Vector V320 GNSS Smart Antenna

User Guide

Part No. 875-0351-0 Rev. A1

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.

Copyright Notice

Trademarks

Patents

Hemisphere GNSS products may be covered by one or more of the following U.S. Patents:

6,111,549	6,397,147	6,469,663	6,501,346	6,539,303
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		

Other U.S. and foreign patents pending.

Notice to Customers

Contact your local dealer for technical assistance. To find the authorized dealer near you:

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Technical Support

If you need to contact Hemisphere GNSS Technical Support:

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Chapter 1: Introduction

Overview

The Eclipse Vector™ V320™ GNSS Smart Antenna supports GNSS, GLONASS, BeiDou, Athena RTK and Atlas L-band which is based on Hemisphere GNSS' exclusive Eclipse Vector™ H321™ GNSS module.

Figure 1-1: V320 side view

Note: When referring to the Vector V320 GNSS Smart Antenna this manual uses the term V320.

Based on Eclipse Vector™ GNSS technology, the V320 (Figure 1-1) is designed for marine and land applications that require precise heading and RTK position performance from the Vector V320 GNSS smart antenna. Featuring an all-in-one Hemisphere GNSS Eclipse Vector-based receiver and two integrally separated antennas, with a baseline of 50.0 cm. The V320 achieves heading accuracy of up to 0.17° RMS (depending on environmental conditions) and offers robust positioning performance.

The standard model V320 tracks L1/L2 GPS, GLONASS and BeiDou. The V320 comes with Hemisphere's patented Athena RTK technology and can be upgraded via subscriptions to support Atlas L-band.

Athena RTK is Hemisphere's most advanced RTK processing software that can be added to the V320 as a subscription service. Athena RTK has the following benefits:

- Improved Initialization time - Performing initializations in less than 15 seconds at better than 99.9% of the time
- Robustness in difficult operating environments - Extremely high productivity under the most aggressive of geographic and landscape oriented environments

Atlas L-band is Hemisphere's industry leading correction service, which can be added to the V320 as a subscription. Atlas L-band has the following benefits:

- Positioning accuracy - Competitive positioning accuracies down to 2 cm RMS in certain applications
- Positioning sustainability - Cutting edge position quality maintenance in the absence of correction signals, using Hemisphere's patented technology
- Scalable service levels - Capable of providing virtually any accuracy, precision and repeatability level in the 5 to 100 cm range
- Convergence time - Industry-leading convergence times of 10-40 minutes

For more information about Athena RTK, see: http://hemispheregnss.com/Technology
For more information about Atlas L-band, see: http://hemispheregnss.com/Atlas

Key Features

Key features of the V320 include:

- Easy to use all-in-one robust GNSS smart antenna.
- High-precision positioning in Athena RTK, L1/L2, SBAS, beacon, and Atlas L-band
- Athena technology improves RTK performance, especially with GLONASS and BeiDou
- Atlas* L-band technology provides highly accurate corrections over the air.

  *Requires the purchase of a subscription
- Heave of 30 cm RMS (DGNSS), 10 cm (RTK)
- Pitch and roll < 1° RMS
- Accurate heading up to 3 minutes during GNSS outages
- Integrated gyro and tilt sensors deliver fast startup times and provide heading updates during temporary loss of GNSS

Parts List

Note: The V320's parts comply with IEC 60945 Section 4.4: "exposed to the weather."

Table 1-1 lists the parts included with your V320. The V320 GNSS Smart Antenna 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) • V320	 1	 940-3104-0
All the following are accessory items available for purchase separately from your V320		
Power/data cable, 15m Power/data cable, 30 m Each cable includes the following items: • Clamp • Screw • Washer	1 1	880-1042-000 880-1043-000
Serial-to-NMEA 2000 adapter, includes the following items: • Screws • Washers	1	710-0113-000#
Installation bracket (black)	1	602-1113-000#

This User Guide is available for download from the Hemisphere GNSS website at www.hgnss.com.

Chapter 2: Installation

Mounting Location

This section provides information on determining the best location for the V320.

GNSS Satellite Reception

When considering where to mount the V320, consider the following satellite reception recommendations:

- Consider GNSS (and hence SBAS) reception, ensuring there is a clear view of the sky available to the V320 so the GNSS and SBAS satellites are not masked by obstructions that may reduce system performance
- Since the V320 computes a position based on the internal primary GNSS antenna element, mount the V320 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 V320 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-5 on page 41

Environmental Considerations

Hemisphere vector smart antennas are designed to withstand harsh environmental conditions; however, adhere to the following limits when storing and using the V320:

- 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 smart antenna can still track GLONASS and/or BeiDou satellites maintaining heading and position. For example, if installing the V320 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 GNSS 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 GNSS 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.
- Hand-held 5W VHF radios may not provide suitable filtering and may interfere with the V320's operation if too close.

