BR2G *Reference Manual*

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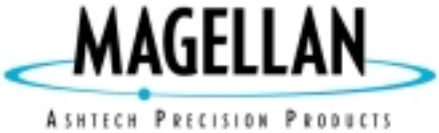

BR2G Reference Manual

FCC NOTICE

The BR2G combination GPS/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 BR2G combination GPS/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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Preface

Welcome to the Ashtech BR2G Reference Manual and congratulations on purchasing this high performance differential GPS product. The purpose of this manual is to familiarize you with the proper installation, configuration, and operation of your new receiver.

The BR2G is a fully integrated DGPS sensor, possessing both GPS and beacon differential receiver technologies. The GPS engine housed within the BR2G is Ashtech's leading L1 G-12 Card product, employing proven hardware and software features for real-time positioning and navigation applications. The beacon engine contained within the BR2G is based upon the state-of-the-art, fully automatic, dual channel SBX-2 from Communication Systems International, Inc.. This integrated DGPS product is designed to function in a wide array of applications and environments. Compact, lightweight, yet rugged, the BR2G 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 BR2G combination GPS/Beacon receiver, and the associated MGL-3, combination GPS/Beacon antenna.

Chapter 2: Installation - describes how to install the BR2G receiver and MGL-3 antenna, and provides a foundation for interfacing the BR2G with an external data logging or monitoring device.

Chapter 3: Configuration and Operation - provides details and instructions to configure and operate the BR2G receiver.

Chapter 4: GPS NMEA 0183 Interface - describes the subset of NMEA 0183 commands and queries used to communicate with the GPS features of the BR2G.

Chapter 5: Beacon NMEA 0183 Interface - describes the subset of NMEA 0183 commands and queries used to communicate with the beacon features of the BR2G.

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 BR2G receiver, and MGL-3 antenna.

Appendix B: BR2G Connectivity - Provides instruction to interface the BR2G with external devices in its four distinct operating modes {GBX-3, GBX-E, MBX-3, MBX-E}.

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

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

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 Ashtech Customer Service. The associated contact numbers and e-mail address are:

Telephone number:	+1-408-615-5980 or 1-800-229-2400 (US only)
Fax number:	+1-408-615-5200
E-mail address:	support@ashtech.com

Technical Support is available from 7:00 AM to 6:00 PM Pacific Standard Time, Monday through Friday. To expedite the support process, please have

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

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

WORLD WIDE WEB SITE

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

www.astech.com

This site presents detailed company, industry, and product information.

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 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 BR2G combination GPS/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 beacon technology, and a description of the BR2G receiver, MGL-3 antenna, 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 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

[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.

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 $1/100^{th}$ of a Decibel (dB) per km. This type of loss is the least significant of those described.

1.6 BR2G RECEIVER INFORMATION

The BR2G combination GPS/300 kHz radiobeacon receiver receives GPS L1 signals and computes three dimensional differential GPS positions employing RTCM formatted DGPS corrections transmitted by 300 kHz radiobeacons adhering to the broadcast standards set out by the International Association of Lighthouse Authorities (IALA). It houses Ashtech's advanced G-12 GPS engine and a high performance dual channel beacon receiver.

The BR2G features:

- 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 installed through the serial port
- User-selectable baud rates for compatibility with differential-ready GPS products
- 2-line by 16-character display and 3-key control panel for operation of the receiver, and monitoring performance.

1.7 MGL-3 ANTENNA INFORMATION

The antenna supplied with the BR2G receiver is the MGL-3 that combines two individual antenna elements: an H-field Loop beacon antenna and an L1 GPS patch antenna within a single PVC plastic enclosure. Both of these antenna elements are active and draw their power from the BR2G receiver. The MGL-3 outputs both Beacon and GPS signals through the single antenna

output port to the BR2G receiver, where they are separated and routed to the appropriate internal sensor.

The H-field Loop antenna within the MGL-3 is sensitive to the magnetic field of the radiobeacon broadcast, and is less susceptible to P-static and noise from thunderstorms, than an E-field Whip antenna. It receives beacon signals which are band-pass filtered and amplified, allowing only radiobeacon frequencies to be transmitted to the beacon receiver.

The L1 GPS patch 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 your Ashtech Customer Service or your dealer for recommendations.

Technical specifications for the MGL-3 are detailed in Appendix A. Refer to Section 2.4 for instructions regarding antenna installation.

2. INSTALLATION

This chapter contains instructions and recommendations for the installation of the BR2G receiver and MGL-3 antenna.

2.1 SYSTEM PARTS LIST

The following list of standard equipment is included with the BR2G receiver system:

- BR2G receiver
- MGL-3 Antenna
- Power Cable
- Antenna Cable
- Data Cable
- Universal Mounting Bracket
- 5/8" Survey Adapter
- BR2G Reference Manual
- G-12 Reference Manual

2.2 RECEIVER LAYOUT AND CONNECTIONS

The BR2G receiver is easily installed requiring only power, data, antenna, and ground connections. Figure 2-1 illustrates the cable connections required for this receiver.

Caution - The BR2G receiver provides 10 VDC across the antenna port. Connection to incompatible devices may result in damage to equipment.

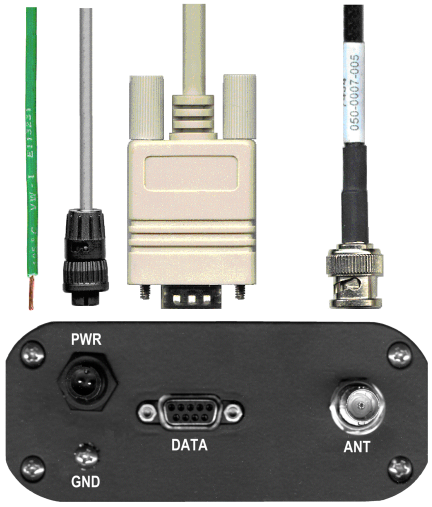


Figure 2-1 BR2G Cable Connectivity

2.3 INSTALLING THE BR2G RECEIVER

To ensure optimum receiver performance and ease of operation, observe the following considerations when installing the BR2G.

2.3.1 Receiver Placement

The Universal Mounting Bracket (U-bracket) supplied with the BR2G is used to secure the receiver to the selected mounting surface. You may install this bracket from either the top or the bottom of the BR2G using the thumbscrews provided. The U-bracket allows you to tilt the BR2G up or down to achieve the best viewing angle.

When selecting a location to install the BR2G 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 receiver display and keypad for trouble shooting purposes.
- Use the Universal Mounting Bracket (U-bracket) as a template when planning and drilling through holes.

2.3.2 Environmental Considerations

The BR2G is designed to operate in an environment in which the temperature remains between -30 °C and +70 °C and relative humidity is less than 95%. The receiver may be stored between -40 °C and +80 °C.

2.3.3 Power Considerations

The BR2G possesses a 2-conductor, positive locking, circular connector for application of power. The BR2G accepts 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 BR2G remains illuminated while power is applied.

Table 2-1 Power Requirements of the BR2G

Input Voltage	Input Current	Input Power
9-40 VDC	< 500 mA @ 12 VDC	< 6.0 W

To power the BR2G:

- 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 BR2G.

