FBA3 / FBX3

Operator's Manual

Part Number: OME-FBX3-30Z
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Connecting FBA3 to a PC

The following steps are for Hyperterminal in Windows 95

1) Connect FBA3 to PC using a standard 9 pin serial cable

2) Open Terminal* (Win 3.1) or Hyperterminal (in Win95)

3) Make a New Connection, name it, and click OK

4) Choose a connection depending on which port the FBA3 is connected (ie: Direct to Com 1,2,3, or 4) and click OK

5) Select 4800 Bits per second, 8 Data bits, no parity, Hardware flow control and click OK

6) Go to Properties, click on the settings tab, then ASCII Setup, select Send line ends with line feeds, Echo typed characters locally, Append line feeds to incoming line ends, and Wrap lines that exceed terminal width. Click OK then OK again

7) Connect power cable to FBA3. Several lines of text should appear on the PC screen, all beginning with "$PCSI,xx..."

8) It should now be possible to enter and send commands to the FBA3 (make sure the antenna is connected)

The following commands were used in testing:

$PCSI,4 The Wipe Search command; instructs both the FBX3 and FBA3 to erase all parameters within the beacon almanac and to initiate a new Global Search to identify the beacon signals available for a particular area.

$PCSI,5,r where r = 2400,4800, or 9600 baud A proprietary command for use with the FBA3 only.

$GPMSK,fff.f,M,,A,n where fff.f is freq. in kHz, M designates manual freq selection, A designates automatic MSK rate, and n is the period of the performance status message as output by the FBA3. This command instructs the FBA3 and FBX3 to tune to a specified freq and automatically select the correct MSK rate.

* Similar settings should be used in Terminal under Windows 3.1

FBA3 / FBX3 Operator's Manual

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FCC NOTICE

The FBA3 and FBX3 Beacon Receivers comply with the Part 15, Subpart J Emission Requirement for Class A digital devices for use in commercial, business, and industrial environments.

CE

The FBA3 and FBX3 Beacon Receivers comply with relevant sections of the following CE certification 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

FURUNO LIMITED WARRANTY

A warranty registration card is included with the system packaging of this receiver. Please complete this document and return it to:

FURUNO USA, INC.
4400 NW Pacific Rim Blvd.
Camas, WA 98607-9408

Table of Contents

List of Figures

List of Tables

Preface

Welcome to the FBA3 and FBX3 Operator's Manual and congratulations on purchasing one of these high performance differential GPS products. The purpose of this manual is to familiarize you with the proper installation, configuration, and operation of your new receiver. Although the FBA3 and FBX3 are similar in many ways, Chapter 3 is devoted to configuration and operation of the FBA3, while Chapter 4 deals exclusively with the FBX3. Throughout the rest the manual the two receivers are discussed as though they were a single product with notes indicating differences where required.

The FBA3 and FBX3 Beacon Receivers contain an extremely sensitive 300 kHz minimum shift keying (MSK) demodulator with dual channel beacon receiver technology. They obtain differential GPS corrections broadcast from radiobeacons adhering to the standards defined by the International Association of Lighthouse Authorities (IALA), and operate in the frequency range of 283.5 to 325 kHz.

Both receivers feature a proven, fully automatic radiobeacon search algorithm. The FBX3 incorporates a 2-line by 16-character LCD display and keypad for control of the receiver, while the FBA3 is a lower cost "black box" product with lock and power indicators.

ORGANIZATION

This manual contains the following chapters:

Chapter 1: Introduction - provides an introduction to GPS and DGPS technology, the FBA3 and FBX3 receivers, and beacon antenna.

Chapter 2: Installation - describes how to install the FBA3 and FBX3 receivers and antennas, and provides a foundation for interfacing with a DGPS capable GPS device.

Chapter 3: FBA3 Configuration and Operation - provides details and instructions to configure and operate the FBA3.

Chapter 4: FBX3 Configuration and Operation - provides details and instructions to configure and operate the FBX3.

Chapter 5: NMEA 0183 Interface - describes the subset of NMEA 0183 commands and queries used to communicate with the FBA3 and FBX3 receivers.

Chapter 6: 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 FBA3 and FBX3 receivers, and antenna.

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

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 FURUNO Customer Service. The contact numbers and e-mail address for FURUNO Customer Service are:

Phone : (360) 834-9300
Fax : (360) 833-5195

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

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

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

DOCUMENT CONVENTIONS

Arial Bold is used to emphasize certain points.

