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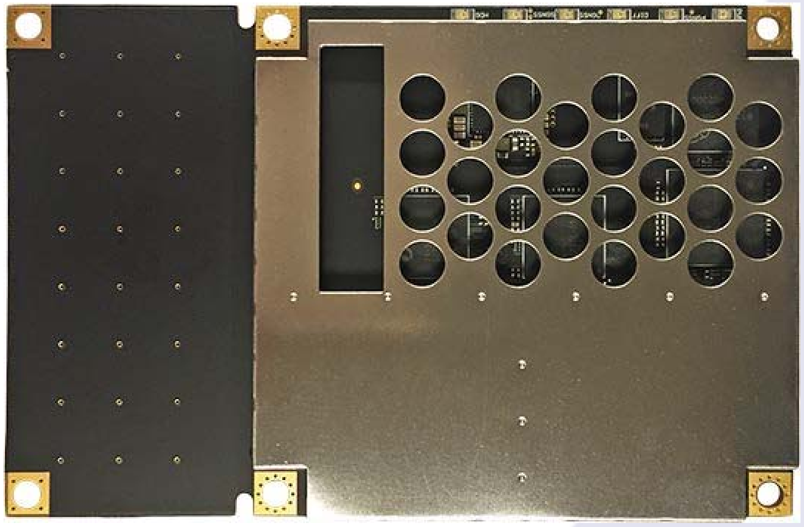

875-0384-0

Crescent® Vector™ H220 Board

Integrator Guide

Revision: A1

November 01, 2017

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(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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Chapter 1: Introduction

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Introduction

The Crescent® Vector™ H220 GNSS OEM board is the next generation, single-frequency, high-performance GNSS heading, positioning, and altitude module available from Hemisphere GNSS.

Note: Throughout the rest of this manual, the Crescent® Vector™ H220 OEM board is referred to simply as the H220.

The H220 provides integrators with an opportunity for developing sophisticated marine, navigation, and land applications in challenging, dynamic environments. The H220 uses Hemisphere's advancements in Vector technology, advanced multipath mitigation techniques, and Hemisphere's patented Multifunction Application.

H220 is capable of providing heading of 0.04° with a 5-meter antenna baseline and either RTK or SBAS positioning depending on your location requirements. With Atlas corrections, the H220 can obtain instant submeter accuracy worldwide while being more robust than SBAS even in SBAS regions.

Integrate the robust H220 GNSS OEM board into your applications to experience exceptional heading, positioning, and attitude performance in a compact size. Diversity and cost savings make it an ideal part of your solution for system integrators.

Product Overview and Features

Designed with a new hardware platform, it offers true scalability with centimeter-level accuracy in either single-frequency mode or Atlas-capable mode that supports fast RTK initialization times over long distances. The H220 offers fast accuracy heading of better than 0.30 degrees at 0.5 m antenna separation in ideal conditions and aiding gyroscope and tilt sensors for temporary GNSS outages. The 109-mm x 71 mm module with 34-pin header is a drop-in upgrade for existing designs using the H200.

The latest technology platform enables simultaneous tracking of all L1 constellations including GPS, GLONASS, BeiDou, Galileo, and QZSS, making it robust and reliable. The updated power management system efficiently governs the processor, memory, and ASIC, making it ideal for multiple integration applications. The H220 offers flexible and reliable connectivity by supporting Serial, USB, and CAN for ease-of-use and integration. Optional output rates of up to 50 Hz are also supported.

Advanced Technology Features

The H220 offers integrated L-band support for Atlas corrections providing global sub-meter position accuracy while Hemisphere's Tracer™ technology helps maintain position during correction signal outages.

Fitted with Hemisphere's patented Crescent receiver technology, the H220 computes heading and DGPS position using L1 GPS,GLONASS, BeiDou, Galileo and QZSS. Develop robust marine navigation and land solutions in a world full of complex dynamic environments through Hemisphere GNSS' advancements in Vector technology. The H220 brings a series of new features to the patented Crescent Vector technology including a more robust heading solution and excellent positioning through RTK. The H220 outputs heading, pitch, and roll.

H220 OEM Board Options

The H220 is available in the hardware configuration shown in Table 1-1.

Table 1.1 H220 OEM Board Options

Model	GNSS Systems	L-band
H220™	L1 GPS, GLONASS, BeiDou, Galileo and QZSS	Yes

What's Included

The H220 is available in two configurations:

- **H220 OEM board only -** designed for integrators who are familiar with H220 OEM board integration
- **H220 OEM board and Universal Development Kit -** designed for integrators who are new to H220 integration (assembly required: OEM board and Universal Development kit sold separately)

The Universal Development Kit is designed to work with various Hemisphere OEM boards and includes an enclosure with carrier board, adapter boards, and various cables.

For more information on the Universal Development Kit go to www.hemispheregnsss.com and navigate to the Precision OEM Products page.

Integrating the H220

Successful integration of the H220 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 H220 GNSS engine is a low-level module intended for custom integration with the following general integration requirements:

- Regulated power supply input (3.3 VDC ± 5%) and 1.7 mA continuous current
- Low-level serial port (3.3 V CMOS) and USB port communications
- Radio frequency (RF) input to the engine from a GNSS antenna is required to be actively amplified (10 to 40 dB gain)
- GNSS antenna is powered with a separate regulated voltage source up to 15 VDC maximum
- Antenna input impedance is 50 Ω
- Antenna voltage input is 15 VDC maximum
- Antenna gain input range is 10 to 40 dB

Features of the H220

Some notable features of the H220 are:

- Multi-channel GNSS engine (12 L1CA GPS, 12 L1P GPS, 12 L1 GLONASS, 22 B1 BeiDou, 12 E1 Galileo, 4 L1 QZSS and 3 channels dedicated to SBAS tracking)
- Sub-meter horizontal accuracy 95%
- Raw measurement output (via documented binary messages)
- Position and heading update rates of 50 Hz maximum
- Quick times to first fix
- Four full-duplex serial ports, a dedicated RTCM input port, and two USB ports (one USB host, one USB device)
- 1 CAN NMEA2000, ISO-11783
- 1 PPS timing output
- Event marker input
- L-band capable
- Fast RTK acquisition and reacquisition times
- 10 cm RTK-enabled heave accuracy
- Improved heading accuracy with different baseline lengths (up to 5 m)
- Same form factor as Hemisphere GNSS' Crescent® Vector II OEM board

Note: See Appendix B, Technical Specifications for complete H220 specifications.