A 1.5 A slow blow fuse, situated in-line of the power cable protects the BR2G receiver from power surges. The fuse container should remain accessible after installation.

Caution - Do not operate the BR2G with the 1.5 A fuse bypassed. Such modification will void the product warranty.

2.3.4 Grounding the BR2G

For best performance and RF noise mitigation, connect the BR2G to a counterpoise ground. The back plate of the BR2G includes a grounding point to which you may connect a 14+ gauge electrical wire. 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.

2.3.5 Connecting the BR2G To External Devices

The BR2G operates at the RS-232C interface level to communicate with external data loggers, navigation systems, and other devices. It features a single multi-port "Smart" data connector to transmit and receive data to and from a variety of external devices (Refer to Appendix B).

You may command the BR2G to any of four distinct operating modes that dictate the input/output state of the receiver (Refer to Section 3.2). The data port is located at the back panel of the BR2G and is a DB9 socket connector.

Table 2-2 provides pin-assignment information for the BR2G data port.

Table 2-2 BR2G Data Port Pin-out, RS-232C Interface Level

Pin #	Signal	Description
2	TXA	BR2G NMEA 0183 /RTCM Output
3	RXA	BR2G NMEA 0183 Input
5	Sig.Ground	Signal Return
6	TXB	Aux. GPS Output Port
8	RXB	External RTCM Input (GBX-E Mode)
9	1 PPS	1 Pulse Per Second Timing Output (TTL, 75Ω)

To establish communications between the BR2G and your data logging or monitoring device, you must:

- Connect Pin-2-TXA of the BR2G to the receive pin of the monitor
- Connect Pin-3-RXA of the BR2G to Tx of the monitor device if bi-directional communication is required
- Connect Pin-5-Common Ground of the BR2G to the signal return or common ground of the external device.

Figure 2-2 illustrates standard connectivity for the BR2G when interfaced to an external device:

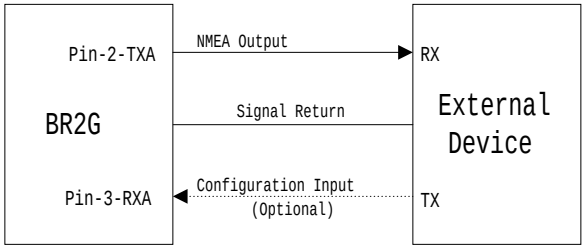


Figure 2-2 BR2G Connectivity, RS-232C Interface Level

Refer to Appendix B for connectivity when operating in the various operating modes defined in Section 3.2.

For successful communications, the P1-Main baud rate of the BR2G must be set to match that of the device to which it is connected. Refer to Section 3.5 and Section 3.6 for instructions related to setting the BR2G baud rate.

2.4 INSTALLING THE MGL-3 ANTENNA

The following sections provide antenna installation details and information on various mounting options available.

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 BR2G combination GPS/Beacon receiver. The following list provides some general guidelines for deciding upon an antenna location:

- Choose a location with a clear, unobstructed view of the sky.
- 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.
- If you are installing the antenna on a vessel, 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.

You may use the following procedure to position the antenna, minimizing interference. A valid beacon signal must be available at your location. Refer to Chapter 3 - Configuration and Operation for a description of BR2G display and keypad operation.

- Turn off the vehicle and all electrical accessories.
- Connect the antenna to the receiver, and power the receiver.
- Navigate to the Beacon Status menu and set the frequency and bit rate for a known beacon. If this information is not available, set the receiver to Automatic mode and allow it to select the best available beacon on its own. The receiver should indicate a signal lock within 3 minutes, indicated by the lock symbol discussed in Section 3.1.
- Record the average SS and SNR over 1 minute as indicated on the receiver display.

- Power the vehicle and all accessories used during normal operations.
- Record the average SS and SNR over 1 minute. If lock is lost and not regained after 3 minutes, move the antenna to another location on the vessel/vehicle.
- If the average SNR recorded when auxiliary equipment is powered differs by less than 2 or 3 dB from when the 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 beacon signal SNR during normal system operation while maintaining a clear unobstructed view of the sky.

2.4.2 Antenna Installation

The MGL-3 uses a 1-14-UNS thread for mounting. For best performance, mount this antenna so that the center of the black gasket is at least 8 cm (3 inches) above the metal surface upon which it rests.

The MGL-3 requires a 50 Ω impedance antenna extension cable such as RG-58U (up to 10 m (33 ft) in length) for proper operation. No antenna ground connection is required with the MGL-3.

Caution – Install the antenna only hand-tight. Damage resulting from over-tightening the antenna is not included under warranty.

Note - Mount this antenna with a clear, unobstructed view of the sky, and 8 cm (3 inches) away from any metal surface

2.4.3 Routing and Securing the Antenna Cable

The MGL-3 require 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.

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.

2.4.4 Survey Adapter

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

3. CONFIGURATION AND OPERATION

This chapter introduces the display and keypad features of the BR2G, operating modes, menu structure, and receiver default operating parameters.

3.1 FRONT DISPLAY AND KEYPAD

The BR2G features a 2-line by 16-character LCD and 3-key control panel. The control panel is composed of an up arrow ⬆, enter ENTER, and down arrow ⬇ key. These keys allow you to navigate through the intuitive BR2G menu system, configuring operating parameters and viewing status information. Figure 3-1 shows the display and keypad of the BR2G. The top line of the display is the active Focus Line for keypad operations.

Figure 3-1 BR2G Display and Keypad

Note - The top line of the BR2G display is the Focus Line. The field of interest must be "in focus" for keystrokes to have the desired effect.

3.1.1 Position Fix Status

The BR2G provides an indication of the GPS lock status, as contained within the $GPGGA message string output from the data port of the receiver. This indicator is located in the lower right hand corner of the BR2G display. Figure 3-2, describes the three states of GPS lock.

Figure 3-2 BR2G GPS Position Fix Indicator

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 states that the receiver is tracking four satellites or more, and is computing a 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.

3.1.2 Beacon Lock Status

The BR2G indicates beacon lock status in the upper right hand corner of the display. The lock symbol, illustrated in Figure 3-3, remains in the closed position when the BR2G is locked to an RTCM signal, and open, when no broadcast is available for the specified frequency and/or MSK bit rate.

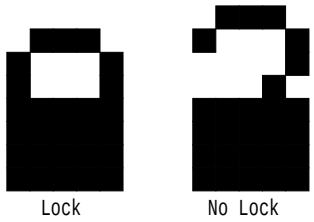


Figure 3-3 BR2G Beacon Lock Indicator

Note – The GPS output of the BR2G will not be differentially corrected until lock has been attained on a valid RTCM broadcast.

3.2 OPERATING MODES

In addition to its standard operating mode (GBX-3 Mode), the BR2G provides the ability to accept an RTCM input stream from an external RTCM source (GBX-E Mode). The BR2G can also be configured to operate as a stand-alone RTCM source, providing differential corrections to an external GPS receiver (MBX-3 Mode). In addition to acting as an RTCM source for an external GPS receiver, you may configure the BR2G to display the GPS position status from the external GPS sensor (MBX-E Mode). A fifth operating mode, GLX-3 should not be used with the BR2G receiver.