America Bold indicates information presented on the display of the receiver.

This icon indicates that you should press the up arrow button of the FBX3 receiver keypad.

This icon indicates that you should press the Enter button of the FBX3 receiver keypad.

This icon indicates that you should press the down arrow button of the FBX3 receiver keypad.

NOTES, CAUTIONS, AND WARNINGS

Notes, Cautions, and Warnings stress important information regarding the installation, configuration, and operation of the FBA3 and FBX3 Beacon Receivers.

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

The FBA3 and FBX3 receivers are fully automatic, dual channel, 300 kHz, DGPS products designed to function in a wide array of applications. Compact, lightweight, yet rugged, they will provide you with years of reliable operation.

This chapter provides a brief overview of GPS, differential GPS beacon technology, and a description of the FBA3 and FBX3 receivers, various antenna options, and accessories.

1.1 GPS

The United States Government has designed and implemented a reliable, 24-hour a day, all-weather Global Positioning System.

Navstar, the original name given to this geographic positioning and navigation tool, includes a constellation of 24 satellites orbiting the Earth in six distinct planes, approximately 22,000 km above the ground. These Space Vehicles (SV's) transmit radio signals containing precise satellite time and position information. Reception of any four or more of these signals allows a GPS receiver to compute its 3-dimensional coordinates relative to the World Geodetic System, 1984 (WGS-84). Software algorithms may also provide the user with alternate reference frames required for different applications.

The positioning accuracy offered by GPS varies depending upon the type of service and equipment to which a user has access. For reasons of National Security, GPS exists in two distinct forms, 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, authorized federal agencies, and NATO partners. The United States Government provides the SPS free of charge worldwide, to all civilian users.

Though GPS satellites broadcast at two frequencies, designated L1 (1.575 GHz) and L2 (1.227 GHz), the SPS provides access to encoded information at the L1 frequency only. The SPS L1 code, called the Coarse Acquisition Code (C/A code), provides civilian receivers with distance measurements between the receiver's antenna and the GPS satellites in view of the antenna. A GPS receiver calculates a 3-dimensional position by incorporating any four or more pseudorange measurements into its solution. A pseudorange is not a true range due to contributing errors that bias the measurement.

In order to maintain a strategic advantage, the US DoD artificially degrades the performance of the SPS so that the positioning accuracy is 100 meters 2-DRMS[1]. In other words, approximately 95% of the time, the two dimensional positioning accuracy available to civilian users will be better than 100 meters in the horizontal plane. The primary mechanism for implementing this policy of Selective Availability (SA) is to degrade the accuracy of the broadcast GPS time. Allowance has also been made to degrade the accuracy of the broadcast satellite orbit parameters should this prove necessary.

For many positioning and navigation applications, an accuracy of 100 meters or more is insufficient, and differential positioning techniques must be employed.

[1] 2-DRMS refers to twice the distance root mean squared. The root mean square is a statistical value that is closely related to a standard deviation.

1.2 REAL-TIME DIFFERENTIAL GPS

The purpose of differential GPS (DGPS) is to eliminate or dramatically reduce the effects of SA, atmospheric, and satellite errors. To accomplish this, a reference GPS receiver is established at a point of known coordinates. This receiver makes pseudorange measurements to each of the GPS satellites visible above a certain elevation mask angle, and computes a non-differentially corrected, 3-dimensional GPS position. The receiver also calculates true ranges using its known position, and the location of each tracked satellite. The amount by which the true range to one satellite and the observed range differ, is the differential correction.

These corrections are transmitted to a remote receiver in real-time to permit the solution of a DGPS position, with the assumption that the sources of error are the same at both stations. The remote receiver corrects its range measurements using these differential corrections, providing a much more accurate position. Network based DGPS services are also available that incorporate correction information from a number of reference stations to derive pseudorange corrections valid over a larger area.

1.3 DGPS FORMAT

For manufacturers of GPS equipment, commonality is essential to maximize the marketability 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 broadcast standards have been established 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 in use today, designated RTCM SC-104 V2.2.

Different differential systems and applications employ various portions of this standard. Radiobeacons conforming to the standards sanctioned by the International Association of Lighthouse Authorities broadcast a limited selection of RTCM SC-104 messages, including message types 1, 2, 3, 5, 6, 7, 9, and 16.