Configuring the H220

The H220 has four communication ports: A, B, C, and D. Ports A, B, and C are fully independent and can have different messages output at different rates. You can configure each of these ports for external correction input or output binary message information or RTCM corrections from an outside source. You can also configure the output of ports A, B, or C through any of these ports. Configure the baud rates if necessary; the default is 19200 for Ports A, B, and C.

Port D is reserved for RTCM differential corrections and may be used by the Hemisphere GNSSSBX-4™ board (not included with H220).

You can configure the H220 to use the following differential operation modes:

- SBAS
- Beacon (with optional SBX-4 board)
- L-band
- External corrections

Message Interface

The H220 uses a NMEA 0183 interface, allowing you to easily make configuration changes by sending text-type commands to the receiver.

The H220 also supports a selection of binary messages. There is a wider array of information available through the binary messages, plus binary messages are inherently more efficient with data. If the application has a requirement for raw measurement data, this information is available only in a binary format.

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

Using PocketMax4 to Communicate with the H220

Hemisphere's PocketMax4 is a free utility program that runs on your Windows PC or Windows mobile device.

Simply connect your Windows device to the H220 via the COM port and open PocketMax4.

The screens within PocketMax4 allow you to easily interface with the H220 to:

- Select the internal SBAS, external beacon, or RTCM correction source and monitor reception (beacon optional)
- Configure GNSS message output and port settings
- Record various types of data
- Monitor the H220 status and function

PocketMax4 is available for download from the Hemisphere GNSS website.

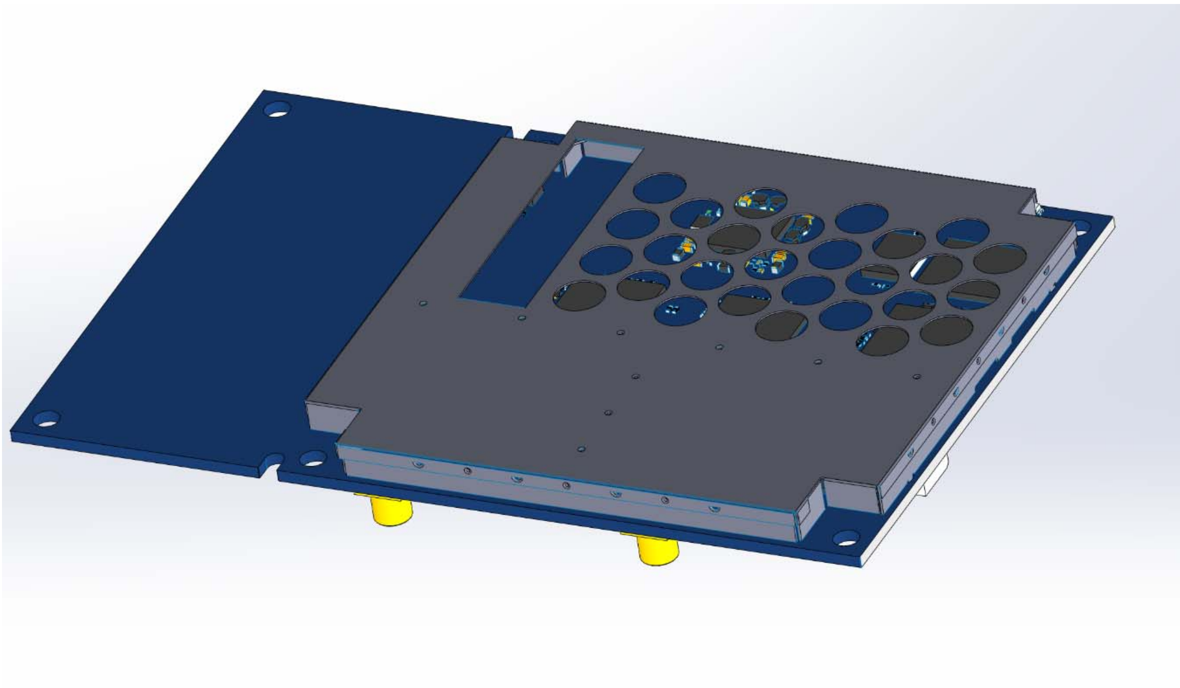
Chapter 2: Board Overview

H220 OEM Board Key Features
Mechanical Layout
Connectors
Mounting Options
Header Layouts and Pinouts
Signals
Shielding
Receiver Mounting
Mounting the Antennas
Mounting Orientation
H220 Orientation and Sensor Calibration
Planning the Optimal Antenna Placement
Connecting Antennas to the H220
Thermal Concerns

Board Overview

H220 OEM Board Key Features

With small form factor, low power consumption, and simple on-board firmware, the H220 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).



H220 is offered in the H200 form factor (109L x 71W mm) with integrated L-band. The reliable positioning performance of H220 is further enhanced by RTK, Atlas corrections, aRTK, and TRACER™ technology. The dual antenna H220 provides fast accuracy heading and with on-board gyro and tilt sensor continues to provide heading during short GNSS outages.

With multi-GNSS RTK experience centimeter level accuracy and fewer RTK dropouts in congested environments, faster reacquisition, and more robust solutions due to better cycle slip detection.

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 30 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 30 to 100 cm range
- **Convergence time -** Industry-leading convergence times of 10-40 minutes

H220 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 Atlas L-band, see: http://hgnss.com/Atlas.

aRTK Position Aiding

aRTK is an innovative feature available in Hemisphere's H220 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.

H220 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 H220 OEM board. All dimensions are in millimeters.