3.2.1 GBX-3 Mode

This is the default mode of BR2G operation. In GBX-3 mode, you have display and keypad access to all information related to GPS Position and Satellite status, as well as beacon receiver status and configuration. The receiver outputs GPS NMEA formatted messages through the transmit line of

the data port, and receives GPS and Beacon engine configuration commands and status queries through the data port receive pin.

3.2.2 GBX-E Mode

This is an alternate mode of receiver operation in which the BR2G accepts DGPS correction messages from an external source of RTCM. In GBX-E mode, you have display and keypad access to all information related to GPS Position and Satellite status. Beacon receiver status information is unavailable, since an external DGPS source is used. The receiver outputs GPS NMEA formatted messages through the transmit data line of the serial port, and receives GPS engine configuration commands and status queries through the data port primary receive (pin-3). Differential GPS corrections are provided via the auxiliary input (pin-8).

You may select GBX-E mode from the **Options** section of the **Setup** menu, as described in Section 3.4.5. Refer to Appendix B to connect to an external RTCM source. Please consult your external RTCM device user guide for information regarding interface communication parameters.

When in GBX-E mode, the beacon receiver lock indicator in the upper right hand corner of the display is replaced with an 'E' indicator as illustrated in Figure 3-4.

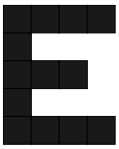


Figure 3-4 GBX-E External RTCM Source Indicator

3.2.3 MBX-3 Mode

In MBX-3 mode the BR2G acts as a stand-alone 300 kHz DGPS beacon receiver and outputs RTCM messages to an external GPS receiver. Access is provided to all information related to beacon receiver operation and

configuration only. The receiver outputs RTCM data through the transmit data line of the serial port, and receives beacon configuration commands and status queries through the data port receive pin.

You may select MBX-3 mode from the **Options** section of the **Setup** menu, as described in Section 3.4.5. Refer to Appendix B to connect to an external GPS receiver. Please consult your GPS receiver user's guide for information regarding interface communication parameters.

3.2.4 MBX-E Mode

In MBX-E operating mode, the BR2G continues to output RTCM corrections as per MBX-3 mode, while accepting standard NMEA 0183 GPS messages ($GPGGA, $GPVTG, $GPZDA, and $GPSAT) from the external GPS receiver. The position, navigation, and satellite information contained within these messages is parsed and displayed by the BR2G in the Position Status section of the menu tree. This feature can be very useful when working with an external GPS receiver that does not provide a graphical interface.

You may select MBX-E mode from the **Options** section of the **Setup** menu, as described in Section 3.4.5. Refer to Appendix B to connect an external GPS receiver for MBX-E operations. Please consult Chapter 4, or your GPS receiver user's guide for more information on these GPS NMEA messages.

3.2.5 GLX-3 Mode

Do not configure the BR2G for GLX-3 mode of operation.

3.3 BEACON TUNE MODES

The BR2G may be operated in either Automatic or Manual Tune mode. In Automatic Beacon Search (ABS) mode, the receiver will automatically identify and tune to the station providing the strongest DGPS signal. In Manual 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 3-5, and Section 3.6 to switch between Automatic and Manual Tune modes using the display and keypad.

3.3.1 Automatic Beacon Search (ABS) Mode

The BR2G receiver operates in Automatic Beacon Search (ABS) mode by default, selecting and tuning to the most appropriate beacon without operator intervention. The BR2G uses its two independent beacon channels to identify and lock to DGPS beacons without interrupting the continuous flow of RTCM data to the internal G-12 GPS engine.

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.

3.3.1.1 Global Search

When powered for the first time in ABS mode, the BR2G initiates a Global Search, 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 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 BR2G will initiate a fresh Global Search, continuing this cycle until it finds a valid beacon.

3.3.1.2 Background Search

During the Background Search, the second channel examines all frequencies at both the 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 BR2G 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 **Auto Bx Search** feature accessible in the **Setup** sub-menu of the BR2G display menu system.

3.3.2 Manual Mode

In Manual tune mode, you may select a specific frequency and bit rate for the receiver to tune to, or specify the frequency only, allowing the BR2G 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 BR2G also provides the capability to select a beacon by name from the World Beacon Table stored within receiver memory. You may also construct a custom User list of up to 10 beacons, as described in Section 3.7, allowing quicker access to the beacons that you use the most often.

3.4 BR2G MENU SYSTEM

Figure 3-5 illustrates the BR2G display and keypad actuated menu system.

3.4.1 Start-Up Sequence

When power is applied, the BR2G will sequence through four initialization screens. These start up screens include a receiver initialization and memory check, a display test, a customized splash screen, and a screen displaying the receiver serial number, software version, and the current operating mode.

Following initialization, the receiver proceeds directly to the **Position Status** branch of the menu tree. When operating in MBX-3 mode, the BR2G will proceed directly to the **Beacon Status** branch of the menu tree.

