Hemisphere®

875-0365-0

H328 Vector Eclipse

Integrator Guide

Revision: A2

September 25, 2017

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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6711501	7373231	7835832	8174437	8334804	
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Chapter 1: Introduction

Product Overview and Features

H328 OEM Board Options

What's Included

H328 Integration

Common Features

Message Interface

Using PocketMax3 to Communicate with the H328

Introduction

Product Overview and Features

This chapter provides an overview of the Eclipse Vector H328 board key features and integration.

This guide does not cover receiver operation, the PocketMax3™ utility, the SLXMON utility, or commands and messages (NMEA 0183, NMEA2000® or HGNSS proprietary). For information on these subjects refer to the Hemisphere GNSS Technical Reference.

The Vector H328 is our most advanced GNSS heading and positioning board. The Vector H328 utilizes dual antenna ports to create a series of additional capabilities to Eclipse™ Vector technology including fast, high-accuracy heading over short baselines, RTK positioning, onboard Atlas L-band, RTK-enabled heave, low-power consumption, and precise timing. It is well suited for sophisticated machine control and navigation solutions in complex dynamic environments

H328 OEM Board Options

The Eclipse™ H328 OEM board is available in the hardware configuration shown in Table 1-1.

Table 1-1: H328 Board Options

Model	GNSS Systems	L-band
H328™	• GPS L1CA/L1P/L2P/L2C/L5 • GLONASS G1/G2/Pcode (P1/P2) • BeiDou B1/B2/B3 • Galileo E1BC/E5a/E5b • QZSS L1CA	Yes

What's Included

The H328 is available in two configurations:

- H328 OEM board only - designed for integrators who are familiar with Eclipse board integration
- H328 OEM board and H328 adaptor board (by request only P/N 725-1521-0).

For more information on requesting the H328 adaptor board, go to the HGNSS OEM Products page or contact your local dealer.

To access a pdf version of the OEM adapter board schematics, go to the HGNSS Home page/Products/OEM Boards/Position & Heading/Vector™ Eclipse™ H328 OEM Board/H328 Adapter Board Schematics, and click Open.

H328 Integration

Successful integration of the H328 within a system requires electronics expertise that includes:

- Power supply design
- Serial port level translation
- Reasonable radio frequency competency
- An understanding of electromagnetic compatibility
- Circuit design and layout

The H328 GNSS engine is a low-level module intended for custom integration with the following general requirements:

- Regulated power supply input: 3.3 VDC ± 3% @ 1.9A maximum continuous
- 2x 3.3V CMOS UART and 1x RS232 serial ports" and "USB device port
- Radio frequency (RF) input to the engine from a GNSS antenna is required to be amplified (10 to 40 dB gain)
- Antenna input impedance is 50 Ω capable of supplying 5VDC @ 75ma for amplified antenna

Common Features

Common features of H328 include:

✓ 394-channel GNSS engine	✓ Tracer™ technology that provides consistent performance with correction data
✓ Sub-meter horizontal accuracy 95%	✓ e-Dif®-ready - a base station-free way of differentially positioning
✓ Raw measurement output (via documented binary messages)	✓Position update rates of 50 Hz max
✓ Two CAN ports (NMEA2000, ISO-11783)	✓ Three full-duplex serial ports - two 3.3V CMOS UART (one with flow control) and one RS232 with flow control
✓ One Ethernet 10/100 TCP/IP	✓ One USB device port
✓ Event marker input	✓ One PPS timing output

Message Interface

The H328 uses a NMEA 0183 interface, allowing you to easily make configuration changes by sending text-type commands to the receiver.

The H328 also supports a selection of binary messages. There is a wider array of information available and more data efficiency through the binary messages. If your application has a requirement for raw measurement data, this information is available only in a binary format.

For more information on NMEA 0183 commands, messages and binary messages, refer to the Hemisphere GNSS Technical Reference.

Using PocketMax3 to Communicate with the H328

Hemisphere's PocketMax3 is a free utility program that runs on your Windows PC or Windows mobile device.

Simply connect your Windows device to the H328 via the COM port and open PocketMax3.

The screens within PocketMax3 allow you to easily interface with the H328 to:

- Select the internal SBAS, external beacon, or RTCM correction source and monitor reception (beacon optional)
- Configure GPS message output and port settings
- Record various types of data
- Monitor the H328 status and function

PocketMax3 is available for download from the Hemisphere GNSS website.

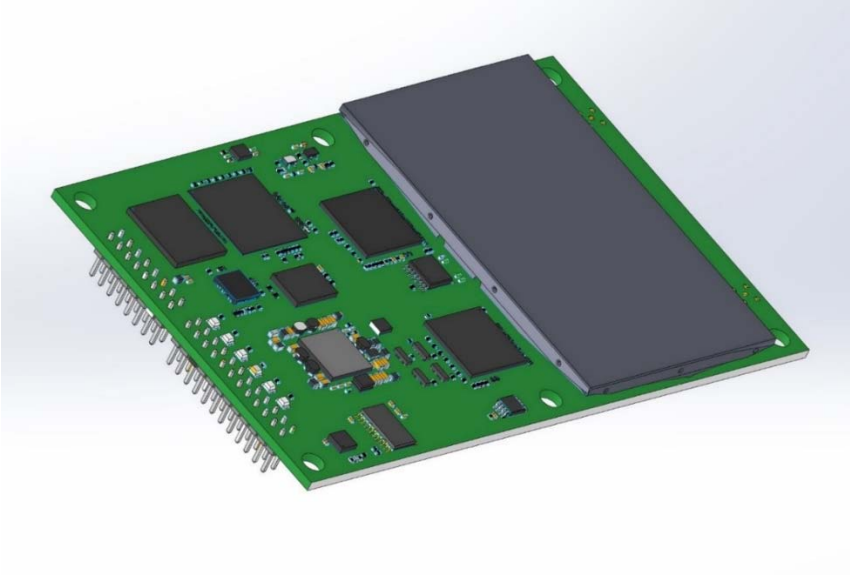
Chapter 2: Board Overview

H328 OEM Board Key Features
Mechanical Layout
Connectors
Mounting Options
Header Layouts and Pin-outs
Signals
Shielding
Receiver Mounting
Mounting the Antennas
Mounting Orientation
H328 Orientation and Sensor Calibration
Planning the Optimal Antenna Placement
Connecting Antennas to the H328
Thermal Concerns

Board Overview

H328 OEM Board Key Features

With small form factor, low power consumption, and simple on-board firmware, the H328 is an ideal solution for integrators, offering scalability and expandability from L1 GPS with SBAS to multi- frequency GPS, GLONASS, BeiDou, Galileo and QZSS (with RTK capability).



H328 is offered in the common industry form factor (100L x 60W mm) with integrated L-band. The reliable positioning performance of H328 is further enhanced by Athena RTK, Atlas corrections, aRTK, SureFix and TRACER™ technology. The dual antenna H328 provides fast accuracy heading and with on-board gyro and tilt sensor continues to provide heading during short GNSS outages.

With H328, RTK performance is scalable. The H328 uses the same centimeter-level accuracy in L1- only mode, or employs the full performance of fast RTK performance over long distances with L1/L2/L5 GPS signals. H328 benefits from fewer RTK dropouts in congested environments, faster reacquisition, and more robust solutions due to better cycle slip detection.

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 that broadcasts corrections over a wireless link to the rover. The localized corrections are processed on the rover to achieve superior accuracy and repeatability. Performance testing has shown exceptional positioning accuracy even in harsh environments.

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
- Performance on long baselines - Industry-leading position stability for long baseline applications

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. Atlas L-band is Hemisphere's industry leading correction service, and can be added as a subscription.

Atlas L-band has the following benefits:

- **Positioning accuracy -** Competitive positioning accuracies down to 4 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 4 to 100 cm range
- **Convergence time -** Industry-leading convergence times of 10-40 minutes

H328 is supported by our easy-to-use Atlas Portal https://www.atlasgnss.com/ which empowers you to update firmware and enable functionality, including Atlas subscriptions for accuracies from meter to sub-decimeter levels.

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

aRTK Position Aiding

aRTK is an innovative feature available in Hemisphere's H328 that greatly mitigates the impact of land-based communication instability. Powered by Hemisphere's Atlas L-band system service, aRTK augments the ability to maintain an RTK solution when the original RTK data link is lost or interrupted. The aRTK provides an additional layer of communication redundancy to RTK users, assuring that productivity is not impacted by intermittent data connectivity.

H328 receives aRTK augmentation correction data over satellite, while also receiving the land- based RTK correction data. The receiver internally operates with two sources of RTK correction, creating one additional layer of correction redundancy as compared to typical RTK systems.

After a few seconds , the process is established, and (, the receiver can operate in the absence of either correction source, and the receiver is able to continue generating RTK positions in case the land-based RTK correction source becomes unavailable.

Tracer™

Most accurate positioning tech-niches such as RTK and Atlas (Hemisphere's L-band global correction service) operate by using a correction data stream source.

Positioning methods are limited due to constant connectivity requirements with the correction source. In most cases, the GNSS engine needs to receive correction data with very low data interruption to maintain a reasonable position accuracy. For example, certain systems in the GNSS market only allow as much as 10 to 20 seconds of signal interruption before RTK level accuracy solution completely stops.

Tracer™ is a core feature used in Hemisphere GNSS products to sustain positioning in the absence of corrections. With the use of specialized algorithms, Tracer™ greatly mitigates the impact of correction loss on the system positioning accuracy.

Tracer™ is essential in an environment where connectivity over satellite, radio, or internet is unstable, as it allows most users to operate with negligible loss of accuracy during outage periods. The length of the outage and associated performance loss varies with the positioning technique used and the satellite geometry and interference environment.

Mechanical Layout

Figure 2-1 shows the mechanical layout for the H328 OEM board. Dimensions are in millimeters.