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

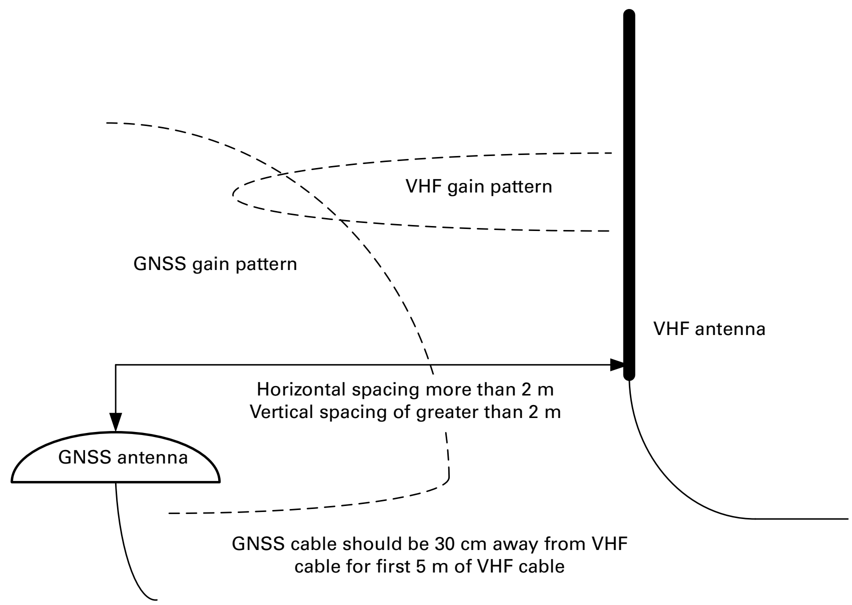


Figure 2-1: V320 distance from nearby VHF radios

Mounting Orientation

The V320 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.

Note: Regardless of which mounting orientation you use, the V320 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.hgnss.com/support and click the GNSS Reference icon).

Parallel Orientation: The most common installation is to orient the V320 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 smart antenna, you can enter a heading bias in the V320 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 smart antenna is 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.

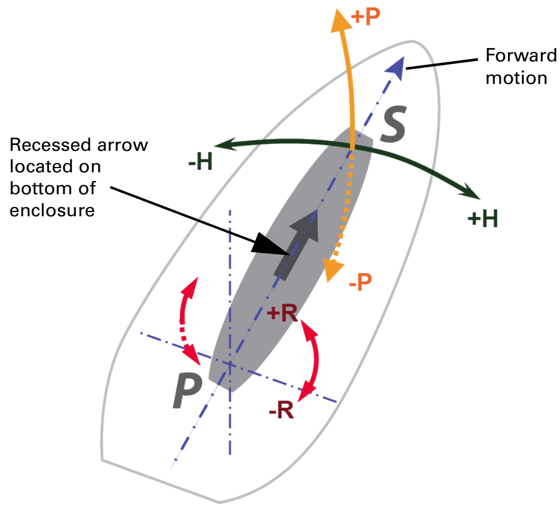


Figure 2-2: Recommended orientation and resulting signs of HPR values

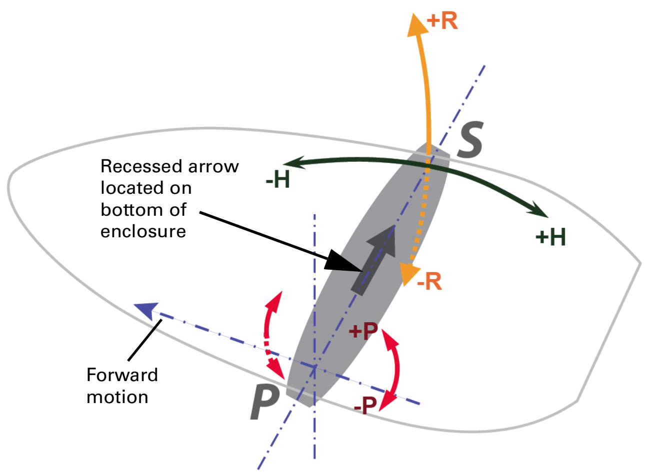


Figure 2-3: Alternate orientation and resulting signs of HPR values

V320 Alignment

The top of the V320 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 +/- 1°, while alignment through the short site (Figure 2-5) is approximately +/- 2.5°.

Figure 2-4: Long site alignment

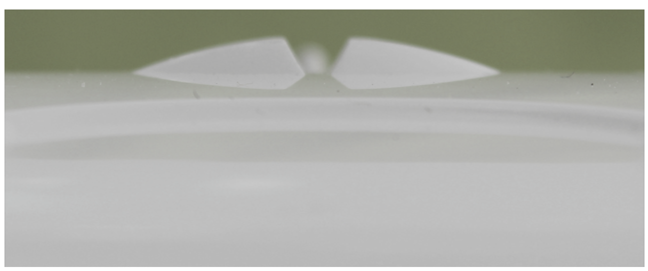


Figure 2-5: Short sight alignment

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 V320 alignment within the V320 software configuration. Alternatively, you can physically adjust the heading of the V320 so that it renders the correct heading measurement; however, adding a software offset is an easier process.

