



# **Vector V103 / V113 GPS Compass User Guide**

Part No. 875-0287-000 Rev. B1

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

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Hemisphere GNSS Precision GNSS Applications

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6,549,091	6,631,916	6,711,501	6,744,404	6,865,465
6,876,920	7,142,956	7,162,348	7,277,792	7,292,185
7,292,186	7,373,231	7,400,956	7,400,294	7,388,539
7,429,952	7,437,230	7,460,942		

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## **Chapter 1: Introduction**

Overview

Parts List

## Overview

The Vector™ V103™ GNSS Compass and V113™ GNSS Compass supports GPS and GLONASS which is based on Hemisphere GNSS' exclusive Crescent® and Crescent Vector™ H200™ GNSS module.



**Figure 1-1: V103/113 side view**

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**Note:** When referring to both the Vector V103 GNSS Compass and the Vector V113 GNSS Compass this manual uses the term V103/113. When referring to either product this manual uses either V103 or V113, respectively.

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The V103/113 is a complete GPS and GLOANASS compass system for heading and positioning in a single enclosure that requires only one power/data cable connection. With its CAN support and ease of installation, the V103/113 is the perfect solution for professional, commercial marine, Radar/ARPA, AIS, ECDIS, scanning sonar and machine control applications.

There are no mechanical parts such as gimbals or rotating motor, thus the V103 and V113 compass is free from routine maintenance. Since heading is determined from GNSS there is no need to wait for settling time, gyrocompass calibration and speed corrections. Our Vector performance is not affected by geomagnetism making it the perfect solution for any marine application.

The V103/113 is an integrated system that houses the following:

- Crescent and Crescent Vector H200 module
- Dual GNSS multipath-resistant antennas
- DGPS beacon module and H-field beacon antenna (V113 only)
- Power supply
- Single axis gyro
- Tilt sensor on each axis (X and Y axes)

The gyro and tilt sensors are present to improve system performance and to provide backup heading information in the event a GNSS heading is not available due to signal blockage. The gyro provides a substitute heading for a short period, accurate to within 1° per minute for up to three minutes.

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**Note:** The V103 GNSS Compass is identical to the V113 GNSS Compass with the exception that it does not contain a DGPS beacon module and antenna. If you purchased the V103 GNSS Compass, disregard the sections of this manual that discuss the beacon signal, receiver operation, and implications to installation relating to the beacon signal.

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Crescent Vector H200 module supports multiple RF front ends - enabling tighter coupling of measurements from separate antennas for use in heading-based products. Users will achieve excellent accuracy and stability due to Crescent's more accurate code phase measurements, improved multipath mitigation, and fewer components.

The V103/113's GPS antennas are separated by 50.0 cm between their phase centers, resulting in a heading performance better than 0.30° rms. The V103/113 provides heading and positioning updates of up to 20 Hz and delivers positioning accuracy of 0.6 m 95% of the time when using differential GPS corrections from beacon (V113 only) or from Space Based Augmentation Systems (SBAS).

The V103/113 also features Hemisphere GNSS' exclusive COAST™ technology that enables Hemisphere GNSS receivers to utilize old differential GPS correction data for 40 minutes or more without significantly affecting the positioning quality. The V103/113 is less likely to be affected by differential signal outages due to signal blockages, weak signals, or interference when using COAST.

If you are new to GNSS and SBAS, refer to the Hemisphere GNSS Technical Reference (go to [www.hemispheregns.com/support](http://www.hemispheregns.com/support) and click the GNSS Reference icon) for further information on these services and technologies before proceeding.

## Parts List

**Note:** The V103/113's parts comply with IEC 60945 Section 4.4: "exposed to the weather."

Table 1-1 lists the parts included with your V103 or V113. The V103/113 GPS Compass and the power/data cable (accessory item) are the only two required components.

**Table 1-1: Parts list**

Part Name	Qty	Part Number
Vector receiver model (one of the following models)		
• V103	1	940-3094-0
• V113	1	940-3095-0
<i>All the following are accessory items available for purchase separately from your V103 or V113.</i>		
Power/data cable, 15m	1	880-1042-000
Power/data cable, 30 m	1	880-1043-000
Each cable includes the following items:		
• Clamp		
• Screw		
• Washer		
Serial-to-NMEA 2000 adapter, includes the following items:	1	710-0113-000#
• Screws		
• Washers		
Installation bracket (black)	1	602-1113-000#



**Table 1-1: Parts list**

<b>Part Name</b>	<b>Qty</b>	<b>Part Number</b>
Replacement connector, 18-pin (when upgrading from V101/111 to V103/113)	1	400-0246-000#

This User Guide is available for download from the Hemisphere GNSS website at [www.hemispheregnss.com](http://www.hemispheregnss.com).

## **Chapter 2: Installation**

Mounting Location

Mounting Orientation

Mounting Options

Ports

Powering the V103/113

Connecting the V103/113 to External Devices

Default Parameters

## Mounting Location

This section provides information on determining the best location for the V103/113.

### GNSS Satellite

When considering where to mount the V103/113, consider the following satellite reception recommendations:

- Consider GNSS (and hence SBAS) reception, ensuring there is a clear view of the sky available to the V103/113 so the GNSS and SBAS satellites are not masked by obstructions that may reduce system performance
- Since the V103/113 computes a position based on the internal primary GNSS antenna element, mount the V103/113 where you desire a position with respect to the primary GNSS antenna (located on the end opposite the recessed arrow on the underside of the enclosure)



- Locate any transmitting antennas away from the V103/113 by at least a few meters to ensure tracking performance is not compromised, giving you the best performance possible
- Make sure there is enough cable length to route into the vessel to reach a breakout box or terminal strip
- Do not locate the antenna where environmental conditions exceed those specified in Table B-6 on page 45

### Beacon Reception

When using the V113's internal beacon receiver as the correction source, consider the possible mounting locations from the perspective of ambient noise within the beacon band.

Keep the following in mind when deciding upon a location with respect to maximizing beacon performance:

- Ensure that the antenna is as far as possible from all other equipment that emits electromagnetic interference (EMI), including DC motors, alternators, solenoids, radios, power cables, display units, and other electronic devices.
- If you are installing the antenna on a vessel, mount the vector compass as high as possible, considering maintenance and accessibility. In addition,

ensure that the antenna is higher than the highest metal object on the vessel.

- If a radar system is present, mount the antenna outside the path of the radar beam.

The V113's internal beacon receiver calculates a signal-to-noise ratio (SNR), measured in decibels (dB), that indicates the receiver's performance. The SNR is the height of the signal above the noise floor: the higher the SNR, the better your beacon receiver demodulates the signal. The optimum antenna location will be a position where your average SNR is highest. You should turn on all accessories that you intend to use during normal operation when locating the best position for the antenna. By monitoring the SNR, you can determine the optimum location with respect to beacon reception. The SNR is available in the \$CRMSS NMEA message described in the Hemisphere GNSS Technical Reference (go to [www.hemispheregns.com/support](http://www.hemispheregns.com/support) and click the GNSS Reference icon).

## Environmental Considerations

Hemisphere vector compasses are designed to withstand harsh environmental conditions; however, adhere to the following limits when storing and using the V103/113:

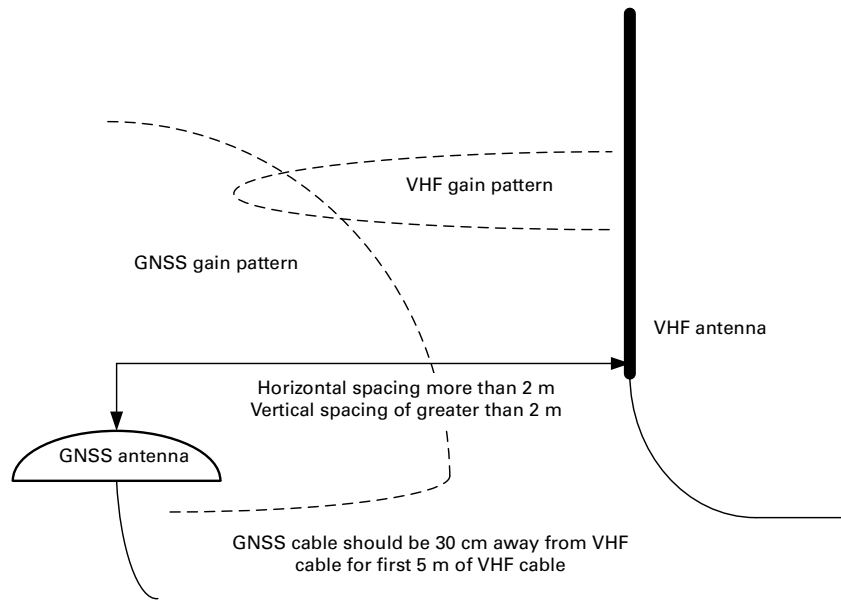
- Operating temperature: -30°C to +70°C (-22°F to +158°F)
- Storage temperature: -40°C to +85°C (-40°F to +185°F)
- Humidity: 95% non-condensing

## VHF Interference

VHF interference from such devices as cellular phones and radio transmitters may interfere with GPS operation, however the Vector compass can still track GLONASS satellites maintaining heading and position. For example, if installing the V103/113 near marine radios consider the following:

- VHF marine radio working frequencies (Channels 1 to 28 and 84 to 88) range from 156.05 to 157.40 MHz. The L1 GPS working center frequency is 1575.42 MHz. The bandwidth is +/- 2MHz to +/- 10 MHz, which is dependent on the GNSS antenna and receiver design.
- VHF marine radios emit strong harmonics. The 10th harmonic of VHF radio, in some channels, falls into the GPS working frequency band, which may cause the SNR of GNSS to degrade significantly.
- The radiated harmonic signal strength of different brands/models varies.
- Follow VHF radio manufacturers' recommendations on how to mount their radios and what devices to keep a safe distance away.
- Handheld 5W VHF radios may not provide suitable filtering and may interfere with the V103/113's operation if too close.