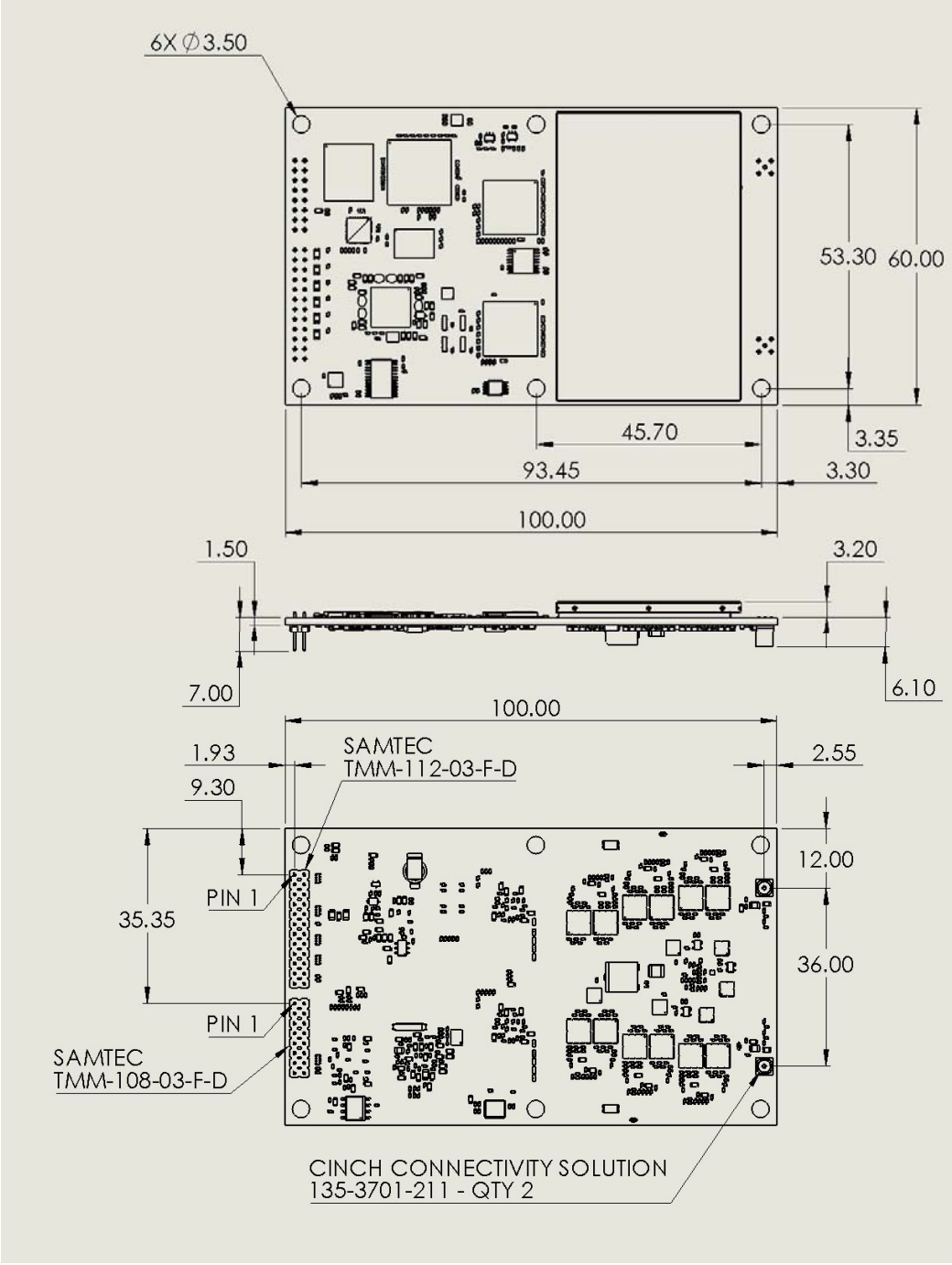


Figure 2-1: Vector Eclipse H328 Mechanical Layout

Connectors

Table 2-1 describes H328 connectors and mating connectors. You can use different compatible connectors; however, the requirements may be different. The antenna input impedance is 50 Ω.

Table 2-1: H328 Connectors

H328 Board and Connector Type		SMT Connector	Mating Connector
H328	RF	MMCX, female straight jack Emerson (Johnson) 133-3711-202	MMCX, male straight plug Samtec RSP-127824-01
	Power / data	24-pin (12x2) male header, 0.0787 in (2 mm) pitch Samtec TMM-112-03-T-D	Board Mates: Samtec CLT, ESQT, MMS, SMM, SQT, SQW, TLE Cable Mates: TCSD
	Power / data	16-pin (8x2) male header 0.0787 in (2 mm) pitch Samtec TMM-108-03-T-D	Board Mates:Samtec CLT, ESQT, MMS, SMM, SQT, SQW, TLE Cable Mates: TCSD

Mounting Options

There are two methods for mounting the H328:

- Direct Electrical Connection
- Indirect Electrical Connection (Cable)

Direct Electrical Connection Method

Place an RF connector, heading connector, and mounting holes on the carrier board and mount the H328 on the standoffs and RF and header connectors. This method is very cost effective as it does not use cable assemblies to interface with the H328.

Note: Be aware of the GPS RF signals present on the carrier board and ensure the correct standoff height to avoid any stress on the board when fastening.

The H328 uses a standoff height of 7.0 mm (0.2756 in). With this height, there should be no washers between either the standoff and the H328, or the standoff and the carrier board; otherwise, you must make accommodations. You may need to change the standoff height if you select a different header connector.

If you want to use a right angle MMCX connector, use a taller header than the Samtec part number suggested in this guide. This provides clearance to have a right-angle cable-mount connector and reduces the complexity, as the carrier board does not handle the RF signals. See Table 2-1 for H328 connector information.

The mounting holes of the H328 have a standard inner diameter of 3.50 mm (0.138 in).

Indirect Electrical Connection (Cable) Method

The second method is to mount the H328 mechanically, so you can connect a ribbon power/data cable to the H328. This requires cable assemblies, which reduce reliability and increase expense.

Header Layouts and Pin-outs

The H328 uses a dual-row header connector to interface with power, communications, and other signals.

To identify the first header pin, orient the board so the diamond is to the upper left of the pins; the first pin is on the left directly below the diamond (see Figure 2-2). The pins are then sequentially numbered per row from top to bottom.

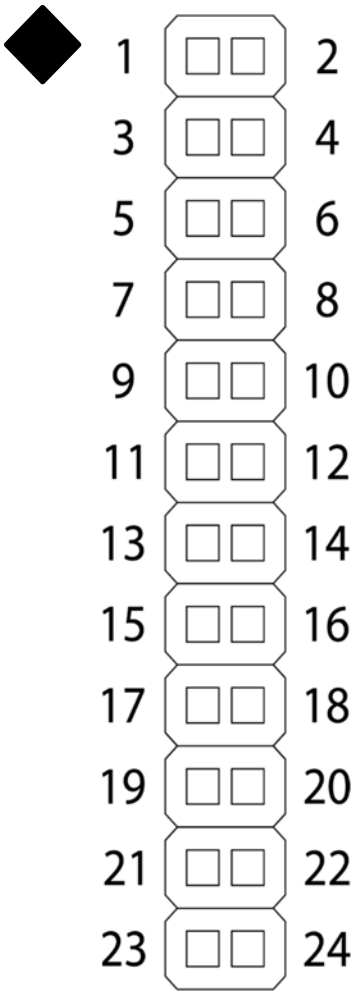


Figure 2-2: Identifying the First Pin on the Header Connector

H328 24-Pin Header Layout/Pinout

The H328 boards have a 24-pin header. Figure 2-3 shows the H328 24-pin header layout and Table 2-2 provides the 24-pin header pin-out.

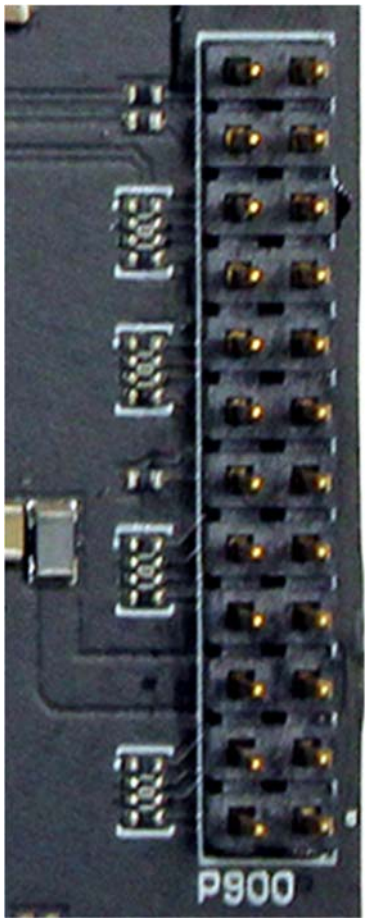


Figure 2-3: H328 24-Pin Header Layout

Table 2-2: H328 24-Pin Header Pin-Out

Pin	Name	Signal	Description
1	Ground	Power	Ground
2	Alarm	3.3V CMOS	GPIO Active high
3	SPEED PULSE CMOS	3.3V CMOS	VARF
4	PPS Output, Rising Edge	3.3 V CMOS	PPS
5	PWR IN	POWER	PWR
6	PWR IN	POWER	PWR
7	Receive Port C	3.3V CMOS	COM 3_RX
8	Manual Mark, Falling Edge	3.3V CMOS	MMARK
9	ERROR	3.3V CMOS	PWR ACT HIGH
10	PValid	3.3V CMOS	PValid High
11	CTS Port B / Gyro MISO	3.3V CMOS	COM2 CTS / SPI
12	RESET, Active Low	OPEN DRAIN	RESET
13	RTS Port B / Gyro MOSI	3.3V CMOS	COM2 RTS / SPI
14	Receive Port B	3.3V CMOS	COM2 RX
15	CTS Port A RS-232	RS-232	COM1 232 CTS
16	Transmit Port B	3.3V CMOS	COM2 TX
17	RTS Port A RS-232	RS-232	COM1 232 RTS
18	Receive Port A	RS-232	COM1 232 RX
19	Transmit Port C	3.3V CMOS	COM3 TX
20	Transmit Port A	RS-232	COM1 232 TX
21*	USB D-	USB	USB-
22*	USB D+	USB	USB+
23	Ground	Power	Ground
24	Ground	Power	Ground

Note: Pins are not 5 V tolerant. The pin voltage range is 0 to 3.3 VDC, unless otherwise noted. Leave any data or I/O pins that will not be used unconnected.

