SBA-1 Reference Manual

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Copyright Notice

FCC Notice

The SBA-1 Beacon Receiver complies with the Part 15, Subpart J Emission Requirement for Class A digital devices for use in commercial, business, and industrial environments.

CE

The SBA-1 Beacon Receiver complies with relevant sections of the following European harmonized documents:

- EN 60945 Marine Navigation Requirements
- EN 50081-1 Emissions for Residential, Commercial and Light Industry
- EN 50082-1 Immunity for Residential, Commercial and Light Industry

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CSI Wireless Inc. (hereinafter referred to as "CSI Wireless") products are warranted, subject to the conditions set forth herein below, against defects in material and workmanship for a period of 12 months. Warranty services will be provided through your CSI Wireless distribution center, please contact them for shipping information. You must retain your proof of purchase for warranty purposes.

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

CSI Wireless reserves the right to modify CSI Wireless products without any obligation to notify, supply or install any improvements or alterations to existing products.

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Preface

Welcome to the SBA-1 Reference Manual and congratulations on purchasing this high performance beacon receiver. The purpose of this manual is to familiarize you with the proper installation and operation of your new receiver.

The SBA-1 contains CSI's extremely sensitive 300 kHz SBX-2 beacon receiver incorporating dual channel, digital technology, and an innovative E-field antenna. The SBA-1 receives differential GPS corrections broadcast by radiobeacons in the frequency range of 283.5 to 325 kHz. The internal SBX-2 beacon receiver features a proven, fully automatic radiobeacon search algorithm for hands-free operation.

An SBA-1 Interfacing Manual is available on the CSI Web site. It provides detailed information on interfacing to the SBA-1 using NMEA 0183 command and query sentences. This document is not required for installation and normal operation of the SBA-1, but is intended as an addendum. This document contains information to interface the SBA-1 to connect various GPS products offered by major brands.

Organization

This manual contains the following chapters:

Chapter 1: Introduction - provides an introduction to GPS and DGPS technology, and the SBA-1.

Chapter 2: SBA-1 Installation - describes how to install the SBA-1, and provides a foundation for interfacing with a differential-ready GPS receiver.

Chapter 3: SBA-1 Operation - provides instructions to check and test your installation and operate the SBA-1.

Chapter 4: Troubleshooting - provides diagnostic information to aid in finding a source of difficulty for a particular installation.

Appendix A: Specifications - details the technical characteristics of the SBA-1 receiver / antenna and its power / data cable.

Appendix B: CSI Web Site and SBA-1 Resources - provides an overview of the various SBA-1 resources available on the CSI Web site.

The **Index** provides a listing of the locations of subject matter 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 Technical Support. The contact numbers and e-mail address for CSI Technical Support:

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 Technical Support.

In the event that your equipment requires service, we recommend that you contact your dealer directly. If this is not possible, you must contact CSI Customer Service to obtain a Return Merchandise Authorization (RMA) number before returning any product to CSI. If you are returning a product for repair, you must provide a fault description before CSI will issue an RMA number. A proof of purchase is required for warranty claims.

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

Document Conventions

Arial Bold is used to emphasize certain points.

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings stress important information regarding the installation, configuration, and operation of the SBA-1.

Note - Notes outline important information of a general nature.

Caution - 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 gives a brief overview of GPS, differential GPS, DGPS beacon technology, and a brief description of the SBA-1.

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).

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 artificially degrades the performance of the SPS so that the positioning accuracy is limited to 100 meters 95% of the time. This intentional degradation is called Selective Availability (SA).

For many positioning and navigation applications, an accuracy of 100 meters is insufficient, and differential positioning 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 should be, 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 very expensive and often limited to precise survey applications due to technical constraints on their use.

1.2.3 Radiobeacon DGPS

Radiobeacon DGPS is a user-friendly system consisting of local beacon transmitting sites and easy to operate, inexpensive user equipment. Transportation and Marine authorities around the world have installed large public networks of DGPS Radiobeacons. These radiobeacon stations transmit real-time differential corrections to remote users free of charge, for the purpose of enhancing GPS accuracy. The medium frequency (MF) signal transmitted by radiobeacons provides robust signal coverage at large ranges from the transmitting site (283.5 to 325 kHz). Figure 1-1 describes the radiobeacon DGPS .

