but still usable, as they will have more significant tropospheric refraction errors. A satellite below the elevation mask is ignored from the position solution. See Section 5.9.3 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.

No Diff Corr 0	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.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.9.1.3 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 DGPS MAX. This menu is detailed in Figure 5-9.



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

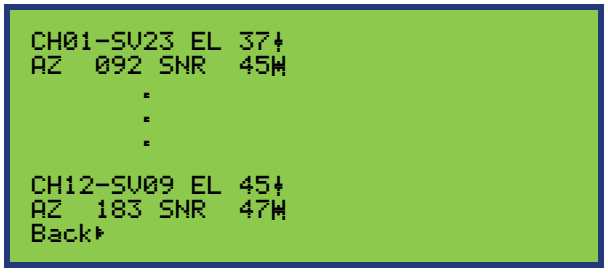
DSP:CarLock	The DSP:CarLock is a description of the L-band carrier lock. Under normal operation, this field should indicate YES.
DSP:BER	This is an indication of whether or not the internal L-band receiver has acquired a Viterbi lock (signal lock). Under normal operation, this field should indicate YES.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

DSP:FRMSync	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.
DSP:TrkMode	This has the same meaning as the CarLock. Under normal operation, this field should indicate YES.
ARM:GPSLock	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.
ARM:DifData	This menu item indicates if differential data is being successfully decoded by the GPS receiver. Under normal operation, this field should indicate YES.
ARM:ARMLock	Under normal operation, this field should indicate YES.
ARM:DGPS	Under normal operation, this field should indicate YES.
ARM:Soution	This menu item indicates if the GPS solution is deemed correct by the processor. Under normal operation, this field should indicate YES
Back▸	When accessed using the e button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the e button, this menu item returns the menu system to the main menu.

5.9.2 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 5-9.



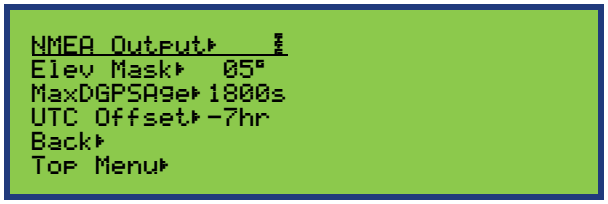
Pressing the ▲ and ▼ keys allows you to scroll through the available GPS receiver channels, numbered Ch01 through Ch12. Pressing the e button with any item in focus that does not have the menu access indicator, ▸ , will display a signal tracking bar chart. Pressing the e button with the Back▸ or Top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

CHxx-SVxx	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.
EL xx	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.
AZ xx	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.
SNR xx	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 DGPS MAX requires an SNR of above approximately 40. This information is parsed from the GPGSV NMEA message.

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

5.9.3 GPS Configure Menu

This menu provides access to various configurable GPS parameters. This portion of the menu system, including submenus, is detailed in Figure 5-9.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ 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 ⓔ button, this menu item will take the menu system of the DGPS MAX to the NMEA Output menu for configuration of the messages output by the receiver.
Elev Mask▸ 5°	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 ⓔ.

MaxDGPSAge▸1800s	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 ⓔ. This will allow you to adjust the subsequent number and so on.
UTC Offset▸-7hr	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 ⓔ.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.9.3.1 NMEA Output Menu

This menu allows you to toggle the output of various NMEA messages that are output from the MAIN port of the DGPS MAX. This menu is detailed in Figure 5-9. The NMEA messages within this menu are described in detail within Chapter 7.

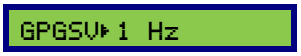
Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

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

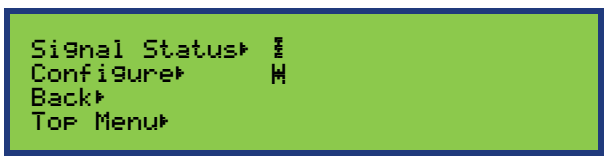
This menu item allows you to toggle the output of the Binary 95 message (contains GPS ephemeris data) through the MAIN port of the

DGPS MAX receiver. To change the current update rate, press the button followed by adjusting the rate using the or key, then press . This message may be set for output at 1 Hz only.

Bin96▸ 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 DGPS MAX receiver. To change the current update rate, press the button followed by adjusting the rate using the or key, then press . This message may be set for output at 5 Hz, 1 Hz, 5 s updates or may be turned off.
RTCM ▸ Off	This menu item allows you to toggle the output of the RTCM data through the MAIN port of the DGPS MAX receiver. When set to output RTCM, this data comes from the current DGPS source in use. To toggle its output, press the button followed by adjusting the rate using the or key, then press . This data may be turn on or off.
Back▸	When accessed using the button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the button, this menu item returns the menu system to the main menu.