H328 16-Pin Header Layout/Pinout

The H328 board has a 16-pin header. Figure 2-4 shows the Eclipse 16-pin header layout and Table 2-3 provides the Eclipse 16-pin header pin-out.

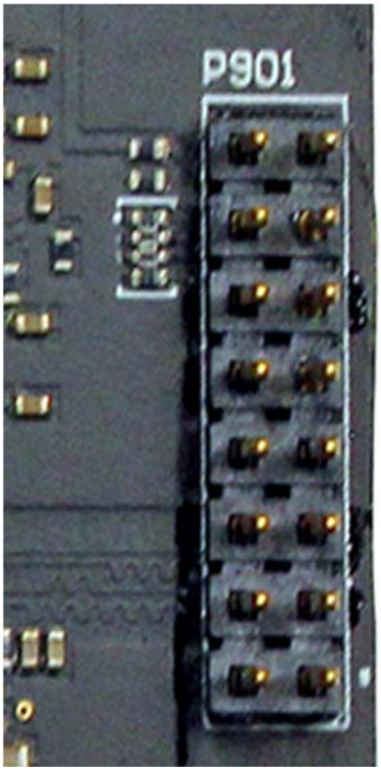


Figure 2-4: Eclipse 16-Pin Header Layout

Table 2-3: Eclipse 16-Pin Header Pinout

Pin	Name	Type	Description
1	Ethernet Receive -	Ethernet	ENET RX-
2	Ethernet Receive +	Ethernet	ENET RX-
3	RDCT	POWER	RX Magnetic Cap
4	Ethernet Transmit +	Ethernet	ENET TX+
5	Ethernet Transmit -	Ethernet	ENET TX-
6	RDCT	POWER	TX Magnetic Cap
7	Ethernet LED	3.3V CMOS	LED A
8	n/c	n/c	n/c
9	Ground	Power	GND
10	CAN Transmit Port A	3.3V CMOS	CAN1TX
11	CAN Receive Port A	3.3V CMOS	CAN1RX
12	CAN Transmit Port B / Gyro SCLK	3.3V CMOS	CAN2TX / SPI
13	CAN Receive Port B / Gyro CS	3.3V CMOS	CAN2RX / SPI
14	USB OTG ID	ANALOG	USB ID
15	USB OTG 5V	POWER	VBus
16	Ground	Power	Ground

Note: Pins are not 5 V tolerant. The pin voltage range is 0 to 3.3 VDC, unless otherwise noted. Leave any data or I/O pins that will not be used disconnected.

Signals

This section provides information on the signals available via connectors.

Note: USB-OTG-ID must be connected to ground for the USB port to operate.

RF Input

The H328 is designed to work with active GNSS antennas with an Low Noise Amplifier (LNA) gain range of 10 to 40dB. The purpose of the range is to accommodate for losses in the cable system.

There is a maximum cable loss budget of 30dB for a 40dB gain antenna. Depending on the chosen antenna, the loss budget will likely be lower (a 24dB gain antenna would have a 14dB loss budget).

When designing the internal and external cable assemblies and choosing the RF connectors, do not exceed the loss budget, or you will compromise the tracking performance of the H328.

Serial Ports

The H328 has three UART serial communication ports:

- **Port A-** RS-232 with flow control
  Pin 18 (RX), input
  Pin 20 (TX), output
  Pin 15 (CTS), input
  Pin 17 (RTS), output

- **Port B-** 3.3V CMOS with flow control
  Pin 14 (RX), input
  Pin 16 (TX), output
  Pin 11 (CTS), input
  Pin 13 (RTS), output

- **Port C-** 3.3V CMOS
  Pin 7 (RX), input
  Pin 19 (TX), output

If serial ports B or C (3.3V CMOS) are used for external devices which utilize RS-232, an RS-232 transceiver is required.

USB Ports

The H328 USB device port: serves as a high-speed data communications port, such as for a PC.

Note: USB OTG ID must be connected to ground for the USB port to operate.

The H328 USB data line is bi-directional and is a differential pair. The USB data lines should be laid out on printed wire board (PWB) with 90 Ω±15% differential impedance.

The traces should be over a solid continuous ground plane to maintain parallel traces and symmetry. There shall be no traces or breaks in the ground plane underneath the D+ and D- traces. It is also recommended to leave a minimum 20 mil spacing between USB signals and other signals. Treat the data lines as if they are RF signals. USB Transient Voltage Suppressors (TVS's) should be considered on D+ and D- for transient and electrostatic discharge protection.

Note: The USB_ID pin needs to be grounded for the USB port to function.

CAN

A CAN Transceiver is required. The H328 CAN RX and CAN TX are 3.3V CMOS signals. The H328 connects to the transceiver on the single-ended CMOS port. CANH and CANL are CAN standard signals on the physical bus side of the transceiver(the H328 does not connect to this portion of the transceiver).

Ethernet

There is 10/100 base-T Ethernet provided. To properly utilize it requires the appropriate magnetics and connector to interface to external Ethernet cabling.

LED Indicators

The H328 features the following surface-mounted diagnostic LEDs that indicate board status (see Figure 2-5):

- PWR - Power
- PGNSS – Primary GNSS lock
- SGNSS-Secondary GNSS lock
- DIFF - Differential lock
- DGPS - DGPS position
- HDG-Heading

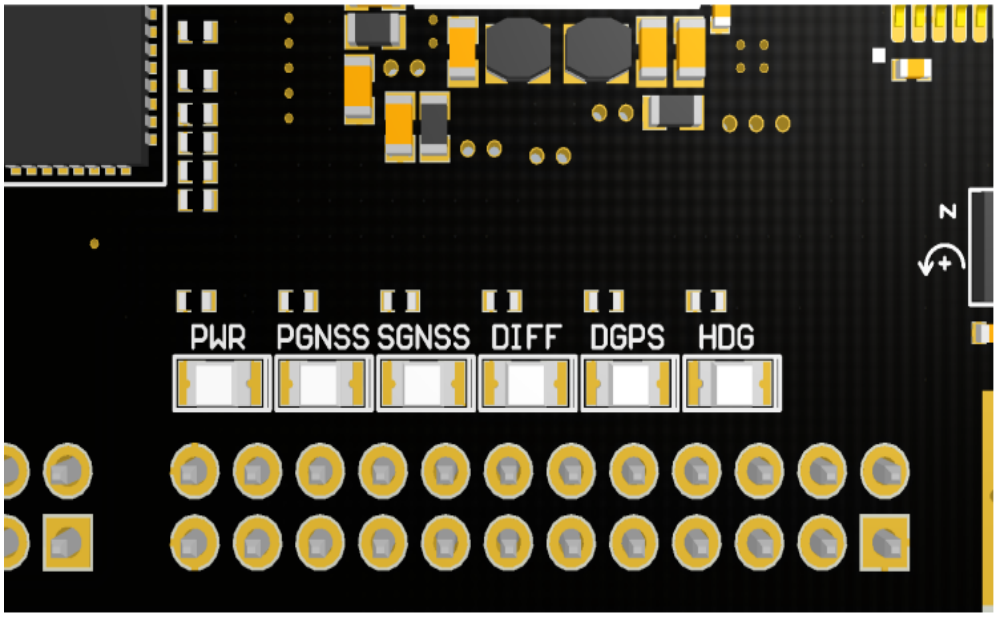


Figure 2-5: Onboard LEDs

Note: Each signal pin can offer only 1 mA of current and is active low. Since 1 mA of current may be inadequate for the application, you may want to transistor-buffer these signals to provide more current capacity for acceptable LED luminance.

1 PPS Timing Signal

The one pulse per second (1 PPS) timing signal is used in applications where devices require time synchronization.

Note: 1 PPS is typical of most GPS boards but not essential to normal receiver operation. Do not connect this pin if you do not need this function.

The 1 PPS signal is 3.3 V CMOS, active high with rising edge synchronization. The 1 PPS signal is capable of driving a load impedance greater than 10 kΩ in parallel with 10 pF. The pulse is approximately 1 ms. The pulse width can be adjusted by 100 ns.

The H328 supports a programmable PPS. Users can select the frequency to 1,2,5 or 10Hz. The H328 can support widths up to 900ms.

The width command parameter is in usec (microseconds).

$JPPS,RATE,<Rate_In_Hz (limited to 1.0 ,2.0 ,5.0 ,10.0 >,[SAVE]

or if you prefer to work with the period (inverse of RATE)

$JPPS,PERIOD,<Period in seconds (limited to 1.0, 0.5, 0.2, 0.1)

PPS Width can be controlled using

$JPPS,WIDTH,<width in usec>,[SAVE]

Note: $JSAVE does NOT save the JPPS configuration so the desired 1PPS configuration settings must be applied every time the receiver is powered on.

Each parameter must be individually saved as it is entered (by adding the optional SAVE at the end of the command)

Event Marker Input

A GPS solution may need to be forced in an instance (Such as indicating to the GPS receiver when a photo is taken from a camera used for aerial photography), and not synchronized with GPS time, depending on the application.

Note: Event marker input is typical of most GPS boards but not essential to normal receiver operation. Do not connect this pin if you do not need this function.

The event marker input is 3.3 V CMOS, active low with falling edge synchronization. The input impedance and capacitance is higher than 10 kΩ and 10 pF respectively, with a threshold of lower than 0.7 V required to recognize the input.

Grounds

You must connect all grounds together when connecting the ground pins of the H328. These are not separate analog and digital grounds that require separate attention. Refer to Table 2-1 through Table 2-2 for H328 pin-out ground information.