Mounting Options

The V320 allows for two different mounting options: flush mount and pole mount.

- Flush mount - The bottom of the V320 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 V320 as a drop-in replacement. The outer four holes provide a wider mounting option.
- Pole mount - The bottom of the V320 contains a mounting plate with a hole (1" thread, 0.9" depth) for easy pole mounting. Hand tighten until snug (<u>do not</u> over-tighten). The set screws on the long sides of the base (see middle drawing in Figure 2-6) allow you to secure the V320 in place (3/16” Allen wrench not included).
- Bracket mount - You can purchase on optional mounting bracket. See Table 1-1 on page 4 for bracket part information.

V320 Dimensions

Figure 2-6 illustrates the physical dimensions of the V320.

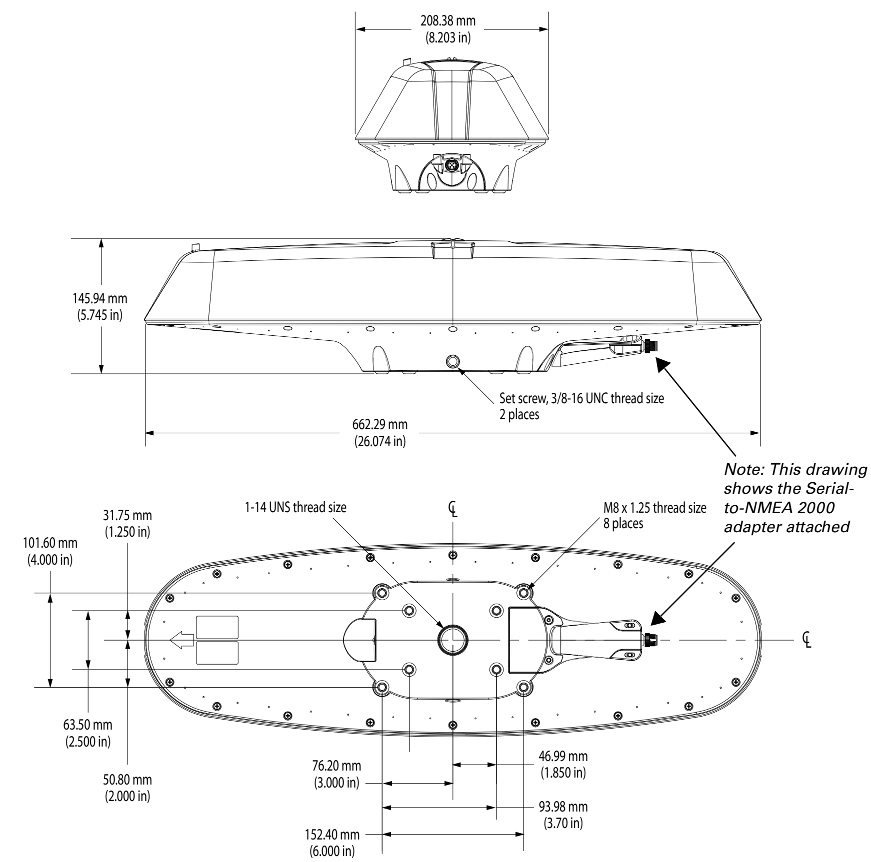


Figure 2-6: V320 dimensions

Power/Data Cable Considerations

Before mounting the V320 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 V320 end
- Secure along the cable route using plastic wraps

WARNING: Improperly installed cable near machinery can be dangerous.

Mounting the V320

This section describes how to flush mount or pole mount the V320.

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 V320 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 V320

The bottom of the V320 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 V320

Complete the following steps to flush mount the V320:

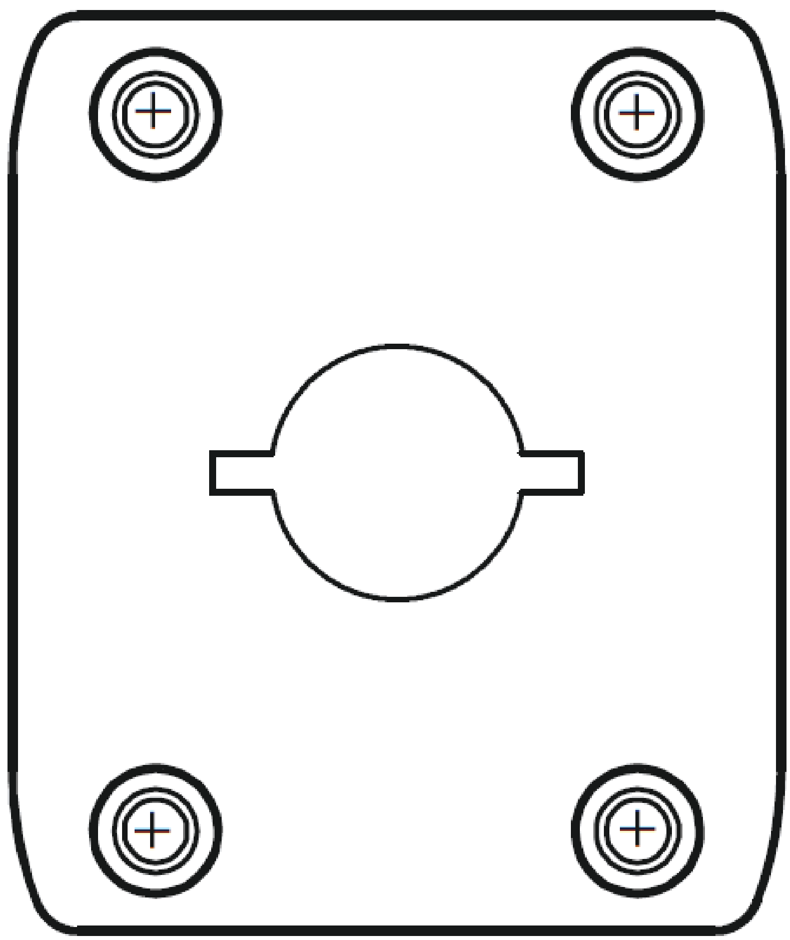
1. Determine the desired location and proper orientation for the V320. See “Mounting Orientation” on page 8 for information on determining the desired orientation.
2. Use the supplied template of the V320 that contains the four mounting holes (see template below) for use as a template to plan the mounting hole locations.

   Always check the printed template against the bottom of the V320 to ensure you have the right size and the holes lineup.
3. Mark the mounting hole centers on the mounting surface.
4. Place the V320 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 V320 over the mounting holes and insert the mounting screws through the bottom of the mounting surface into the V320.

⚠WARNING: When installing the V320, hand tighten only. Damage resulting from over-tightening is not covered by the warranty.

Flush Mount Template

Print this page with a 1:1 setting on your printer. This will create a usable template for mounting the V320 to any mountable surface.



Pole Mounting the Vector Smart Antenna

If you need the GNSS-assisted roll measurement, install the V320 perpendicular to the vessel's axis. If you do not need this measurement, install the V320 parallel with the vessel's axis. For more information refer to Figure 2-2 and Figure 2-3 on page 9.

Complete the following steps to pole mount the V320:

1. Determine the desired location and proper orientation for the V320. See "Mounting Orientation" on page 8 for information on determining the desired orientation.
2. Using the provided mounting bracket, secure the bracket to the bottom of the V320 using the four (4) M8 screws and washers included in the package. The bracket is secured by placing it against the bottom of the V320 and adding a washer to the M8 screw to ensure a tight connection.
3. Hand tighten each screw to the bottom of the V320 until snug.
4. Place the V320 on the pole and hand tighten the V320 on the pole until snug (unit is stable on pole) while ensuring correct orientation.

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

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5. Use the full threaded set screws on the long sides of the base (see Figure 2-6 on page 11) to secure the V320 in place (3/16" Allen wrench).

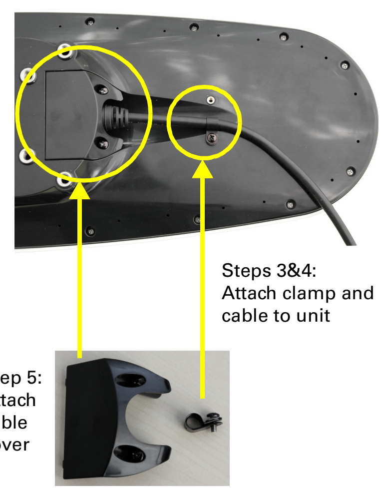
Connecting the Serial Cable or Serial-to-NMEA 2000 Adapter to the V320

After you mount the V320 connect either the serial power/data cable or the serial-to-NMEA 2000 adapter to the V320.

Connecting the Serial Power/Data Cable

1. Align the cable connector key-way with the V320 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.

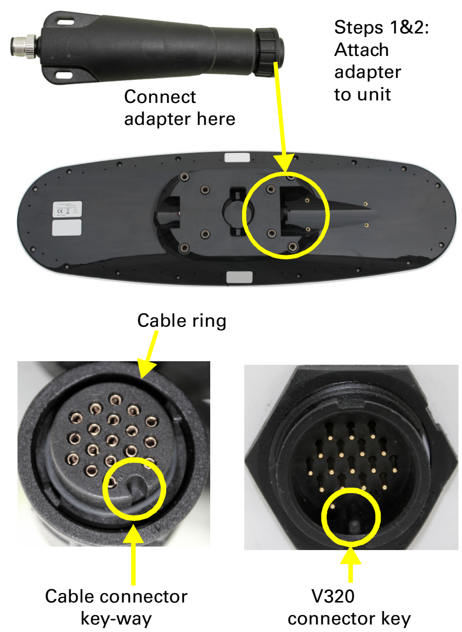
3. Attach the power/data cable to the cable clamp.
4. Fasten the clamp to the bottom of the V320 using the screw and washer.
5. Attach the cable cover.