5.10 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 5-4 when using corrections from the internal WAAS receiver. This portion of the menu system, including submenus, is detailed in Figure 5-10.



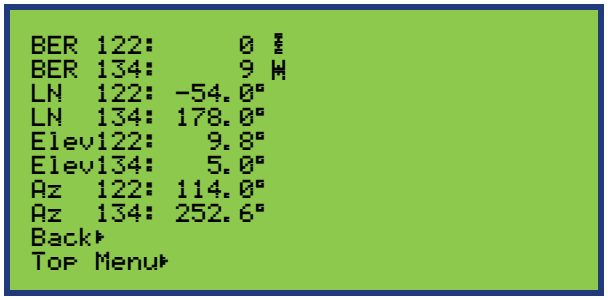
Pressing the and keys allows you to scroll through the available options. Pressing the button with any item in focus will take the menu system to that submenu. Pressing the

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▸	Pressing the ⓔ button with this menu item in focus will take the menu system to the WAAS signal status menu.
Configure▸	Pressing the ⓔ 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.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.10.1 WAAS Signal Status Menu

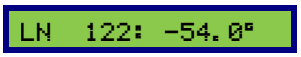
This menu provides various information regarding the status and operation of the WAAS demodulator. This portion of the menu system, including submenus, is detailed in Figure 5-10.



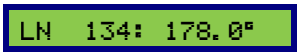
Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any status information in focus will display the signal tracking bar chart. Pressing the ⓔ button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main 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 3.3.2 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 3.3.2 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°.

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°.

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

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

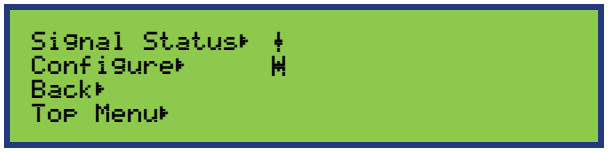
5.10.2 WAAS Configure Menu

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 5-10.

Pressing the △ and ▽ keys allows you to scroll through the differential options. Pressing the ⓔ 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 ⓔ button.

5.11 OmniSTAR Menu

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

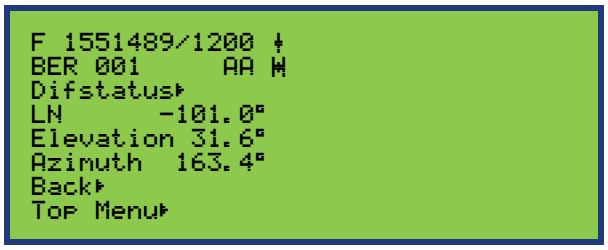


Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

Signal Status▸	Accessing this submenu by pressing the ⓔ 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 ⓔ button allows you to configure the internal OmniSTAR receiver.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.11.1 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 5-11.



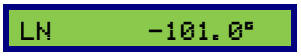
Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any status information in focus will display the signal tracking bar chart. Pressing the ⓔ button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main 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 3.3.2 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 e 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.

Azimuth xxx.x°	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 ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.11.1.1 Difstatus Menu

This menu provides details on the OmniSTAR differential service. This menu is detailed in Figure 5-11.

Pressing the △ and ▽ keys allows you to scroll through the available options. Pressing the ⓔ button with any status information in focus will display the signal tracking bar chart. Pressing the ⓔ 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 DGPS MAX 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 DGPS MAX, 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 DGPS MAX 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 DGPS MAX 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 DGPS MAX will display 'OK', otherwise the receiver will display 'BAD'.

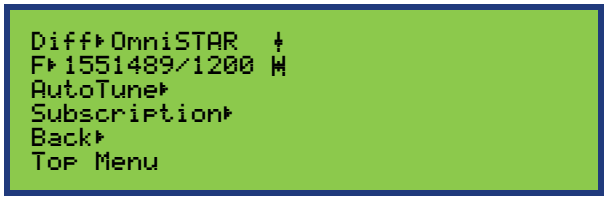
When accessed using the e button. this menu

item returns the menu system to the previous menu.

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

5.11.2 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 DGPS MAX. This menu is detailed in Figure 5-11.



Pressing the △ and ▽ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ 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.
F▸1551489/1200 W	When accessed using the ⓔ 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 ⓔ button. When prompted to tune the frequency, adjust each character using the △ and ▽ keys, followed by pressing the ⓔ 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 ⓔ button to complete the process.

AutoTune▸	When accessed using the e button, the OmniSTAR receiver will be tuned in automatic mode. A screen will indicate that the receiver is in automatic mode.
Subscription▸	When accessed using the e 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 e button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the e button, this menu item returns the menu system to the main menu.

5.11.2.1 Subscription Menu

When operating the DGPS MAX 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 5-11.

Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the e button with any item in focus will take the menu system to that submenu. Pressing the e 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 e button, this menu will provide you with the beginning date of your subscription.
Expiry Date▸	When accessed using the e button, this menu will provide you with the expiry date for your subscription.