Before installing the vector compass use the following diagram to ensure there are no nearby devices that may cause VHF interference.



**Figure 2-1: V103/113 distance from nearby VHF radios**

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## Mounting Orientation

The V103/113 outputs heading, pitch, and roll readings regardless of the orientation of the antennas. However, the relation of the antennas to the boat's axis determines whether you will need to enter a heading, pitch, or roll bias. The primary antenna is used for positioning and the primary and secondary antennas, working in conjunction, output heading, pitch, and roll values.

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**Note:** Regardless of which mounting orientation you use, the V103/113 provides the ability to output the heave of the vessel. This output is available via the \$GPHEV message. For more information on this message refer to the Hemisphere GNSS Technical Reference (go to [www.hemispheregnss.com/support](http://www.hemispheregnss.com/support) and click the GNSS Reference icon).

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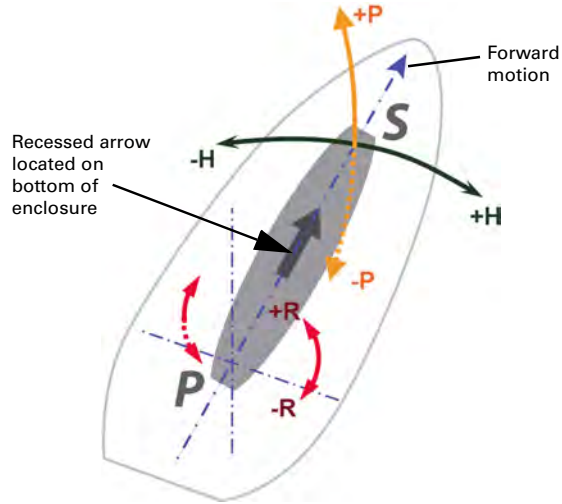
**Parallel Orientation:** The most common installation is to orient the V103/113 parallel to, and along the centerline of, the axis of the boat. **This provides a true heading.** In this orientation:

- If you use a gyrocompass and there is a need to align the vector compass, you can enter a heading bias in the V103/113 to calibrate the physical heading to the true heading of the vessel.
- You may need to adjust the pitch/roll output to calibrate the measurement if the Vector is not installed in a horizontal plane.

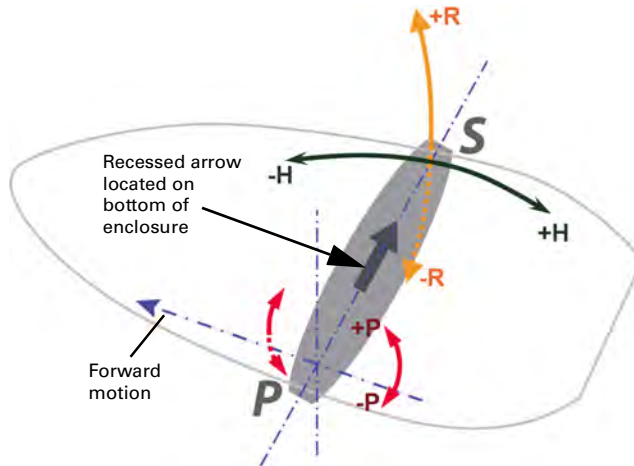
**Perpendicular Orientation:** You can also install the antennas so they are oriented perpendicular to the centerline of the boat's axis. In this orientation:

- You will need to enter a heading bias of +90° if the primary antenna is on the starboard side of the boat and -90° if the primary antenna is on the port side of the boat.
- You will need to configure the receiver to specify the GNSS antennas are measuring the roll axis using \$JATT,ROLL,YES.
- You will need to enter a roll bias to properly output the pitch and roll values.
- You may need to adjust the pitch/roll output to calibrate the measurement if the Vector is not installed in a horizontal plane.

Figure 2-2 and Figure 2-3 provide mounting orientation examples.



**Figure 2-2: Recommended orientation and resulting signs of HPR values**



**Figure 2-3: Alternate orientation and resulting signs of HPR values**

### Vector Compass Alignment

The top of the V103/113 enclosure incorporates sight design features to help you align the enclosure with respect to an important feature on your vessel.

To use the sights, center the small post on the opposite side of the enclosure from you, within the channel made in the medallion located in the center of the enclosure top as shown in Figure 2-4 and Figure 2-5. Alignment accuracy when looking through the long site (Figure 2-4) is approximately  $\pm 1^\circ$ , while alignment through the short site (Figure 2-5) is approximately  $\pm 2.5^\circ$ .



**Figure 2-4: Long site alignment**



**Figure 2-5: Short sight alignment**

If you have another accurate source of heading data on your vessel, such as a gyrocompass, you may use its data to correct for a bias in V103/113 alignment within the V103/113 software configuration. Alternatively, you can physically adjust the heading of the V103/113 so that it renders the correct heading measurement; however, adding a software offset is an easier process.



## Mounting Options

The V103/113 allows for two different mounting options: flush mount and pole mount.

- Flush mount - The bottom of the V103/113 contains eight M8-1.25 holes for flush mounting the unit to a flat surface (see Figure 2-6). The eight holes comprise two sets of four holes. The inner four holes are in the same location as the V102, allowing you to use the V103/113 as a drop-in replacement. The outer four holes provide a wider mounting option.
- Pole mount - The bottom of the V103/113 contains a mounting hole (1" thread, 0.9" depth) for easy pole mounting. Hand tighten until snug (do not overtighten). The set screws on the long sides of the base (see middle drawing in Figure 2-6) allow you to secure the V103/113 in place (3/16" Allen wrench not included).
- Bracket mount - You can purchase an optional mounting bracket. See Table 1-1 on page 3 for bracket part information.

### V103/113 Dimensions

Figure 2-6 illustrates the physical dimensions of the V103/113.

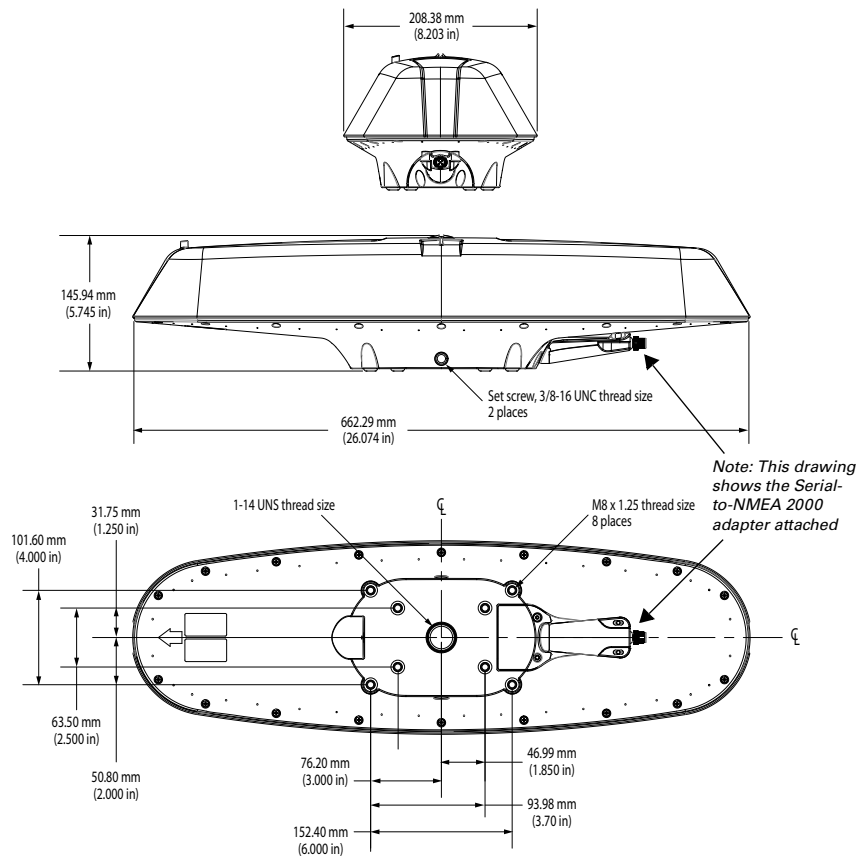


Figure 2-6: V103/113 dimensions

### **Power/Data Cable Considerations**

Before mounting the V103/113 consider the following regarding power/data cable routing:

- Cable must reach an appropriate power source
- Cable may connect to a data storage device, computer, or other device that accepts GNSS data
- Avoid running the cable in areas of excessive heat
- Keep cable away from corrosive chemicals
- Do not run the cable through door or window jams
- Keep cable away from rotating machinery
- Do not crimp or excessively bend the cable
- Avoid placing tension on the cable
- Remove unwanted slack from the cable at the V103/113 end
- Secure along the cable route using plastic wraps

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**▲WARNING:** Improperly installed cable near machinery can be dangerous.