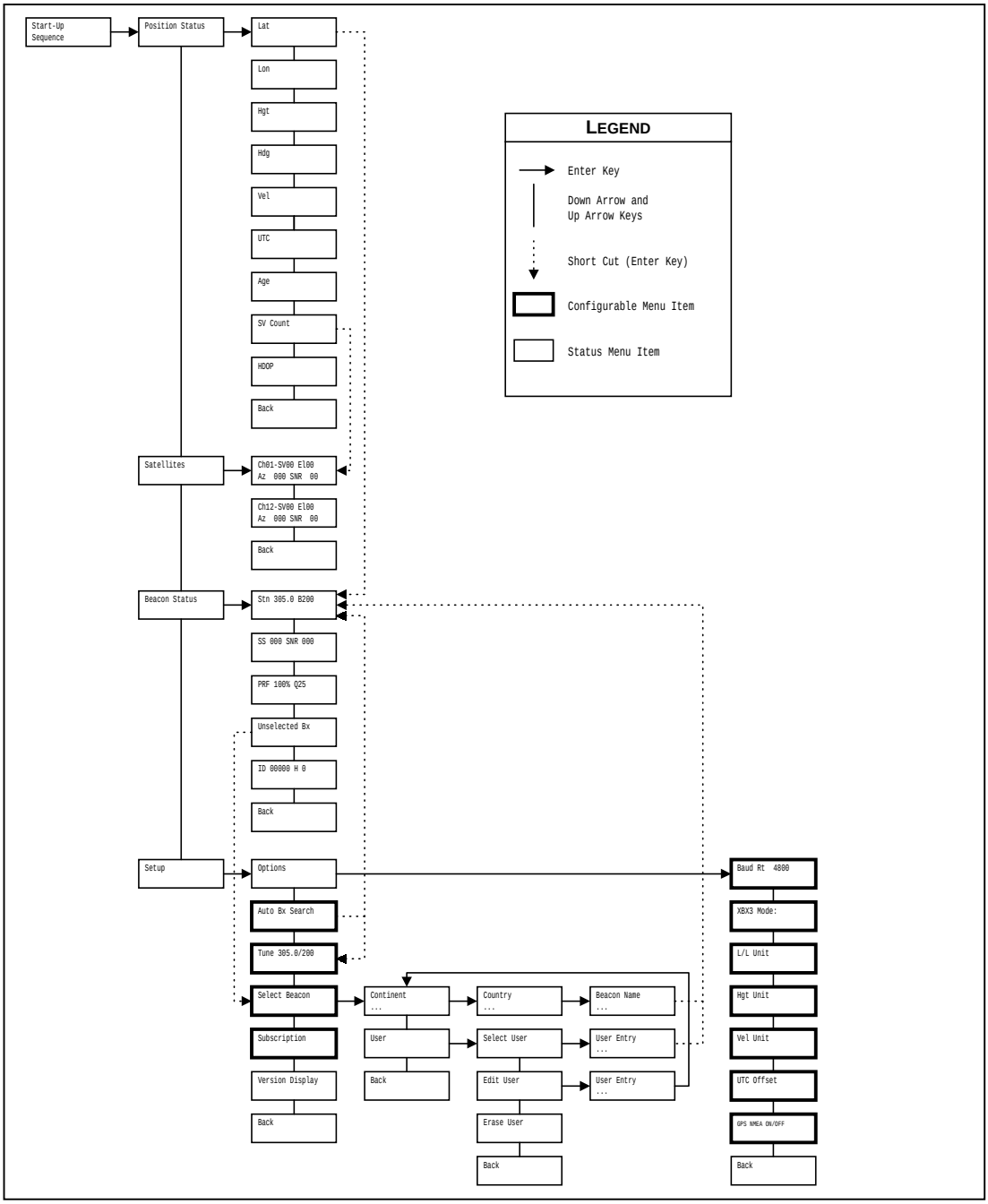
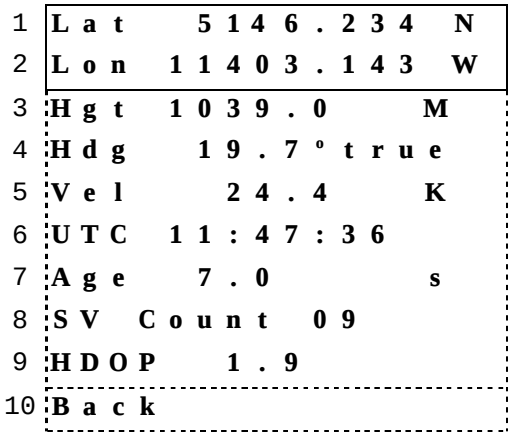


Figure 3-5 BR2G Menu System

3.4.2 Position Status

The **Position Status** section of the menu tree provides access to GPS position and navigation status information.



Lat Displays the current latitude in degrees, minutes, decimal minutes (DM.M). This information is parsed from the NMEA $GPGGA message string.

Lon Displays the current longitude in degrees, minutes, decimal minutes (DM.M). This information is parsed from the NMEA $GPGGA message string.

Hgt Displays the current height in either meters or feet depending on the units selected (See Section 3.4.5). This information is parsed from the NMEA $GPGGA message string.

Hdg Displays the horizontal heading clockwise from True North in degrees. This information is parsed from the NMEA $GPVTG message string.

Vel Displays the horizontal speed in KPH, MPS, or knots depending on the units selected (See Section 3.4.5). This information is parsed from the NMEA $GPVTG message string.

UTC Displays the current UTC Time. If a local offset has been specified, "Time" replaces the "UTC" field identifier. This information is parsed from the NMEA $GPZDA message string.

Age Displays the current DGPS age of correction in seconds. This information is parsed from the NMEA $GPGGA message string.

SV Count 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.

HDOP Displays the Horizontal Dilution of Precision (HDOP). This information is parsed from the NMEA $GPGGA message string.

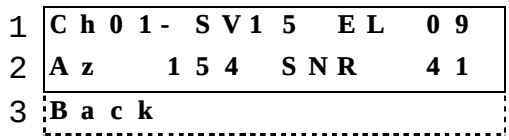
Back Returns the BR2G to the previous menu level.

Note - When Line 1, Lat, is in focus, you may press ENTER to proceed directly to the Beacon Status menu, as defined in Section 3.4.4.

Note - When Line 7, SV Count is in focus, you may press ENTER to proceed directly to the Satellites status menu, as defined in Section 3.4.3.

3.4.3 Satellites

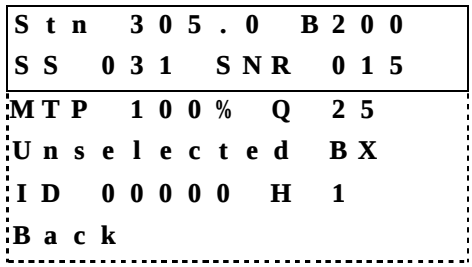
The **Satellites** section of the menu tree provides access to GPS satellite information. Pressing the ↑ and ↓ keys allows you to scroll through the available GPS receiver channels, numbered **Ch01** through **Ch12**.



Ch01	Displays the external GPS receiver channel (01-12) for which the satellite information provided is valid. This information is parsed from the NMEA $PASHR,SAT message.
SV15	Displays the GPS satellite SV number tracked by channel 'XX' of the external GPS receiver. This information is parsed from the NMEA $PASHR,SAT message.
El	Displays the elevation angle (0° - horizon to 90°- vertical) of the SV relative to the external GPS receiver antenna. This information is parsed from the NMEA $PASHR,SAT message.
Az	Displays the azimuth angle (0° = 360° = North) of the SV relative to the external GPS receiver antenna. This information is parsed from the NMEA $PASHR,SAT message.
SNR	Displays the signal to noise ratio of the satellite signal measured by the external GPS receiver. This information is parsed from the NMEA $PASHR,SAT message.
Back	Returns the BR2G to the previous menu level.

3.4.4 Beacon Status

The **Beacon Status** section of the menu tree provides access to information related to the status of the BR2G beacon receiver's primary channel.



Stn — Frequency in kilohertz (kHz) to which the BR2G is tuned.

B — MSK bit rate in bits per second (bps) at which the BR2G is demodulating RTCM data.

SS — Signal Strength in dBμV/m; SS = 20 is 10 μV/m

SNR — Ratio of SS over computed noise floor in dB

MTP — Message throughput (correct data ÷ total data x 100%)

Q — Number of consecutive 30 bit RTCM words received correctly. The maximum Q count is 25.

Unselected BX — Name of the beacon to which the receiver is tuned. This field is only updated if a specific beacon is selected from the receiver's Global Beacon Table.

ID — Reference Station identifier as contained within the RTCM header words of the beacon broadcast messages.

H — Health of the transmitting beacon. Table 3-1 defines the range and interpretations of health values.

Table 3-1 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

Top Menu — Returns the receiver to the top menu level.

Back — Returns the receiver to the last viewed menu.