SerialNum Disp▸ When accessed using the ⓔ button, this menu will provide you with the OmniSTAR unit number for your DGPS MAX. OmniSTAR uses this number for subscription purposes. Please have it ready when subscribing your receiver when contacting OmniSTAR.

Countdown Tmr▸ When accessed using the ⓔ button, this menu item will display the time left, if a countdown timer has been subscribed to your receiver.

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

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

5.12 Beacon Menu

This menu provides access to the signal status and configuration parameters of the internal SBX beacon receiver inside the DGPS MAX. Please note that the icon in the upper right corner of the display will be a padlock symbol as shown in Figure 5-6 when operating in beacon DGPS mode. This portion of the menu system, including submenus, is detailed in Figure 5-12.

Pressing the △ and ▽ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ 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▸ Using the ⓔ button, this menu item allows you to access a menu that provides Signal Status information from the internal beacon DGPS receiver.

Configure▸ Accessing this menu using the ⓔ button allows you to configure the internal SBX beacon receiver.

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

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

5.12.1 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 5-12.

Pressing the △ and ▽ keys allows you to scroll through the available options. Pressing the ⓔ button with any status information in focus will display the signal tracking bar chart. Pressing the ⓔ 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). The SS value is expressed in dBµV and may be considered a true signal strength as the calibration factor of the CDA-3 antenna is 1:1. For example, a 20 dBµV signal level equates to a 20 dBµV/m field strength due to the unity calibration factor. 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 3.4.2.

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.

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 CSI Wireless'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.

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

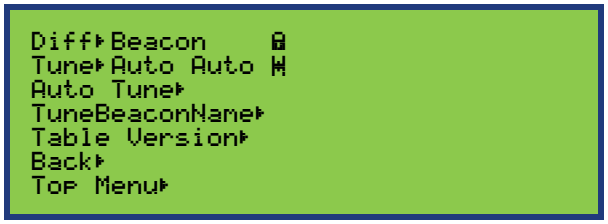
When accessed using the button, this menu item returns the menu system to the main menu.

Table 5-1 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

5.12.2 Beacon Configure Menu

This menu provides access to the various methods to tune the internal SBX beacon sensor inside the DGPS MAX. This submenu is detailed in Figure 5-12.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ 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▸Beacon`

Using the ⓔ 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.

`Tune▸Auto Auto`

When accessed using the ⓔ 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.

`Auto Tune▸`

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

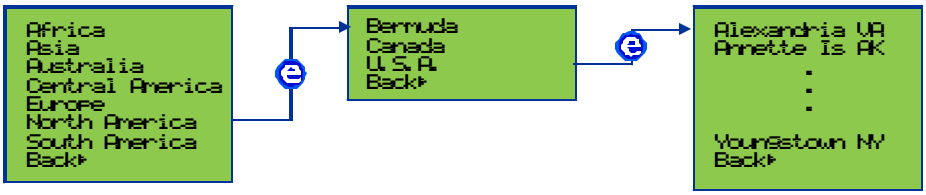
`TuneBeaconName▸`

When accessed using the ⓔ 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 5.12.2.1

Table Version▸	When accessed using the ⓔ button, this menu will identify the version of the current beacon table in memory.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.12.2.1 TuneBeaconName Menu

This menu allows you to tune the beacon receiver inside the DGPS MAX 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 ⓔ button, the beacon receiver will manually tune to that beacon.



5.13 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 5-7 when operating the DGPS MAX with external corrections. This portion of the menu system, including submenus, is detailed in Figure 5-13.

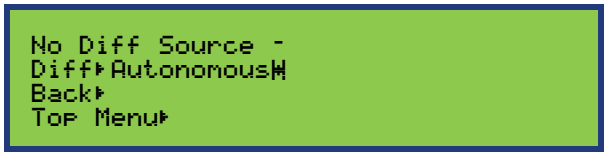
Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any status information (items without the menu access indicator, ▸) in focus will display the signal tracking bar chart. Pressing the ⓔ button on any item in focus with the menu access indicator will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

External RTCM ±	This menu item indicates that the current correction source comes from an external device. Pressing the ⓔ button on this menu item will display the signal tracking bar chart.
Diff▸Extrn RTCM	Accessing this menu item using the ⓔ 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.
RTCM In▸ 9600	When accessed using the ⓔ 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.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button. this menu

item returns the menu system to the main menu.

5.14 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 5-14.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any status information (items without the menu access indicator, ▸) in focus will display the signal tracking bar chart. Pressing the ⓔ button on any item in focus with the menu access indicator will take the menu system to that submenu. Pressing the ⓔ 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 ⓔ button, the signal tracking bar chart will be displayed.