Speed Radar Output

Note: Speed radar output is not essential to normal receiver operation. Do not connect these pins if you do not need this function.

Pin 3 relates to the Speed Radar Pulse on the H328:

- **Speed Radar Pulse -** Outputs a square wave with 50% duty cycle. The frequency of the square wave varies directly with speed. 97 Hz represents a speed of 1 m/s (3.28 ft./s).

Note: This pin has no form of isolation or surge protection. If utilizing the Speed Radar Pulse output. Hemisphere GNSS strongly recommends incorporating some form of isolation circuitry into the supporting hardware. Contact Hemisphere GNSS Customer Support for an example of an optically isolated circuit.

Shielding

The H328 is a sensitive instrument. When integrated into an enclosure, the H328 requires shielding from other electronics to ensure optimal operation. The H328 shield design consists of a thin piece of metal with specific diameter holes, preventing harmful interference from penetrating, while still allowing air circulation for cooling.

Receiver Mounting

The H328 is a precision instrument. To ensure optimal operation, consider mounting the receiver to minimize vibration and shock.

When mounting the H328 immediately adjacent to the GPS antenna, Hemisphere GNSS highly recommends shielding the board from the LNA of the antenna.

Note: This step can be more complex than some integrators initially estimate. Attempt to confirm the operation in your application as early in the project as possible.

The inclusion of the tilt sensor and gyro in the H328 makes it more complicated to configure than many traditional pieces of GNSS equipment. The following steps summarize the primary installation steps and the things you need to consider to successfully install the H328.

Mounting the Antennas

The H328 is compatible with the following Hemisphere GPS single and dual frequency antennas:

- **Single frequency:** A21 and A31 (beacon)
- **Dual frequency:** A45 and A43 (beacon)

When mounting the antennas, consider the following:

- Mounting orientation (parallel or perpendicular)
- Proper antenna placement (See Planning the Optimal Antenna Placement)

Mounting Orientation

The H328 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.

Parallel Orientation: The most common installation is to orient the antennas 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, you can enter a heading bias in the H328 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:

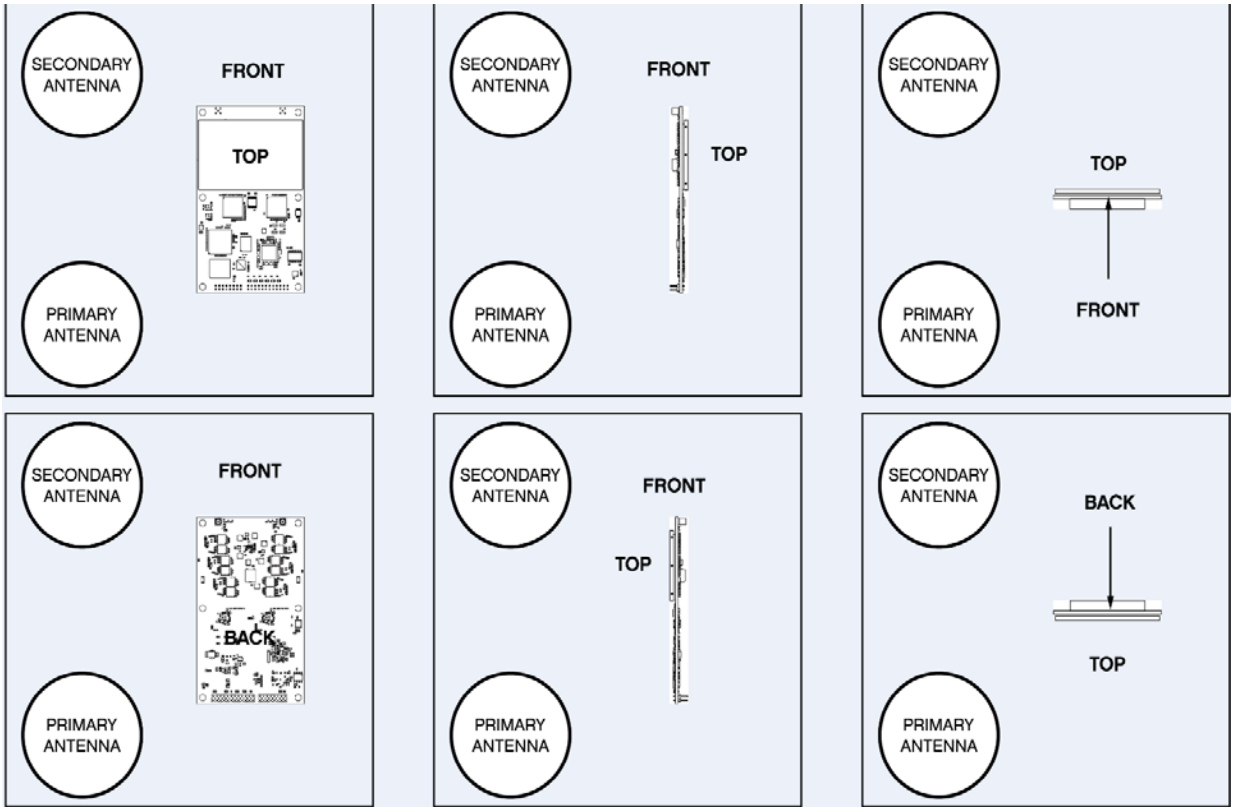
- Enter a heading bias of +90° if the primary antenna is on the starboard side of the boat and -90° if the primary antenna is on the port side of the boat.
- Configure the receiver to specify the GNSS antennas are measuring the roll axis using $JATT,ROLL,YES.
- Enter a roll bias to properly output the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

Note: Regardless of which mounting orientation you use, the H328 provides the ability to output the heave of the machine via the $GPHEV message. For more information on this message refer to the Hemisphere GNSS Technical Reference.

H328 Orientation and Sensor Calibration

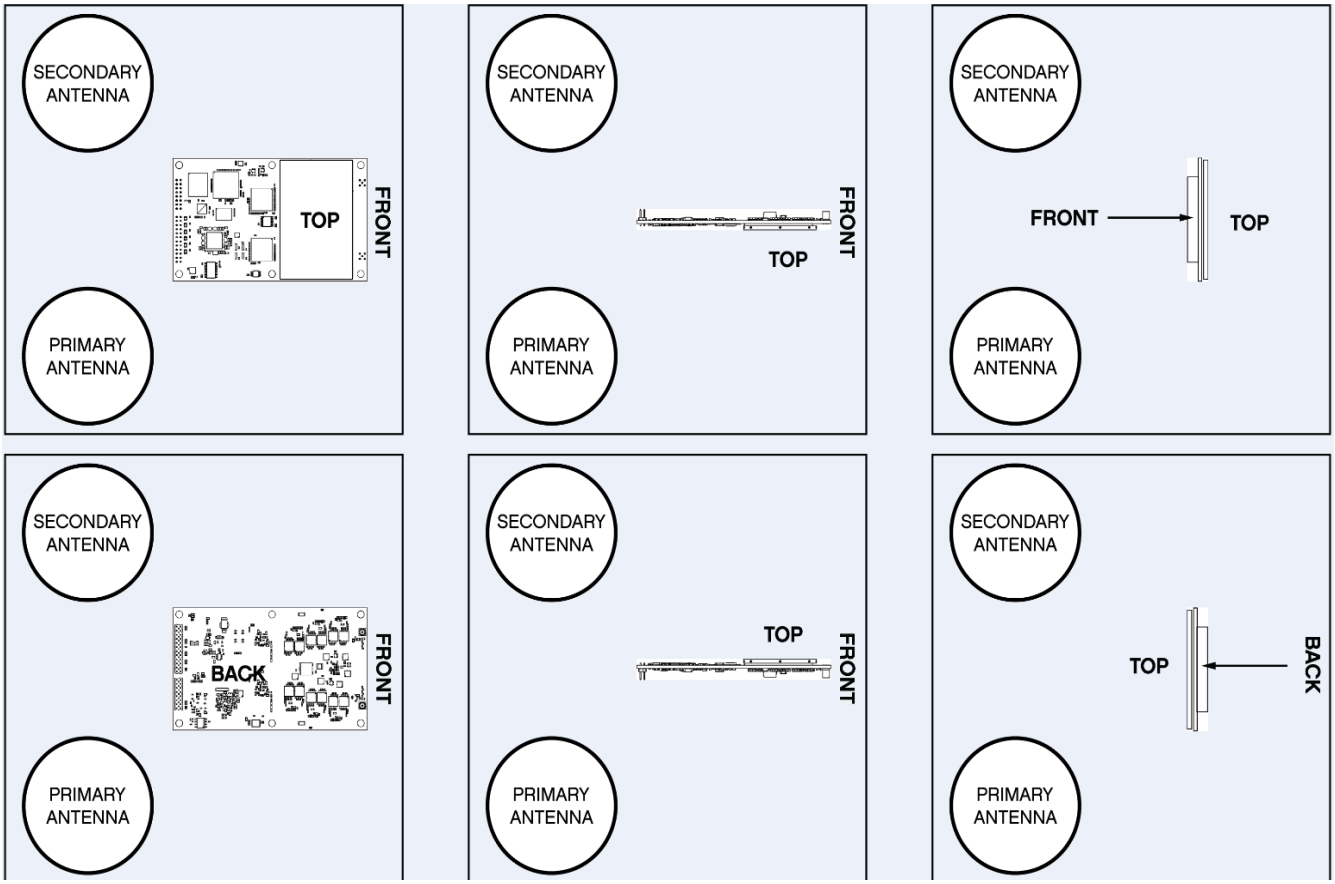
The H328 can determine mounting orientation in 90 degree steps using integrated inertial sensors. This allows the receiver to be installed in various orientations without affecting performance. A simple one-time calibration procedure is required to complete the orientation and sensor calibration:

1. Determine which of Group A, B, C or D the installation matches
2. Send the appropriate $JATT,ACC180,YES/NO and $JATT,ACC90,YES/NO commands that match the installation (as shown in Figures 2-6, 2-7, 2-8 and 2-9)
3. Send the command $JATT,TILTCAL to finalize the calibration



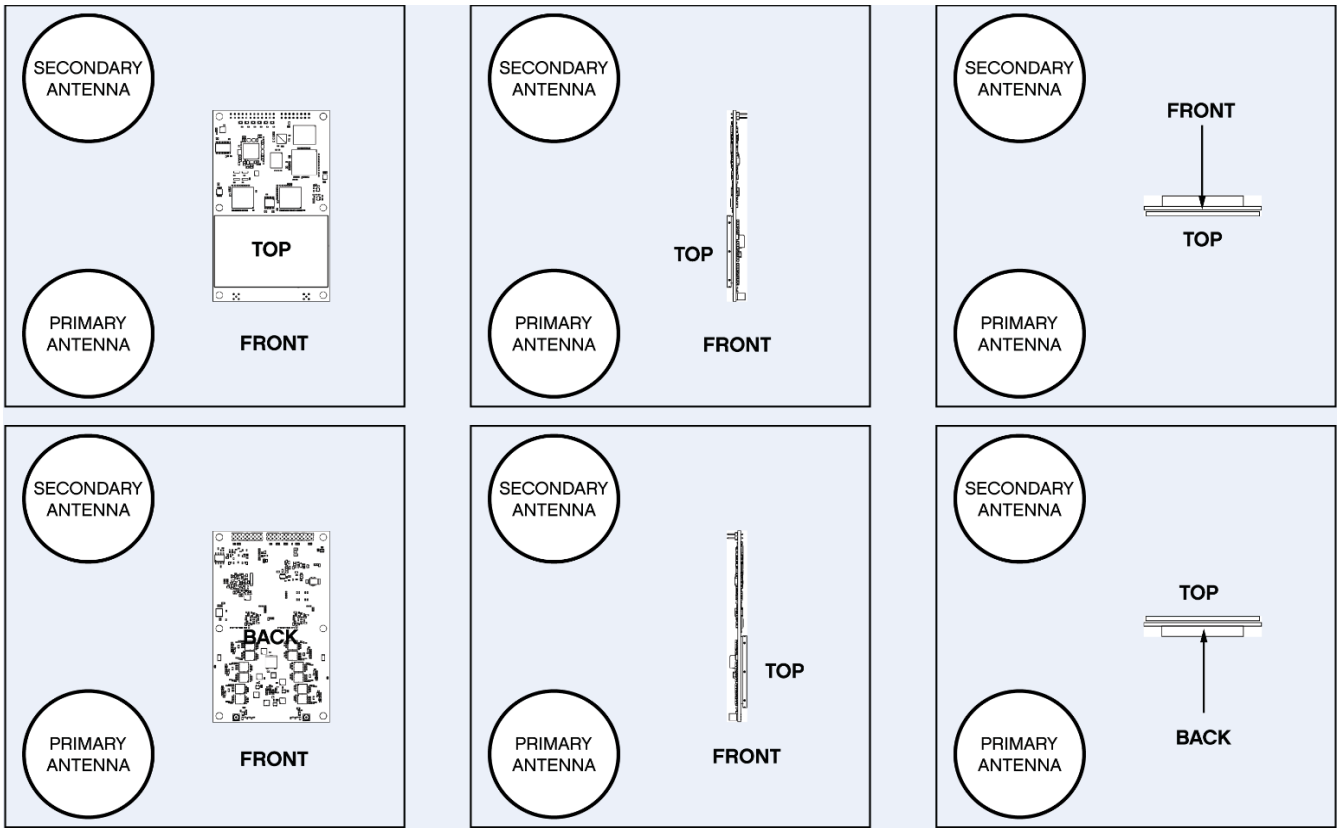
$JATT,ACC90,NO
$JATT,ACC180,NO

Figure 2-6: Group A



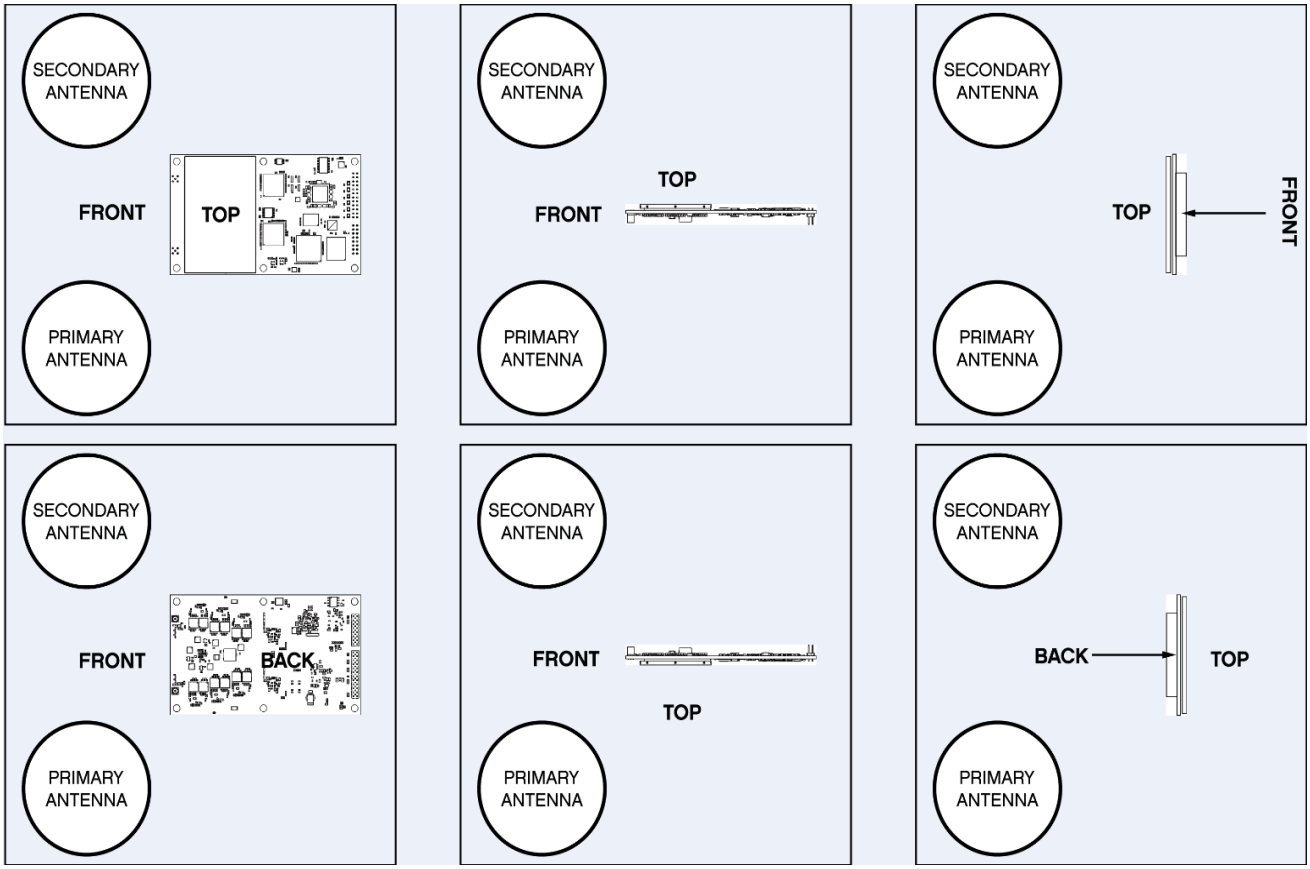
$JATT,ACC90,YES
$JATT,ACC180,NO

Figure 2-7: Group B



$JATT,ACC90,NO
$JATT,ACC180,YES

Figure 2-8: Group C



$JATT,ACC90,YES
$JATT,ACC180,YES

Figure 2-9: Group D

Planning the Optimal Antenna Placement

Proper antenna placement is important to obtain a high-precision GNSS reading.

Place the antennas:

- With a clear view of the horizon
- Away from other electronics and antennas
- Along the vessel's centerline

You must install the primary antenna along the vessel's centerline; you cannot adjust the position readings if the primary antenna is installed off the centerline. Positions are computed for the primary antenna.

Install on a level plane with a 5.0 m maximum separation (default of 1.0 m) away from radio frequencies as high as possible.

For optimal performance, orient the antennas so the antennas' connectors face the same direction.

Figures 2-10 through 2-12 provide examples of mounting orientation.