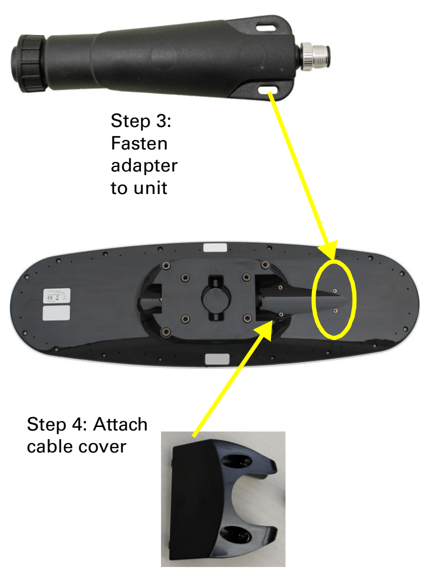
Connecting the Serial-to-NMEA 2000 Adapter

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

1. Align the adapter connector key-way with the V320 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 V320 using the provided screws and the two slots in the adapter.
4. Attach the cable cover.



Ports

The V320 offers either serial port or NMEA 2000 port functionality.

Serial Ports

The V320 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).

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

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

Note: The V320 has maximum baud rate of 38400.

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 19200 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.

Note: For successful communications use the 8-N-1 protocol and set the baud rate of the V320's serial ports to match that of the devices to which they are connected. Flow control is not supported.

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.hgnss.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 V320 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 V320 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 V320 to another device unless it is able to send configuration commands to the V320. Since the V320 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 V320 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 V320 by aligning the keys. You can then attach the adapter to the unit using the supplied screws (machine, 8-32, ½", 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

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

Table 2-1 shows the requested PGNs with the V320 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 V320 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 V320

Power Considerations

For best performance use a clean and continuous power supply. The V320 power supply features reverse polarity protection but will not operate with reverse polarity.

See Table B-3 on page 41 for complete power specifications.

Connecting to a Power Source

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.

Before you power up the V320 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.

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

To interface the V320 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 V320 will start when an acceptable voltage is applied to the power leads of the extension cable.

Electrical Isolation

The V320'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 V320 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 V320 and then attach a standard NMEA 2000 drop-line cable to the adapter.

Power/Data Cable Considerations

The V320 uses a single 15 m (49 ft) or 30 m (98 ft) cable for power and data input/ output.

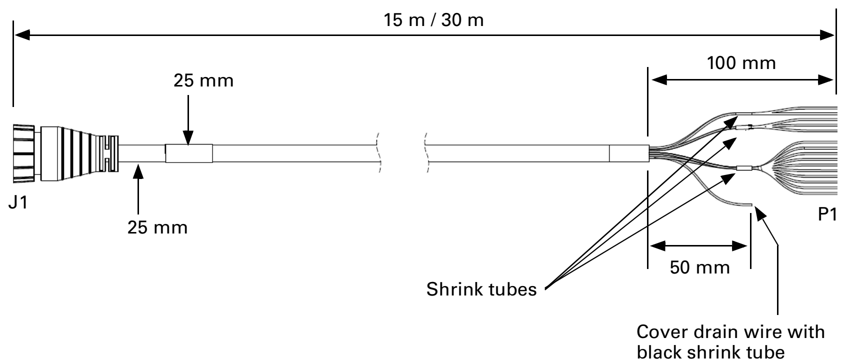


Figure 2-9: Power/data cable, 15 m or 30 m

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 V320, 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 pin-out, while Table 2-3 shows the cable's pin-out specifications.

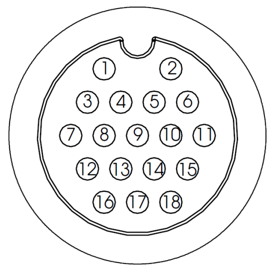


Figure 2-10: Power/data cable pin assignment

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 V320'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		
Note: 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
V320	Max DGNSS age (correction age)	2700 seconds
	Elevation mask	5°
	Differential mode	SBAS

Chapter 3: Understanding the V320

GNSS Overview

For your convenience, the GNSS operation of the V320 features automatic operational algorithms. When powered for the first time, the V320 performs a “cold start,” which 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 V320’s internal GNSS receiver.

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

Automatic Tracking

The V320’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 V320 works by finding four or more GNSS 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 V320 also tracks a differential correction. The V320 uses these corrections to improve its position accuracy to better than 0.5 m 95% with SBAS, and better than 0.1 m 95% with Atlas.

There are two main aspects of GNSS receiver performance:

- Satellite acquisition
- Positioning and heading calculation

When the V320 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 V320 will result in positioning accuracies of 2.5 m 95% of the time. To improve positioning quality to sub-meter levels, the V320 is able to use differential corrections received through the internal SBAS demodulator, externally-supplied RTCM corrections, and Atlas L-Band.

In addition to these differential services the V320 comes with the Athena RTK activation, which enables 0.02 m positioning performance.

For more information on the differential services and the associated commands refer to the Hemisphere GNSS Technical Reference (go to www.hgnss.com and click the GNSS Reference icon).