Note - When Line 1, Stn xxxx.x Byyy, is in focus, you may press ENTER to proceed directly to the Tune command line of the Setup menu. You may then press ENTER again to change the frequency and

bit rate to which the receiver is tuned using the ↑ and ↓ keys. When the correct frequency and bit rate are displayed, press ENTER a third time to return to the Beacon Status menu.

Note - When Line 4, Unselected BX, is in focus, you may press ENTER to proceed directly to the Select Beacon command line of the Setup menu. You may then press ENTER again to select a specific beacon by geographic region, by name using the ↑, ↓ and ENTER keys. When the correct beacon name is displayed, press ENTER to return to the Beacon Status menu.

3.4.5 Setup

The **Setup** section of the menu tree provides access to BR2G configuration information and sub-menus.

```
1 Options                    ← Focus Line
2 Auto BX Search
3 Tune 325.0/200
4 Select Beacon
5 Subscription
6 Version Display
7 Back
```

The **Options** sub-menu provides access to the following configuration parameters:

```
1 Baud Rt 4800               ← Focus Line
2 XBX3 Mode:GBX-3
3 L/L Unit DM.M
4 Hgt Unit Meters
5 Vel Unit KPH
6 UTC Offset 0
```

```
7 GPS NMEA ON/OFF
8 Defaults
9 Back
```

Baud Rate {2400, 4800, 9600 bd}
Baud rate at which the BR2G communicates through the Port A of its external bi-directional DB-9S data connector (Pins 2 and 3). Change this parameter to match the baud rate of the external device with which the BR2G is communicating.

XBX3 Mode {GBX-3, GBX-E, MBX-3, MBX-E, GLX-3}

GBX-3 Factory preset mode of operation. In GBX-3 mode, the BR2G GPS receiver accepts RTCM correction messages from the internal beacon receiver, and outputs differentially corrected NMEA-0183 GPS messages.

GBX-E Mode of operation in which the BR2G accepts RTCM corrections from an external source. In this mode, the internal beacon receiver remains inactive.

MBX-3 Beacon receiver mode of operation in which the BR2G acts as a stand-alone 300 kHz Beacon receiver accepting beacon command and query message input, and outputting RTCM and NMEA status messages to an external GPS device.

MBX-E Beacon receiver mode of operation in which the BR2G will output RTCM correction data to an external GPS receiver and display GPS position, navigation, and satellite data as input from an external GPS device (GGA, VTG, ZDA, SAT NMEA message input required).

GLX-3 **Do not configure the BR2G for this mode of operation.**

L/L Unit {DM.M, DMS, DD}
Pressing ENTER with this line in focus allows you set the units of the **Lat** and **Lon** parameter displayed in the **Position Status** section of the menu. Use

the ▲ and ▼ keys to select the desired units, and press ENTER again to implement the change.

Hgt Unit

{Meters, Feet}
Pressing ENTER with this line in focus allows you set the units of the **Hgt** parameter displayed in the **Position Status** section of the menu. Use the ▲ and ▼ keys to select the desired units, and press ENTER again to implement the change.

Vel Unit

{KPH, MPH, k}
Pressing ENTER with this line in focus allows you set the units of the **Vel** parameter displayed in the **Position Status** section of the menu. Use the ▲ and ▼ keys to select the desired units (kilometers/hour, miles/hour, or knots), and press ENTER again to implement the change.

UTC Offset

{-12 to +12 hours}
Pressing ENTER with this line in focus allows you set the local time offset from UTC allowing the display of local time, in the **Position Status** section of the menu. Use the ▲ and ▼ keys to select the desired offset in hours, and press ENTER again to implement the change.

GPS NMEA ON/OFF

{GGA, GLL, GSA, GSV, RMC, VTG, ZDA, SAT}
Pressing ENTER with this line will allow you to activate the various GPS messages available for output by the BR2G. Use the ▲ and ▼ keys to select the desired message, and press ENTER to toggle the output status.

Back

Returns the BR2G to the **Setup** menu level.

The **Setup** menu also provides the following configuration and information options.

Auto Bx Search

Pressing ENTER with this line in focus sets the BR2G to ABS mode, erasing the stored Global Search Table and forcing a new Global Search. Selecting **Auto Bx Search** will erase the Global Search Table.

Tune 325.0/200

Pressing ENTER with this line in focus allows you set the beacon frequency and MSK rate to which the receiver should tune. The ▲ and ▼ keys increment

the frequency by 500 Hz, with three MSK rate options, 100 bps, 200 bps, and Auto, available for each increment. Select **Auto** if you know the frequency of the beacon but are uncertain of the correct MSK rate. When the correct frequency and bit rate is displayed, press ENTER to proceed to the **Beacon Status** menu. Selecting Auto/Auto from the **Tune** field will not erase the Global Search Table.

Select Beacon

This feature allows you to select a particular beacon for a geographical region. Geographic regions are resolved into continent and country. Additionally, you may create a custom 10 element User Defined Table of beacons selected from the global listing. This feature can be useful if your operations are restricted to one or two geographic regions, i.e., the West Coast of the Northern United States. Upon selecting a beacon, the BR2G will automatically return to the **Beacon Status** menu, updating the **Stn xxx.x Byyy** and beacon name fields.

Subscription

The subscription feature allows you to configure the BR2G for operation within a CSI proprietary encrypted RTCM broadcast network.

Version Display

Displays the BR2G serial number, resident firmware, SBX-2 firmware, and receiver diagnostic checksums.

Back

Returns the BR2G to the top menu level.

3.5 FACTORY PRESET CONFIGURATION PARAMETERS

Tables 3-2, 3.3, and 3.4 identify the configuration settings that are required for correct operation of the BR2G. These configuration parameters are preset at the factory prior to shipment.

Caution - The changes you make to the BR2G configuration are saved in memory for subsequent power-up.

Table 3-2 Preset BR2G Operating Settings

Tune Mode	Operating Mode
Automatic	GBX-3

Table 3-3 Preset BR2G Port Settings

Baud Rate	Data Bits	Parity	Stop Bit	Interface Level
P1-Main: 9600	8	None	1	RS-232

Note – The BR2G external Port A, P1-Main, baud rate controls the baud rate at which the BR2G communicates with external devices.

Table 3-4 Preset BR2G GPS NMEA Message Output

GPS NMEA Message Output
GGA,GSA,**SAT**,VTG,ZDA

3.6 CONFIGURING THE RECEIVER

The following subsections provide detailed instructions for you to configure important operating parameters of the BR2G.

3.6.1 Change Baud Rate

To modify the baud rate of the BR2G data port (P1-Main) (Refer to Figure 3-5):

- Navigate to **Options** in the **Setup** menu and press ENTER.
- Observe the current **Baud Rt** setting. If incorrect, press ENTER.
- Scroll with the ↑ or ↓ keys to the required baud rate {2400, 4800, or 9600} and press ENTER.

3.6.2 Change Frequency and MSK Rate

To modify the frequency and MSK rate to which the receiver is manually tuned (Refer to Figure 3-5):

- Navigate to **Tune** in the **Setup** menu and press ENTER.
- Scroll with the ↑ or ↓ keys until the desired Frequency and MSK Rate are displayed and press ENTER {283.5/100 to Auto/Auto}.