Although broadcasting authorities often rate these at 8 to 10 meters of horizontal accuracy for safety of life, the true accuracy is about one to five meters depending on the GPS receiver's performance capabilities. Each beacon station uses redundant equipment to maintain signal availability if a failure occurs in the system. Integrity monitoring stations monitor the content of the differential corrections to ensure that the information broadcast by the radiobeacon is valid.

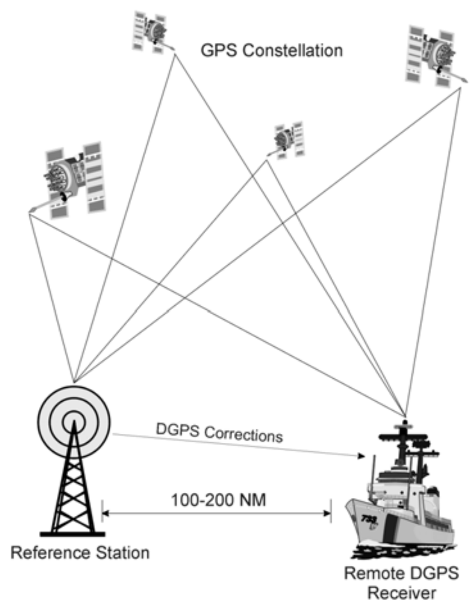

Figure 1-1 Radiobeacon DGPS Pictorial

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.

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 from those at the remote user's location. This geographic, or 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 latency of differential corrections broadcast by a radiobeacon also affects the achievable positioning accuracy at the remote receiver. 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. Latency can become a concern if lock on the differential signal is lost for ten seconds or more.

To account for latency and the rapidly changing SA error, a GPS receiver can calculate approximate corrections until new corrections are available. Calculating the differential correction for a new epoch, using old corrections, leads to inaccuracy that grows with time. Accuracy is restored when new corrections become available.

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.

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 results in 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 an 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 radiobeacon DGPS transmissions. These GPS receivers tend to be significantly more expensive than the average consumer-grade product.

1.5 Beacon Signal Information

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, atmospheric losses, and local noise.

The strength of a signal decreases with distance from the transmitting station, due in large part to free space (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 type of surface over which it travels.

The portion of the beacon signal that is broadcast skywards is known as the sky wave. The sky wave can reflect off the ionosphere back to Earth. Signal fading can occur if receiver equipment receives both sky and ground waves at the same time, with similar magnitude. This problem usually occurs in the evening when the ionosphere becomes more reflective, and usually on the edge of coverage areas. Beacon networks are designed to accommodate for signal fading by providing overlapping beacon coverage, which increases beacon signal availability.

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

Beyond the various environmental factors that affect the availability of a beacon signal in a particular area, local noise sources may also affect beacon reception. Various sources of noise include:

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

These sources of noise do not usually cause reception problems in good signal areas, but have a more noticeable effect towards the outer range of beacon coverage. You can take steps to minimize the effect these noise sources may have on reception. For example, you may turn off various accessories nearby that could cause reception issues in weaker signal areas, or operate away from these sources, if possible. Locating the antenna away from sources of noise often improves reception.

1.6 Beacon Receiver Information

The SBA-1 is a Smart Beacon Antenna, with a built-in 300 kHz DGPS beacon receiver and antenna. It receives and demodulates RTCM SC-104 differential correction data transmitted by DGPS radiobeacons broadcasting within the 283.5 to 325.0 kHz frequency band. The internal beacon receiver is CSI's high performance, 2-channel SBX-2 .

The SBA-1 features:

- Fully automatic operation for hands-free operation
- Fast acquisition times ensuring that you are up and running quickly
- Firmware upgrades uploaded through the serial port
- Full NMEA 0183 command protocol for configuration, operation, and monitoring of receiver performance – consult the SBA-1 Interfacing Manual available on-line at www.csi-wireless.com.
- User-selectable baud rates for compatibility with differential-ready GPS products (requires NMEA command)
- Command and status message support for some GPS receivers, providing on-screen tuning and status monitoring (requires support of various NMEA sentences by the GPS receiver)

2. SBA-1 INSTALLATION

This chapter contains instructions for installation of the SBA-1. Six steps are required to install the SBA-1:

1. Choose a proper location for the SBA-1
2. Mount the SBA-1 in this location
3. Run the power / data cable from the antenna to the GPS receiver
4. Connect the power input to the SBA-1
5. Interface the SBA-1 to a GPS receiver
6. Connect the antenna ground to a ground plane

The first three steps are discussed in Section 2.2 Installation, while the last three steps are discussed in Section 2.3 Interfacing.