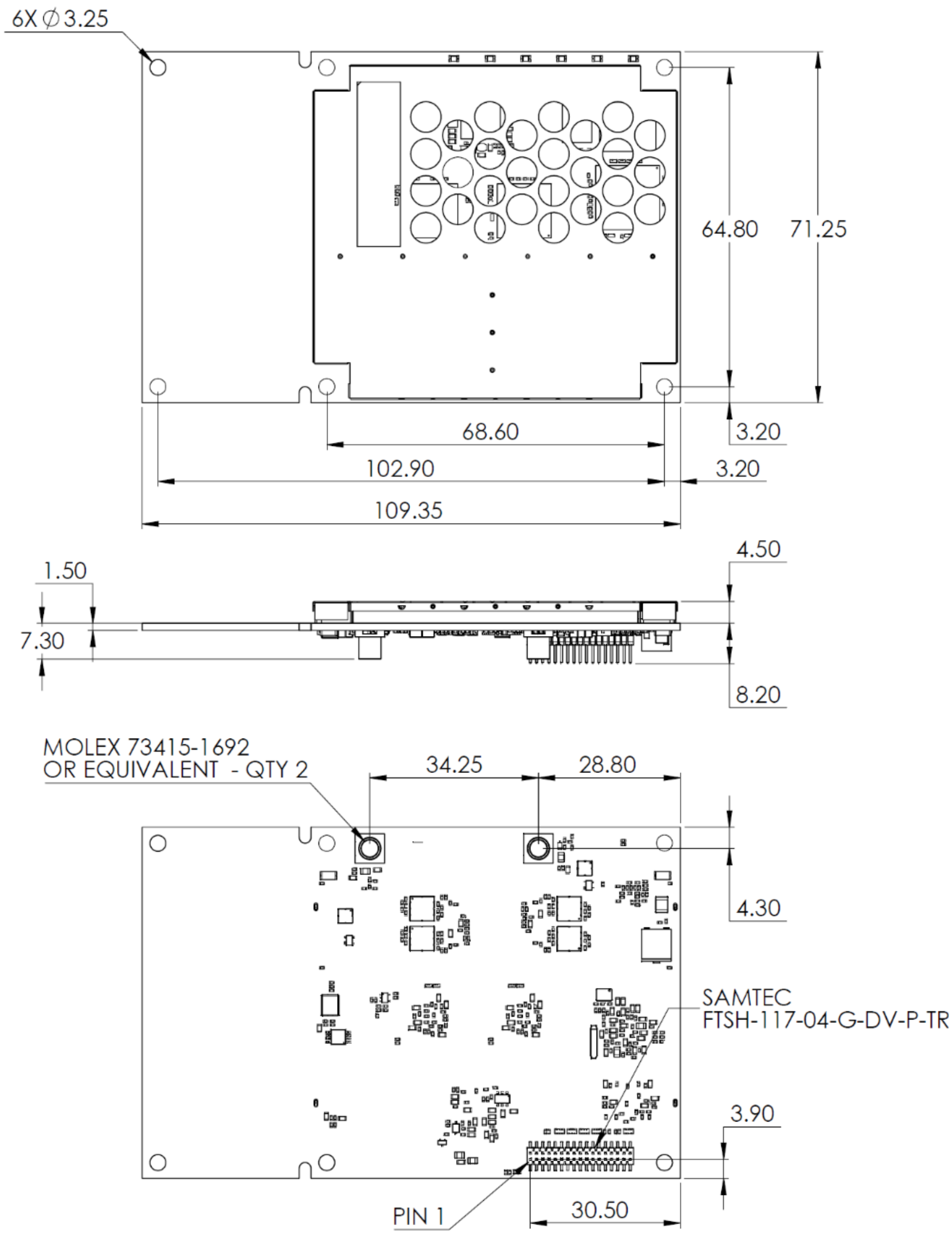


Figure 2-1: H220 Mechanical Layout

Connectors

Table 2-1 describes the H220's connectors and the mating connectors. You can use different compatible connectors; however, the requirements may be different. The antenna input impedance is 50 Ω.

Table 2-1: H220 Connectors

Connector	H220 SMT Connector	Mating Connector
RF	MCX, straight jack (female) (Molex 73415-1692)	MCX, straight plug (male) (AMP: 1061015-1)
Interface	17x2 pin header plug (male) 0.05 in (1.27 mm) pitch (Samtec: FTSH-117-04-G-DV-P-TR)	17x2, SMT header socket (female) 0.05 in (1.27 mm) pitch (Samtec: FLE-117-01-G-DV)

Mounting Options

There are two options for mounting the H220:

- Direct Electrical Connection method
- Indirect Electrical Connection (Cable) method

Direct Electrical Connection Method

Place an RF connector, heading connector, and mounting holes on the carrier board and then mount the H220 on the standoffs and RF header connectors. This method is very cost effective as it does not use cable assemblies to interface the OEM board.

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

The H220 uses a standoff height of 0.79 cm (0.3125 in). With this height, there should be no washers between either the standoff and the H220 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 MCX connector, use a taller header than the Samtec part number that Hemisphere suggests. This will provide clearance to have a right-angle cable-mount connector and reduce the complexity by not having the carrier board handle the RF signals. See Table 2-1 on for H220 connector information.

The mounting holes of the H220 have a standard inner diameter of 0.32 cm (0.125 in).

Indirect Electrical Connection (Cable) Method

The second method is to mount the H220 mechanically, so you can connect a ribbon power/data cable to the H220. This requires cable assemblies and there is a reliability factor present with cable assemblies in addition to increased expense.

Header Layouts and Pinouts

The H220 uses a dual-row 34-pin (17 pins x 2 rows) 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.