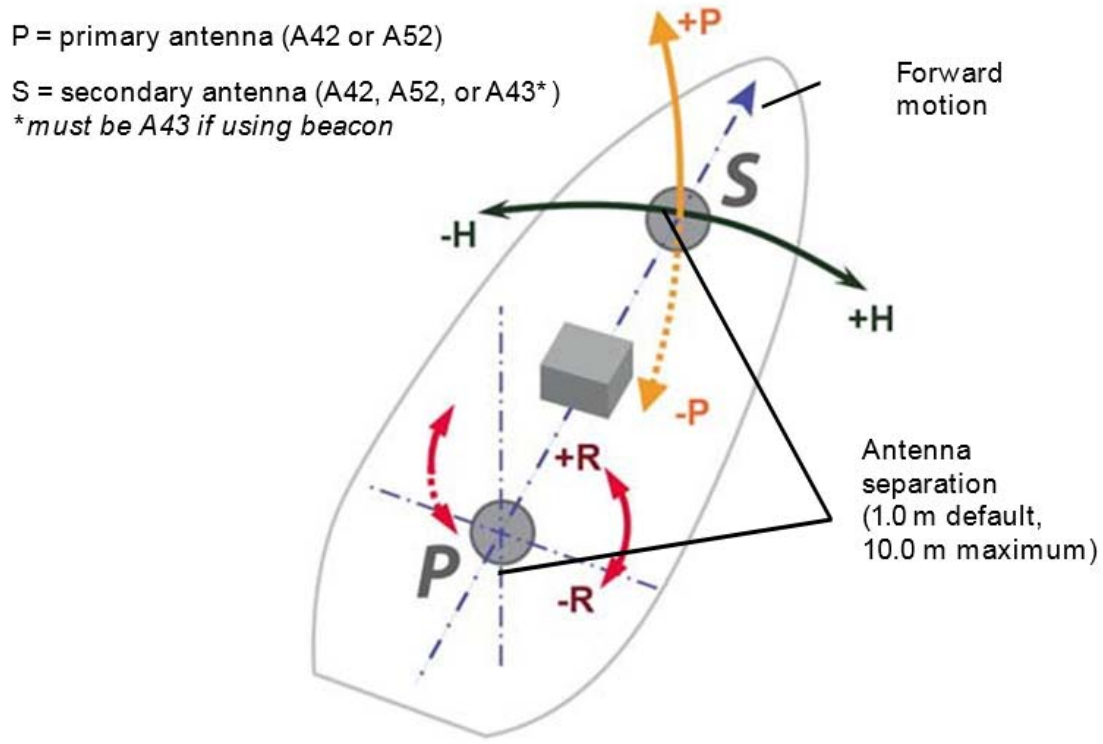


Figure 2-10: Recommended Orientation and Resulting Signs of HPR Values

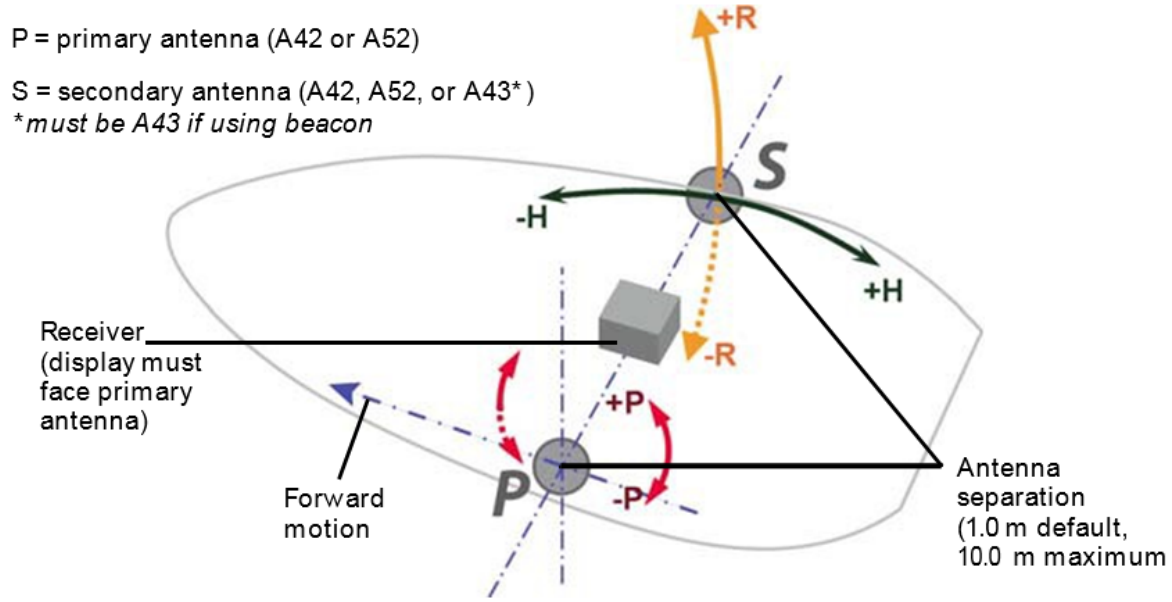


Figure 2-11: Alternate Orientation and Resulting Signs of HPR Values

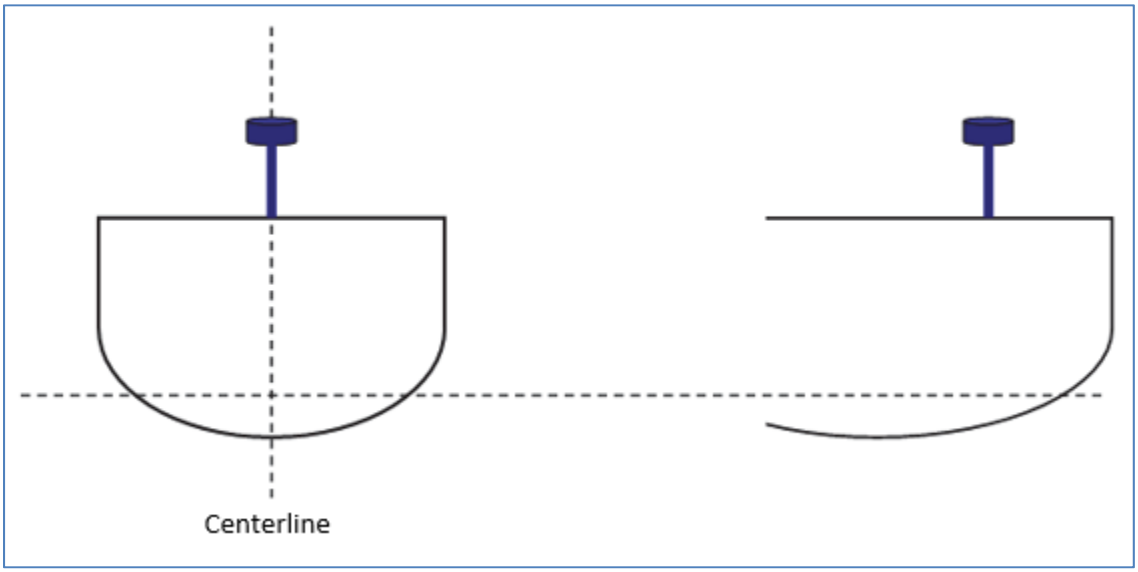


Figure 2-12 Antenna Installation: Cross-section of Boat

Connecting the Antennas to the H328

Connect the following:

- Primary antenna to J1000 port on the H328
- Secondary antenna to J2000 port on the H328

Thermal Concerns

The power consumption of the H328 receiver will generate heat. Since this may raise the ambient temperature inside an enclosure, ensure the internal enclosure temperature does not exceed the maximum operating temperature for the H328.

To achieve maximum dissipation, metal standoffs must be used on all six mounting points of the H328. Users should implement preferred industry standards for heat management.

Note: Thermal design may only be a concern if the integrated product's maximum design temperature is expected to be close to that of the H328.

Chapter 3: Setup and Configuration

Powering the H328

Communicating with the H328

Configuring the H328

Firmware

Configuring the Data Message Output

'THIS' Port and the 'OTHER' Port

Saving the H328 Configuration

Configuration Defaults

Setup and Configuration

This chapter provides H328 operation information, such as communicating with the H328, firmware, and configuration defaults.

Note: Install the antenna outdoors so it has a clear view of the entire sky. If you place the antenna indoors near a window, you will likely not track enough satellites. With a properly installed antenna, the H328 provides a position within approximately 60 seconds.

Powering the H328

The H328 is powered by a 3.3 VDC power source. Once you connect appropriate power, the H328 is active. Although the H328 proceeds through an internal startup sequence upon application of power, it is ready to communicate immediately.

Communicating with the H328

The H328 features three primary serial ports (Port A, Port B, Port C) that you can configure independently from each other. You can configure the ports for any combination of NMEA 0183, binary, and RTCM SC- 104 data. The usual data output is limited to NMEA data messages as these are industry standard.

Configuring the H328

You can configure all aspects of H328 operation through any serial port using proprietary commands. For information on these commands refer to the Hemisphere GNSS Technical Reference.

You can configure the following:

- Select one of the two firmware applications
- Set communication port baud rates
- Select which messages to output on the serial ports and the update message rate
- Set various receiver operating parameters

For a complete list of commands and messages refer to the Hemisphere GNSS Technical Reference.

To issue commands to the H328 you will need to connect it to a terminal program or Hemisphere GNSS' software applications (SLXMon or PocketMax3).

Firmware

The software that runs the H328 is often referred to as firmware since it operates at a low level. You can upgrade the firmware in the field through any serial port as new versions become available.

The H328 currently ships with the Athena based firmware. Refer to the Hemisphere GNSS Technical Reference for information on querying and talking to the H328 board.

Configuring the Data Message Output

The H328 features three primary bi-directional ports (Ports A, B and CYou can configure messages for all ports by sending proprietary commands to the H328 through any port. For a complete list of commands and messages refer to the Hemisphere GNSS Technical Reference.

'THIS' Port and the 'OTHER' Port

Both Port A and Port B use the phrases "THIS" and "OTHER" when referring to themselves and each other in NMEA messages.

'THIS' port is the port you are currently connected to for inputting commands. To output data through the same port ('THIS' port) you do not need to specify 'THIS' port. For example, when using Port A to request the GPGGA data message be output at 5 Hz on the same port (Port A), issue the following command:

$JASC,GPGGA,5<CR><LF>

The 'OTHER' port is either Port A or Port B, whichever one you are not using to issue commands. If you are using Port A to issue commands, then Port B is the 'OTHER' port, and vice versa. To specify the 'OTHER' port for the data output you need to include 'OTHER' in the command. For example, if you use Port A to request the GPGGA data message be output at 5 Hz on Port B, issue the following command:

$JASC,GPGGA,5,OTHER<CR><LF>

When using Port A or Port B to request message output on Port C, you must specifically indicate (by name) you want the output on Port C. For example, if you use Port A to request the GPGLL data message be output at 10 Hz on Port C, issue the following command:

$JASC,GPGLL,10,PORTC<CR><LF>

Saving the H328 Configuration

Each time you change the H328's configuration you may want to save the configuration so you do not have to reconfigure the receiver each time you power it on.

To save the configuration, issue the $JSAVE command to the H328 using a terminal program or Hemisphere GNSS' applications (SLXMon or PocketMax3).

The H328 will save the configuration to non-volatile memory and indicates (after several seconds) when the configuration has been saved. Refer to the Hemisphere GNSS Technical Reference.