3.6.3 Select a Beacon By Name

To tune to a specific beacon by name (Refer to Figure 3-5):

- Navigate to the **Select Beacon** in the **Setup** menu and press ENTER.
- Scroll with the ↑ or ↓ keys until the desired continent is displayed then press ENTER.
- Scroll with the ↑ or ↓ keys until the desired country is displayed then press ENTER.
- Scroll with the ↑ or ↓ keys until the name of the specific beacon is displayed then press ENTER.

3.6.4 Set to Automatic Beacon Search Mode

To set the receiver to ABS mode (Refer to Figure 3-5):

- Navigate to **Auto Bx Search** in the **Setup** menu and press ENTER.

-or-

- Navigate to **Tune** in the **Setup** menu and press ENTER.
- Scroll with the ↑ or ↓ keys until **Auto/Auto** is displayed and press ENTER.

The previous method erases any previous search information, while the later method does not.

3.6.5 Change Operating Mode

To change Operating Mode (Refer to Figure 3-5):

- Navigate to **Options** in the **Setup** menu and press ENTER.
- Scroll with the ↑ or ↓ keys until **XBX3 Mode** is displayed and press ENTER.
- Scroll with the ↑ or ↓ keys to the correct mode {GBX-3, GBX-3, MBX-3, or MBX-E}and press ENTER.

3.7 USER DEFINED BEACON TABLE

The BR2G provides the facility to generate and store a User Table of up to ten frequently used stations. You may use the receiver display and keypad to create this convenient reference selecting individual entries from the Global

Beacon listing within receiver memory. Use the following instructions to create or edit the user table.

To create or edit an entry in the User Table (Refer to Figure 3-5):

- Navigate to **Select Beacon** from the **Setup** menu and press ENTER.
- Scroll with the ↑ or ↓ keys until **User** is displayed, then press ENTER.
- Scroll with the ↑ or ↓ keys until **Edit User** is displayed, then press ENTER.
- Scroll with the ↑ or ↓ keys until the **User Entry** field that you wish to modify is displayed and press ENTER.
- Scroll with the ↑ or ↓ keys until the continent of the beacon you wish to enter into the User Table is displayed then press ENTER.
- Scroll with the ↑ or ↓ keys until the country of the beacon you wish to enter into the User Table is displayed then press ENTER.
- Scroll with the ↑ or ↓ keys until the name of the specific beacon you wish to enter into the User Table is displayed then press ENTER.

To select an entry from the User Table (Refer to Figure 3-5):

- Navigate to the **Select Beacon** from the **Setup** menu and press ENTER.
- Scroll with the ↑ or ↓ keys until **User** is displayed, then press ENTER.
- Scroll with the ↑ or ↓ keys until **Select User** is displayed, then press ENTER.
- Scroll with the ↑ or ↓ keys until the name of the beacon you wish to tune to is displayed, and press ENTER.

4. GPS NMEA 0183 MESSAGES

The internal Ashtech G-12 GPS receiver of the BR2G supports the output of a variety of GPS related NMEA status messages. This chapter presents the commands used to activate or deactivate the various messages, and defines the message contents.

4.1 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

4.2 NMEA MESSAGE ELEMENTS

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

Example: $GPYYY,xxx,xxx,xxx…<CR><LF>

The components of this generic NMEA message example are displayed in Table 4-1.

Table 4-1 NMEA Message Elements

Element	Description
$GP	Message Identifier Indicating a GPS Related Message
YYY	Type of GPS NMEA Message
xxx	Variable Length Message Fields
<CR>	Carriage Return
<LF>	Line Feed

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

To issue NMEA commands, use a program with a terminal utility running on a PC computer. You may type these commands into the terminal window once you have matched the communication parameters between the terminal program and the BR2G. You must ensure that when you press the Enter key on your PC or terminal device to send a command, it represents both a carriage return <CR> and line feed <LF>. If a NMEA command is not working, this terminal facility option may not be set correctly.

4.3 GPS NMEA MESSAGE ACTIVATION

The Ashtech G-12 GPS engine contained within the BR2G uses one command to set the various NMEA messages output by the receiver. This command has the following format:

$PASHS,NME,x,p,y<CR><LF>

The x field identifies the GPS message to be turned on or off, and may be selected from {GGA, GLL, GSA, RMC, SAT, VTG, or ZDA}. The p field indicates the data port to which the messages will be output, where p = A for TXA (Pin-2), and p = B for TXB (Pin-6). The y field is the activation status, where y = ON or y = OFF.

To change the update rate of the NMEA messages from the BR2G , use the following command:

$PASHS,NME,PER,p<CR><LF>

The p field specifies the number of seconds between successive message outputs.

After receiver configuration, it is necessary to save all changes. The following command will ensure that changes that you have made are maintained after power is cycled:

$PASHS,SAV,Y<CR><LF>

4.4 GPS RECEIVER NMEA DATA MESSAGES

In this section, GGA, GLL, GSA, RMC, SAT, VTG, and ZDA NMEA data messages are defined.

Note - By default the BR2G is configured to output the GGA, GSA, SAT, VTG, and ZDA messages.

4.4.1 GGA Data Message

The GGA message contains detailed GPS position information, and is the most frequently used NMEA data message. In Table 4-2, the GGA data message is broken down into its components. This message takes the following form:

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

Table 4-2 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 = uncorrected 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
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

4.4.2 GLL Data Message

The GLL message contains Latitude and Longitude information. In Table 4-3, the GLL data message is broken down into its components. This message has the following format:

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

Table 4-3 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

4.4.3 GSA Data Message

The GSA message contains GPS DOP and active satellite information. Only satellites used in the position computation are output. Null fields are present when data is unavailable due to the number of satellites tracked. Table 4-4, 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 4-4 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

4.4.4 RMC Data Message

The RMC message contains recommended minimum specific GPS data. Table 4-5 breaks down the RMC data message into its components. This message has the following format:

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

Table 4-5 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

4.4.5 SAT Data Message

The SAT message contains GPS satellite tracking status information. Table 4-6 breaks down the SAT data message into its components. This message has the following format:

$PASHR,SAT,d1,n(d2,d3,d4,f1,c)*cc<CR><LF>

Table 4-6 SAT Data Message Defined

Field	Description
d1	Number of SVs locked
d2	SV PRN number
d3	SV azimuth angle in degrees
d4	SV elevation angle in degrees
f1	SV signal/noise ratio in dB Hz
c	SV used in position computation U = used, - = not used
*cc	Checksum
<CR><LF>	Carriage return and line feed

4.4.6 VTG Data Message

The VTG message contains velocity and course information. Table 4-7 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 4-7 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
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 miles/h
ggg.gg	Speed over ground, 000 to 999 km/h
u	Speed over ground units, u = K = kilometers/h
*cc	Checksum

<CR><LF>	Carriage return and line feed

4.4.7 ZDA Data Message

The ZDA message contains Universal Time information. Table 4-8 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 4-8 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

5. BEACON NMEA 0183 MESSAGES

This chapter identifies the selection of NMEA 0183 command and status messages appropriate to the beacon receiver functions of the BR2G.