A DGPS beacon will broadcast either Type 1 or Type 9 messages, both of which contain similar information. These two messages contain pseudorange corrections and range rate corrections to each GPS satellite. The Type 9 message is more efficient than the Type 1 message, and results in lower overall data latency for those satellites whose range errors are changing most quickly. The US Coast Guard and Army Corps of Engineers broadcast the Type 9 message rather than the Type 1 message due to greater efficiency.

The Type 3 message contains the beacon's reference station position, often accurate to within centimeters with respect to the WGS-84 reference datum.

The Type 6 message contains null information, and is broadcast so that a beacon receiver demodulating the data from the broadcast does not lose lock when the beacon station has no new data to transmit.

The Type 7 message contains the radiobeacon almanac information composed of location, frequency, service range, and health information of sister stations for the currently tuned beacon.

The Type 16 message provides users with a 90 character text string that may contain information regarding the status of the system, weather warnings, etc.

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 in the vicinity of the beacon and remote user
- 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), depending primarily upon transmission power. Consequently, some of the errors associated with GPS at the base station differ somewhat from those at the remote user's location. This decorrelation of errors can result in a relative position offset from the absolute coordinates of the remote receiver. This offset is typically on the order of 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 time it takes the base station to determine the measurement corrections, the data rate of the radio link, the time it takes the signal to reach the user, and the time required for the remote beacon receiver to demodulate the signal and communicate it to the GPS receiver. 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 be observed (dependent upon the number of satellites in view). For the purposes of radiobeacon DGPS no appreciable accuracy degradation should occur provided the total correction latency is maintained at less than ten seconds.

To account for any latency and the rapidly changing SA error, a GPS receiver uses the rate of change of the corrections to each satellite to propagate the computed correction forward in time. Calculating the differential correction for a new epoch, using the old correction, leads to a small amount of inaccuracy, due to the high rate of change of the SA error. The validity of this method decreases with time, resulting in degraded positional accuracy until the GPS receiver obtains new corrections.

The state of the atmosphere can differ substantially between the base station and remote user, which can result in significant positioning errors at the remote station. The decorrelation of ionospheric conditions in particular, is a function of the baseline length between the reference and remote receivers.

The number of satellites visible and their geometry in the sky influences positioning accuracy. Generally, the more satellites that are visible to both the reference and remote receivers, the higher the potential for accuracy. However, if all or a majority of the satellites are gathered in one portion of the sky, this weak geometry serves to reduce accuracy, and increase the Dilution of Precision, or DOP, which estimates the strength of the GPS solution.

Satellite signals received by the GPS receiver via an indirect path (multipath) can cause decreased positional accuracy. These reflected signals increase the measured range to a satellite as the multipath signal takes a longer route to the receiver. Certain precautions will minimize GPS antenna sensitivity to these reflected signals. Operating away from large reflective structures such as buildings, or using multipath mitigating ground planes, choke rings, or specialized GPS receiver software and hardware help to reduce the impact of multipath.

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, and atmospheric attenuation.

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

A radiobeacon transmission can have 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, as well as attenuation by the terrain over which it travels.

The portion of the beacon signal transmitted skywards that reflects off the ionosphere back to earth is known as the sky wave. The relative strength of the sky wave to the ground wave is negligible in the immediate vicinity of the transmitting station, increasing to a strength comparable to the ground wave by as few as 50 to as many as 500 km away (31 to 310 miles). The signal strength of the sky wave decreases due to spreading loss and atmospheric attenuation, and is not affected by surface conductivity. As a result, it can travel greater distances than the ground wave.

As the relative strength of the sky wave to the ground wave increases as a function of distance from the transmitter, the two can interact destructively with one another. This interference, called fading, results in a periodic decrease in the field strength of the beacon signal. Fading can cause short-term variations in field strength, and ultimately loss of signal lock near the boundaries of a beacon's coverage area.

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 soil, absorb the power of the transmission more than higher conductivity surfaces, such as sea water.

Atmospheric attenuation also plays a part in signal transmission range, as the constituents of the atmosphere absorb and scatter the signal at a rate of approximately 1/100th of a Decibel (dB) per km. This type of loss is the least significant of those described.

1.6 BEACON RECEIVER INFORMATION

The FBA3 and FBX3 receive, and demodulate RTCM SC-104 differential corrections transmitted by 300 kHz radiobeacons adhering to the broadcast standards set out by the International Association of Lighthouse Authorities (IALA). Both receivers house a dual channel beacon receiver engine that features high-performance beacon search algorithms and a highly sensitive, adaptive architecture.