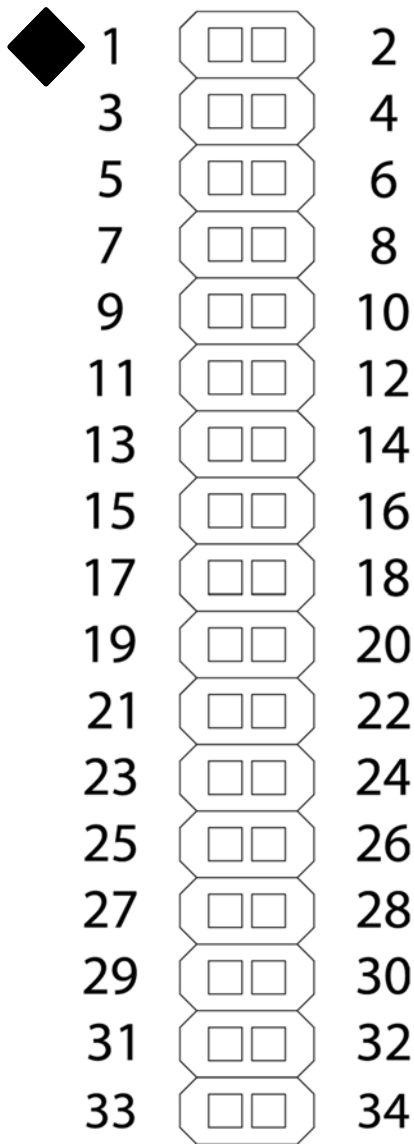


Figure 2-2: Identifying the First Pin on the Header Connector

Table 2-2: H220 34-Header Pin-Out

Pin	Name	Type	Description
1	3.3 V	Power	Receiver power supply, 3.3 V
2	3.3 V	Power	Receiver power supply, 3.3 V
3	Antenna Pwr	Power	Antenna power, DC, 5 V max
4	Batt Backup	Power	Backup power input (1.6 - 3.6 VDC, <5 μA consumption)
5	USB DEV+	I/O	USB device data +
6	USB DEV–	I/O	USB device data -
7	GND	Power	Receiver ground
8	GND	Power	Receiver ground
9	PATX	Output	Port A serial output, 3.3 V CMOS, idle high
10	PARX	Input	Port A serial input, 3.3 V CMOS, idle high
11	PBTX	Output	Port B serial output, 3.3 V CMOS, idle high
12	PBRX	Input	Port B serial input, 3.3 V CMOS, idle high
13	PDTX	Output	Port D serial output, 3.3 V CMOS, idle high
14	PDRX	Input	Port D serial input, 3.3 V CMOS, idle high
15	1 PPS	Output	1 PPS, 3.3 V CMOS, active high, rising edge
16	Manual mark	Input	3.3 V CMOS, active low, falling edge
17	Master (primary) GPS lock	Output	Status indicator (M-GPS LED), 3.3 V CMOS, active low, 1 mA max, optional connection
18	Differential lock	Output	Status indicator (DIFF LED), 3.3 V CMOS, active low, 1 mA max, optional connection
19	DGPS position	Output	Status indicator (DGPS LED), 3.3 V CMOS, active low, 1 mA max, optional connection
20	Alarm	Output	RTC alarm output
21	CANTX	Output	3.3 V CMOS
22	Secondary GPS lock	Output	Status indicator (S-GPS LED), 3.3 V CMOS, active low, 1 mA max
23	CANRX	Input	3.3 V CMOS
24	Heading lock	Output	Status indicator (HDG LED), 3.3 V CMOS, active low, 1 mA max
25	Speed radar pulse	Output	0 - 3 V variable clock output
26	Speed radar ready signal	Output	Speed valid indicator, 3.3 V CMOS, active low
27	GND	Power	Receiver ground
28	GND	Power	Receiver ground
29	USB HOST +	Output	USB host data +
30	USB HOST –	Output	USB host data –
31	PCTX	Output	Port C serial output, 3.3 V CMOS, idle high
32	PCRX	Input	Port C serial input, 3.3 V CMOS, idle high
33	NC		No connect
34	Reset	Open collector	Reset, open collector, 3.3 V typical, not required

Note: *Leave any data or I/O pins unconnected if not in use.*

The H220 OEM board, the Crescent Vector II OEM board, and the Crescent Vector OEM board differ from their predecessor, the Vector OEM, in that they do not have power supply or communication translation: this must be accomplished by a carrier board.

Signals

This section provides more detail on the signals available via connectors.

RF Input

The H220 is designed to work with active GNSS antennas with a Low Noise Amplifier(LNA) gain range of 10 to 40 dB. The purpose of the range is to accommodate for losses in the cable system.

Essentially, there is a maximum cable loss budget of 30 dB for a 40-dB gain antenna. Depending on the chosen antenna, the loss budget will likely be lower (a 24-dB gain antenna would have a 14-dB 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 H220.

Serial Ports

The H220 has four UART serial communication ports, all 3.3V CMOS:

Port A
Pin 10 (RX), input
Pin 9 (TX), output

Port B
Pin 12 (RX), input
Pin 11 (TX), output

Port C
Pin 32 (RX), input
Pin 31 (TX), output

Port D - Exclusively used to interface with Hemisphere's SBX™ beacon board or an external corrections source. This port will not output normal GNSS-related NMEA messages. When communicating into either Port A, B, or C, a virtual connection may be established to the device on Port D using the $JCONN command. See "Communication Port D" for more information on Port D.
Pin 14 (RX), input
Pin 13 (TX), output

If the serial ports which are 3.3V CMOS are used for external devices which utilize RS-232, an RS-232 transceiver is required.

Communication Port D

The exclusive function of Port D is for external correction input to the H220. The source of corrections may depend on the geographical use of your final product, market, customer, and positioning performance requirements. If you intend to market products outside of SBAS coverage, you may want to allow your product to be used with external correction input or integrate a second source of corrections along with H220, such as the Hemisphere SBX beacon module. For more information on SBAS refer to the Hemisphere GNSS Technical Reference Guide.

If used, Port D will free up the task of Port A, B, or C from being used for external correction input. If you want to support external correction input when the product is in the field, Hemisphere recommends that you offer the facility to the user to input corrections on Port A, B or C, and that Port D remain within the integration only.

Note: DGPS corrections are not required for heading accuracies as specified. External corrections will only affect positioning performance.

CAN

A CAN Transceiver is required. The H220 CAN RX and CAN TX are 3.3V CMOS signals. The H220 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 H220 does not connect to this portion of the transceiver).

LED Indicators

The H220 features the following surface-mounted diagnostic LEDs that indicate board status (see Figure 2-3):

- PWR – Power
- P-GNSS - Primary GNSS lock
- DIFF - Differential lock
- DGNSS - DGNSS position
- S-GNSS - Secondary GNSS lock
- HDG - Heading lock

Figure 2-3: Onboard LEDs

With the exception of the PWR LED the signals that drive the LEDs are available via the header connector. Refer to Table 2-2 for pin number descriptions for the H220.

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 GNSS boards but not essential to normal receiver operation. Do not connect the 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 H220 supports a programmable PPS. Users can select the frequency to 1,2,5 or 10Hz. The H220 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 GNSS solution may need to be forced at a particular instance, not synchronized with GNSS time depending on the application, such as identifying features during a bathymetric survey.

Note: Event marker input is typical of most GNSS 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 H220. These are not separate analog and digital grounds that require separate attention.

Refer to Table 2-2 for pinout ground information for the H220.

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.