2.1 SYSTEM PARTS LIST

The following equipment is included with the beacon receiver system:

- SBA-1 Smart Beacon Receiver (part number 801-1004-00A)
- 10 meter power / data (part number 050-0004-000)
- Lock Nut (part number 676-1003-000)
- Sealing tape (part number 682-1005-000)
- Reference manual (part number 875-0027-001)

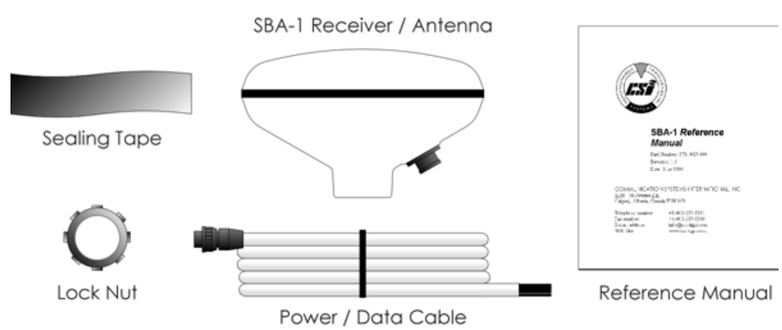

Figure 2-1 SBA-1 System

2.2 INSTALLATION

This section helps you to choose a suitable location, mount the SBA-1, and run its power / data cable.

2.2.1 Choosing a location for the SBA-1

Your vessel generates a certain amount of local interference that may affect the operation of the SBA-1. To minimize potential reception problems, you should locate the antenna:

- Outside the path of radar
- Away from transmitting antennas
- Away from other sources of interference such as DC motors, solenoids, and other electronic devices.

Other recommendations for choosing a mounting location include:

- Choose a location at least one to two meters away from bulkheads
- Mount the SBA-1 with a view of the horizon in all directions
- Mount the SBA-1 close enough to the GPS system that when the 10 meter power / data cable is run, the length will be sufficient for interfacing.
- Mount the SBA-1 in an easily accessible location. You do not need to mount it high as with some two-way radio equipment. The DGPS beacon signal is not line of sight.

2.2.2 Mounting the SBA-1

The SBA-1 possesses a standard 1.0"-14 marine thread for mounting (1-14-UNS). **This is not compatible with ¾ NPT threads (pipe thread)**. Local marine supply stores stock a variety of mounting hardware.

The SBA-1 comes with a lock nut for mounting. It allows you to achieve a desired orientation without overtightening the SBA-1 on the mount.

Figure 2-2 Lock Nut

For optimum reception, you must mount the SBA-1 12 inches above any metallic surface to which the antenna is grounded, as illustrated in Figure 2-3.
To mount the SBA-1:

1. Install the mount in the desired location (1-14-UNS mount)
2. Thread the lock nut onto the mount approximately 3 cm (1.5")
3. Thread the SBA-1 onto the mount nut firmly by hand until it meets the nut (do not bottom out).
4. Holding the nut against the mount of the SBA-1, rotate the SBA-1 into the desired orientation.
5. Holding the SBA-1 still, tighten the nut against the mount of the SBA-1 by hand. The SBA-1 and nut should be 'locked' in position on the mount, without the SBA-1 bottoming out.
6. Connect the Power/Data/Ground cable.

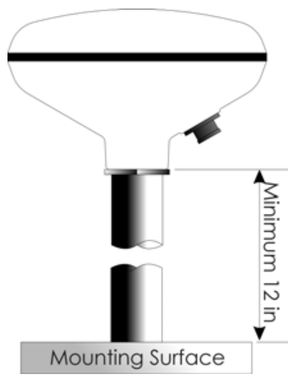

Figure 2-3 SBA-1 Mounting

Caution – Thread the SBA-1 onto the mount by hand only. Do not use any tools. CSI does not warrant damage caused by over tightening.

2.2.3 Running the Power / Data Cable

The power / data cable provided with the SBA-1 is terminated on one end with a circular 6-pin connector. This connector is keyed, and must be aligned with the mating connector on the SBA-1 before securing it in place with the locking collar.