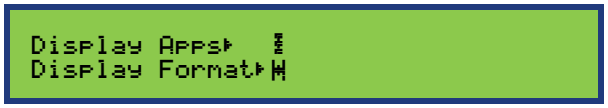
Accessing this menu item using the ⓔ button allows you to choose the source of differential corrections. Correction source options include the WAAS demodulator, internal OmniSTAR receiver, the internal beacon receiver, the use of external corrections, or autonomous operation. Autonomous operation uses no differential corrections.

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

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

5.15 System Setup Menu

This menu provides access to DGPS MAX configuration menus. This portion of the menu system, including submenus, is detailed in Figure 5-15.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the e button with any item in focus will take the menu system to that submenu. Pressing the e 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 e 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 e 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.

When accessed using the e button, this menu will provide access to the baud rates submenu where the speed of the external MAIN and AUX ports may be changed.

When accessed using the e button, this menu will provide access to a submenu that allows you to query the DGPS MAX for each version of firmware.

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

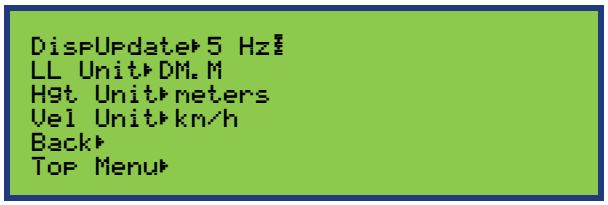
When accessed using the e button, this menu item returns the menu system to the main menu.

5.15.1 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 5-15.

5.15.2 Display Format Menu

This menu provides access to DGPS MAX configuration information and sub-menus. This menu system is detailed in Figure 5-15.



Pressing the ▲ and ▼ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ 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 ⓔ 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 ⓔ 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)

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

5.15.3 Baud Rates Menu

This menu allows you to change the data rates of the external MAIN and AUX serial ports of the DGPS MAX 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 5-15.

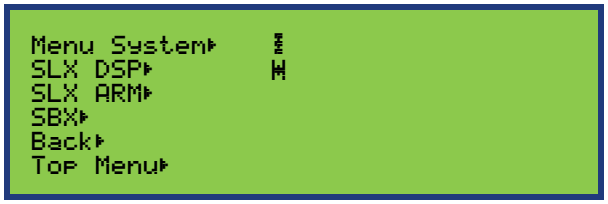
Pressing the △ and ▽ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ button with the Back▸ or Top Menu▸ item in focus will take the menu system to the previous menu or the Main menu, respectively.

NMEA I/O▸ 9600	Accessing this using the ⓔ 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 ⓔ 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 ⓔ button, this menu item returns the menu system to the previous menu.

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

5.15.4 Software Display Menu

This menu provides access to version of firmware installed within the DGPS MAX receiver. There are four types of firmware described below. This menu system is detailed in Figure 5-15.



Pressing the △ and ▽ keys allows you to scroll through the available options. Pressing the ⓔ button with any item in focus will take the menu system to that submenu. Pressing the ⓔ 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.

Menu System▸	Accessing this menu item using the ⓔ button will display the version of firmware for the menu system.
SLX DSP▸	Accessing this menu item using the ⓔ button will display the version of firmware for the SLX's DSP.
SLX ARM▸	Accessing this menu item using the ⓔ button will display the version of firmware for the ARM processor on the SLX.
SBX▸	Accessing this menu item using the ⓔ button will display the version of firmware for the SBX beacon receiver.
Back▸	When accessed using the ⓔ button, this menu item returns the menu system to the previous menu.
Top Menu▸	When accessed using the ⓔ button, this menu item returns the menu system to the main menu.

5.16 Configuring the Receiver

The following subsections provide detailed instructions for you to configure important operating parameters of the DGPS MAX.

5.16.1 Changing the Source of DGPS Corrections

To change the source of corrections used by the internal GPS sensor within the DGPS MAX receiver:

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

5.16.2 Changing the Output Data Messages

To change data messages output by the DGPS MAX receiver:

- Using the ▲ or ▼ key, move the GPS▸ menu, located in the root menu, into focus and press ⓔ.
- Press ▼ to move the Configure▸ menu item in focus and press ⓔ.
- Press ⓔ 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 ⓔ.
- Adjust the output rate to that desired using the ▲ or ▼ key and pressing the ⓔ button.
- Continue for each data message as required.

5.16.3 Changing the Baud Rates

To modify the baud rate of the DGPS MAX data ports:

- Using the ▲ or ▼ key, move the Setup▸ menu, located in the root menu, into focus and press ⓔ.
- Using the ▲ or ▼ key, move the Baud Rates▸ menu into focus and press ⓔ.
- 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 ⓔ.
- Scroll with the ▲ or ▼ keys to the required baud rate and press ⓔ.