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## Mounting the V103/113

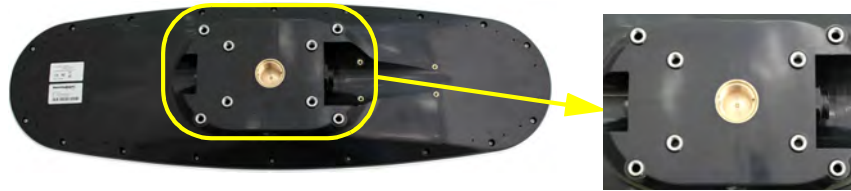
This section describes how to flush mount or pole mount the V103/113.

Keep the following in mind when planning your installation:

- Hemisphere GNSS does not supply mounting surface hardware or a mounting pole. You must supply the appropriate hardware or mounting pole required to complete V103/113 installation.
- You do not necessarily need to orient the antenna precisely as you can enter a software offset to accommodate for a heading measurement bias due to installation.

### Flush Mounting the V103/113

The bottom of the V103/113 contains eight holes (two sets of four holes) for flush mounting the unit to a flat surface (Figure 2-7). The flat surface may be something you fabricate per your installation, an off-the-shelf item (such as a radar mounting plate), or an existing surface on your vessel.



**Figure 2-7: Flush mounting holes on bottom of V103/113**

Complete the following steps to flush mount the V103/113:

1. Determine the desired location and proper orientation for the V103/113. See “Mounting Orientation” on page 9 for information on determining the desired orientation.
2. Use the supplied template or photocopy the section of the V103/113 that contains the eight mounting holes (see Figure 2-7) for use as a template to plan the mounting hole locations. Use the inner four holes or the outer four holes per your installation.  
If using a photocopy make sure it is scaled one-to-one with the mounting holes on the bottom of the V103/113.
3. Mark the mounting hole centers on the mounting surface.
4. Place the V103/113 over the marks to ensure the planned hole centers align with the true hole centers (adjusting as necessary).
5. Use a center punch to mark the hole centers.
6. Drill the mounting holes with a 9 mm bit appropriate for the surface.
7. Place the V103/113 over the mounting holes and insert the mounting screws through the bottom of the mounting surface into the V103/113.

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**⚠WARNING:** When installing the V103/113, hand tighten only. Damage resulting from overtightening is not covered by the warranty.

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### **Pole Mounting the Vector Compass**

If you need the GNSS-assisted roll measurement, install the V103/113 perpendicular to the vessel's axis. If you do not need this measurement, install the V103/113 parallel with the vessel's axis. For more information refer to Figure 2-2 and Figure 2-3 on page 10.

Complete the following steps to pole mount the V103/113:

1. Determine the desired location and proper orientation for the V103/113. See "Mounting Orientation" on page 9 for information on determining the desired orientation.
2. Hand tighten the V103/113 on the pole until snug (unit is stable on pole) while ensuring correct orientation.

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**⚠ WARNING:** Hand tighten only. Damage resulting from over-tightening is not covered by the warranty.

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3. Use the set screws on the long sides of the base (see Figure 2-6 on page 12) to secure the V103/113 in place (3/16" Allen wrench not included).

## Connecting the Serial Cable or Serial-to-NMEA 2000 Adapter to the V103/113

After you mount the V103/113 connect either the serial power/data cable or the serial-to-NMEA 2000 adapter to the V103/113.

### Connecting the Serial Power/Data Cable

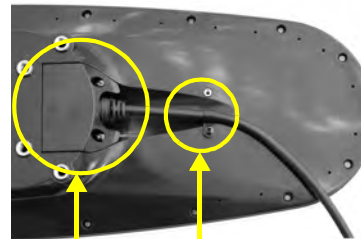
1. Align the cable connector keyway with the V103/113 connector key.
2. Rotate the cable ring clockwise until it locks. The locking action is firm; you will feel a positive "click" when it has locked.



Steps 1&2:  
Attach  
cable  
to unit



3. Attach the power/data cable to the cable clamp.
4. Fasten the clamp to the bottom of the V103/113 using the screw and washer.
5. Attach the cable cover.



Steps 3&4:  
Attach clamp and  
cable to unit

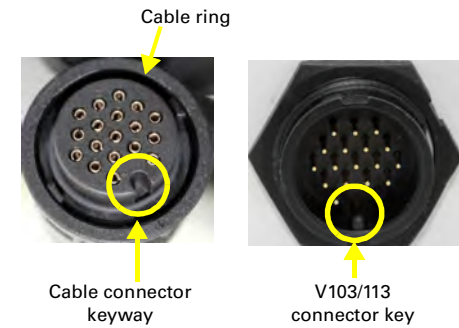
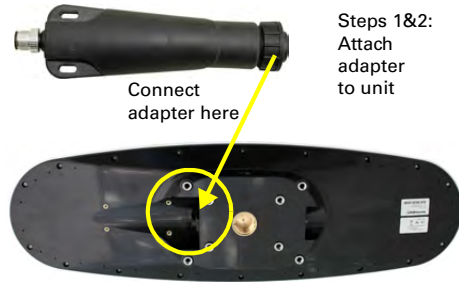


Step 5:  
Attach  
cable  
cover

**Connecting the Serial-to-NMEA 2000 Adapter**

For more information on the serial-to-NMEA 2000 adapter see “NMEA 2000 Port” on page 19.

1. Align the adapter connector keyway with the V103/113 connector key.
2. Rotate the cable ring clockwise until it locks. The locking action is firm; you will feel a positive “click” when it has locked.



3. Fasten the adapter to the body of the V103/113 using the provided screws and the two slots in the adapter.
4. Attach the cable cover.



## Ports

The V103/113 offers either serial port or NMEA 2000 port functionality.

### Serial Ports

The V103/113 has three ports (Port A, Port B, and Port C), where:

- Port A can be both full-duplex RS-232 and half-duplex RS-422 (transmit only)
- Port B is full-duplex RS-422
- Port C is for NMEA 2000 and only available via serial-to-NMEA 2000 adapter

You can receive external differential corrections via either Port A (full-duplex RS-232) or Port B (full-duplex RS-422). You can connect up to three devices at one time using two ports. One device can receive data via Port A (RS-422 transmit only) while two devices can transmit and receive data via Ports A and B (one connected to Port A RS-232 and one connected to Port B).

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**Note:** Port A (RS-422) or Port B is required for communicating to an IMO-approved device.

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You can update firmware via Port A (RS-232) or Port B.

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**Note:** The V103/113 has maximum baud rate of 38400.

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### Serial Port Configuration

You may configure Port A or Port B of the GNSS receiver to output any combination of data. Port A can have a different configuration from Port B in terms of data message output, data rates, and the baud rate of the port. This allows you to configure the ports independently based upon your needs.

For example, if you want one generalized port and one heading-only port, you can configure the ports as follows:

- Port A to have GPGGA, GPVTG, GPGSV, GPZDA, and GPHDT all output at 1 Hz over a 9600 baud rate.
- Port B for GPHDT and GPROT message output at their maximum rate of 20 Hz over a 19200 baud rate.

The messages you configure each port to output and the rate of the port will be the same for both RS-232 and RS-422 interface levels. For example, the RS-232 Port A and RS-422 Port A output the same data messages at the same baud rate. If the baud rate or messages for the RS-422 port need to be changed, this needs to be commanded through the RS-232 port.

Both RS-232 and RS-422 output signals may be used simultaneously.

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**Note:** For successful communications use the 8-N-1 protocol and set the baud rate of the V103/113's serial ports to match that of the devices to which they are connected. Flow control is not supported.

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### Selecting Baud Rates and Message Types

When selecting your baud rate and message types use the following formula to calculate the bits/sec for each message and then sum the results to determine the baud rate for your required data throughput.

Message output rate \* Message length (bytes) \* bits in byte = Bits/second  
(1 character = 1 byte, 8 bits = 1 byte, use 10 bits/byte to account for overhead)

See “Common Commands and Messages” on page 34 for an example of this calculation. For information on message output rates refer to the Hemisphere GNSS Technical Reference (go to [www.hemispheregnss.com/support](http://www.hemispheregnss.com/support) and click the GNSS Reference icon).

### Recommendations for Connecting to Other Devices

When interfacing to other devices, ensure the transmit data output from the V103/113 is connected to the data input of the other device. The signal grounds must also be connected.

Since RS-422 is a balanced signal with positive and negative signals referenced to ground, ensure you maintain the correct polarity. For example, when connecting the transmit data output positive signal to the receive line of the other device, it should be connected to the receive positive terminal. The negative transmit data signal from the V103/113 is then connected to the receive data negative input of the other device.