5.1 BR2G SUPPORTED BEACON MESSAGES

Table 5-1 BR2G Supported Beacon NMEA Messages

Message Description	Description
Commands	
$GPMSK (FullManualTune)	Sets the receiver into FullManualTune Mode
$GPMSK (PartialManual Tune)	Sets the receiver into PartialManualTune Mode
$GPMSK (ABS Mode)	Sets the receiver into Automatic Beacon Search Mode
Queries	
$GPCRQ Operation Query	Queries the receiver for operation parameters
$GPCRQ Performance Query	Queries the receiver for performance parameters

5.2 BR2G BEACON COMMANDS

This section discusses the beacon related NMEA 0183 commands accepted by the BR2G receiver.

5.2.1 Full Manual Tune Command ($GPMSK)

This command instructs the BR2G to tune to a specified frequency and MSK Rate. It has the following form:

$GPMSK,fff.f,M,ddd,M,n<CR><LF>

Response:

N/A

In this message, fff.f is the frequency in kHz, and M designates manual frequency selection. The ddd field represents the desired MSK bit rate in bits per second (100, 200 bps, or non-standard), and the second M designates

manual MSK rate. The n parameter is the period of the performance status message output by the receiver (0 to 100 seconds). When power is cycled, the status output interval resets to zero.

The beacon status message output by the BR2G, as initiated using this command, is the CRMSS message response discussed in Section 5.3.2.

Caution - If the n field in this message is non-zero, the status data message output by the internal beacon sensor may interrupt the flow of RTCM messages to the internal G-12 GPS receiver.

5.2.2 Partial Manual Tune Command ($GPMSK)

This command instructs the BR2G to tune to a specified frequency and automatically select the correct MSK rate. It has the following form:

$GPMSK,fff.f,M,,A,n<CR><LF

Response:

N/A

In this message, fff.f is the frequency in kHz, and M designates manual frequency selection. The A field designates automatic MSK rate. The n parameter is the period of the performance status message, as output by the BR2G (0 to 100 seconds). When power is cycled, the status output interval resets to zero.

Again, the beacon status output is the CRMSS message response, discussed in Section 5.3.2.

Caution - If the n field in this message is non-zero, the status data message output by the internal beacon sensor may interrupt the flow of RTCM messages to the internal G-12 GPS receiver.

5.2.3 Automatic Beacon Search Command ($GPMSK)

This command initiates the BR2G automatic mode of operation in which the receiver operates without operator intervention, selecting the most appropriate beacon station. This command has the following format:

$GPMSK,,A,,A,n<CR><LF>

Response:

N/A

In this message, the first A designates automatic frequency selection, and the second A designates automatic MSK rate. The n parameter is the output period of the performance status message from the receiver (0 to 100 seconds). When power is cycled, the status output interval resets to zero.

CRMSS is the BR2G beacon performance status message, output every n seconds, and is discussed in Section 5.3.2.

The BR2G provides the above response to this $GPMSK message, and immediately tunes to the optimum beacon station, provided a valid beacon almanac is present in receiver memory. Without a valid almanac, the BR2G will perform a Global Search to identify candidate stations in the area.

Caution - If the n field in this message is non-zero, the status data message output by the internal beacon sensor may interrupt the flow of RTCM messages to the internal G-12 GPS receiver.

5.3 BR2G BEACON QUERIES

This section discusses the NMEA 0183 queries accepted by the BR2G receiver.

5.3.1 Receiver Operating Status Query ($GPCRQ)

This query prompts the BR2G receiver for its beacon receiver operational status. It has the following format:

$GPCRQ,MSK<CR><LF>

Response:

$CRMSK,fff.f,X,ddd,Y,n*CS

When queried for its operational status, the BR2G will return this NMEA response where fff.f is the current frequency in kHz, X is the tune mode (A = automatic and M = manual), ddd is the MSK bit rate, Y is the MSK mode (A = automatic and M = manual), and n is the output period of the CRMSS performance status message. The *CS field is the checksum that terminates the NMEA response.

5.3.2 Receiver Performance Status Query ($GPCRQ)

This query prompts the BR2G receiver for its beacon performance status:

$GPCRQ,MSS<CR><LF>

Response:

$CRMSS,xx,yy,fff.f,ddd*CS

The BR2G will return this NMEA response when queried for its performance status. The xx field is the signal strength in dBµV/m, yy is the signal to noise ratio in dB, fff.f is the current frequency in kHz, and ddd is the corresponding MSK bit rate in bps. The *CS termination is the checksum that terminates the response message.

6. TROUBLESHOOTING

Use the following checklist to troubleshoot anomalous BR2G 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 (9-40 VDC) • Check current restrictions imposed by power source (maximum > 0.5 A)
No data from BR2G	• Check receiver power status (display illuminated?) • Verify that BR2G is locked to a valid beacon (Beacon Lock symbol engaged) • Verify that BR2G is locked to GPS satellites (Lock symbol engaged) • Check integrity and connectivity of power and data cable connections • Verify BR2G Mode of operation = GBX-3
Random data from BR2G	• Check mode of operation • Verify baud rate settings of BR2G and terminal device
No GPS lock	• Check integrity of antenna cable • Verify BR2G antenna port output voltage (10 VDC) • Verify 10 VDC across antenna cable connector • Verify MGL-3's unobstructed view of the sky • Verify antenna cable length < 10 meters • Verify GPS receiver output messages are active (GGA, VTG, SAT)
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 Bx Search** • Verify BR2G antenna port output voltage (10 VDC) • Verify 10 VDC across antenna cable

	connector
Low SNR	• Check integrity of antenna connections • Select alternate antenna position
Non-differential GPS output	• Verify BR2G lock status • Verify matched beacon output and GPS RTCM input baud rates • Verify G-12 GPS receiver DGPS configuration
No BR2G response to NMEA commands and queries	• Verify baud rate settings of BR2G and terminal device • Verify communication parameter settings (8 data bits - No parity - 1 stop bit) • Check integrity of data cable connections • Verify pin connectivity between BR2G and terminal device • Ensure receiver is in GBX-3 mode

Appendix A - Specifications

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

- the BR2G combination GPS/Beacon receiver
- the MGL-3 Combination Antenna

Table A-1 BR2G Combination GPS/Beacon Receiver Specifications

Internal GPS Engine Operational Specifications	
Item	**Specification**
Frequency	1.575 GHz
Channels	12
Horizontal Accuracy	< 1 meter 2DRMS
*Please refer to your G-12 Manual for detailed GPS receiver specifications.	