5.16.4 Monitoring the OmniSTAR Subscription Status

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

- Using the ▲ or ▼ key, move the OmniSTAR▸ menu, located in the root menu, into focus and press ⓔ.
- Using the ▲ or ▼ key, move the Configure▸ menu into focus and press ⓔ.
- Use the ▲ or ▼ key to move the Subscription▸ menu into focus and press ⓔ.

- Press ⓔ 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.

5.16.5 Tuning the Internal Beacon Sensor

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

5.16.5.1 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 ⓔ.
- Using the ▲ or ▼ key, move the `Configure▸` menu into focus and press ⓔ. Use the ▲ or ▼ key to move the `Tune▸` menu into focus and press ⓔ.
- Using the ▲ or ▼ keys, adjust the frequency and MSK bit rate to the values that you desire and press ⓔ. You may select a beacon within the 283.5/100 to Auto/Auto range of values.

5.16.5.2 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 ⓔ.
- Using the ▲ or ▼ key, move the `Configure▸` menu into focus and press ⓔ.
- Using the ▲ or ▼ key, move the `TuneBeaconName▸` menu into focus and press ⓔ.
- Scroll with the ▲ or ▼ keys until the desired continent is displayed on the focus line and press ⓔ.
- Scroll with the ▲ or ▼ keys until the desired country is displayed on the focus line and press ⓔ.
- Scroll with the ▲ or ▼ keys until the name of the specific beacon is displayed on the focus line and press ⓔ.

5.16.5.3 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 ⓔ.
- Using the ▲ or ▼ key, move the `Configure▸` menu into focus and press ⓔ.
- Using the ▲ or ▼ key, move the `Auto Tune▸` menu into focus and press ⓔ.

-or-

- Using the ▲ or ▼ key, move the `Beacon▸` menu, located in the root menu, into focus and press ⓔ.
- Using the ▲ or ▼ key, move the `Configure▸` menu into focus and press ⓔ.
- Use the ▲ or ▼ key to move the `Tune▸` menu into focus and press ⓔ.

- 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.

5.17 Firmware Updates

Please contact CSI Wireless Customer Service for the latest firmware update for your DGPS MAX receiver. Firmware releases include a Field Upgrade Program, installation instructions, and release notes.

6. 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 6-1 presents the Configuration Wizard menu layout.