There is likely little reason to connect the receive data input of the V103/113 to another device unless it is able to send configuration commands to the V103/113. Since the V103/113 uses proprietary NMEA 0183 commands for control over its configuration, the vast majority of electronics will not be able to configure its settings unless the other device has a terminal setting where you can manually issue commands.

### NMEA 2000 Port

To use V103/113 for NMEA 2000 you have to connect the included serial-to-NMEA 2000 adapter (P/N 710-0113-000#, see Figure 2-8) to the unit. Insert the 18-pin connector of the adapter into the male end of the 18-pin connector on the V103/113 by aligning the keys. You can then attach the adapter to the unit using the supplied screws (machine, 8-32, 1/2", PPHC, SS) and washer (flat, #8, SS). The 5-pin male Micro-C connector connects to your NMEA 2000 drop cable.



**Figure 2-8: Serial-to-NMEA 2000 adapter**

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**Note:** The serial-to-NMEA 2000 adapter is not an IMO requirement and may not be used in such an application.

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Table 2-1 shows the requested PGNs with the V103/113 in NMEA 2000 mode.

**Table 2-1: Received messages based on a request**

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
059392	ISO Acknowledgement Used to acknowledge the status of certain requests addressed to a specific ECU.	B	On Request	On Request
059904	ISO Request Request the transmission of a specific PGN, addressed or broadcast.	B	On Request	On Request
060928	ISO Address Claim Used to identify to other ECUs the address claimed by an ECU.	B	On Request	On Request
126996	Product Information NMEA 2000 database version supported, manufacturer's product code, NMEA 2000 certification level, Load Equivalency number, and other product-specific information.	B	On Request	On Request
126464	Receive/Transmit PGNs group function The Transmit / Receive PGN List Group type of function is defined by first field. The message will be a Transmit or Receive PGN List group function.	B	On Request	On Request
129538	GNSS Control Status GNSS common satellite receiver parameter status.	B	On Request	On Request
129545	GNSS RAIM Output Used to provide the output from a GNSS receiver's Receiver Autonomous Integrity Monitoring (RAIM) process. The Integrity field value is based on the parameters set in PGN 129546 GNSS RAIM Settings.	B	On Request	On Request
129546	GNSS RAIM Settings Used to report the control parameters for a GNSS Receiver Autonomous Integrity Monitoring (RAIM) process.	B	On Request	On Request

Table 2-2 shows the transmitted PGNs with their default update rate with the V103/113 in NMEA 2000 mode.

**Table 2-2: Transmitted messages**

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
126992	System Time The purpose of this PGN is twofold: To provide a regular transmission of UTC time and date. To provide synchronism for measurement data.	B	1000	1
127250	Vessel Heading Heading sensor value with a flag for True or Magnetic. If the sensor value is Magnetic, the deviation field can be used to produce a Magnetic heading, and the variation field can be used to correct the Magnetic heading to produce a True heading.	B	100	10
127251	Rate of Turn Rate of change of the Heading.	B	100	10
127257	Attitude Provides a single transmission that describes the position of a vessel relative to both horizontal and vertical planes. This would typically be used for vessel stabilization, vessel control and onboard platform stabilization.	B	1000	1
127258	Magnetic Variation Message for transmitting variation. The message contains a sequence number to allow synchronization of other messages such as Heading or Course over Ground. The quality of service and age of service are provided to enable recipients to determine an appropriate level of service if multiple transmissions exist.		1000	1
129025	Position, Rapid Update Provides latitude and longitude referenced to WGS84. Being defined as single frame message, as opposed to other PGNs that include latitude and longitude and are defined as fast or multi-packet, this PGN lends itself to being transmitted more frequently without using up excessive bandwidth on the bus for the benefit of receiving equipment that may require rapid position updates.	B	100	10
129026	COG & SOG, Rapid Update Single frame PGN that provides Course Over Ground (COG) and Speed Over Ground (SOG).	B	250	4

**Table 2-2: Transmitted messages (continued)**

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
129027	Position Delta, High Precision Rapid Update The 'Position Delta, High Precision Rapid Update' Parameter Group is intended for applications where very high precision and very fast update rates are needed for position data. This PGN can provide delta position changes down to 1 mm with a delta time period accurate to 5 msec.	B	100	10
129028	Altitude Delta, High Precision Rapid Update The 'Altitude Delta, High Precision Rapid Update' Parameter Group is intended for applications where very high precision and very fast update rates are needed for altitude and course over ground data. This PG can provide delta altitude changes down to 1 millimeter, a change in direction as small as 0.0057°, and with a delta time period accurate to 5 msec.	B	100	10
129029	GNSS Position Data Conveys a comprehensive set of Global Navigation Satellite System (GNSS) parameters, including position information.	B	1000	1
129033	Time & Date Single transmission that provides UTC time, UTC Date, and Local Offset.	B	1000	1
129539	GNSS DOPs Provides a single transmission containing GNSS status and dilution of precision components (DOP) that indicate the contribution of satellite geometry to the overall positioning error. There are three DOP parameters reported: horizontal (HDOP), Vertical (VDOP), and time (TDOP).	B	1000	1
129540	GNSS Sats in View GNSS information on current satellites in view tagged by sequence ID. Information includes PRN, elevation, azimuth, SNR, defines the number of satellites; defines the satellite number and the information.	B	1000	1

## Powering the V103/113

### Power Considerations

For best performance use a clean and continuous power supply. The V103/113 power supply features reverse polarity protection but will not operate with reverse polarity.

See Table B-4 on page 45 for complete power specifications.

### Connecting to a Power Source

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**Note:** This section refers to powering the unit via serial connection. To power the unit via NMEA 2000 connection, follow the standard procedure for powering up via NMEA 2000.

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Before you power up the V103/113 you must terminate the wires of the power cable as required. There are a variety of power connectors and terminals on the market from which to choose, depending on your specific requirements.

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**⚠ WARNING:** Do not apply a voltage higher than 36 VDC. This will damage the receiver and void the warranty.

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To interface the V103/113 power cable to the power source:

- Connect the red wire of the cable's power input to DC positive (+)
- Connect the black wire of the cable's power input to DC negative (-)

The V103/113 will start when an acceptable voltage is applied to the power leads of the extension cable.

### Electrical Isolation

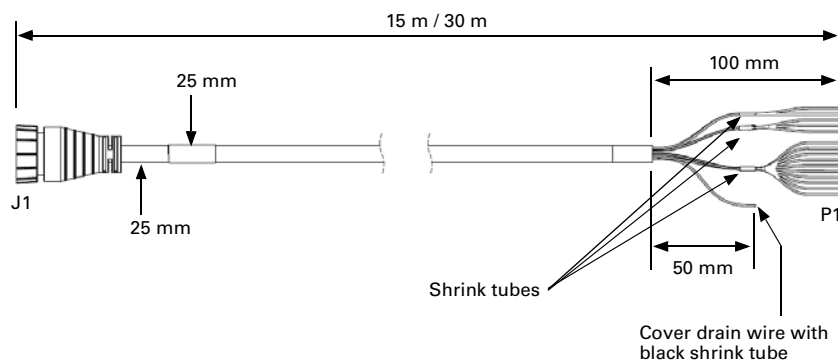
The V103/113's power supply is isolated from the communication lines and the PC-ABS plastic enclosure isolates the electronics mechanically from the vessel (addressing the issue of vessel hull electrolysis).

## Connecting the V103/113 to External Devices

**Note:** This section refers to a serial connection. For connecting external NMEA 2000 devices, plug the serial-to-NMEA 2000 adapter into the V103/113 and then attach a standard NMEA 2000 dropline cable to the adapter.

### Power/Data Cable Considerations

The V103/113 uses a single 15 m (49 ft) or 30 m (98 ft) cable for power and data input/output.



**Figure 2-9: Power/data cable, 15 m or 30 m**

The receiver end of the cable is terminated with an environmentally sealed 18-pin connection while the opposite end is unterminated and requires field stripping and tinning.

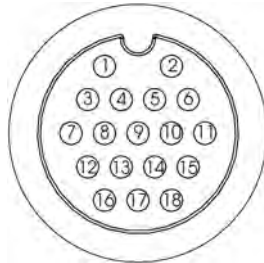
Depending on the application and installation needs, you may need to shorten this cable. However, if you require a longer cable run than 30 m, you can bring the cable into a break-out box that incorporates terminal strips, within the vessel.

When lengthening the cable keep the following in mind:

- To lengthen the serial lines inside the vessel, use 20-gauge twisted pairs and minimize the additional wire length.
- When lengthening the power input leads to the V103/113, ensure the additional voltage drop is small enough that your power system can continue to power the system above the minimum voltage of the system. Wire of 18-gauge or larger should also be used.
- Minimize RS-232 cable length to ensure reliable communication

## Power/Data Cable Pinout Specifications

Figure 2-10 shows the power/data cable pinout, while Table 2-3 shows the cable's pinout specifications.