In addition to sharing the beacon technology, both receivers feature:

- Fast acquisition times ensuring that you are up and running quickly
- Low power consumption giving extended battery life for portable applications
- Automatic and manual tune modes for operational versatility
- Full NMEA 0183 command protocol for configuration, operation, and monitoring of receiver performance
- Firmware upgrades uploaded through the serial port
- User-selectable baud rates for compatibility with "differential-ready" GPS products

In addition, the FBX3 features a 2-line by 16-character display and 3-key control panel for operation of the receiver, and monitoring performance. It also has the ability to display position and satellite information from a connected GPS receiver's NMEA data output messages.

The FBA3 receiver is a cost-effective "black box" product with power and lock LED indicators. Its primary mode of operation is automatic mode, for hands-free operation.

1.7 ANTENNA INFORMATION

The FBA-3 antenna, referred to as an E-field Whip antenna, is sensitive to the electrical component of the radiobeacon broadcast. An integral low noise amplifier, contained in the base of the FBA-3, amplifies signals in the 283.5 to 325 kHz frequency band.

The FBA-3 is compatible with standard marine threaded mounts, and must be grounded for optimum performance. The base of the antenna is threaded nylon, while the whip portion of the antenna is constructed of fiberglass.

2. INSTALLATION

This chapter contains instructions and recommendations for the installation of the FBA3 or FBX3 receiver and its antenna.

2.1 SYSTEM PARTS LIST

The following list of standard equipment is included with the beacon receiver system:

- Receiver
- Antenna
- Power Cable
- Antenna Cable
- Data Cable
- Universal Mounting Bracket
- Operator's Manual

2.2 RECEIVER LAYOUT AND CONNECTIONS

The FBA3 and FBX3 receivers are easily installed, requiring only power, data, antenna, and ground connections. Both receivers have identical real-panel connections. Figure 1-1 illustrates the required receiver cable connections.

Caution - The FBA3 and FBX3 receivers provide 10 VDC across their antenna ports. Connection to incompatible devices may result in damage to equipment.

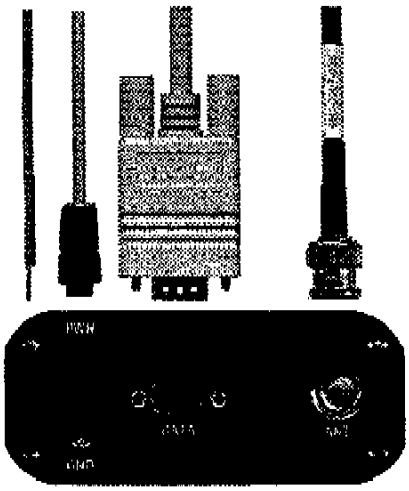

Figure 2-1 Illustration of Receiver Cable Connectivity

2.3 INSTALLING THE RECEIVER

To ensure optimum receiver performance and ease of operation, observe the following considerations when installing the FBA3 or FBX3 receiver.

2.3.1 Receiver Placement

The Universal Mounting Bracket (U-bracket) supplied with the system is used to secure the receiver to the selected mounting surface. You may install this bracket from either the top or the bottom using the thumbscrews provided. The U-bracket allows you to tilt the receiver up or down to achieve the best viewing angle.

When selecting a location to install the receiver, you must:

- Ensure that the receiver is within reach of power, data, and antenna cable connections.
- Ensure that sufficient room is available at the back of the receiver to connect and disconnect the power, data, antenna, and ground cables if required.
- Ensure that once you have installed the receiver, cables will not be bent or pinched as the receiver is tilted up or down.
- Ensure that you a clear view and access to the receivers front panel, to monitor the receiver status.
- Use the Universal Mounting Bracket (U-bracket) as a template when planning and drilling through holes.

2.3.2 Environmental Considerations

Both the FBA3 and FBX3 are designed to operate within enclosed environments where the temperature remains between -30 °C and +70 °C and relative humidity is less than 95%. They may be stored between -40 °C and +80 °C.

2.3.3 Power Considerations

The FBA3 and FBX3 possess a 2-conductor, positive locking, circular connector for application of power. They operate with an input voltage between 9 and 40 VDC. For best performance, the supplied power should be continuous and clean. You may use an in-line power filter to minimize power fluctuations resulting from additional electrical accessories connected to the same power supply.