The un-terminated end of the cable may be routed through a bulkhead with a minimal opening. Consider the following recommendations when running the power / data cable:

- Avoid running the cable near areas of excessive heat.
- Keep the cable away from corrosive chemicals.
- Do not run the cable through door or window jams.
- Keep the cable away from rotating machinery.

- Do not bend excessively or crimp the cable.
- Do not allow the cable to be under excessive tension when installed.
- Remove unwanted slack at the opposite end of the SBA-1.
- Secure the cable run with tie wraps where appropriate.
- Leave enough slack in the cable at the SBA-1 to connect and disconnect the cable easily.

The power / data cable may be shortened as necessary. When shortening the cable, we recommend that you not shorten the cable shield until you have determined how much length you require for the antenna ground connection. If you must lengthen the power or data wires, keep the additional length to a minimum. Section 2.3.4 discusses lengthening of the antenna ground wire (cable shield) if required.

Warning - A cable run can be dangerous, and can cause personal injury and damage to property if improperly installed near machinery.

2.3 SBA-1 INTERFACE

The SBA-1 is easily interfaced, requiring only power, data, and antenna ground connections.

The un-terminated end of the power / data cable consists of six color-coded wires and a braided cable shield (the antenna ground). Table 2-1 describes the function of each wire.

Table 2-1 SBA-1 Power / Data Cable

Color	Signal
Red	Power + (9 to 16 VDC)
Black	Power - (Power source ground)
Blue	SBA-1 Transmit Data (Tx)
White	Signal Ground
Green	SBA-1 Receive Data (Rx)
Yellow	Signal Ground
Cable Drain (Bare Wire)	Antenna Ground
Braided Cable Shield	Antenna Ground

2.3.1 Power / Data Cable Preparation

This section describes how to prepare the un-terminated end of the power/data cable for interfacing with a power supply, GPS receiver, and antenna ground connection.

Three steps are required to prepare the cable:

1. Remove the cable sheath - Figure 2-4 illustrates the power/data cable with a few inches of the sheathing removed. When removing the sheathing, be very careful not to cut the metal braid beneath the sheath. We recommend that you use a sharp utility knife to score the sheath completely around its circumference, and gently pull it away from the rest of the cable.
2. Spread apart the cable braid – As illustrated in Figure 2-5, and using a fine blunt tool, such as a pen, gently separate the braid so that you have access to the wire assembly beneath. Slide the braid down the cable towards the sheath to provide additional slack and further spread the braid apart.
3. Remove the wire assembly from inside the braid - Figure 2-6 shows the wire assembly (including drain wire) being removed from inside the braid. To remove it, gently bend the cable at the braid opening, and pull the wire assembly out using the fine blunt tool. Figure 2-7 shows the prepared cable.

Caution - When preparing the cable according to these instructions, be careful not to cut the cable braid or insulation of any wires in the assembly. Power and data wires exist in close proximity. Damage to insulation may cause a short circuit and damage the SBA-1.

Figure 2-4Removing the Cable Sheath

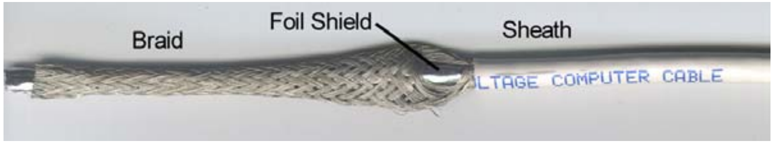

Figure 2-5 Spreading Apart the Cable Braid

Figure 2-6 Removing the Wire Assembly from Inside Braid

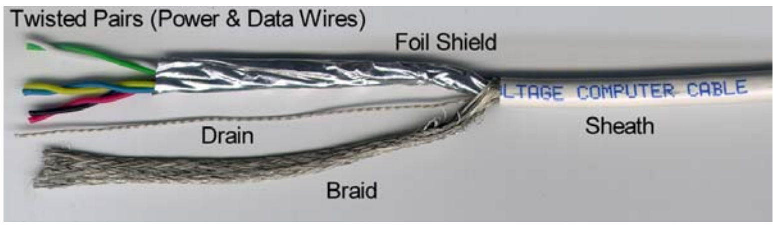

Figure 2-7 Prepared Cable Ready for Interfacing

When the cable preparation is complete, you may remove the foil shield surrounding the wire assembly down to the cable sheath without affecting performance.