Automatic SBAS Tracking

The V320 automatically scans and tracks SBAS signals without the need to tune the receiver. The V320 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.

Athena RTK

Athena RTK (Real time kinematic) technology is available on Eclipse-based GNSS receivers. Athena RTK requires the use of two separate receivers: a stationary base station (primary receiver) that broadcasts corrections over a wireless link to the rover (secondary receiver). The localized corrections are processed on the rover to achieve superior accuracy and repeatability. Performance testing has shown positioning accuracy at the centimeter level.

Atlas L-Band

Atlas L-band corrections are available worldwide. With Atlas, the positioning accuracy does not degrade as a function of distance to a base station, as the data content is not composed of a single base station's information, but an entire network's information.

V320 Overview

The V320 provides accurate and reliable heading and position information at high update rates. To accomplish this task, the V320 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 V320 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.

Fixed Baseline Moving Base Station RTK

The V320's internal GNSS receiver uses both the L1/L2 GNSS 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/L2 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 V320 restricts the RTK solution by knowing that the secondary GNSS antenna is a fixed distance from the primary GNSS antenna. The default value is 0.5 m. This is called a fixed baseline and it defines the search volume of the secondary antenna as the surface of a sphere with radius 0.5 m centered on the location of the primary antenna (see Figure 3-1).

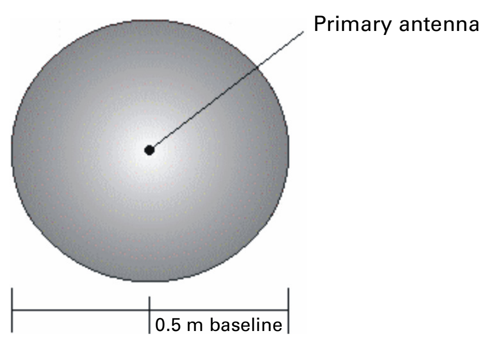


Figure 3-1: Secondary antenna's search volume

Note: The V320 moving base station algorithm only uses GNSS to calculate heading. Differential and RTK corrections are not used in this calculation and will not affect heading accuracy.

GLONASS & BeiDou

The V320 is available in its base form as L1/L2 GPS, GLONASS and BeiDou. As the number of available satellites increases, the ability to obtain and maintain a heading solution increases. For a heading calculation, GPS, GLONASS and BeiDou satellites are used interchangeably, as inter-system biases cancel inside the V320—this translates into being able to work in more obstructed areas and maintain a GNSS heading solution.

L2 Advantages

Compared to Hemisphere GNSS' Crescent Vector technology, Eclipse Vector's dual frequency technology allows for:

- Longer range RTK
- Faster and more robustly computed GNSS heading solution

Supplemental Sensor

The V320 has an integrated gyro, which is enabled by default. The supplemental sensor may be enabled or disabled. The supplemental sensor is mounted on the printed circuit board inside the V320.

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.

The Hemisphere GNSS Technical Reference (go to www.hgnss.com and click the GNSS Reference icon) describes the commands and methodology required to recalibrate, query, or change the sensors status.

Tilt Aiding

The V320's accelerometers (internal tilt sensors) are factory calibrated and enabled by default. This constrains the RTK heading solution beyond the volume associated with a fixed antenna separation. This is because the V320 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 startup and reacquisition times (see Figure 3-2).

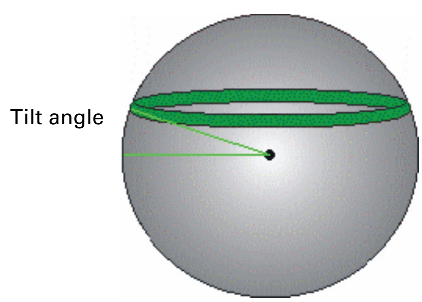


Figure 3-2: V320's tilt aiding

Gyro Aiding

The V320'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).

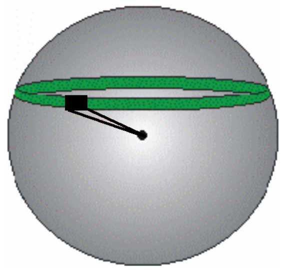


Figure 3-3: V320's gyro aiding

The gyro aiding accurately smooths the heading output and the rate of turn. It provides an accurate substitute heading for a short period depending on the roll and pitch of the vessel, ideally seeing the system through to reacquisition. The gyro provides an alternate source of heading, 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 V320 begins outputting null fields in the heading output messages. There is no user control over the timeout period of the gyro.

The gyro initializes itself at power up and during initialization, or you can calibrate it as outlined in the Hemisphere GNSS Technical Reference (go to www.hgnss.com and click the GNSS Reference icon). For optimal performance, when the gyro is first initializing, the dynamics the gyro experiences during this warm-up period are similar to the regular operating dynamics. For example, if you use the V320 on a high speed, maneuverable craft, it is essential that when gyro aiding in the V320 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 V320 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.hgnss.com 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.