Configuration Defaults

Below is the standard configuration for the H328. For more information on these commands refer to the Hemisphere GNSS Technical Reference.

```
$JOFF,ALL
$JOFF,PORTA
$JOFF,PORTB
$JOFF,PORTC
$JOFF,PORTD

$JAGE,2700
$JLIMIT,10
$JMASK,5
$JNP,8
$JWAASPRN,AUTO
$JDIFF,WAAS
$JPOS,51.0,-114.0
$JSMOOTH,LONG
$JTAU,COG,0.00
$JTAU,SPEED,0.00
$JAIR,AUTO
$JALT,NEVER
$JFREQ,AUTO

$JATT,HTAU,0.1
$JATT,HRTAU,2.0
$JATT,COGTAU,0.0
$JATT,MSEP,1.0
$JATT,GYROAID,YES
$JATT,TILTAID,YES
$JATT,LEVEL,NO
$JATT,EXACT,NO
$JATT,HIGHMP,YES
$JATT,FLIPBRD,NO
$JATT,HBIAS,0.0
$JATT,NEGTILT,NO
$JATT,NMEAHE,0
$JATT,PBIAS,0.0
$JATT,PTAU,0.5
$JATT,ROLL,NO
$JATT,SPDTAU,0.0

$JASC,GPGGA,1,PORTA
$JASC,GPHDT,10,PORTA
$JASC,GPROT,10,PORTA
$JASC,GPHPR,1,PORTA

$JASC,GPGGA,1,PORTB
$JASC,GPHDT,10,PORTB
$JASC,GPROT,10,PORTB
$JASC,GPHPR,1,PORTB

$JBAUD,19200,PORTA,SAVE
$JBAUD,19200,PORTB,SAVE


$JSAVE
```

Appendix A: Frequently Asked Questions

Integration

Support and Repair

Power, Communication, and Configuration

GNSS Reception and Performance

SBAS Reception and Performance

External Corrections

Installation

Appendix A: Frequently Asked Questions

Integration

Do I need to use the 1 PPS and event marker?

No, these are not necessary for H328 operation.

What should I do with the 1 PPS signal if I do not want to use it?

We recommend you tie to ground through a 1k resistor.

What should I do with the manual mark input if I am not going to use it?

Do not connect the pin because this signal is active low.

Do I need to use the lock indicators?

No, these are present for applications where it is desirable to have an LED visible to the user. These signals need to be transistor-buffered, as these lines can only offer 1 mA. Depending on the product and the application, LEDs can be very useful to the end user. These signals are active low.

Do I need to use a shield-can for the H328?

Not necessarily. But you may need to if there are RF interference issues, such as if the H328 interferes with other devices. A shield-can is a good start in terms of investigating the benefit. If you are designing a smart antenna system, a shield can is likely needed. Hemisphere GNSS recommends that you always conduct an RF pre-scan when integrating OEM boards.

If my company wishes to integrate this product, what type of engineering resources will I need to do this successfully?

Hemisphere GNSS recommends you have sufficient engineering resources with the appropriate skills in and understanding of the following:

- Electronic design (including power supplies and level translation)
- RF implications of working with GPS equipment
- Circuit design and layout
- Mechanical design and layout

As an integrator, you are responsible for ensuring that the correct resources are in place to technically complete integration. Hemisphere GNSS makes every effort to provide adequate support, but you should expect to have reasonable expertise to use this Integrator's Guide.

Support and Repair

How do I solve a problem I cannot isolate?

Hemisphere GNSS recommends contacting your HGNSS dealer first. With their experience with this product, and other products from Hemisphere GNSS, they should be able to help isolate a problem. If the issue is beyond the capability or experience of the dealer, Hemisphere GNSS Technical Support is available from 8:00 AM to 5:00 PM Mountain Standard Time, Monday through Friday.

See "Technical Support" for Technical Support contact information.

What if I cannot resolve a problem after trying to diagnose it myself?

Contact your dealer to see if they have any information that may help to solve the problem. They may be able to provide some in-person assistance. If this is not viable or does not solve the problem, Hemisphere GNSS Technical Support is available from 8:00 AM to 5:00 PM Mountain Standard Time, Monday through Friday.

See "Technical Support" for Technical Support contact information.

Can I contact Hemisphere GNSS Technical Support directly regarding technical problems?

Yes, however, Hemisphere GNSS recommends speaking to the dealer first as they are the local support. They may be able to solve the problem quickly, due to their proximity and experience with Hemisphere GNSS equipment.

Power, Communication, and Configuration

My H328 system does not appear to be communicating. What do I do?

This could be one of a few issues:

- Examine the H328 cables and connectors for signs of damage or offset.
- Ensure the H328 system is properly powered with the correct voltage.
- Ensure there is a good connection to the power supply since it is required to terminate the power input with the connector.
- Check the documentation of the receiving device, if not a PC, to ensure the transmit line from the H328 is connected to the receive line of the other device. Also, ensure the signal grounds are connected.
- If the H328 is connected to a custom or special device, ensure the serial connection to it does not have anyincompatible signal lines present that prevent proper communication.
- Make sure the baud rate of the H328 matches the other device. The other device must also support an 8-data bit, 1 stop bit, no parity port configuration (8-N-1). Some devices support different settings that may be user configurable. Ensure the settings match.
- Consult the troubleshooting section of the other device's documentation to determine if there may be a problem with the equipment.

Am I able to configure two serial ports with different baud rates?

Yes, all the ports are independent. For example, you may set one port to 4800 and another port to 19200.

Am I able to have the H328 output different NMEA messages through multiple ports?

Yes, different NMEA messages can be sent to the serial ports you choose. These NMEA messages may also be at different update rates. A high enough baud rate is needed to transmit all the data; otherwise, some data may not be transmitted.

How can I determine the current configuration of the H328?

The $JSHOW command will request the configuration information from the H328. The response will be similar to:

$>JSHOW,BAUD,19200
$>JSHOW,BIN,1,5.0
$>JSHOW,BAUD,4800,OTHER
$>JSHOW,ASC,GPGGA,1.0,OTHER
$>JSHOW,ASC,GPVTG,1.0,OTHER
$>JSHOW,ASC,GPGSA,1.0,OTHER

How can I be sure the configuration will be saved for the subsequent power cycle?

Query the receiver to make sure the current configuration is correct by issuing a $JSHOW command. If not, make the necessary changes and reissue the $JSHOW command. Once the current configuration is acceptable, issue a $JSAVE command and wait for the receiver to indicate the save is complete. Do not power off the receiver until the "save complete" message appears.

How do I change the baud rate of a port from that port?

Connect at the current baud rate of the H328 port and then issue a $JBAUD command to change the port baud rate to the desired rate. Now change the baud rate in your application to the desired rate.

What is the best software tool to use to communicate with the H328 and configure it?

Hemisphere GNSS uses two different software applications:

- **SLXMon** - Available at www.hgnss.com. This application is a very useful tool for graphically viewing tracking performance and position accuracy, and for recording data. It can also configure message output and port settings. SLXMon runs on Windows 95 or higher.
- **PocketMax3 -** Available at www.hgnss.com. Similar to SLXMon, you can use this application to graphically view tracking performance and position accuracy, record data, and configure message output and port settings. PocketMax3 runs on multiple Windows platforms using the Windows .NET framework.

GNSS Reception and Performance

How do I know what the H328 is doing?

The H328 supports standard NMEA data messages. The $GPGSV and Bin99 data messages contain satellite tracking and SNR information. If available, the computed position is contained in the $GPGGA message. Additionally, the H328 has surface-mounted status LEDs that indicate receiver status.

Do I have to be careful when using the H328 to ensure it tracks properly?

For best performance, the H328 antenna must have a clear view of the sky for satellite tracking. The H328 can tolerate a certain amount of signal blockage because redundant satellites are often available. Only four satellites are required for a position; however, the more satellites that are used, the greater the positioning accuracy.

SBAS Reception and Performance

How do I know if the H328 has acquired an SBAS signal?

The H328 outputs the $RD1 message that contains the SBAS Bit Error Rate (BER) for each SBAS channel. The BER value describes the rate of errors received from SBAS. Ideally, this should be zero. However, the H328 performs well up to 150 BER. The SLXMon and PocketMax3 utilities provide this information without needing to use NMEA commands.

How do I know if the H328 is offering a differentially-corrected or RTK-corrected position?

The H328 outputs the $GPGGA message as the main positioning data message. This message contains a quality fix value that describes the GPS status. If this value is 2, the position is differentially corrected; if this value is 5, the position is RTK-corrected. The SLXMon and PocketMax3 utilities provide this information without needing to use NMEA commands.

How do I select an SBAS satellite?

By default, the H328 will automatically attempt to track the appropriate SBAS satellites. If multiple satellites are available, the one with the lowest BER value is selected to be used to decode the corrections.

You can manually select which SBAS satellites to track (not recommended). Refer to the Hemisphere GNSS Technical Reference.

External Corrections

My H328 system does not appear to be using DGPS or RTK corrections from an external correction source. What could be the problem?

This could be due to several factors. To isolate the issue:

- Make sure DGPS corrections are RTCM v2.3 protocol.
- Make sure RTK corrections are either ROX, RTCM v3, CMR, or CMR+ protocol.
- Verify the baud rates used by the H328 match that of the external correction source.
- The external correction should be using an 8-data bit, no parity, 1 stop bit (8-N-1) serial port configuration.
- Inspect the cable connection to ensure there is no damage.
- Check the pin-out information for the cables to ensure the transmit line of the external correction source is connected to the receive line of the H328's serial port and that the signal grounds are connected.
- Make sure the H328 has been set to receive external corrections by issuing the $JDIFF command. Refer to the Hemisphere GNSS Technical Reference.

Installation

How will the antenna selection and mounting affect H328 performance?

For best results:

- Select a multipath-resistant antenna
- Ensure the antenna tracks all the available signals for the receiver
- Mount the antenna with the best possible view of the sky in a location with the lowest possible multi-path
- Using a magnetic mount for the antenna will not affect performance

I could not install my antennas at the same height. How do I calibrate for the height offset?

