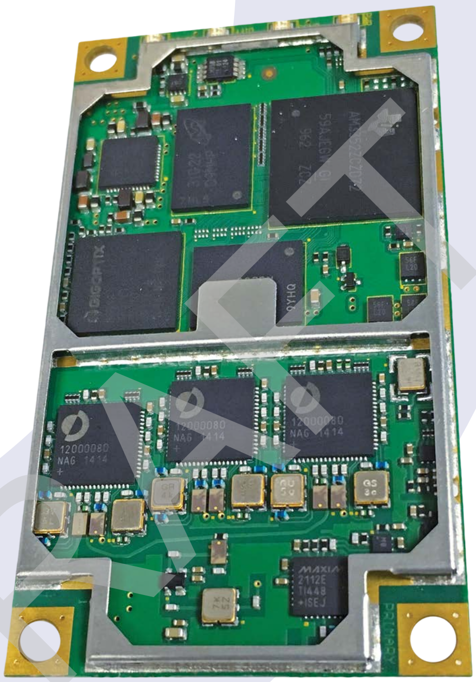
Hemisphere®



Eclipse P326 and P327

Integrator's Guide

Part No. 875-0359-0 Rev. A1

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

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

Patents

Hemisphere GNSS products may be covered by one or more of the following patents:

U.S. Patents					Australia Patents
6111549	6876920	7400956	8000381	8214111	2002244539
6397147	7142956	7429952	8018376	8217833	2002325645
6469663	7162348	7437230	8085196	8265826	2004320401
6501346	7277792	7460942	8102325	8271194	
6539303	7292185	7689354	8138970	8307535	
6549091	7292186	7808428	8140223	8311696	
6711501	7373231	7835832	8174437	8334804	
6744404	7388539	7885745	8184050	RE41358	
6865465	7400294	7948769	8190337		

Other U.S. and foreign patents pending.

Notice to Customers

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

Hemisphere GNSS, Inc.
8515 East Anderson Drive
Scottsdale, AZ 85255 USA
Phone: (480) 348-6380
Fax: (480) 270-5070
precision@hemispheregnss.com
www.hemispheregnss.com

Technical Support

If you need to contact Hemisphere GNSS Technical Support:

Hemisphere GNSS, Inc.
8515 East Anderson Drive
Scottsdale, AZ 85255 USA
Phone: (480) 348-6380
Fax: (480) 270-5070
techsupport@hemispheregnss.com

Documentation Feedback

Hemisphere GNSS is committed to the quality and continuous improvement of our products and services. We urge you to provide Hemisphere GNSS with any feedback regarding this guide by writing to the following email address: techsupport@hemispheregnss.com.

Contents

Chapter 1: Introduction

This manual does not cover receiver operation, the PocketMax™ utility, or commands and messages (NMEA 0183, NMEA2000® or HGNSS proprietary). For information on these subjects refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide).

P326 and P327 OEM Board Options

The Eclipse™ P326 and P327 OEM boards are available in two form factors as shown in Table 1-1.

Table 1-1: P326/P327 board options

Model	GNSS Systems	Compatibility	L-Band Support
P326™	L1CA/L1P/L1C/L2P/L2C/L5 GPS G1/G2/P code (P1/P2) GLONASS B1/B2 B3 (separate variant without L5) BEIDOU E1BC/E5a/E5b Galileo L1CA/L1C/L2C/L5 QZSS*	Hemisphere GNSS' standard pin-out configuration (34-pin)	Yes
P327	L1CA/L1P/L1C/L2P/L2C/L5 GPS G1/G2/P code (P1/P2) GLONASS B1/B2 B3 (separate variant without L5) BEIDOU E1BC/E5a/E5b Galileo L1CA/L1C/L2C/L5 QZSS*	Industry standard pin-out configuration (20-pin)	Yes
*Future FW update			

What's Included

The P326 and P327 are available in two configurations:

- P326 and P327 OEM boards only - designed for integrators who are familiar with Eclipse board integration
- P326 and P327 OEM boards and Universal Development Kit - designed for integrators who are new to Eclipse board integration

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

  For more information on the Universal Development Kit visit www.hemispheregnss.com and navigate to the OEM Products page or contact your local dealer.