The following two pins on the H220 relate to the Speed Radar:

- **Speed Radar Pulse (pin 25) -** 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).
- **Speed Radar Ready Signal (pin 26) -** Indicates when the speed signal on the "Speed Radar Pulse" pin is valid. In static situations, such as when the vehicle has stopped, the GNSS position may still have slight variations from one moment to the next. During these instances, the signal on the 'Speed Radar Ready Signal' pin is 'high' (or +Vcc), indicating the speed coming out of the 'Speed Radar Pulse' pin is erroneous and not truly indicative of the GNSS receiver's actual speed. Therefore, it should not be referred to or be used. Once the vehicle starts moving again and meets a minimum threshold speed, the output on the 'Speed Radar Ready Signal' pin will go 'low' indicating valid speed information is present on the 'Speed Radar Pulse' pin.

Note: Neither pin 25 nor pin 26 has any form of isolation or surge protection. If utilizing the Speed Radar Pulse output, Hemisphere strongly recommends incorporating some form of isolation circuitry into the supporting hardware. Contact Hemisphere Technical Support for an example of an optically isolated circuit.

Shielding

Typically, the H220 does not require shielding for improving immunity to RF noise incident upon the board and its various devices. You may, however, wish to shield the H220 from the rest of the integration if you determine it interferes with other devices or systems.

If you are designing a smart antenna based on the H220 (the H220 and the two GNSS antennas in close proximity), you will likely want to shield the H220 so that it does not interfere with the incoming GNSS signals to the antenna.

Receiver Mounting

The H220 is a precision instrument. To ensure optimal operation, consider mounting the receiver to minimize vibration and shock.

When mounting the H220 immediately adjacent to the GNSS 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 H220 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 H220.

Mounting the Antennas

The H220 is compatible with the following Hemisphere GNSS single-frequency and L-band capable antennas:

- A21 A25, and A31 (beacon)

When mounting the antennas, consider the following:

- Mounting orientation (parallel or perpendicular)
- Proper antenna placement

Mounting Orientation

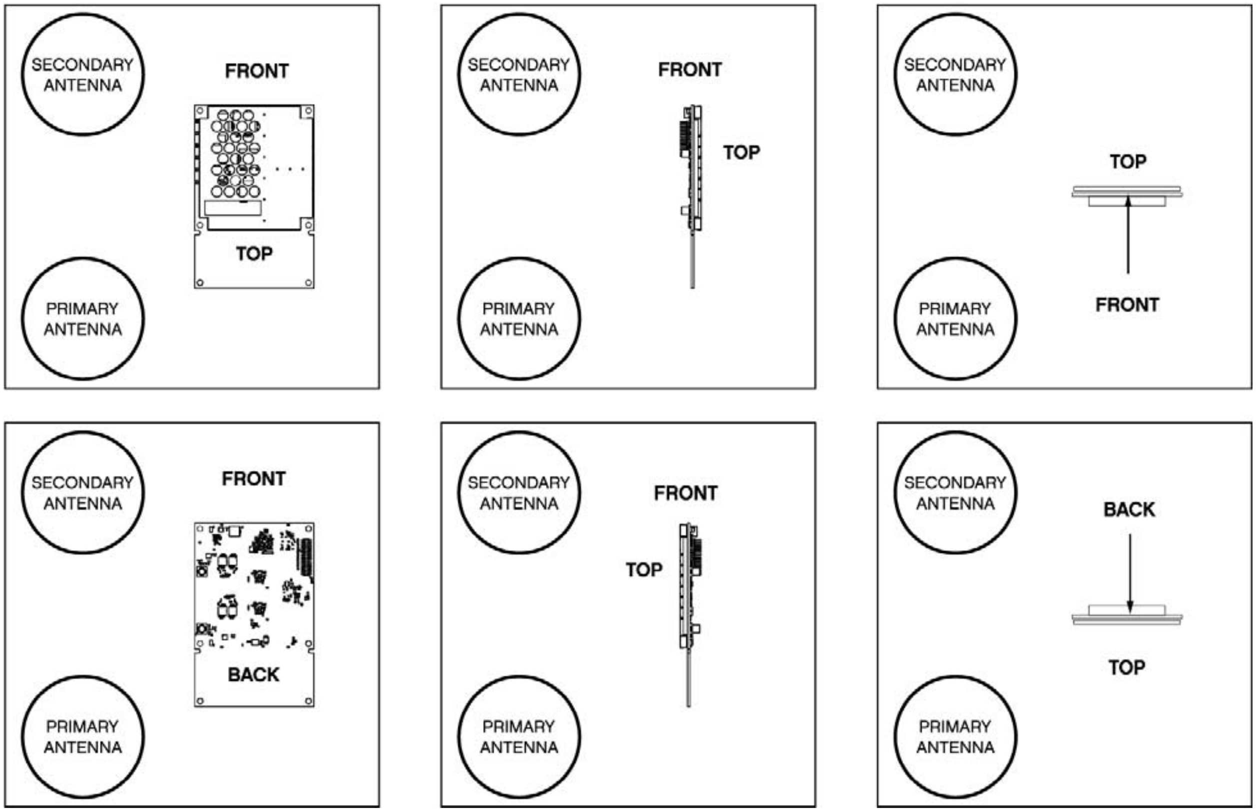
The H220 outputs heading, pitch, and roll readings regardless of the orientation of the antennas. However, the relation of the antennas to the boat's axis determines whether you will need to enter a heading, pitch, or roll bias. The primary antenna is used for positioning and the primary and secondary antennas, working in conjunction, output heading, pitch, and roll values.

Note: Regardless of which mounting orientation you use, the H220 provides the ability to output the heave of the machine via the $GPHEV message. For more information on this message refer to the HGNSS Technical Reference Guide.