The backlit LCD display of the FBX3 receiver remains illuminated while power is applied. The FBA3 power LED remains illuminated while power is applied.

Table 2-1 Power Requirements of the FBA3 and FBX3

Receiver	Input Voltage	Input Current	Input Power
FBA3	9-40 VDC	140 mA @ 12 VDC	1.7 W
FBX3	9-40 VDC	210 mA @ 12 VDC	2.5 W

To power the receiver:

- 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 receiver's power input connector, labeled PWR.

Both receivers possess reverse polarity protection to prevent damage resulting from incorrect connection of power cable leads.

A 1.5 A slow blow fuse, situated in-line of the power cable protects the receiver from power surges. The fuse container should remain accessible after installation.

Caution - Do not operate either the FBA3 or FBX3 with the 1.5 A fuse bypassed. Such modification will void the product warranty.

2.3.4 Grounding the Receiver

For best performance and RF noise mitigation, connect the FBA3 and FBX3 to a counterpoise ground. The back plate of these receivers includes a grounding point to which you may connect a 14+ gauge electrical wire, labeled GND. Secure this grounding lead to a counterpoise ground plane. You may use a vehicle chassis, or in the case of a wooden or fiberglass marine vessel, a copper ground plate. For optimal performance when using the FBA-3 Whip, ground the antenna to the same counterpoise ground via a separate cable run (Refer to Section 2.4.2).

2.3.5 Connecting the Receiver To External Devices

Both receivers support RS-232C and RS-422 interface levels for communication with differentially capable GPS products. They features one external bi-directional data port used for transmitting RTCM SC-104 differential correction data to a GPS receiver, and for remote control and querying of the beacon receiver using a terminal device. This data port is located at the back panel of the receiver and is a DB9 socket connector.

Table 2-2 provides pin-assignment information for the data port of the receiver, at the RS-232C interface level. Table 2-3 provides the pin-assignments for the data port at the RS-422 level. The wire colors listed in Tables 2-2 and 2-3 are specific to the custom DB-9P to un-terminated data cable included with your system.

Table 2-2 Receiver Data Pin-out, RS-232C Interface Level

Pin #	Color	Signal	Description
2	Green	Transmit	RTCM SC-104/Status Output
3	Brown	Receive	NMEA Input
5	Black	Signal Ground	Signal Return

Table 2-3 Receiver Data Pin-out, RS-422 Interface Level

Pin #	Color	Signal	Description
d1	Blue	Transmit +	RTCM SC-104/Status Output +
2	Green	Transmit -	RTCM SC-104/Status Output -
4	White	Receive -	NMEA Input -
5	Black	Signal Ground	Signal Return
7	Red	Receive +	NMEA Input +

To establish communications between the beacon receiver and your GPS device, you must connect the transmit pin(s) of the beacon receiver to the receive pin(s) of the GPS receiver.

Optionally, you may connect the receive pin(s) of the beacon receiver to the GPS, or communicating device transmit line. This is required for display of GPS information on the FBX3 LCD display when in FBX-E mode, and for tuning of the FBA3 and FBX3 receivers remotely. You must connect the signal ground (pin 5) of the beacon receiver to the signal return or common ground of the external GPS device.

Figure 2-1 illustrates this requirement for a GPS receiver operating at the RS-232C communications level:

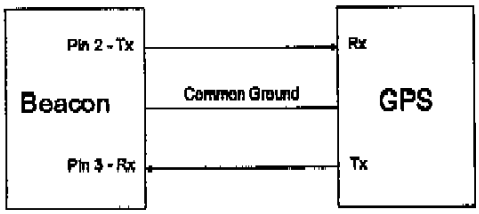

Figure 2-1 Receiver Connectivity, RS-232C

The following figure illustrates this requirement for a GPS receiver operating at the RS-422 communications level:

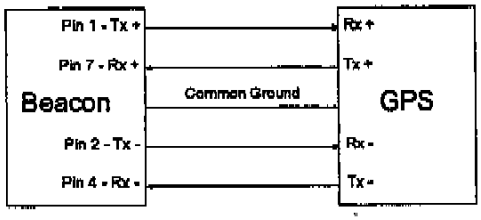

Figure 2-2 Receiver Connectivity, RS-422

For successful communications, the baud rate of the beacon receiver must be set to match that of the GPS receiver. Refer to Section 4.3.6 for instructions set the FBX3 baud rate using the display and keypad, and Section 5.7.2 for information to change the baud rate of either the FBA3 or FBX3 using proprietary NMEA commands.