You may enter a non-level bias calculation that adjusts the pitch/roll output to calibrate the measurement if the antenna array is not installed on a horizontal plane.

To calibrate the pitch/roll reading, send the following command:

$JATT,PBIAS,x<CR><LF>

where x is a bias (in degrees) that will be added to the pitch/roll measurement. The acceptable pitch bias range is -15.0º to 15.0º (default is 0.0º).

To determine the current pitch compensation angle, send the following command:

$JATT,PBIAS<CR><LF>

The pitch/roll bias is added after the negation of the pitch/roll measurement (if so invoked with the **$JATT,NEGTILT** command).

Appendix B: Troubleshooting

Appendix B: Troubleshooting

Use the following checklist to troubleshoot anomalous H328 operation. Table B-1 provides a list of issues with possible solutions.

Table B-1: Troubleshooting

Issue	Possible Solution
What is the first thing I do if I have a problem with the operation of the H328?	Try to isolate the source of the problem. Problems are likely to fall within one of the following categories: • Power, communication, and configuration • GPS reception and performance • Beacon reception and performance • SBAS reception and performance • External corrections • Installation • Shielding and isolating interference **Note:** It is important to review each category in detail to eliminate it as a problem.
• No data from the H328 • No communication	• Check receiver power status (this may be done a Multimeter • Confirm communication with H328 via Hemisphere query command **$JI, $JSHOW** • Verify that H328 is locked to GPS satellites (this can often be done on the receiving device or by using SLXMon) • Check integrity and connectivity of power and data cable connections
Random binary data from the H328	• Verify that the RTCM or Bin messages are not being accidentally output (send a $JSHOW command). • Verify that the baud rate settings of H328 and remote device match. • Potentially, the volume of data requested to be output by the H328 could be higher than the current baud rate supports. Try using 19200 or higher for the baud rate for all devices.

Table B-1: Troubleshooting (continued)

Issue	Possible Solution
No GPS lock	• Check integrity of antenna cable • Verify antenna's view of the sky • Verify the lock status and signal to noise ratio of GPS satellites (this can often be done on the receiving device or by using SLXMon)
No SBAS	• Check antenna cable integrity • Verify antenna's view of the sky, especially towards that SBAS satellites, south in the northern hemisphere. • Verify the bit error rate and lock status of SBAS satellites (this can often be done on the receiving device or by using SLXMon - monitor BER value). • SBAS corrections are only applied to the position, not to the heading. If SBAS lock is lost, you will still have the same heading accuracy, but your position accuracy may be degraded.
No DGPS position in external RTCM mode	• Verify that 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 (the "ground" pin and pin-out must be connected, and from the "transmit" from the source must connect to the "receiver" of the RTCM input port).
Non-DGPS output	• Verify H328 SBAS and lock status (or external source is locked). • Confirm baud rates match an external source correctly • Issue a $JDIFF command and see if the expected differential mode is in fact the current mode. • Differential corrections are only applied to the position, not to the heading. If differential lock is lost, you will still have the same heading accuracy, but your position accuracy may be degraded.

Table B-1: Troubleshooting (continued)

Issue	Possible Solution
No heading or incorrect heading values	• Ensure the antennas are connected to the proper ports: J1000 and J2000 are for the primary and secondary antennas. • Heading is from primary to secondary antenna, so the secondary antenna should be toward the bow and primary toward the stern. • Check the measurement of the antenna separation. • The Measured (MSEP) and Calculated (CSEP) values are in meters and should agree to within 1 cm. CSEP continuously changes, so average this reading over several minutes to obtain an approximate value. • Check CSEP value is fairly constant without varying more than 1 cm. Larger variations may indicate a high multipath environment and require moving the antenna locations. • Reduce antenna separation - Hemisphere GNSS recommends that the separation between the antennas remain below 5 m for accurate and timely heading reading output • $JATT,SEARCH command forces the H328 to acquire a new heading solution. This should also be used after entering a new MSEP value • $JATT, GYROAID, YES Enable gyro aid as this will give heading for up to 3 minutes in times of GNSS signal loss • Enable tilt aid to reduce heading search times • Check the applications receiver using the $JAPP query; the receiver should answer $JAPP, MFAATT, 1,2 • Monitor the number of satellites and SNR values for both antennas within SLXMON; at least 3 satellites should have SNR values > 20 • Antenna connectors should both be facing the same direction

Appendix C: Technical Specifications

H328 Specifications

Appendix C: Technical Specifications

H328 Specifications

Table C-1 through Table C-6 provide technical specifications for the H328.

Table C-1: H328 Sensor Specifications

Item	Specification
Receiver type	GPS, GLONASS, BeiDou, Galileo and QZSS, RTK with carrier phase and L-band dual antenna
Channels	788
Satellites	12 L1CA GPS 12 L1P GPS 12 L2P GPS 12 L2C GPS 15 L5 GPS 12 G1 GLONASS 12 G2 GLONASS 12 G3 GLONASS 22 B1 BeiDou 22 B2 BeiDou 14 B3 BeiDou 12 Galileo E1 12 Galileo E5a 12 Galileo E5b 4 QZSS 3 SBAS or 3 additional L1CA GPS 2 L-band
Primary antenna	GPS L1,L1P,L2C,L2P,L5 GLONASS G1,G2,Pcode BeiDou B1,B2,B3 Galileo E1,E5a,E5b QZSS L1 L-band
Secondary antenna	GPS L1,L1P,L2C,L2P GLONASS G1,G2 BeiDou B1,B2 Galileo E1,E5b QZSS L1 L-band
GPS sensitivity	-142 dBm
SBAS tracking	3-channel, parallel tracking
Update rate	10 Hz standard, 20 Hz and 50 Hz available

Table C-1: H328 Sensor Specifications (continued)

Item	Specification		
Horizontal accuracy		RMS (67%)	2DRMS (95%)
	RTK [1,2]	8 mm + 1 ppm	15 mm + 2 ppm
	Atlas:	0.04m	0.08m
	SBAS (WAAS)[1]	0.3 m	0.6 m
	Autonomous, no SA[1]	1.2 m	2.4 m
Heading accuracy	< 0.17º rms @ 0.5 m antenna separation < 0.09º rms @ 1.0 m antenna separation < 0.04º rms @ 2.0 m antenna separation < 0.02º rms @ 5.0 m antenna separation		
Pitch/roll accuracy	< 1° rms		
Heave accuracy	30 cm[4]		
Rate of turn	145°/s maximum		
Timing (1PPS) accuracy	20 ns		
Cold start time	< 60 s typical (no almanac or RTC)		
Warm start time	< 30 s typical (almanac and RTC)		
Hot start time	< 10 s (almanac, RTC, and position)		
Maximum speed	1,850 km/h (999 kts)		
Maximum altitude	18,288 m (60,000 ft)		
Differential options	SBAS, Autonomous, External RTCM v2.3, RTK v3, L-band (Atlas), and DGPS		
Antenna LNA gain input	10 to 40 dB		

Table C-2: H328 Communication Specifications

Item	Specification
Serial ports	3x full-duplex UART's 2x 3.3V CMOS 1x RS-232
CAN	2 CAN ports NMEA2000, ISO-11783
Baud rates	4800 - 115200
Data I/O protocol	NMEA 0183, CAN, Hemisphere GPS binary
Correction I/O protocol	Hemisphere GNSS' ROX, RTCM v2.3 (DGPS), RTCM v3 (RTK), CMR, CMR+[3], and Atlas
Timing output	1 PPS CMOS, active high, rising edge sync, 10 kΩ, 10 pF load
Event marker input	CMOS, active low, falling edge sync, 10 kΩ 10 pF load
USB	1 USB Device, OTG with future firmware update
Ethernet	1x 10/100 base-T

Table C-3: H328 Power Specifications

Item	Specification
Input voltage	3.3 VDC +/- 5%
Power consumption	4.95W Maximum (All signals and L-band)
Current consumption	1.5A Maximum
Antenna voltage input	5 VDC Maximum
Antenna short circuit	Yes
Antenna input	50 Ω

Table C-4: H328 Environmental Specifications

Item	Specification
Operating temperature	-40°C to +85°C (-40°F to +185°F)
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% non-condensing (when installed in an enclosure)
Shock and vibration[4]	Vibration: EP455 Section 5.15.1 Random Mechanical Shock: EP455 Section 5.14.1 Operational (when mounted in an enclosure with screw mounting holes utilized)
EMC[5]	CE (ISO 14982 Emissions and Immunity) FCC Part 15, Subpart B CISPR22

Table C-5: H328 Mechanical Specifications

Item	Specification
Dimensions	100 L x 60 W x 10 H mm (2.81 L x 1.60 W x 0.40 H in)
Weight	35-37 grams
Status indication	Power, GNSS lock, Differential lock, DGNSS position, Heading lock
Power/Data connector	24-pin (12x2) male header 0.078 in (2 mm) pitch 16-pin (8x2) male header 0.078 in (2 mm) pitch
Antenna connector	MMCX, female, straight

Table C-6: H328 L-band Sensor Specifications

Item	Specification
Receiver Type	Single Channel
Channels	1525 to 1560 MHz
Sensitivity	140 dBm
Channel Spacing	5.0 kHz
Satellite Selection	Manual and Automatic
Reacquisition Time	15 seconds (typical)

Table C-7: H328 Aiding Devices

Device	Description
Gyro	Provides smooth heading, fast heading reacquisition, and reliable < 3° heading for periods up to 3 minutes when loss of GPS has occurred.[5]
Tilt Sensor	Provide pitch and roll data and assist in fast startup and reacquisition of heading solution.

1 Depends on multi-path environment, number of satellites in view, satellite geometry, and ionospheric activity

2 Depends also on baseline length

3 Receive only, does not transmit this format

4 When integrated in conjunction with the recommended shielding and protection as outlined in this guide

Under static conditions

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