H220 Orientation and Sensor Calibration

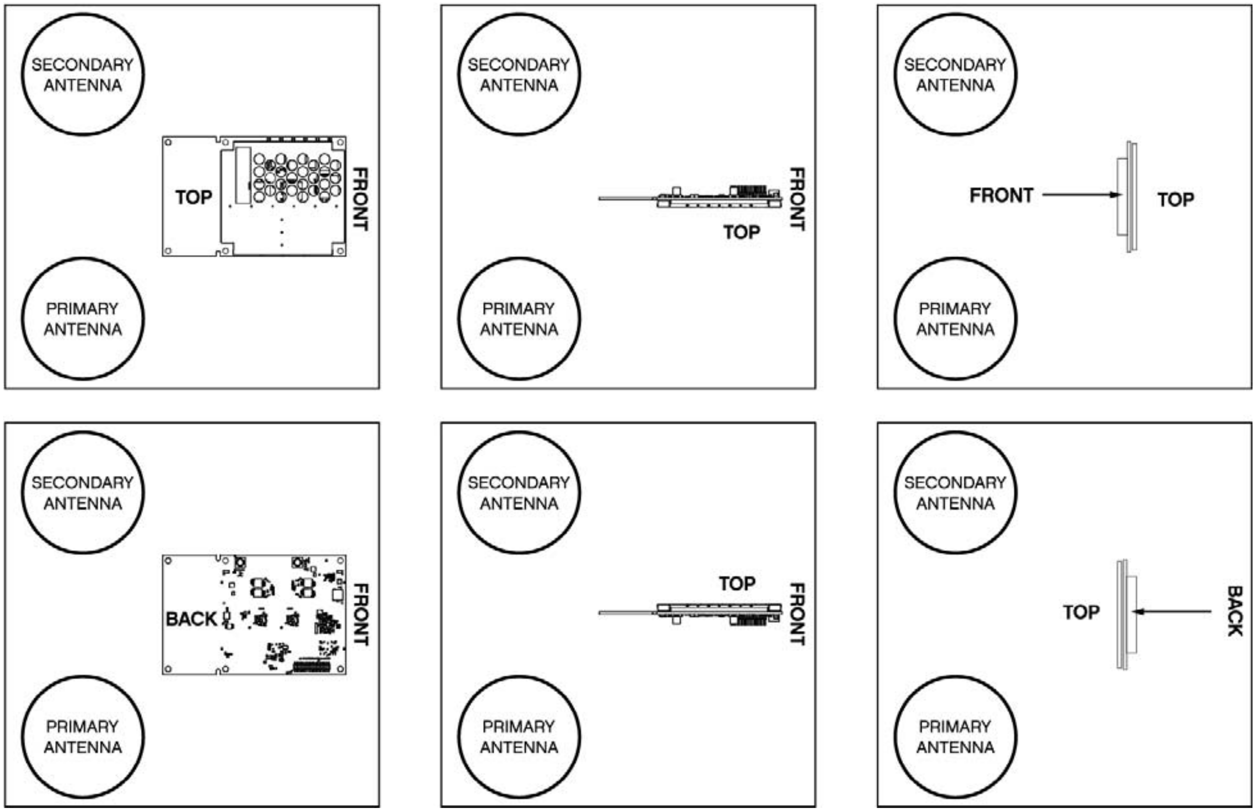
The H220 can determine mounting orientation in 90-degree steps using integrated inertial sensors. This allows the receiver to be installed in various orientations without affecting performance. A simple one-time calibration procedure is required to complete the orientation and sensor calibration:

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



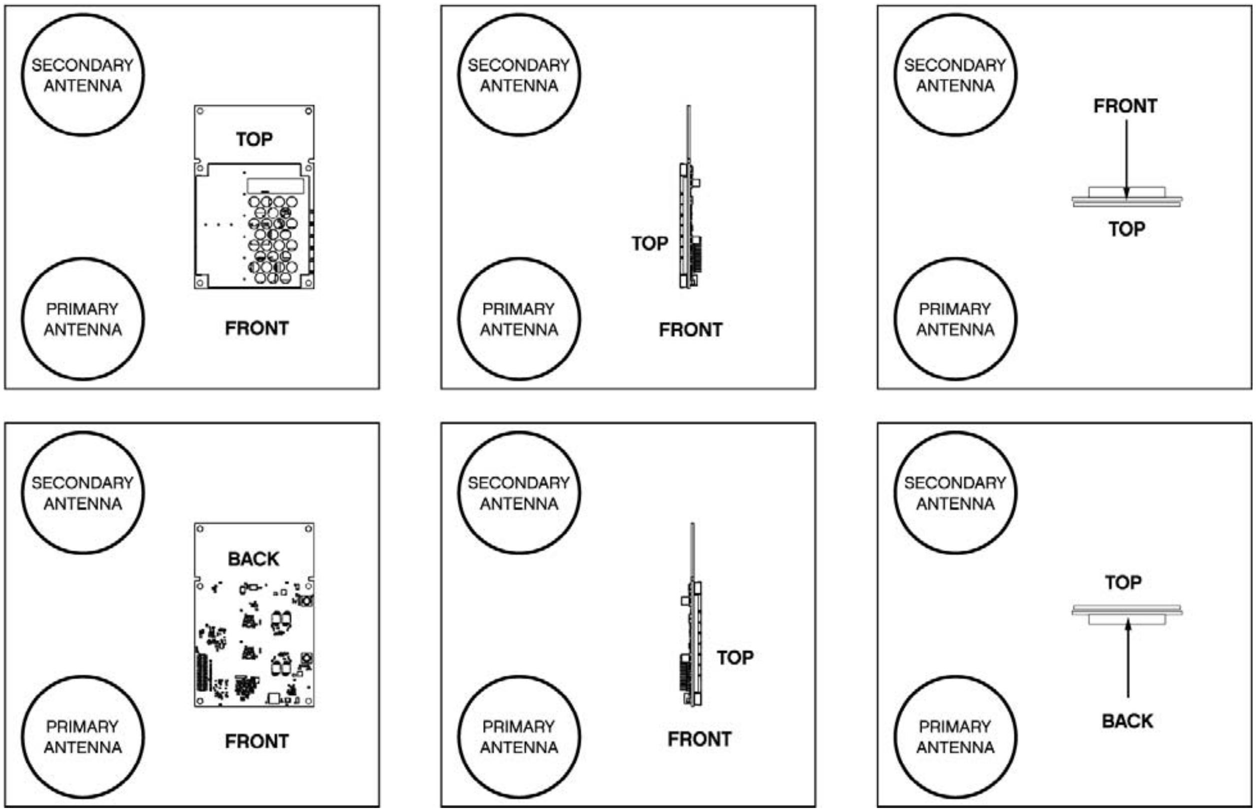
$JATT,ACC90,NO
$JATT,ACC180,NO

Figure 2-6: Group A



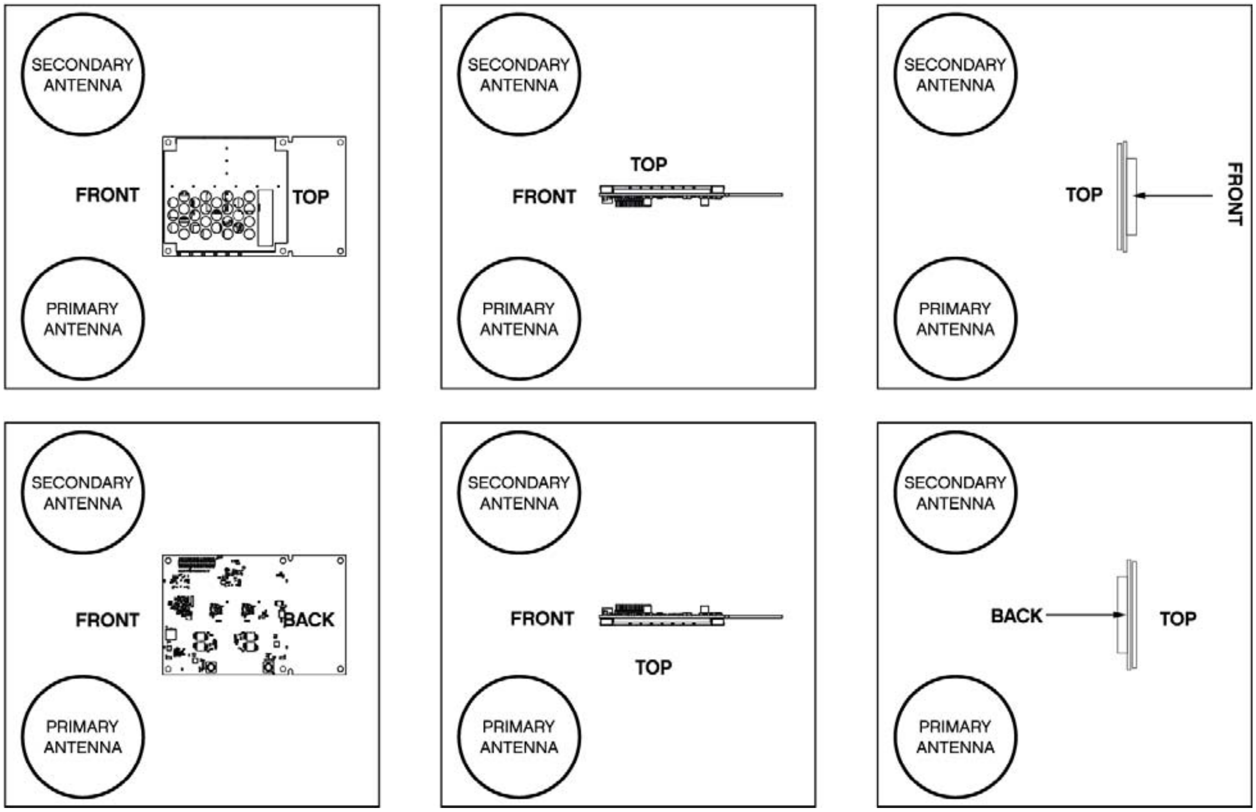
$JATT,ACC90,YES
$JATT,ACC180,NO

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

⚠WARNING: 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.

Connecting the Antennas to the H220

Connect the following:

- Primary antenna to J1000 port on the H220
- Secondary antenna to J2000 port on the H220

Thermal Concerns

The power consumption of the H220 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 H220.

To achieve maximum dissipation, metal standoffs must be used on all six mounting points of the H220. 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 H220.

Chapter 3: Setup and Configuration

Powering the H220

Communicating with the H220

Configuring the H220

Firmware

Configuring the Data Message Output

'THIS' Port and the 'OTHER' Port

Saving the H220 Configuration

Configuration Defaults

Setup and Configuration

This chapter provides H220 operation information, such as communicating with the H220, 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 H220 provides a position within approximately 60 seconds.

Powering the H220

The H220 is powered by a 3.3 VDC power source. Once you connect appropriate power, the H220 is active. Although the H220 proceeds through an internal startup sequence upon application of power, it is ready to communicate immediately.

Communicating with the H220

The H220 features four primary serial ports (Port A, Port B, Port C, Port D) 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 H220

You can configure all aspects of H220 operation through any serial port using proprietary commands. For information on these commands refer to the Hemisphere GNSS Technical Reference Guide.

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 Guide.

To issue commands to the H220 you will need to connect it to a terminal program or Hemisphere GNSS' software applications (SLXMon or PocketMax4).

Firmware

The software that runs the H220 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.

Configuring the Data Message Output

The H220 features four primary bi-directional ports (Ports A, B C and D. You can configure messages for all ports by sending proprietary commands to the H220 through any port. For a complete list of commands and messages refer to the Hemisphere GNSS Technical Reference Guide.

‘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 H220 Configuration

Each time you change the H220’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 H220 using a terminal program or Hemisphere GNSS’ applications (SLXMon or PocketMax4).

The H220 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 Guide.