2.3.6 RS-232 and RS-422 Operation

A majority of GPS receiver products communicates at the RS-232 level, similar to a PC computer. However, there are a number of chart-plotting devices, incorporating GPS capabilities, that operating at the RS-422 interface level. The default communication level of the FBA3 and FBX3 is RS-232C.

To switch from the default RS-232C communication level, you must remove the FBX3's front and back panels to slide the receiver board out of the case approximately two inches. You do not need to remove the face-place of the FBA3. Always observe proper electrostatic discharge precautions (ESD) when handling the beacon receiver or its components, outside of the enclosure. Such precautions include proper grounding of personnel, tools, and the surface upon which the receiver rests.

You will require a Philip's screwdriver to open the front and back panels of the FBX3, and the back panel of the FBA3. Once you have removed the front panel screws for the FBX3, carefully remove the front plate and disconnect the ribbon cables of the display and switch keypad, taking note of connector orientation when secured. Do not pull on the ribbon cables, hold onto the connector when removing so that stress is not placed on the cable.

When making this modification, do not draw the printed circuit board fully out of the enclosure. Instead, slide the board out no more than two inches before reaching in to reposition the RS-232/RS-422 slide switch. Use of a plastic ball-point pen is recommended when making this adjustment. Figure 2-3 illustrates the location of the RS-232/RS-422 slide switch within the receiver:

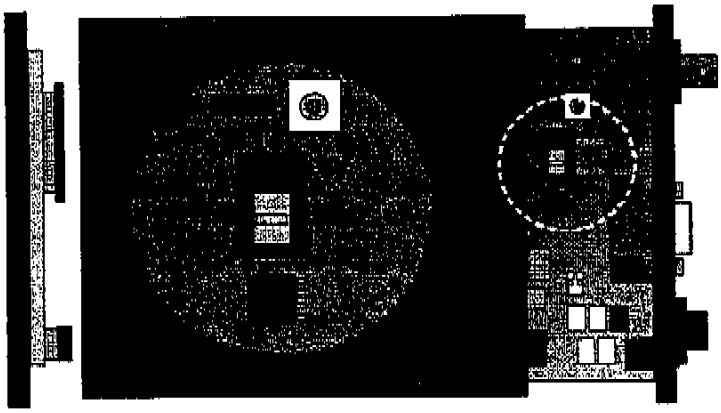

Figure 2-3 RS-232/RS-422 Configuration

With the switch set to the lower position (as viewed in Figure 2-3), the receiver communicates at the RS-232C level. When set to the upper position, the receiver communicates at the RS-422 level. The interface level corresponding to the switch position is silk-screened onto the circuit board for identification.

Caution – The FBA3 and FBX3 are electrostatic sensitive devices. Observe proper precautions when handling these receivers during this procedure. Damage caused to the receiver by ESD is not covered under warranty.

Once you have set the slide switch to the desired position, slide the receiver board back into the enclosure. For the FBX3, reconnect the front panel display and keypad ribbon cables. When replacing the front and back plate screws ensure that no cables or components catch between the panels and the housing.

2.4 INSTALLING THE ANTENNA

The following sections provide antenna installation details

2.4.1 Antenna Placement To Optimize Reception

Selecting an appropriate location for installation of the beacon antenna will greatly influence the performance of the receiver. The following list provides some general guidelines for deciding upon an antenna location:

- Choose a location that is at least three feet away from all forms of transmitting antennas and communication equipment.
- 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 a radar is present, mount the antenna outside the path of the radar beam.
- Do not locate the antenna where environmental conditions exceed those specified in Section 2.3.2.
- Choose a location where the antenna has an open view of the horizon
- If you are installing the antenna on a vessel, mount the antenna as high in possible, considering maintenance and accessibility. In addition, ensure that the antenna is lower than the highest metal object on the vessel.

You may use the following procedure to position the antenna, minimizing interference for the beacon receiver. A valid beacon signal must be available at your location. Refer to Chapter 4 – FBX3 Configuration and Operation for a description of FBX3 operation. This procedure remains valid for the FBA3, however, a PC computer must be used to monitor the NMEA 0183 status message output which is discussed in Chapter 5.