Internal Beacon Engine Operational Specifications	
Item	**Specification**
Frequency Range	283.5 - 325 kHz
Channels	2
Input Sensitivity	2.5 µV/m for 10 dB SNR @ 100 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 @ $f_0 \pm 500$ Hz
Decoding	RTCM 6/8
Demodulation	MSK

Serial Interface Specifications	
Item	**Specification**
Interface Levels	RS-232C
Data Connector	DB9 Socket
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	9-40 VDC
Power Consumption	< 6.0 W
Power Connector	Circular 2-pin Locking Plug

Mechanical Characteristics	
Item	**Specification**
Enclosure	Extruded Aluminum with Aluminum Front and Back Plates.
Length	163 mm (6.4")
Width	125 mm (4.9")
Height	51 mm (2.0")
Weight	0.64 kg (1.4 lb)
Antenna Connector	BNC Socket

Environmental Specifications	
Item	**Specification**
Storage Temperature	-40°C to 80°C
Operating Temperature	-30°C to 70°C
Humidity	95% Non-Condensing
Compass Safe Distance	1 m (3.3 ft)

Table A-2 MGL-3 Combined Loop / GPS Antenna Specifications

Operational Specifications	
Item	**Specification**
Frequency Range, Beacon	283.5 - 325 kHz
LNA Gain, Beacon	34 dB
Pre-Amplifier, Beacon	Integral Low Noise Amplifier
Frequency Range, GPS	1.575 GHz (L1)
LNA Gain, GPS	Various available

Power Specifications	
Item	**Specification**
Input Voltage	4.9-13 VDC supplied by receiver
Input Current	50-60 mA

Mechanical Characteristics	
Item	**Specification**
Enclosure	PVC Plastic
Mounting Thread	1-14-UNS-2B
Length	128 mm (5.06″)
Width	128 mm (5.06″)
Height	84 mm (3.33″)
Weight	450 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 80°C
Operating Temperature	-30°C to 70°C
Humidity	100% Condensing

Appendix B – BR2G Connectivity

Section 3.2 identifies four distinct BR2G operating modes; GBX-3, GBX-E, MBX-3, and MBX-E. Each of these modes requires specific connectivity between the BR2G and the device to which it is interfaced.

GBX-3 Operating Mode

To establish communications between the BR2G and your data logging or monitoring device, you must:

- Connect Pin-2-TXA of the BR2G to the receive pin of the monitor
- Connect Pin-3-RXA of the BR2G to Tx of the monitor device if bi-directional communication is required
- Connect Pin-5-Common Ground of the BR2G to the signal return or common ground of the monitor.

Figure B-1 illustrates the required connectivity between the BR2G and an external device:

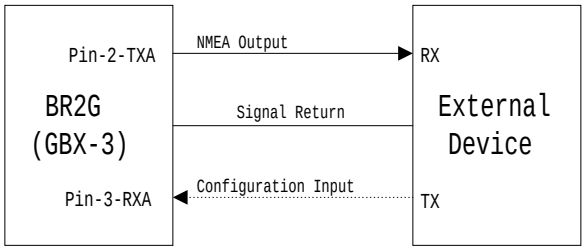


Figure B-1 BR2G Connectivity (GBX-3 Mode)

For successful communications, the baud rate of the BR2G must be set to match that of the monitor. Refer to Section 3.4.5 and Section 3.6 for instructions related to setting the BR2G baud rate.

GBX-E Operating Mode

To establish communications between the BR2G, an external RTCM source, and your data monitoring device, you must:

- Connect Pin-2-TXA of the BR2G to the receive pin of the monitor
- Connect Pin-3-RXA of the BR2G to TX of the monitor device if bi-directional communication is required
- Connect Pin-5-Common Ground of the BR2G to the signal return or common ground of the monitor.
- Connect Pin-8-RXB of the BR2G to TX of the external RTCM source
- Connect Pin-5-Common Ground of the BR2G to the signal return or common ground of the external RTCM source

Figure B-2 illustrates the required connectivity between the BR2G, an external RTCM source, and external device:

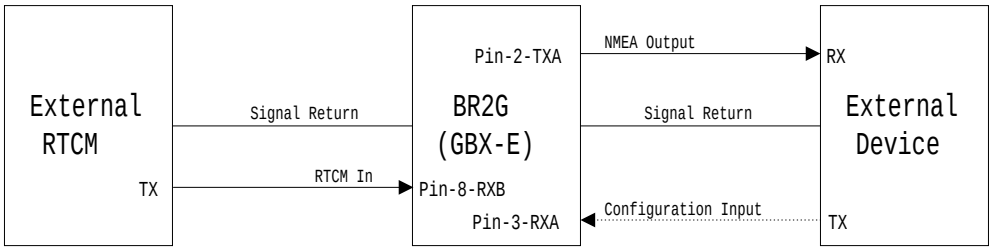


Figure B-2 BR2G Connectivity (GBX-E Mode)

For successful communications, the baud rate of the BR2G must be set to match that of both the monitor and the external RTCM source. Refer to Section 3.4.5 and Section 3.6 for instructions related to setting the BR2G baud rate.

MBX-3 Operating Mode

To establish communications between the BR2G and an external GPS receiver when in MBX-3 mode, you must:

- Connect Pin-2-TXA of the BR2G to the receive pin of the GPS receiver
- Connect Pin-5-Common Ground of the BR2G to the signal return or common ground of the monitor.

Figure B-3 illustrates the required connectivity between the BR2G and an external GPS receiver:

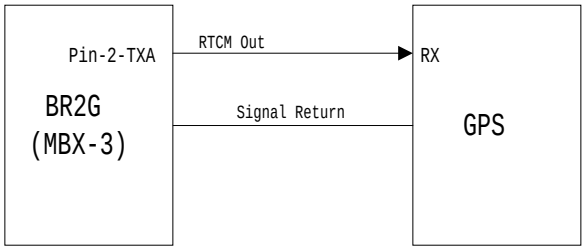


Figure B-3 BR2G Connectivity (MBX-3 Mode)

For successful communications, the baud rate of the BR2G must be set to match that of the external GPS receiver. Refer to Section 3.4.5 and Section 3.6 for instructions related to setting the BR2G baud rate.

MBX-E Operating Mode

To establish communications between the BR2G and an external GPS receiver when in MBX-E mode, you must:

- Connect Pin-2-TXA of the BR2G to the receive pin of the GPS receiver
- Connect Pin-3-RXA of the BR2G to TX of the monitor device
- Connect Pin-5-Common Ground of the BR2G to the signal return or common ground of the monitor.

Figure B-4 illustrates the required connectivity between the BR2G and an external GPS receiver:

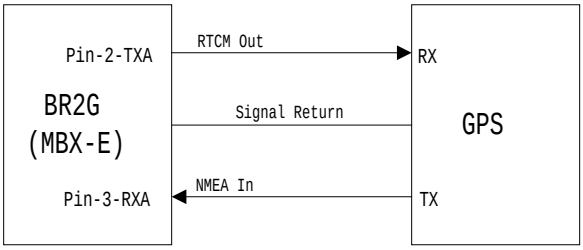


Figure B-4 BR2G Connectivity (MBX-E Mode)

For successful communications, the baud rate of the BR2G must be set to match that of the external GPS receiver. Refer to Section 3.4.5 and Section 3.6 for instructions related to setting the BR2G baud rate.

Appendix C - Beacon Information

Communication Systems International, Inc. endeavors to maintain an accurate listing of DGPS radiobeacons worldwide. This information is available on the Internet from the CSI home page:

www.csi-dgps.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, you may contact CSI Sales and Marketing at 1-403-259-3311.

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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