2.3.2 SBA-1 Power Interface

The SBA-1 operates with an input voltage between 9 and 16 VDC. For best performance, the supplied power should be continuous and clean. Figure 2-8 depicts the power connection.

To apply power to the SBA-1:

1. Connect the **red** wire of the supplied cable to the positive terminal of your power source
2. Connect the **black** wire to the negative terminal of your power source.

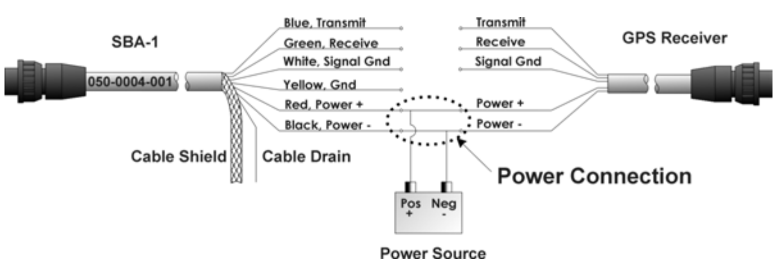

Figure 2-8 SBA-1 Power Interface

2.3.3 SBA-1 Data Interface

The SBA-1 features a bi-directional serial communication port operating at the RS-232C interface level.

To interface the SBA-1 to your GPS receiver:

1. Connect the **blue** transmit wire of the SBA-1 to the receive pin of the GPS receiver.
2. Connect the **white** signal ground wire of the SBA-1 to the signal ground or common ground of the GPS receiver.
3. Connect the **green** receive wire of the SBA-1 to the transmit line of the GPS receiver.
4. Connect the **yellow** signal ground wire of the SBA-1 to the signal ground or common ground of the GPS receiver.

When making these connection, we strongly recommend that you solder the wires together and insulate using heat-shrink or electrical tape.

Figure 2-9 illustrates the SBA-1 / GPS data interface to an arbitrary GPS device supporting the RS-232C interface level:

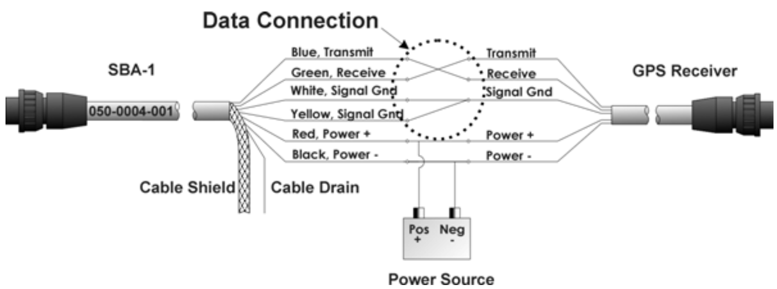

Figure 2-9 SBA-1 to GPS Interface

Note - If the interface cable of your GPS product is shielded with a wire braid and / or foil shield, you should connect the drain wire to the braid / drain wire of the SBA-1 power / data cable. The drain wire is the only un-insulated wire, if present.

The SBA-1 supports $GPMSK and $PSLIB NMEA 0183 tuning sentences that are discussed in the SBA-1 Interfacing Manual available on the CSI Web site at www.csi-wireless.com. Please contact your dealer or CSI Technical Support for further information.

Note - **If your GPS receiver is not capable of tuning the SBA-1 or monitoring status using these messages, connect the green receive wire of the SBA-1 cable to the signal ground (same connection as white and yellow wires).**

2.3.4 SBA-1 Antenna Ground Interface

The antenna inside the SBA-1 requires a ground connection, depicted in Figure 2-10, which becomes part of the antenna. The cable drain (bare wire) and the braided shield of the power/data cable are the ground for the antenna. Twist the drain and the braid together and connect them to one of the following:

- A through-hull RF ground plate on a vessel (such as manufactured by Dynaplate)
- Lead keel with sea water contact
- Metallic vessel hull in contact with sea water
- The engine block
- Counterpoise ground (artificial ground)

The ideal grounding point is a through-hull RF ground plate with seawater contact. RF grounding plates typically have a coarse texture, which increases their surface area, improving the efficiency of the ground.

If an RF grounding plate is not available, the next best solution is to ground to a metallic hull or a keel (if present) the engine block, or a counterpoise ground (artificial ground). The SBA-1 performance may vary depending on the quality of the grounding point used.