**Figure 2-10: Power/data cable pin assignment**

**Table 2-3: Power/data cable pinout**

Pin	Function	Wire Color
1	Power (+)	Red
2	Power (-)	Black
3	Port A Tx RS-232	Blue
4	Port A Rx RS-232	Black/blue stripe
5	Reserved	
6	Port A Tx RS-422(+)	Green
7	Port B Rx RS-422(+)	Brown
8	Port B Rx RS-422(-)	Black/brown stripe
9	Reserved	
10	Drain	Bare wire
11	Port A Tx RS-422(-)	Green/black stripe
12	Signal ground	Grey
13	Alarm	White
14	Alarm	White/red stripe
15	1 PPS(+)	Orange
16	Port B Tx RS-422(+)	Yellow
17	Port B Tx RS-422(-)	Yellow/black stripe
18	1 PPS(-)	Orange/black stripe

## Default Parameters

Table 2-4 and Table 2-5 provide details on the default port settings, available baud rates, differential age, elevation mask, and default differential mode.

**Note:** Use the \$JSAVE command to save changes you make to the V103/113's configuration for the changes to be present in subsequent power cycles.

**Table 2-4: Default port settings**

Port	Baud Rate	NMEA Messages	Update Rate
Port A (RS-232)	19200	GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT	1 Hz
Port C (RS-232)	19200	GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT	1 Hz
Power RED (+) BLK (-)	6 - 36 VDC		
<b>Note:</b> The default update rate for NMEA 0183 messages is 1 Hz. 10 Hz is the standard maximum rate, but you can purchase a subscription to upgrade the output rate to 20 Hz.			

**Table 2-5: Default parameters**

Unit	Parameter	Specification
V103 and V113	Max DGNSS age (correction age)	2700 seconds
	Elevation mask	5°
	Differential mode	V103: SBAS V113: Beacon
V113 (internal beacon parameters)	Frequency selection	Automatic
	MSK rate selection	Automatic

## **Chapter 3: Operation**

GNSS Overview

V103/113 Overview

Common Commands and Messages



## GNSS Overview

For your convenience, both the GNSS and SBAS operation of the V103/113 features automatic operational algorithms. When powered for the first time, the V103/113 performs a 'cold start' that involves acquiring the available GNSS satellites in view and the SBAS differential service.

If SBAS is not available in your area, an external source of RTCM SC-104 differential corrections may be used. If you use an external source of correction data, it must support an eight data bit, no parity, one stop bit configuration (8-N-1).

## GNSS Operation

The GNSS receiver is always operating, regardless of the DGNSS mode of operation. The following sections describe the general operation of the V103/113's internal GNSS receiver.

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**Note:** Differential source and status have no impact on heading, pitch, or roll. They only have an impact on positioning and heave.

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### Automatic Tracking

The V103/113's internal GNSS receiver automatically searches for GNSS satellites, acquires the signals, and manages the navigation information required for positioning and tracking.

### Receiver Performance

The V103/113 works by finding four or more GPS satellites in the visible sky. It uses information from the satellites to compute a position within 2.5 m. Since there is some error in the GNSS data calculations, the V103/113 also tracks a differential correction. The V103/113 uses these corrections to improve its position accuracy to better than 0.6 m.

The two main aspects of GNSS receiver performance are 1) satellite acquisition, and 2) positioning and heading calculation.

When the V103/113 is properly positioned, the satellites transmit coded information to the antennas on a specific frequency. This allows the receiver to calculate a range to each satellite from both antennas. GNSS is essentially a timing system. The ranges are calculated by timing how long it takes for the signal to reach the GNSS antenna. The GNSS receiver uses a complex algorithm incorporating satellite locations and ranges to each satellite to calculate the geographic location and heading. Reception of any four or more GNSS signals allows the receiver to compute three-dimensional coordinates and a valid heading.

## Differential Operation

The purpose of differential GNSS (DGNSS) is to remove the effects of selective availability (SA), atmospheric errors, timing errors, and satellite orbit errors, while enhancing system integrity. Autonomous positioning capabilities of the V103/113 will result in positioning accuracies of 2.5 m 95% of the time. In order to improve positioning quality to better than 0.6 m 95%, the V103/113 is able to use differential corrections received through the internal SBAS demodulator or beacon receiver, or through externally-supplied RTCM corrections.

### **Automatic SBAS Tracking**

The V103/113 automatically scans and tracks SBAS signals without the need to tune the receiver. The V103/113 features two-channel tracking that provides an enhanced ability to maintain a lock on an SBAS satellite when more than one satellite is in view. This redundant tracking approach results in more consistent tracking of an SBAS signal in areas where signal blockage of a satellite is possible.

### **Beacon Operation**

Many marine authorities, such as coast guards, have installed networks of radio-beacons that broadcast DGNSS (only a few Beacon stations outside of North America. V113 supports DGNSS corrections) corrections to users of this system. With the increasing utility of these networks for terrestrial applications, there is an increasing trend toward densification of these networks inland. The dual channel beacon receiver in the V113 can operate in manual or automatic tuning mode, or, using database mode, will select the closest station in compliance with IEC 61108-4 standards.

## **V103/113 Overview**

The V103/113 provides accurate and reliable heading and position information at high update rates. To accomplish this task, the V103/113 uses a high performance GNSS receiver and two antennas for GNSS signal processing. One antenna is designated as the primary GNSS antenna and the other is the secondary GNSS antenna. Positions computed by the V103/113 are referenced to the phase center of the primary GNSS antenna. Heading data references the vector formed from the primary GNSS antenna phase center to the secondary GNSS antenna phase center.

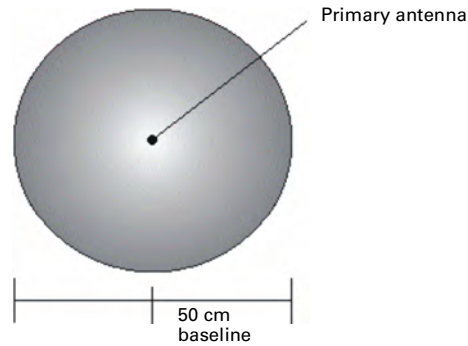
The heading arrow located on the bottom of the V103/113 enclosure defines system orientation. The arrow points in the direction the heading measurement is computed (when the antenna is installed parallel to the fore-aft line of the vessel). The secondary antenna is directly above the arrow.

### **Fixed Baseline Moving Base Station RTK**

The V103/113's internal GNSS receiver uses both the L1 GPS and GLONASS C/A code and carrier phase data to compute the location of the secondary GNSS antenna in relation to the primary GNSS antenna with a very high sub-centimeter level of precision. The technique of computing the location of the secondary GNSS antenna with respect to the primary antenna, when the primary antenna is moving, is often referred to as moving base station Real Time Kinematic (or moving base station RTK).

Generally, RTK technology is very sophisticated and requires a significant number of possible solutions to be analyzed where various combinations of integer numbers of L1 wavelengths to each satellite intersect within a certain search volume. The integer number of wavelengths is often referred to as the "ambiguity" as they are initially ambiguous at the start of the RTK solution.

The V103/113 restricts the RTK solution. It does this knowing that the secondary GNSS antenna is 50 cm from the primary GNSS antenna. This is called a fixed baseline and it defines the search volume of the secondary antenna as the surface of a sphere with radius 50 cm centered on the location of the primary antenna (see Figure 3-1).



**Figure 3-1: Secondary antenna's search volume**

**Note:** The V103/113 moving base station algorithm only uses GNSS to calculate heading. Differential corrections are not used in this calculation and will not affect heading accuracy.

### Supplemental Sensors

The V103/113 has three supplemental sensors (gyro and two tilt sensors) that are integrated into the unit's carrier board. The supplemental sensors are enabled by default. You can enable/disable the gyro and both tilt sensors (you cannot enable/disable each tilt sensor separately).

The sensors act to reduce the RTK search volume, which improves heading startup and reacquisition times. This improves the reliability and accuracy of selecting the correct heading solution by eliminating other possible, erroneous solutions. Table 3-1 provides a sensor operation summary.

**Table 3-1: Sensor operation summary**

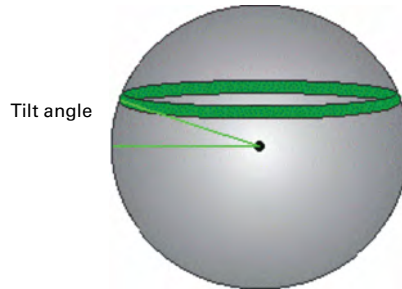
Feature	Normal Operation	Coasting (no GPS)
Heading	GNSS	Gyro
Heave	GNSS	None
Pitch	GNSS	Inertial sensor
Roll	Inertial sensor	Inertial sensor

Refer to the Hemisphere GNSS Technical Reference (go to [www.hemispheregnss.com/support](http://www.hemispheregnss.com/support) and click the GNSS Reference icon) for the commands and methodology required to recalibrate, query, or change a sensor's status.