- Turn off the vehicle or vessel, and all electrical accessories.
- Connect the antenna to the receiver, and power the receiver.
- Navigate to the Beacon Status menu of the FBX3 and set the frequency and bit rate for a known beacon. Refer to Section 5.7 to manually tune the FBA3 or the FBX3 using standard NMEA commands. The receiver should indicate a signal lock within 3 minutes.
- Record the average SS and SNR over 10 seconds as indicated on the receiver display or status message output.
- Power the vehicle and all accessories used during normal operations.
- Record the average SS and SNR over 10 seconds. If lock is lost and not regained after 3 minutes, move the antenna to another location on the vessel/vehicle.
- If the average SS and SNR recorded when auxiliary equipment is powered differs by more than 1 or 2 dB from when the vessel/vehicle and accessories are not powered, try a new antenna location.
- If you cannot find a suitable position, consider raising the antenna using a mounting post of an appropriate length.

The goal of this procedure is to locate the antenna position with the highest SNR during normal system operation. If problems persist, contact your local FURUNO dealer or FURUNO Customer Support.

2.4.2 FBA-3 E-Field Antenna

The FBA-3 antenna is easily mounted with a standard 1.0"-14 thread marine mount (1-14 UNS), and features a 10 m pig tail antenna cable.

Though the antenna will perform better if it is located higher, it is important that it is not be the highest point on the vessel or vehicle upon which it is installed. Degraded performance resulting from precipitation static will be most significant if the antenna is at the highest point. If access to a vessel mast is limited, you may rail-mount the antenna using the appropriate mounting hardware.

The following list provides instructions to install the FBA-3 on a marine pole mount.

- Install the pole mount in the desired location.
- Feed the antenna extension cable through the pole mount.
- Connect the FBA-3 to the antenna extension cable.
- Thread the antenna onto the mount.

If the built-in antenna pigtail of the FBA-3 needs to be lengthened, you must use a 50 Ω impedance antenna extension cable such as RG-58U (up to 150 m (492 ft) in length) for proper operation.

For proper performance, connect the FBA-3 to a counterpoise ground as illustrated in Figure 2-4. The ground wire connection should be as short as possible.

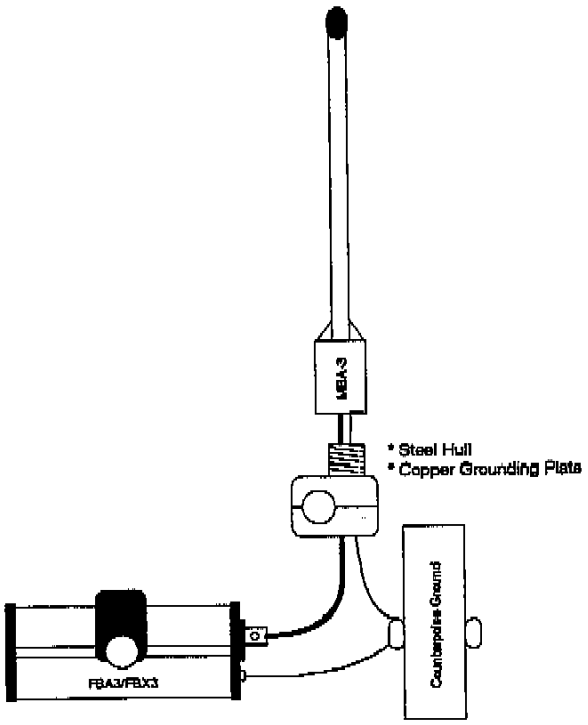

Figure 2-4 Beacon Receiver / FBA-3 Grounding Requirement

The pigtail of the FBA-3 is terminated with a BNC-P connector for direct connection to the beacon receiver. The connector is removable to aid in routing the cable through a bulkhead with a minimal opening. As the connector is removable, do not cut the connector off in order to run the cable. You should minimize the number of times that connector must be removed, to ensure that a quality connection between the connector and the cable is maintained.

When removing the connector from the cable, be sure that you note the order of the various parts within the connector so that they can be re-installed in the same order.

Note - A good antenna ground connection for the FBA-3 is essential for optimum receiver performance. The ground wire should be as short as possible.

2.4.3 Routing and Securing the Antenna Cable

The FURUNO beacon antenna requires a 50 Ω impedance antenna extension cable such as RG-58U (up to a maximum of 150 m (492 ft) in length) for proper operation.

When choosing a route for the antenna extension cable, consider the following recommendations:

- 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 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 FBA3 and FBX3 receivers provide 10 VDC across the antenna port. Connection to incompatible devices may result in damage to equipment.