A counterpoise ground is not a seawater ground, but an artificial ground composed of a number of metal structures bonded together. For example, you could bond a metal railing around the outside edge of a vessel to other metal structures, such as masts, sheet metal, or metal frame members. When choosing components to bond, you should look for items that have a large surface area. When you bond these components together, use a stranded 12 gauge electrical wire (or larger) to make the connection, with metal to metal contact. A copper grounding strip installed within a vessel used for grounding high frequency equipment is not adequate for grounding on its own, as the surface area is not significant enough for medium frequency signal reception. However, you may bond copper ground strips to other metallic objects to form an appropriate counterpoise ground as described.

Diesel engines are typically less noisy than gasoline engines, as there is no ignition system. On diesel engines, the alternator is the most significant noise source, whereas on gasoline engines both the ignition system and alternator contribute to the local noise field. Grounding to the engine block is advisable more for diesel engines than gasoline due to this difference. In the case of a gasoline engine, you may have better reception grounding to a counterpoise ground than the engine block.

If you must lengthen the ground connection (cable drain or braided shield), use a 14 gauge (or greater) stranded wire suitable for marine use. You should also solder the connection between the braid or drain wire and the ground extension wire. Use either heat shrink or electrical tape to insulate and seal the connection.

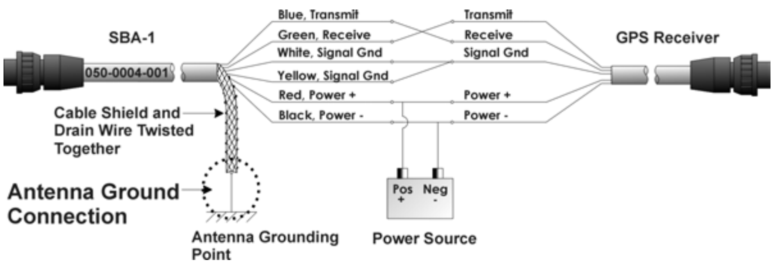

Figure 2-10 SBA-1 Antenna Ground Interface

2.4 CHECKING THE SBA-1 INSTALLATION

Once you have installed the SBA-1, verify that:

- The SBA-1 is mounted securely on the 1.0”-14 marine mount
- The power / data cable is connected securely to the SBA-1
- The cable run is not crimped and is secured appropriately
- Power has been applied to the SBA-1
- The data connection between the SBA-1 and the GPS is correct and secure
- The SBA-1 is connected to a suitable antenna ground

Once verified, you should refer to your GPS receiver and its related documentation to configure it to accept differential corrections from the SBA-1. Chapter 3 discusses SBA-1 operation and configuring your GPS receiver.

2.5 SEALING THE SBA-1 CONNECTOR

Although the SBA-1 power / data connector is designed for use in the harsh marine environment, it is good practice to seal connectors for long-term reliability using the self-amalgamating sealing tape provided with your system. When installed, the sealing tape bonds completely to itself, providing additional protection from the elements.

Figure 2-11 Sealing Tape

We recommend that you seal the power / data connection only **after** your installation is complete and you have verified that your DGPS system is operating correctly. Any changes in SBA-1 mounting or location could require you to disconnect the power / data cable.

Note - The sealing tape provided will become completely bonded over a short time, and, cannot be easily unwrapped.

To install the sealing tape, follow these instructions:

- Ensure that the mating power / data plug and socket are tightly connected, clean, and dry.
- Remove the white backing from the four inches of tape, and stretch the tape until it is approximately twice its original length.

- Hold one end of the tape against the nut where the power / data connector comes out of the SBA-1's enclosure and wrap the tape under tension in a clockwise direction around the fittings. Completely cover the nut before working downwards, overlapping the tape as you proceed.
- Continue overlapping the tape past the connector and onto the white cable material.
- The tape will begin bonding to itself immediately, and will be fully bonded within approximately 24 hours.

Figure 2-12 depicts the installation of the sealing SBA-1 complete with sealing tape.

Figure 2-11 Sealing Tape Installation

3. SBA-1 OPERATION

This chapter describes SBA-1 default operating parameters, SBA-1 operation, and performance monitoring.

3.1 GPS DIFFERENTIAL OPERATION

Once you have installed and interfaced the SBA-1 successfully to your differential-ready GPS receiver, and power source, it will begin its hands-free automatic operation immediately. It should take approximately one minute for the SBA-1 to acquire a beacon from a cold start, provided there is an acceptable signal available. When the SBA-1 acquires a DGPS beacon, reacquisition time should be on the order of a few seconds for subsequent power cycles.