### Tilt Aiding

The V103/113's accelerometers (internal tilt sensors) are factory calibrated and enabled by default. This constrains the RTK heading solution beyond the volume associated with just a fixed antenna separation. This is because the V103/113 knows the

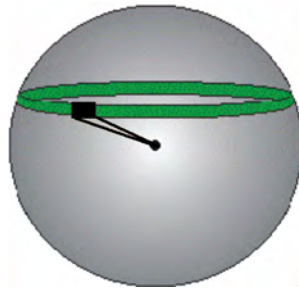
approximate inclination of the secondary antenna with respect to the primary antenna. The search space defined by the tilt sensor will be reduced to a horizontal ring on the sphere's surface by reducing the search volume. This considerably decreases instances of incorrect headings as well as startup and reacquisition times (see Figure 3-2).



**Figure 3-2: V103/113's tilt aiding**

### Gyro Aiding

The V103/113's internal gyro offers several benefits. It reduces the sensor volume for an RTK solution. This shortens reacquisition times when a GNSS heading is lost because the satellite signals were blocked. The gyro provides a relative change in angle since the last computed heading, and, when used in conjunction with the tilt sensor, defines the search space as a wedge-shaped location (see Figure 3-3).



**Figure 3-3: V103/113's gyro aiding**

The gyro aiding accurately smoothes the heading output and the rate of turn. It provides a substitute heading for a short period, accurate to within 1° per minute for up to three minutes, in times of GNSS loss for either antenna. If the outage lasts longer than three minutes, the gyro will have drifted too far and the V103/113 begins outputting null fields in the heading output messages. There is no user control over the timeout period of the gyro.

Calibration, which is set at the factory, is required for the gyro to remove latency from the heading solution as well as provide backup heading when GNSS is blocked. The receiver will calibrate itself after running for a while but it may be important to follow the manual calibration instructions if you want to guarantee performance quickly after powering up the receiver.

The gyro initializes itself at powerup and during initialization, or you can calibrate it as outlined in the Hemisphere GNSS Technical Reference (go to

[www.hemispheregps.com/support](http://www.hemispheregps.com/support) and click the GPS Reference icon). When the gyro is first initializing, it is important that the dynamics that the gyro experiences during this warmup period are similar to the regular operating dynamics. For example, if you use the V103/113 on a high speed, maneuverable craft, it is recommended that when gyro aiding in the V103/113 is first turned on, use it in an environment that has high dynamics for the first five to ten minutes instead of sitting stationary.

With the gyro enabled, the gyro is also used to update the post HTAU smoothed heading output from the moving base station RTK GNSS heading computation. This means that if the HTAU value is increased while gyro aiding is enabled, there will be little to no lag in heading output due to vehicle maneuvers. The Hemisphere GNSS Technical Reference includes information on setting an appropriate HTAU value for the application.

### Time Constants

The V103/113 incorporates user-configurable time constants that can provide a degree of smoothing to the heading, pitch, rate of turn (ROT), course over ground (COG), and speed measurements. You can adjust these parameters depending on the expected dynamics of the vessel. For example, increasing the time is reasonable if the vessel is very large and is not able to turn quickly or would not pitch quickly. The resulting values would have reduced “noise,” resulting in consistent values with time. However, if the vessel is quick and nimble, increasing this value can create a lag in measurements. Formulas for determining the level of smoothing are located in the Hemisphere GNSS Technical Reference (go to [www.hemispheregps.com/support](http://www.hemispheregps.com/support) and click the GNSS Reference icon). If you are unsure on how to set this value, it is best to be conservative and leave it at the default setting.

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**Note:** For heading and rate of turn there is no lag once the gyro is calibrated and enabled.

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**Heading time constant:** Use the \$JATT,HTAU command to adjust the level of responsiveness of the true heading measurement provided in the \$GPHDT message. The default value of this constant is 10.0 seconds of smoothing when the gyro is enabled. The gyro is enabled by default, but can be turned off. By turning the gyro off, the equivalent default value of the heading time constant would be 0.5 seconds of smoothing. This is not automatically done and therefore you must manually enter it. Increasing the time constant increases the level of heading smoothing and increases lag only if the gyro is disabled.

**Pitch time constant:** Use the \$JATT,PTAU command to adjust the level of responsiveness of the pitch measurement provided in the \$PSAT,HPR message. The default value of this constant is 0.5 seconds of smoothing. Increasing the time constant increases the level of pitch smoothing and increases lag.

**Rate of Turn (ROT) time constant:** Use the \$JATT,HRTAU command to adjust the level of responsiveness of the ROT measurement provided in the \$GPROT message. The default value of this constant is 2.0 seconds of smoothing. Increasing the time constant increases the level of ROT smoothing.

**Course Over Ground (COG) time constant:** Use the \$JATT,COGTAU command to adjust the level of responsiveness of the COG measurement provided in the \$GPVTG message. The default value of this constant is 0.0 seconds of smoothing. Increasing the time constant increases the level of COG smoothing. COG is computed using only

the primary GNSS antenna and its accuracy depends upon the speed of the vessel (noise is proportional to 1/speed). This value is invalid when the vessel is stationary, as tiny movements due to calculation inaccuracies are not representative of a vessel's movement.

**Speed time constant:** Use the \$JATT,SPDTAU command to adjust the level of responsiveness of the speed measurement provided in the \$GPVTG message. The default value of this constant is 0.0 seconds of smoothing. Increasing the time constant increases the level of speed measurement smoothing.

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## Alarm Functionality

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**Note:** Alarm functionality is only valid for serial communication.

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A relay is located on the Transmit Heading Device (THD) circuit board. The relay contacts are isolated from all circuitry in the THD. The THD is connected to the coil side of the relay, but not to the contacts that are connected to the external pins through the main IO connector. If the THD loses power or heading, the coil voltage is lost and the relay opens and activates the notification method employed by the user. When the heading is output, the relay contacts remain closed, completing the circuit as an indication that the V103/113 is operational.

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**Note:** Alarm pins must be connected to an IMO-approved device.

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### Alarm Signal

There are two wires (24 AWG multistrands) on the output cable that are used for the external alarm function. The color codes for the two wires are white and white/red stripe and are the output of a relay. When this relay closes, the connection is complete on the user-defined external notification device.

### Watchdog

The watchdog is a timer that is controlled by the software that monitors if the heading is lost. The watchdog software is compliant with IEC 60495.

## Common Commands and Messages

**Note:** When selecting your baud rate and message types use the following formula and example to calculate the bits/sec for each message and then sum the results to determine the baud rate for your required data throughput.

The V103/113 has maximum baud rate of 38400.

Message output rate \* Message length (bytes) \* bits in byte = Bits/second  
(1 character = 1 byte, 8 bits = 1 byte, use 10 bits/byte to account for overhead)

*Example:*

Message	Rate	Bytes	Bits in byte	Bits/sec
GPHDT	10	20	10	2000
GPROT	5	18	10	900
GPHDG	1	33	10	330
GPGGA	1	83	10	830
GPZDA	1	38	10	380
			Total	4440

For information on message output rates refer to the Hemisphere GNSS Technical Reference (go to [www.hemispheregnss.com/support](http://www.hemispheregnss.com/support) and click the GNSS Reference icon).

Table 3-2 below through Table 3-5 on page 37 provide brief descriptions of common commands and messages for the V103/113. Refer to the Hemisphere GNSS Technical Reference for more detailed information.

**Table 3-2: Commands**

Command	Description
\$GPMSK	Tune beacon to specific frequency
\$JAGE	Specify maximum DGPS (COAST) correction age (6 to 8100 seconds)
\$JAPP	Query or specify receiver application firmware
\$JASC	Specify ASCII messages to output to specific ports (see ASCII messages in Table 3-3)
\$JBAUD	Specify RS-232, RS-422 (output) communication rate
\$JBIN	Specify binary messages to output to specific ports (see Table 3-4)
\$JDIFF	Query or specify differential correction mode
\$JGEO	Query or specify SBAS for current location and SBAS satellites
\$JI	Query unit's serial number and firmware versions
\$JOFF	Turn off all dat messages
\$JQUERY,GUIDE	Query accuracy suitability for navigation
\$JMODE,GPSONLY,YES	GPS only mode
\$JMODE,GPSONLY,NO	GPS and GLONASS mode

**Table 3-2: Commands (continued)**

Command	Description
\$JRESET	<p>Reset unit's configuration to firmware defaults</p> <p><b>Note:</b> \$JRESET clears all parameters. For the V103/113 you will have to issue the \$JATT, FLIPBRD, YES command to properly redefine the circuitry orientation inside the product once the receiver has reset. Failure to do so will cause radical heading behavior.</p> <p>You can also issue the \$JRESET command with an optional field as follows:</p> <ul style="list-style-type: none"> <li>\$JRESET,ALL does everything \$JRESET does, plus it clears almanacs</li> <li>\$JRESET,BOOT does everything \$JRESET,ALL does, plus clears use of the real-time clock at startup, clears use of backed-up ephemeris and almanacs, and reboots the receiver when done</li> </ul>
\$JSAVE	Save session's configuration changes

In Table 3-3 the Info Type value is one of the following:

- P = Position
- V = Velocity, Time
- H = Heading, Attitude
- S = Sats, Stats, Quality