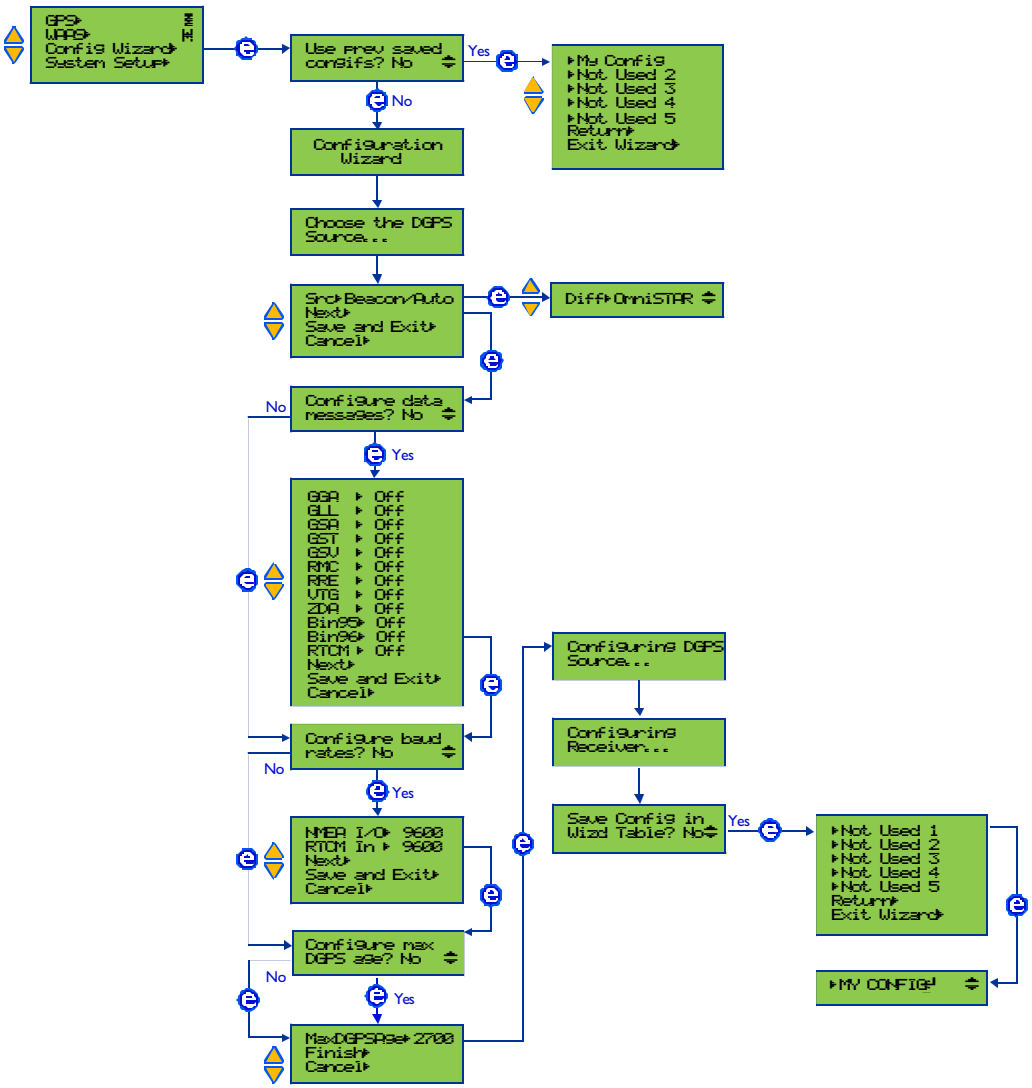


Figure 6-1 Configuration Wizard Menu

6.1 Start-up Sequence

When you turn the DGPS MAX 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 e 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▸`.

6.2 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 ⓔ button when `Configuration Wizard▸` is in focus. This will immediately begin the Wizard process.

6.3 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.

6.4 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 DGPS MAX 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.

6.5 Completing the Step-by-Step Process

When completing the Configuration Wizard, by pressing the ⓔ 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.

6.6 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 ⓔ 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 ⓔ 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 ⓔ button. To complete the new name of the configuration, adjust the current character to ↲ and press the ⓔ button. Pressing the ⓔ 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.

7. NMEA 0183 Messages

This chapter identifies the selection of valid NMEA 0183 output messages for the DGPS MAX receiver.

7.1 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

7.2 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 7-1.

Table7-1 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.

7.3 DGPS MAX Serial Port Configuration

The DGPS MAX 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 DGPS MAX to be configured and monitored remotely. A separate Programming Manual is available that goes into detail on how to use these extended commands. Please contact CSI Wireless for further information on programming the DGPS MAX through its serial port.

7.4 PocketMAX and PocketMAX PC

CSI Wireless offers configuration utilities for the SLX and SBX within the DGPS MAX receiver. PocketMAX is a configuration program designed for Windows PocketPC software that runs on PocketPC 2000, 2002 and 2003 platforms. PocketMAX PC runs on laptop and PC computers running the Microsoft Windows 95 or higher operating system. Both programs can be used to tune and monitor your differential source, configure GPS message output and port settings, and record various types of data, and are available for download from CSI's website.

7.5 GPS NMEA Data Messages

The following subsections describe the data messages listed in Table 5-2 in detail.

Table 7-2 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

7.5.1 GGA Data Message

The GGA message contains detailed GPS position information, and is the most frequently used NMEA data message. In Table 7-3, 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,saaaaa.aa,M,±xxxx.xx,M,sss,aaaa*cc<CR><LF>

Table 7-3 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

7.5.2 GLL Data Message

The GLL message contains Latitude and Longitude. In Table 7-4, 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 7-4 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

7.5.3 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 7-5, 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 7-5 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

7.5.4 GST Data Message

The GST message contains Global Navigation Satellite System (GNSS) psuedorange error statistics. Table 7-6, 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 7-6 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

7.5.5 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 7-7 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 7-7 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) + 30, ss = 0 to 99
*cc	Checksum
<CR><LF>	Carriage return and line feed

7.5.6 RMC Data Message

The RMC message contains recommended minimum specific GPS data. Table 7-8 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 7-8 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

7.5.7 RRE Data Message

The RRE message contains the satellite range residuals and estimated position error. Table 7-9 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 7-9 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

7.5.8 VTG Data Message

The VTG message contains velocity and course information. Table 7-10 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 7-10 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

7.5.9 ZDA Data Message

The ZDA message contains Universal Time information. Table 7-11 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 7-11 ZDA Data Message Defined

Field	Description
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
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

8. Troubleshooting

Use the following checklist to troubleshoot anomalous DGPS MAX receiver operation. Table 6-1 provides a problem symptom, followed by a list of possible solutions.

Table 6-1 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 DGPS MAX	• Check receiver power status (display illuminated?) • Verify that DGPS MAX is locked to a valid DGPS signal (DGPS lock symbol engaged) • Verify that DGPS MAX is locked to GPS satellites (GPS Lock symbol engaged) • Check integrity and connectivity of power and data cable connections • Verify DGPS MAX Mode of operation • 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.
Random data from DGPS MAX	• 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 DGPS MAX and remote device
No GPS lock	• Check integrity of antenna cable • Verify DGPS MAX antenna port output voltage (5 DC) • Verify CDA-3'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-3'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-3'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 DGPS MAX 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 DGPS MAX lock status • Verify matched beacon output and GPS RTCM input baud rates if using external source

Appendix A - Specifications

This appendix provides the operational, mechanical, electrical, physical, and environmental specifications for the DGPS MAX receiver and CDA-3 antenna.