When the SBA-1 acquires a DGPS beacon, it will automatically begin demodulating and outputting differential GPS data to the GPS receiver.

Your GPS receiver may or may not be designed to automatically accept the correction input from the SBA-1 without configuration. To ensure that your GPS is ready to accept the differential correction input, consult the reference documentation that accompanied your GPS system. Inside the documentation, there should be a section devoted to interfacing to a DGPS receiver. You should adjust the baud rate of the GPS serial port to 4800. Other SBA-1 communication parameters are listed in Table 3-2.

Should the baud rates differ between your GPS and the SBA-1, we recommend that you change the baud rate of the GPS to accommodate the SBA-1. Alternatively, you may change the baud rate of the SBA-1 by consulting the SBA-1 Interfacing Manual located on the CSI Web site: **www.csi-wireless.com.**

When you have configured your GPS correctly to accept differential correction input from the SBA-1, you should see it switch to differential mode, once it has acquired a 3-dimensional position. If you have difficulty with your GPS receiver not computing a differentially corrected position, consult your GPS receiver's documentation. If the problem persists, please contact your dealer or CSI Technical Support.

3.2 SBA-1 AUTOMATIC OPERATION

The SBA-1 receiver operates in Automatic mode by default, selecting and tuning to the strongest beacon without operator intervention. The SBA-1 uses its two independent receiver channels to identify and lock to the best DGPS beacon.

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

3.2.1 Initial Search

When powered for the first time in Automatic mode, the SBA-1 initiates a Global Search, examining each available DGPS beacon frequency, and recording signal strength measurements in units of dBμV/m to an internal Global Search Table. The receiver uses these measured values to compute an average signal strength and noise floor, and to sort the frequencies in descending order of signal strength. The two channels then cooperatively examine the frequencies with the highest signal strength measurements to determine the station providing the strongest signal. The receiver's primary channel locks to the first identified DGPS broadcast, while the second channel continues searching in the background for superior beacons. If no signal is available, the SBA-1 will initiate a fresh Global Search, continuing this cycle until it finds a valid broadcast.

3.2.2 Background Search

During the background search, the second channel of the SBA-1 examines the 84 available DGPS beacon channels at both 100 and 200 bps data 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 SBA-1 stores the current primary beacon in memory so that it is available upon subsequent power-up.

3.3 Tuning the SBA-1 Using Your GPS

Some Garmin, Furuno, and other GPS equipment may be able to tune the SBA-1 manually to a specific frequency, however, we recommend that the SBA-1 remain in Automatic mode. Manual operation may also be selected by tuning the SBA-1 by sending appropriate $GPMSK or $PSLIB NMEA 0183 sentences discussed in the SBA-1 Interfacing Manual. **If your GPS is capable of tuning the SBA-1 using the $PSLIB command (such as Garmin), tuning with a frequency and data rate of zero will return the receiver to Automatic mode.**

You should only use Manual operation if you are certain that you wish to use a particular beacon.

3.4 Testing the SBA-1 Performance (SNR Reading)

The Signal to Noise Ratio (SNR) is a measure of beacon receiver performance. The SNR is the difference in power between the beacon signal and the noise floor. The higher the SNR, the better the SBA-1 is receiving the signal. The SNR is also a function of the installation, as it may differ between locations, depending on the amount of local noise at each.

Note - You may or may not have ready access to this value, as its availability depends on your GPS's ability to accept specific commands and queries.

Some Garmin, Furuno, and other GPS equipment are able to monitor the SNR of the SBA-1 using the $GPMSK and $PSLIB NMEA 0183 sentences. If your GPS receiver is not capable of displaying the SNR, you may obtain this number by interfacing to SBA-1 using a PC computer as discussed in the SBA-1 Interfacing Manual. Both the interfacing manual and interface software for the computer are available on the CSI Web site at: www.csi-wireless.com.

The SNR of the SBA-1 may differ from location to location on your vessel, depending on the amount of local noise. The optimum antenna location will be the position where your average SNR is highest. You should turn on all accessories that you intend to use during normal operation to test the SBA-1 installation. If noise is affecting performance, try to find a better location with higher SNR. If this problem continues, contact your dealer or CSI Technical Support.