**Table 3-3: NMEA 0183 and other messages**

Message	Info Type	Max Output Rate	Description	IEC Approved Message
\$GPDTM	P	1 Hz	Datum reference	Yes
\$GPGGA	P	20 Hz	GPS position and fix data	Yes
\$GPGLL	P	20 Hz	Geographic position - lat/long	Yes
\$GPGNS	P	20 Hz	GNSS position and fix data	Yes
\$GPGRS	S	1 Hz	GNSS range residual (RAIM)	Yes
\$GPGSA	S	1 Hz	GNSS DOP and active satellites	Yes
\$GPGST	S	1 Hz	GNSS pseudo range error statistics and position accuracy	Yes
\$GPGSV	S	1 Hz	GNSS satellites in view	Yes
*\$GPHDG	H	20 Hz	Provides magnetic deviation and variation for calculating magnetic or true heading *see last bullet in Note at end of this table	Yes
*\$GPHDM	H	20 Hz	Magnetic heading (based on GPS-derived heading and magnetic declination) *see last bullet in Note at end of this table	No
*\$GPHDT	H	20 Hz	GPS-derived true heading *see last bullet in Note at end of this table	Yes



**Table 3-3: NMEA 0183 and other messages (continued)**

Message	Info Type	Max Output Rate	Description	IEC Approved Message
\$GPHEV	H	20 Hz	Heave value (in meters)	Yes
\$GPRMC	P	20 Hz	Recommended minimum specific GNSS data	Yes
*\$GPROT	H	20 Hz	GPS-derived rate of turn (ROT) *see last bullet in Note at end of this table	Yes
\$GPRRE	S	1 Hz	Range residual and estimated position error	Yes
\$GPVTG	V	20 Hz	COG and ground speed	Yes
\$GPZDA	V	20 Hz	Time and date	Yes
\$PASHR	H	20 Hz	Time, heading, roll, and pitch data in one message	No
\$PSAT,GBS	S	1 Hz	Satellite fault detection (RAIM)	Yes
\$PSAT,HPR	H	20 Hz	Proprietary NMEA message that provides heading, pitch, roll, and time in single message	No
\$PSAT,INTLT	H	1 Hz	Proprietary NMEA message that provides the pitch and roll measurements from the internal inclinometers (in degrees)	Yes
\$RD1	S	1 Hz	SBAS diagnostic information	Yes
\$TSS1	H	20 Hz	Heading, pitch, roll, and heave message in the commonly used TSS1 message format	No
<p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>The GP of the message is the talker ID.</li> <li>GPRGS, GPGSA, GPGST, and GPGSV support external integrity checking. They are to be synchronized with corresponding fix data (GPGGA or GPGNS).</li> <li>For information on outputting roll, pitch, and heave data in one message refer to the Hemisphere GNSS Technical Reference (go to <a href="http://www.hemispheregnss.com/support">www.hemispheregnss.com/support</a> and click the GNSS Reference icon).</li> <li>*You can change the message header for the HDG, HDM, HDT, and ROT messages to either GP or HE using the \$JATT,NMEAHE command. <ul style="list-style-type: none"> <li>To preface these messages with GP, issue the following command: \$JATT,NMEAHE,0&lt;CR&gt;&lt;LF&gt;</li> <li>To preface these messages with HE, issue the following command: \$JATT,NMEAHE,1&lt;CR&gt;&lt;LF&gt;</li> </ul> </li> </ul> <p>For more information on the \$JATT,NMEAHE command refer to the Hemisphere GPS Technical Reference.</p>				

**Table 3-4: Binary messages**

\$JBIN Message	Description
1	GPS position
2	GPS DOPs
80	SBAS
93	SBAS ephemeris data

**Table 3-4: Binary messages (continued)**

<b>\$JBIN Message</b>	<b>Description</b>
94	Ionosphere and UTC conversion parameters
95	Satellite ephemeris data
96	Code and carrier phase
97	Processor statistics
98	Satellites and almanac
99	GPS diagnostics

**Table 3-5: Parameters specific to \$JATT command**

<b>Parameter</b>	<b>Description</b>	<b>Query</b>	<b>Specify</b>
COGTAU	Set/query COG time constant (0.0 to 3600.0 sec)	X	X
CSEP	Query antenna separation	X	
EXACT	Enable/disable internal filter reliance on the entered antenna separation	X	X
FLIPBRD	Turn the flip feature on/off	X	X
GYROAID	Enable/disable gyro	X	X
HBIAS	Set/query heading bias (-180.0° to 180.0°)	X	X
HELP	Show the available commands for GPS heading operation and status	X	
HIGHMP	Set/query the high multipath setting for use in poor GPS environments	X	X
HRTAU	Set/query ROT time constant (0.0 to 3600.0 sec)	X	X
HTAU	Set/query heading time constant (0.0 to 3600.0 sec)	X	X
LEVEL	Enable/disable level operation	X	X
MSEP	Manually set or query antenna separation	X	X
NEGTILT	Enable/disable negative tilt	X	X
NMEAHE	Change the HDG, HDM, HDT, and ROT message headers between GP and HE	X	X
PBIAS	Set/query pitch/roll bias (-15.0° to 15.0°)	X	X
PTAU	Set/query pitch time constant (0.0 to 3600.0 sec)	X	X
ROLL	Configure for roll or pitch GPS orientation	X	X
SEARCH	Force a new GPS heading search		X
SPDTAU	Set/query speed time constant (0.0 to 3600.0 sec)	X	X
SUMMARY	Display a summary of the current Crescent Vector settings	X	
TILTAID	Enable/disable accelerometer, pre-calibrated	X	X
TILTCAL	Calibrate accelerometers		X



## **Appendix A: Troubleshooting**

Table A-1 provides troubleshooting for common problems.

**Table A-1: Troubleshooting**

Symptom	Possible Solution
Receiver fails to power	<ul style="list-style-type: none"> <li>• Verify polarity of power leads</li> <li>• Check integrity of power cable connectors</li> <li>• Check power input voltage (6 to 36 VDC)</li> <li>• Check current restrictions imposed by power source (minimum available should be &gt; 1.0 A)</li> </ul>
No data from V103/113	<ul style="list-style-type: none"> <li>• Check receiver power status to ensure the receiver is powered (an ammeter can be used for this)</li> <li>• Verify desired messages are activated (using PocketMax or \$JSHOW command in any terminal program)</li> <li>• Ensure the baud rate of the V103/113 matches that of the receiving device</li> <li>• Check integrity and connectivity of power and data cable connections</li> </ul>
Random data from V103/113	<ul style="list-style-type: none"> <li>• Verify the RTCM or binary messages are not being output accidentally (send a \$JSHOW command)</li> <li>• Ensure the baud rate of the V103/113 matches that of the remote device</li> <li>• Potentially, the volume of data requested to be output by the V103/113 could be higher than the current baud rate supports (try using 19200 as the baud rate for all devices or reduce the amount of data being output)</li> </ul>
No GPS lock	<ul style="list-style-type: none"> <li>• Verify the V103/113 has a clear view of the sky</li> <li>• Verify the lock status of GPS satellites (this can be done with PocketMax)</li> </ul>
No SBAS lock	<ul style="list-style-type: none"> <li>• Verify the V103/113 has a clear view of the sky</li> <li>• Verify the lock status of SBAS satellites (this can be done with PocketMax - monitor BER value)</li> <li>• Set SBAS mode to automatic with the \$JWAASPRN,AUTO command</li> </ul> <p><b>Note:</b> SBAS lock is only possible if you are in an appropriate SBAS region; currently, there is limited SBAS availability in the southern hemisphere.</p>

**Table A-1: Troubleshooting (continued)**

Symptom	Possible Solution
No heading or incorrect heading value	<ul style="list-style-type: none"> <li>• Check CSEP value is fairly constant without varying more than 1 cm (0.39 in)—larger variations may indicate a high multipath environment and require moving the receiver location</li> <li>• Heading is from primary GPS antenna to secondary GPS antenna, so the arrow on the underside of the V103/113 should be directed to the bow side</li> <li>• \$JATT,SEARCH command forces the V103/113 to acquire a new heading solution (unless gyro is enabled)</li> <li>• Enable GYROAID to provide heading for up to three minutes during GPS signal loss</li> <li>• Enable TILTAID to reduce heading search times</li> <li>• Monitor the number of satellites and SNR values for both antennas within PocketMax—at least four satellites should have strong SNR values</li> <li>• Potentially, the volume of data requested to be output by the V103/113 could be higher than the current baud rate supports (try using 19200 as the baud rate for all devices or reduce the amount of data being output)</li> </ul>
No DGPS position in external RTCM mode	<ul style="list-style-type: none"> <li>• Verify the baud rate of the RTCM input port matches the baud rate of the external source</li> <li>• Verify the pinout between the RTCM source and the RTCM input port (transmit from the source must go to receive of the RTCM input port and grounds must be connected)</li> <li>• Ensure corrections are being transmitted to the correct port—using the \$JDIF,PORTB command on Port A will cause the receiver to expect the corrections to be input through Port B</li> </ul>



## **Appendix B: Technical Specifications**



Table B-1 through Table B-6 provide the V103/113's technical specifications and Table B-7 provides the V103/113's certification information.