Table A-1 DGPS MAX 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 -3	<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-3 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

Appendix B - Interface

This appendix provides information on interfacing the various aspects of your DGPS MAX receiver.

The main purpose of the DGPS MAX receiver is to provide differentially corrected position and position-related information in the standard NMEA format. In addition to the DGPS MAX 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 DGPS MAX depending on your application.

GPS NMEA Output

The data output from the DGPS MAX MAIN port is differentially corrected GPS NMEA data.

To establish communications between the DGPS MAX 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 DGPS MAX and an external device:

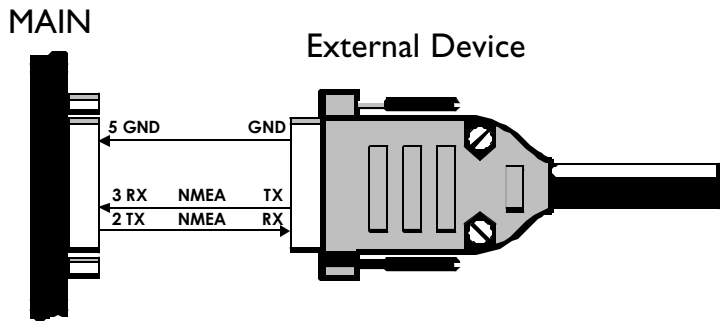


Figure B-1 GPS Data Interface

Note - For successful communications, the baud rate of the DGPS MAX MAIN port must be set to match that of the data logging or monitoring device. Additionally, you must interface the DGPS MAX to an RS-232C serial port of the external device. Refer to Section 5.15.3 for instructions related to setting the DGPS MAX baud rate.

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 DGPS MAX 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 DGPS MAX and a separate GPS receiver:

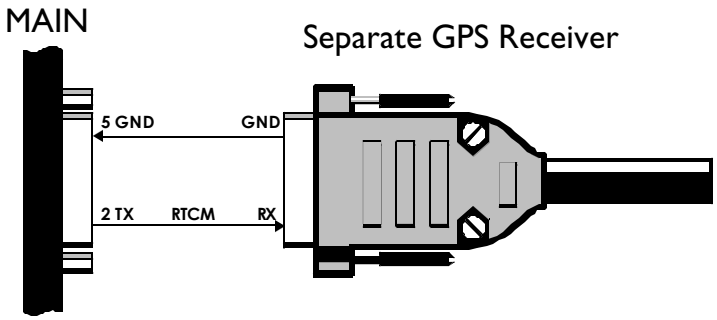


Figure B-2 RTCM Data Interface

Note - For successful communications, the baud rate of the DGPS MAX MAIN port must be set to match that of the separate GPS receiver. Additionally, you must interface the DGPS MAX to an RS-232C serial port of the separate GPS receiver. Refer to Section 5.15.3 for instructions related to setting the DGPS MAX baud rate.

External Correction Input

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

To establish communications between the DGPS MAX 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 DGPS MAX and an external GPS receiver:

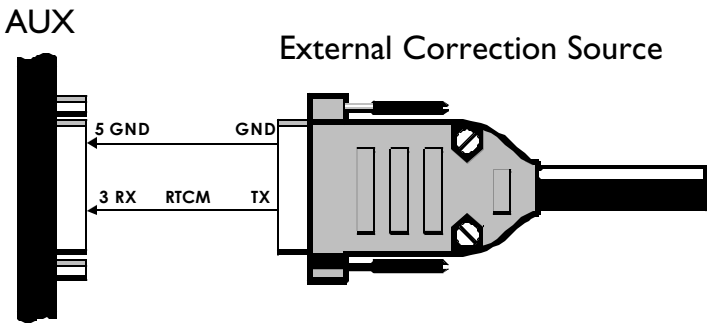


Figure B-3 External Correction Source Interface

Note - For successful communications, the baud rate of the DGPS MAX AUX port must be set to match that of the external correction source. Additionally, you must interface the DGPS MAX to an RS-232C serial port of the external source. Refer to Section 5.15.3 for instructions related to setting the DGPS MAX baud rate.