Table 3-1 describes the general quality of reception as measured by the SNR reading of the SBA-1.

Table 3-1 SBA-1 Performance - SNR Reading

SNR	Reception Description	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

3.5 Configuration

The SBA-1 supports a full suite of NMEA 0183 commands and queries for configuration and monitoring receiver status. The SBA-1 Interfacing Manual is available at the CSI Web site at www.csi-wireless.com. It offers additional information related to configuring the SBA-1 through its serial port, including a discussion of the $GPMSK and $PSLIB tuning commands.

3.6 Factory Default Settings

Table 3-2 presents the factory default settings for the SBA-1. These configuration settings are valid upon initial power-up. The SBA-1 maintains its tune mode and baud rate changes for subsequent power-up.

Table 3-2 Default SBA-1 Serial Port Settings

Tune Mode	Baud Rate	Data Bits	Stop Bit	Interface Level
Automatic	4800	8	1	RS-232C

4. TROUBLESHOOTING

Use the following checklists to troubleshoot anomalous SBA-1 operation. This checklist provides a problem symptom, followed by a list of possible.

Table 4-1 Troubleshooting Checklist

Symptom	Possible Solution
Receiver fails to power	• Verify polarity of power leads • Check integrity of power connections • Check power source output voltage (9-16 VDC) • Check current restrictions imposed by power source (available supply must be greater than 0.25 A)
No data from SBA-1	• Verify that SBA-1 is locked to a valid beacon • Check integrity of power/data cable connections
Bad data from SBA-1	• Check transmitting beacon status • Verify communication settings of the GPS are set to 4800 baud, 8 data bits, and no parity
No signal lock	• Check the antenna cable connection • Check antenna ground
Low SNR	• Check antenna ground • Select alternate mounting location away from noise
Non-differential GPS output	• Verify SBA-1 lock status • Verify GPS baud rate at 4800 • Verify GPS receiver RTCM compatibility • Verify GPS receiver DGPS configuration • Verify data interface between SBA-1 and GPS receiver • Verify communication parameter settings (8 data bits - No parity - 1 stop bit) • Verify communication level of GPS is set to RS-232C • Verify data cable connections are secure

Appendix A - Specifications

This appendix provides the operational, mechanical, electrical, physical, and environmental specifications for the following CSI products:

- the SBA-1 Smart Beacon Receiver
- the SBA-1 power / data cable

Table A-1 SBA-1 Receiver / Antenna Specifications

Operational Specifications	
Item	**Specification**
Frequency Range	283.5 - 325 kHz
Channels	2
Input Sensitivity	10 µV/m 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	60 dB @ f_0 ± 500 Hz
Decoding	RTCM 6/8
Demodulation	MSK

Serial Interface Specifications	
Item	**Specification**
Interface Levels	RS-232C
Data Port Baud Rate	2400, 4800, or 9600 Baud
Data Output Format	RTCM SC-104, NMEA 0183
Data Input Protocol	NMEA 0183

Power Specifications	
Item	**Specification**
Input Voltage	9-16 VDC
Input Current	< 110 mA @ 12 VDC
Power Consumption	< 1.25 W
Power/Data Connector	Circular 6-pin Locking Plug

Mechanical Characteristics	
Item	**Specification**
Enclosure	ABS Plastic
Length	128 mm (5.1")
Width	128 mm (5.1")
Height	84 mm (3.3")
Weight	0.36 kg (0.8 lb)

Environmental Specifications	
Item	**Specification**
Storage Temperature	-40°C to 80°C
Operating Temperature	-30°C to 70°C
Weatherproof	EN60945: Class X

Table A-2 SBA-1 Power / Data Cable Specifications

Operational Specifications	
Item	**Specification**
Length	10 m
Conductor	3 twisted pair (24 gauge), Shielded
Connector	6-pin Circular Locking Socket

Appendix B - CSI Web Site and SBA-1 Resources

CSI maintains a Web site at **www.csi-wireless.com** containing resources for the SBA-1 receiver / antenna. These resources include:

- A worldwide listing of DGPS radiobeacons including station name, station identification numbers, location, status, and frequency information.
- The SBA-1 Interfacing Manual that presents detailed information on interfacing to the SBA-1 with NMEA 0183 command and query sentences. Interfacing information is also contained within this document that provides information on how to connect to various GPS products.
- Free DGPS Command Center software that allows you to interface to the SBA-1 using a PC computer

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