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 0.1 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.

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.

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 parameter is 0.0 seconds of smoothing. Increasing the time constant increases the level of speed measurement smoothing.

Appendix A: Troubleshooting

Table A-1 provides troubleshooting for common problems.

Table A-1: Troubleshooting

Symptom	Possible Solution
Receiver fails to power	• Verify polarity of power leads • Check integrity of power cable connectors • Check power input voltage (6 to 36 VDC) • Check current restrictions imposed by power source (minimum available should be > 1.0 A)
No data from V320	• Check receiver power status to ensure the receiver is powered (an ammeter can be used for this) • Verify desired messages are activated (using PocketMax or $JSHOW command in any terminal program) • Ensure the baud rate of the V320 matches that of the receiving device • Check integrity and connectivity of power and data cable connections
Random data from V320	• Verify the RTCM or binary messages are not being output accidentally (send a $JSHOW command) • Ensure the baud rate of the V320 matches that of the remote device • Potentially, the volume of data requested to be output by the V320 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)
No GNSS lock	• Verify the V320 has a clear view of the sky • Verify the lock status of GNSS satellites (this can be done with PocketMax)
No SBAS lock	• Verify the V320 has a clear view of the sky • Verify the lock status of SBAS satellites (this can be done with PocketMax - monitor BER value) • Set SBAS mode to automatic with the $JWAASPRN,AUTO command **Note:** SBAS lock is only possible if you are in an appropriate SBAS region; currently, there is limited SBAS availability in the southern hemisphere.

Table A-1: Troubleshooting (*continued)*

Symptom	Possible Solution
No heading or incorrect heading value	• 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 • Heading is from primary GNSS antenna to secondary GNSS antenna, so the arrow on the underside of the V320 should be directed to the bow side • $JATT,SEARCH command forces the V320 to acquire a new heading solution (unless gyro is enabled) • Enable GYROAID to provide heading for up to three minutes during GNSS signal loss • Enable TILTAID to reduce heading search times • Monitor the number of satellites and SNR values for both antennas within PocketMax—at least four satellites should have strong SNR values • Potentially, the volume of data requested to be output by the V320 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)
No DGNSS position in external RTCM mode	• Verify the baud rate of the RTCM input port matches the baud rate of the external source • 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) • Ensure corrections are being transmitted to the correct port—using the $JDIFF,PORTB command on Port A will cause the receiver to expect the corrections to be input through Port B

Appendix B: Technical Specifications

Table B-1 through Table B-5 provide the V320's technical specifications and Table B-7 provides the V320's certification information.

Table B-1: GNSS sensor specifications

Item	Specification
Receiver type	Vector GNSS RTK Receiver
Channels	744
GNSS sensitivity	-142 dBm
SBAS tracking	3-channel, parallel tracking
Update rate	10 HZ standard, 20 Hz available by activation
Position accuracy	RMS (67%): Horizontal Vertical Single Point: 1.2 m 2.5 m SBAS (WAAS): 0.3 m 0.6 m L-Band: 0.1 m 0.2 m RTK: 10 mm + 1 ppm 20 mm + 2 ppm
Heading accuracy (RMS)	< 0.17° Normal operation: GNSS Coasting (no GNSS): Gyro
Heave accuracy (RMS)	< 30 cm (DGNSS) <10 cm (RTK) 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	20 ns
Rate of turn	100°/s maximum
Cold start	< 60 s typical (no almanac or RTC)
Warm start	< 30 s typical (almanac and RTC)
Hot start	< 10 s typical (almanac, RTC, and position)
Heading fix	< 20 s typical (valid position)
Maximum speed	1,850 kph (999 kts)
Maximum altitude	18,288 m (60,000 ft)

Table B-2: 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™ [5]

Table B-2: Communication specifications (*continued)*

Item	Specification
Data I/O protocol	NMEA 0183, NMEA 2000, Hemisphere GNSS binary[5], L-Dif

Table B-3: Power specifications

Item	Specification
Input voltage	6 to 36 VDC
Power consumption	~ 7 W nominal (GPS L1/L2 + GLONASS L1/L2 + BeiDou B1/B2 + Atlas L-Band)
Current consumption	~ 0.51 A nominal (GPS L1/L2 + GLONASS L1/L2 + BeiDou B1/B2 + Atlas L-Band)
Power isolation	Isolated to enclosure
Reverse polarity protection	Yes

Table B-4: 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	V320 2.1 kg (4.6 lb)
Power/data connector	18-pin, environmentally sealed

Table B-5: 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
Vibration	IEC 60945
EMC	CE (IEC 60945 Emissions and Immunity), FCC Part 15, Subpart B, CISPR22

Table B-6: L-Band Sensor specifications

Item	Specification
Receiver Type	Single Channel
Channels	1530 to 1560 MHz
Sensitivity	-130 dBm
Channel Spacing	5.0 KHz

Table B-6: L-Band Sensor specifications

Item	Specification
Satellite Selection	Manual or Automatic
Reacquisition Time	15 sec (typical)

[1]Depends on multipath environment, number of satellites in view, satellite geometry, baseline length (for local services), and ionospheric activity

[2]Depends on multipath environment, number of satellites in view, and satellite geometry

[3]Based on a 40 second time constant

[4]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.