**Table B-1: GPS sensor specifications**

Item	Specification
Receiver type	GNSS L1 RTK
Channels	540
GPS sensitivity	-142 dBm
SBAS tracking	2-channel, parallel tracking
Update rate	20 Hz (position and heading)
Position accuracy	RMS (67%): Horizontal Vertical Single Point, no SA: 1.2 m 2.5 m SBAS (WAAS): 0.3 m 0.6 m L-band DGPS: 0.3 m 0.6 m Code Differential GPS: 0.3 m 0.6 m L-band L1/L2: 0.15 m 0.3 m RTK: 10 mm + 1 ppm 20 mm + 2 ppm
Heading accuracy	< 0.30° rms Normal operation: GNSS Coasting (no GNSS): Gyro
Heave accuracy	< 30 cm rms <sup>3</sup> Normal operation: GNSS Coasting (no GNSS): None
Pitch accuracy	< 1° rms Normal operation: GNSS Coasting (no GNSS): Inertial sensor
Roll accuracy	< 1° rms using accelerometer Normal operation: Inertial sensor Coasting (no GNSS): Inertial sensor
Timing (1 PPS) accuracy	50 ns
Rate of turn	90°/s maximum
Cold start	< 60 s typical (no almanac or RTC)
Warm start	< 20 s typical (almanac and RTC)
Hot start	< 1 s typical (almanac, RTC, and position)
Heading fix	< 10 s typical (valid position)
Compass safe distance	75 cm (29.5 in) <sup>4</sup>
Maximum speed	1,850 kph (999 kts)
Maximum altitude	18,288 m (60,000 ft)

**Table B-2: Beacon sensor specifications (V113 only)**

Item	Specification
Channels	2-channel, parallel tracking
Frequency range	283.5 to 325 kHz

**Table B-2: Beacon sensor specifications (V113 only) (continued)**

Item	Specification
Operating modes	Manual, automatic, and database
Compliance	IEC 61108-4 beacon standard

**Table B-3: Communication specifications**

Item	Specification
Serial ports	1 RS-232 (full-duplex) 2 RS-422 (1 full duplex, 1 half duplex)
Baud rates	4800, 9600, 19200, 38400
Correction I/O protocol	RTCM SC-104, L-Dif™ <sup>5</sup>
Data I/O protocol	NMEA 0183, NMEA 2000, Crescent binary <sup>5</sup> , L-Dif

**Table B-4: Power specifications**

Item	Specification	
Input voltage	6 to 36 VDC	
Power consumption	V103 ~ 4.3 W nominal	V113 ~ 4.6 W nominal
Current consumption	V103 ~ 0.36 A nominal (GPS L1 + GLONASS L1)	V113 ~ 0.38 A nominal (GPS L1 + GLONASS L1 + Beacon)
Power isolation	Isolated to enclosure	
Reverse polarity protection	Yes	

**Table B-5: Mechanical specifications**

Item	Specification	
Enclosure	UV resistant, white plastic, AES HW 600G, non-corrosive, self extinguishing	
Dimensions	66.3 L x 20.9 W x 14.6 H (cm) 26.1 L x 8.3 W x 5.8 H (in)	
Weight	V103 2.1 kg (4.6 lb)	V113 2.4 kg (5.4 lb)
Power/data connector	18-pin, environmentally sealed	

**Table B-6: Environmental specifications**

Item	Specification
Operating temperature	-30°C to +70°C (-22°F to +158°F)
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% non-condensing

**Table B-6: Environmental specifications (continued)**

<b>Item</b>	<b>Specification</b>
Vibration	IEC 60945
EMC	CE (IEC 60945 Emissions and Immunity), FCC Part 15, Subpart B, CISPR22

**Table B-7: Certifications**

IMO Resolution MSC.116(73)	ISO 22090-3 Ed.1.0, 2004 incl. Corr. 1,2005
IMO Resolution A.694(17)	IEC 60945 Ed.4.0, 2002 incl. Corr.1, 2008
IMO Resolution MSC.191(79)	IEC 61162-1 Ed.4.0 2010
	IEC 61162-2 Ed.1.0, 1998
	IEC 62288 Ed.1.0, 2008

*IMO wheelmarked for Annex A.1 item 4.41 Transmitting heading device THD (GNSS method. Based on the Directive 2009/26/EC.*

<sup>1</sup>Depends on multipath environment, number of satellites in view, satellite geometry, baseline length (for local services), and ionospheric activity

<sup>2</sup>Depends on multipath environment, number of satellites in view, and satellite geometry

<sup>3</sup>Based on a 40 second time constant

<sup>4</sup>This is the minimum safe distance measured when the product is placed in the vicinity of the steering magnetic compass. The ISO 694 defines "vicinity" relative to the compass as within 5 m (16.4 ft) separation.

<sup>5</sup>Hemisphere GPS proprietary



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**LIMITATION OF REMEDIES.** The purchaser's EXCLUSIVE REMEDY against Hemisphere GNSS shall be, at Hemisphere GNSS's option, the repair or replacement of any defective Product or components thereof. The purchaser shall notify Hemisphere GNSS or a Hemisphere GNSS's approved service center immediately of any defect. Repairs shall be made through a Hemisphere GNSS approved service center only. Repair, modification or service of Hemisphere GNSS products by any party other than a Hemisphere GNSS approved service center shall render this warranty null and void. The remedy in this paragraph shall only be applied in the event that the Product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Hemisphere GNSS's relevant User's Manual and Specifications, AND the Product is not modified or misused. NO OTHER REMEDY (INCLUDING, BUT NOT LIMITED TO, SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL OR CONTINGENT DAMAGES FOR LOST PROFITS, LOST SALES, INJURY TO PERSON OR PROPERTY, OR ANY OTHER INCIDENTAL OR CONSEQUENTIAL LOSS) SHALL BE AVAILABLE TO PURCHASER, even if Hemisphere GNSS has been advised of the possibility of such damages. Without limiting the foregoing, Hemisphere GNSS shall not be liable for any damages of any kind resulting from installation, use, quality, performance or accuracy of any Product.

**HEMISPHERE IS NOT RESPONSIBLE FOR PURCHASER'S NEGLIGENCE OR UNAUTHORIZED USES OF THE PRODUCT.** IN NO EVENT SHALL HEMISPHERE GNSS BE IN ANY WAY RESPONSIBLE FOR ANY DAMAGES RESULTING FROM PURCHASER'S OWN NEGLIGENCE, OR FROM OPERATION OF THE PRODUCT IN ANY WAY OTHER THAN AS SPECIFIED IN HEMISPHERE GNSS'S RELEVANT USER'S MANUAL AND SPECIFICATIONS. Hemisphere GNSS is NOT RESPONSIBLE for defects or performance problems resulting from (1) misuse, abuse, improper installation, neglect of Product; (2) the utilization of the Product with hardware or software products, information, data, systems, interfaces or devices not made, supplied or specified by Hemisphere GNSS; (3) the operation of the Product under any specification other than, or in addition to, the specifications set forth in Hemisphere GNSS's relevant User's Manual and Specifications; (4) damage caused by accident or natural events, such as lightning (or other electrical discharge) or fresh/salt water immersion of Product; (5) damage occurring in transit; (6) normal wear and tear; or (7) the operation or failure of operation of any satellite-based positioning system or differential correction service; or the availability or performance of any satellite-based positioning signal or differential correction signal.

**THE PURCHASER IS RESPONSIBLE FOR OPERATING THE VEHICLE SAFELY.** The purchaser is solely responsible for the safe operation of the vehicle used in connection with the Product, and for maintaining proper system control settings. UNSAFE DRIVING OR SYSTEM CONTROL SETTINGS CAN RESULT IN PROPERTY DAMAGE, INJURY, OR DEATH. The purchaser is solely responsible for his/her safety and for the safety of others. The purchaser is solely responsible for maintaining control of the automated steering system at all times. THE PURCHASER IS SOLELY RESPONSIBLE FOR ENSURING THE PRODUCT IS PROPERLY AND CORRECTLY INSTALLED, CONFIGURED, INTERFACED, MAINTAINED, STORED, AND OPERATED IN ACCORDANCE WITH HEMISPHERE GNSS'S RELEVANT USER'S MANUAL AND SPECIFICATIONS. Hemisphere GNSS does not warrant or guarantee the positioning and navigation precision or accuracy obtained when using Products. Products are not intended for primary navigation or for use in safety of life applications. The potential accuracy of Products as stated in Hemisphere GNSS literature and/or Product specifications serves to provide only an estimate of achievable accuracy based on performance specifications provided by the satellite service operator (i.e. US Department of Defense in the case of GPS) and differential correction service provider. Hemisphere GNSS reserves the right to modify Products without any obligation to notify, supply or install any improvements or alterations to existing Products.

**GOVERNING LAW.** This agreement and any disputes relating to, concerning or based upon the Product shall be governed by and interpreted in accordance with the laws of the State of Arizona.

**OBTAINING WARRANTY SERVICE.** In order to obtain warranty service, the end purchaser must bring the Product to a Hemisphere GPS approved service center along with the end purchaser's proof of purchase. Hemisphere GPS does not warrant claims asserted after the end of the warranty period. For any questions regarding warranty service or to obtain information regarding the location of any of Hemisphere GPS approved service center, contact Hemisphere GPS at the following address:

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