Appendix C - Activating the OmniSTAR DGPS Service

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 DGPS MAX 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 DGPS MAX receiver, follow these instructions:

- Turn the DGPS MAX 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 4.7.1 for information on changing the DGPS source.
- Access the `OmniSTAR▸` menu in the current level of the menu system using either ▲ or ▼ and press ⓔ.
- Use either ▲ or ▼ to cycle the menu system so that `Configure▸` is in focus and press ⓔ.
- Press ▲ or ▼ until `Subscription▸` is in focus and press ⓔ.
- Use either ▲ or ▼ to move the `SerialNum Disp▸` menu item into focus and press ⓔ to access this feature.
- The serial number of the internal SLX receiver will be displayed

When you access the `SerialNum Disp▸` menu item, the DGPS MAX 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.

OmniSTAR Service Activation

You may activate the OmniSTAR DGPS service for your DGPS MAX 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.

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. CSI Wireless is not responsible for this service or this agreement.

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.

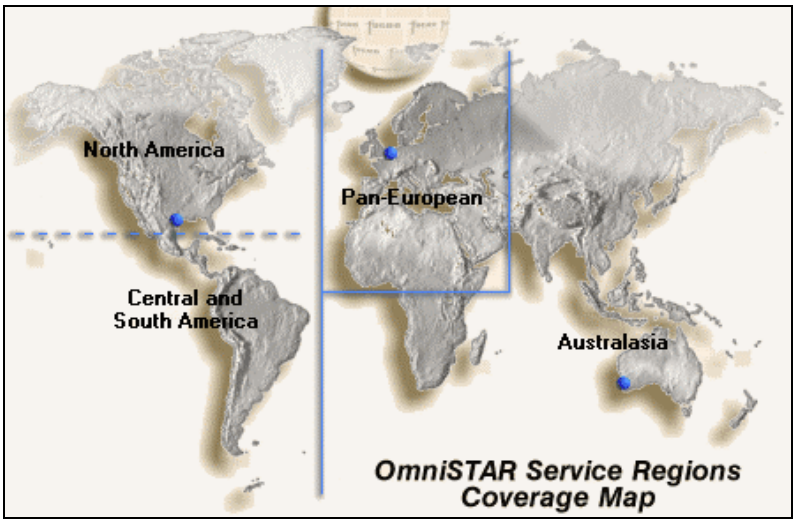


Figure C-1 OmniSTAR Coverage Map

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

Over-Air Subscription Activation

OmniSTAR will activate the subscription within your DGPS MAX receiver over the air. The OmniSTAR L-band DGPS receiver inside your DGPS MAX 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.

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 ⓔ.
- Using the ▲ or ▼ key, move the `Configure▸` menu into focus and press ⓔ.
- Use the ▲ or ▼ key to move the `Subscription▸` menu into focus and press ⓔ.
- Press ⓔ 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.

Appendix D - Beacon Information

CSI Wireless endeavors to maintain an accurate listing of DGPS radiobeacons worldwide that is available on the Internet from the CSI Wireless home page:

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 CSI Wireless dealer or CSI Wireless Sales.

Appendix E - Post Processing

The DGPS MAX is capable of outputting the required raw measurement and satellite navigation information for post-processing.

Binary Messages

The following two raw data messages are present in the NMEA Output menu and are required for post-processing:

- Bin95 - GPS satellite ephemeris information
- Bin96 - Raw code and carrier phase measurement information

Both messages are required for post-processing and must be turned on for post-processing applications.

Although this document is not a manual for post-processing, this receiver may be used for post-processing in both static and kinematic mode. Static processing is the primary purpose of this feature, however, kinematic processing is possible.

In order to achieve acceptable results with kinematic logging of measurement data for post-processing, we recommend that the kinematic logging session begin with a 15 minute static session and also end with a 15 minute static session.

To turn these messages on, use the following procedure:

- Using the ▲ or ▼ key, move the GPS menu into focus and press ⓔ.
- Press ▼ to move the `Configure▸` menu item in focus and press ⓔ.
- Press ⓔ 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 ⓔ.
- Adjust the output rate of the Bin95 message to 1 Hz using the ▲ or ▼ key and pressing the ⓔ button.
- Adjust the output of the Bin96 message to either 1 Hz or 5 Hz using the ▲ or ▼ key and pressing the ⓔ button.

RINEX

RINEX is an acronym for the Receiver Independent Exchange format. This standard was originated for the purpose of having a common data format for post-processing, allowing the mixing of observation data between different models and manufacturers of GPS equipment.

The majority of 3rd party post-processing software supports this data format for raw measurement data. Please consult your post-processing software vendor to determine if your software supports this data format.

RINEXSLX Translator

CSI Wireless has developed a translator from the proprietary binary format in order to convert this data to RINEX. This utility is freely available from CSI Wireless for post-processing purposes. Please contact CSI Wireless or your local dealer for further information on this utility.

Note – CSI Wireless will provide support for raw measurement data output and the associated RINEX translator, however, we are not able to provide direct support on post-processing methodologies or 3rd party post-processing software.

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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