[5]Hemisphere GNSS proprietary

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20. INDEMNIFICATION. Except in relation to an infringement action, Licensee shall indemnify and hold Hemisphere harmless from any and all claims, damages, losses, liabilities, costs and expenses (including reasonable fees of lawyers and other professionals) arising out of or in connection with Licensee's use of the Product, whether direct or indirect, including without limiting the foregoing, loss of data, loss of profit or business interruption.

21. TERMINATION. Licensee may terminate this Agreement at any time without cause. Hemisphere may terminate this Agreement on 30 days notice to Licensee if Licensee fails to materially comply with each provision of this Agreement unless such default is cured within the 30 days. Any such termination by a party shall be in addition to and without prejudice to such rights and remedies as may be available, including injunction and other equitable remedies. Upon receipt by Licensee of written notice of termination from Hemisphere or termination by Licensee, Licensee shall at the end of any notice period (a) cease using the Software; and (b) return to Hemisphere (or destroy and provide a certificate of a Senior Officer attesting to such destruction) the Software and all related material and any magnetic or optical media provided to Licensee. The provisions of Sections 6), 7), 8), 9), 10), 15), 21), 26) and 27) herein shall survive the expiration or termination of this Agreement for any reason.

22. **EXPORT RESTRICTIONS**. Licensee agrees that Licensee will comply with all export control legislation of Canada, the United States, Australia and any other applicable country's laws and regulations, whether under the Arms Export Control Act, the International Traffic in Arms Regulations, the Export Administration Regulations, the regulations of the United States Departments of Commerce, State, and Treasury, or otherwise as well as the export control legislation of all other countries.

23. **PRODUCT COMPONENTS.** The Product may contain third party components. Those third party components may be subject to additional terms and conditions. Licensee is required to agree to those terms and conditions in order to use the Product.

24. **FORCE MAJEURE EVENT.** Neither party will have the right to claim damages as a result of the other's inability to perform or any delay in performance due to unforeseeable circumstances beyond its reasonable control, such as labor disputes, strikes, lockouts, war, riot, insurrection, epidemic, Internet virus attack, Internet failure, supplier failure, act of God, or governmental action not the fault of the non-performing party.

25. **FORUM FOR DISPUTES**. The parties agree that the courts located in Calgary, Alberta, Canada and the courts of appeal there from will have exclusive jurisdiction to resolve any disputes between Licensee and Hemisphere concerning this Agreement or Licensee's use or inability to use the Software and the parties hereby irrevocably agree to attorn to the jurisdiction of those courts. Notwithstanding the foregoing, either party may apply to any court of competent jurisdiction for injunctive relief.

26. **APPLICABLE LAW**. This Agreement shall be governed by the laws of the Province of Alberta, Canada, exclusive of any of its choice of law and conflicts of law jurisprudence.

27. **CISG.** The United Nations Convention on Contracts for the International Sale of Goods will not apply to this Agreement or any transaction hereunder.

28. **GENERAL.** This is the entire agreement between Licensee and Hemisphere relating to the Product and Licensee's use of the same, and supersedes all prior, collateral or contemporaneous oral or written representations, warranties or agreements regarding the same. No amendment to or modification of this Agreement will be binding unless in writing and signed by duly authorized representatives of the parties. Any and all terms and conditions set out in any correspondence between the parties or set out in a purchase order which are different from or in addition to the terms and conditions set forth herein, shall have no application and no written notice of same shall be required. In the event that one or more of the provisions of this Agreement is found to be illegal or unenforceable, this Agreement shall not be rendered inoperative but the remaining provisions shall continue in full force and effect.

Warranty Notice

COVERED PRODUCTS: This warranty covers all products manufactured by Hemisphere GNSS and purchased by the end purchaser (the “Products”), unless otherwise specifically and expressly agreed in writing by Hemisphere GNSS.

LIMITED WARRANTY: Hemisphere GNSS warrants solely to the end purchaser of the Products, subject to the exclusions and procedures set forth below, that the Products sold to such end purchaser and its internal components shall be free, under normal use and maintenance, from defects in materials, and workmanship and will substantially conform to Hemisphere GNSS’ applicable specifications for the Product, for a period of 12 months from delivery of such Product to such end purchaser (the”Warranty Period”). Repairs and replacement components for the Products are warranted, subject to the exclusions and procedures set forth below, to be free, under normal use and maintenance, from defects in material and workmanship, and will substantially conform to Hemisphere Gneiss's applicable specifications for the Product, for 90 days from performance or delivery, or for the balance of the original Warranty Period, whichever is greater.

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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 GNSS approved service center along with the end purchaser's proof of purchase. Hemisphere GNSS 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 GNSS approved service center, contact Hemisphere GNSS at the following address:

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