Configuration Defaults

The following represents the standard configuration for the H220. For more information on these commands refer to the Hemisphere GNSS Technical Reference Guide.

```
#CONFIG,162-0171-0,A1
;NAME,H220 Config File

$JRESET,ALL

$JOFF,PORTA
$JOFF,PORTB
$JOFF,PORTC

$JAIR,AUTO
$JALT,NEVER
$JLIMIT,10
$JPOS,51.0,-114.0

$JDIFF,WAAS
$JWAASPRN,AUTO

$JAGE,2700
$JMASK,5
$JNP,7
$JSMOOTH,LONG
$JTAU,COG,0.00
$JTAU,SPEED,0.00

$JATT,COGTAU,0.0
$JATT,EXACT,NO
$JATT,FLIPBRD,NO
$JATT,GYROAID,YES
$JATT,HBIAS,0.0
$JATT,HIGHMP,YES
$JATT,HRTAU,2.0
$JATT,HTAU,2.0
$JATT,LEVEL,NO
$JATT,MSEP,0.500
$JATT,NEGTILT,NO
$JATT,NMEAHE,0
$JATT,PBIAS,0.0
$JATT,PTAU,0.5
$JATT,ROLL,NO
$JATT,SPDTAU,0.0
$JATT,TILTAID,YES
```

```
$JASC,GPGGA,1,PORTA
$JASC,GPGSV,1,PORTA
$JASC,GPHDT,1,PORTA
$JASC,GPROT,1,PORTA
$JASC,GPVTG,1,PORTA
$JASC,GPZDA,1,PORTA
$JASC,GPGGA,1,PORTB
$JASC,GPGSV,1,PORTB
$JASC,GPHDT,1,PORTB
$JASC,GPROT,1,PORTB
$JASC,GPVTG,1,PORTB
$JASC,GPZDA,1,PORTB

$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 H220 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 H220?

Not necessarily. But you may need to if there are RF interference issues, such as if the H220 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 GNSS 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 H220 system does not appear to be communicating. What do I do?

This could be one of a few issues:

- Examine the H220 cables and connectors for signs of damage or offset.
- Ensure the H220 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 H220 is connected to the receive line of the other device. Also, ensure the signal grounds are connected.
- If the H220 is connected to a custom or special device, ensure the serial connection to it does not have any incompatible signal lines present that prevent proper communication.
- Make sure the baud rate of the H220 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 H220 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 H220?

The $JSHOW command will request the configuration information from the H220. 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 H220 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 H220 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.
- **PocketMax4 -** 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. PocketMax4 runs on multiple Windows platforms using the Windows .NET framework.

GNSS Reception and Performance

How do I know what the H220 is doing?

The H220 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 H220 has surface-mounted status LEDs that indicate receiver status.

Do I have to be careful when using the H220 to ensure it tracks properly?

For best performance, the H220 antenna must have a clear view of the sky for satellite tracking. The H220 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 H220 has acquired an SBAS signal?

The H220 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 H220 performs well up to 150 BER. The SLXMon and PocketMax4 utilities provide this information without needing to use NMEA commands.

How do I know if the H220 is offering a differentially-corrected or RTK-corrected position?

The H220 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 PocketMax4 utilities provide this information without needing to use NMEA commands.

How do I select an SBAS satellite?

By default, the H220 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 Guide.

External Corrections

My H220 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 H220 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 H220's serial port and that the signal grounds are connected.
- Make sure the H220 has been set to receive external corrections by issuing the $JDIFF command. Refer to the Hemisphere GNSS Technical Reference Guide.

Installation

How will the antenna selection and mounting affect H220 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 H220 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 H220?	Try to isolate the source of the problem. Problems are likely to fall within one of the following categories: • Power, communication, and configuration • GNSS 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 H220 • No communication	• Check receiver power status (this may be done a Multimeter • Confirm communication with H220 via Hemisphere query command **$JI, $JSHOW** • Verify that H220 is locked to GNSS 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 H220	• Verify that the RTCM or Bin messages are not being accidentally output (send a $JSHOW command). • Verify that the baud rate settings of H220 and remote device match. • Potentially, the volume of data requested to be output by the H220 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 GNSS 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 H220 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 H220 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

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Appendix C: Technical Specifications

GNSS Sensor

Communication

Power

Environmental

Mechanical

Aiding Devices

Appendix C: Technical Specifications

Table B-1 through Table B-6 provide the internal GNSS sensor, communication, power, mechanical, and environmental specifications of the H220.

Table B-1: GNSS Sensor

Item	Specification	
Receiver type	GNSS L1 RTK	
Signals Received	GPS, GLONASS, BeiDou, Galileo, QZSS, L-band	
Channels	540	
GNSS sensitivity	-142 dBm	
SBAS tracking	2-channel, parallel tracking	
Update rate	Standard 10 Hz, optional 50 Hz (position and heading)	
Positioning accuracy		
RMS (67%)	Horizontal	Vertical
Autonomous[1]	1.2 m	2.5 m
SBAS (WAAS)[1]	0.3 m	0.6 m
Code Differential GPS	0.3 m	0.6 m
RTK[1,2]	10 mm + 1 ppm	20 mm + 2 ppm
Atlas (L-band) Accuracy	30 cm	
Heading accuracy	< 0.30º RMS @ 0.5 m antenna separation < 0.15º RMS@ 1.0 m antenna separation < 0.08º RMS@ 2.0 m antenna separation < 0.04º RMS @ 5.0 m antenna separation	
Pitch/roll accuracy	< 1° RMS	
Heave accuracy	30 cm[3]	
Timing (1PPS) accuracy	20 ns	
Rate of turn	145°/s maximum	
Cold start	< 40 s typical (no almanac or RTC)	
Warm start	< 20 s typical (almanac and RTC)	
Hot start	< 5 s typical (almanac, RTC, and position)	
Heading fix	< 10 s typical (valid position)	
Maximum speed	1,850 kph (999 kts)	
Maximum altitude	18,288 m (60,000 ft)	

Table B-2: Communication

Item	Specification
Serial ports	4 full-duplex 3.3 V CMOS (3 main serial ports, 1 differential-only port)
USB ports	1 USB host, 1 USB device
CAN	1 NMEA2000, ISO11783
Baud rates	4800 - 115200
Data I/O protocol	NMEA 0183, Crescent binary[4]
Corrections I/O protocol	RTCM SC-104, RTCM v2 (DGPS), RTCM v3 (RTK), CMR (RTK), CMR+ (RTK)[5]
Timing output	1PPS, 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
Heading warning I/O	Pin 20

Table B-3: Power

Item	Specification
Input voltage	3.3 VDC +/- 5%
Power consumption	1.82 W nominal GPS (L1) and GLONASS (L1)
Power multi-GNSS	1.97 W (L1) GPS GLONASS BeiDou Galileo QZSS
Power multi-GNSS w/L-band	2.28 W + L-band
Current consumption	< 0.553 A nominal GPS (L1) and GLONASS (L1)

Table B-4: Environmental

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	Mechanical Shock: EP455 Section 5.14.1 Operational (when mounted in an enclosure with screw mounting holes utilized) Vibration: EP455 Section 5.15.1 Random
EMC	CE (IEC 60945 Emissions and Immunity), FCC Part 15, Subpart B, CISPR 22

Table B-5: Mechanical

Item	Specification
Dimensions	10.9 L x 7.1 W x 0.5 H (cm) 4.3 L x 2.8 W x 0.2 H (in)
Weight	~ 50 g (~ 1.8 oz)
Status indicators (LEDs)	Power, master GPS lock, secondary GPS lock, differential lock, DGPS position, and heading lock

Table B-6: Aiding Devices

Device	Description
Gyro	Provides smooth heading, fast heading reacquisition. During loss of GNSS signals heading stability is degraded by <1° per minute for up to 3 minutes[5].
Tilt sensors	Provide pitch and roll data and assist in fast startup and reacquisition of heading solution.

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

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

[3]Based on a 40 second time constant

[4]Hemisphere GNSS proprietary

[5]IMO standard

[6]Receive only, does not transmit this format

[7]Under static conditions

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