P326 and P327 Integration

Successful integration of the P326 and P327 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 P326 and P327 GPS engine is a low-level module intended for custom integration with the following general integration requirements:

- Regulated power supply input (3.3 VDC ± 3%) and 700 mA continuous
- Low-level serial port (3.3 V CMOS) and/or 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)
- GPS antenna is powered with a separate regulated voltage source up to 15 VDC maximum
- Antenna input impedance is 50 Ω

Common Features of P326 and P327 Boards

Common features of P326 and P327 include:

- 394-channel GNSS engine
- Sub-meter horizontal accuracy 95%
- Raw measurement output (via documented binary messages)
- Position update rates of 20 Hz max
- Tracer™ technology that provides consistent performance with correction data
- e-Dif®-ready - a base station-free way of differentially positioning
- Quick times to first fix

- Four full-duplex serial ports
- Two CAN ports (P326 only)
- USB ports
  - USB host and USB device ports
- 1 PPS timing output
- Event marker input

Note: For complete specifications of P326 and P327 boards see Appendix C, "Technical Specifications."

Message Interface

The P326 and P327 use a NMEA 0183 interface, allowing you to easily make configuration changes by sending text-type commands to the receiver.

The P326 and P327 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 (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide).

Using PocketMax to Communicate with the P326 and P327

Hemisphere's PocketMax is a free utility program that runs on your Windows PC or Windows mobile device. Simply connect your Windows device to the P326 and P327 via the COM port and open PocketMax. The screens within PocketMax allow you to easily interface with the P326 and P327 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 P326 or P327's status and function

PocketMax is available for download from the Hemisphere GNSS website (www.hemispheregnss.com).

Chapter 2: Board Overview

P326 and P327 OEM Board Key Features

With its small form factor, low power consumption, and simple on-board firmware P326 and P327 are an ideal solution for integrators, offering scalability and expandability from L1 GPS with SBAS to L1/L2 GPS, GLONASS, BeiDou, and Galileo (with RTK capability).

P326 and P327 are offered in common industry form factors:

- P326 is a drop-in replacements for Hemisphere GNSS' Crescent® and mini Eclipse receivers (34-pin) with integrated L-band
- P327 has a mechanical design compatible with popular after-market products (20-pin) with integrated L-band

The reliable positioning performance of P326 and P327 is further enhanced by Athena RTK, Atlas corrections, aRTK, SureFix and TRACER™ technology.

With P326 and P327, RTK performance is scalable. Utilize the same centimeter-level accuracy in either L1-only mode, or employ the full performance of fast RTK performance over long distances with L1/L2/L5 GPS signals. Benefit 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 (primary receiver) that broadcasts corrections over a wireless link to the rover (secondary receiver). The localized corrections are processed on the rover to achieve superior accuracy and repeatability. Performance testing has shown positioning accuracy at the centimeter level.

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, which 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

P326 and P327 are supported by our easy-to-use Atlas Portal (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: http://hemispheregnss.com/Technology

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

aRTK Position Aiding

aRTK is an innovative feature available in Hemisphere's P326 and P327, that greatly mitigates the impact of land-based communication instability. Powered by Hemisphere's Atlas L-band system service, aRTK provides an additional layer of communication redundancy to RTK users, assuring that productivity is not impacted by intermittent data connectivity.

P326 and P327 receive aRTK augmentation correction data over satellite, while also receiving the land-based RTK correction data. With this, the receiver internally operates with two sources of RTK correction, creating one additional layer of correction redundancy as compared to typical RTK systems. Once that process is established (which takes as less as a few seconds), the receiver is able to operate in the absence of either correction source, or in other words, and the receiver is able to continue generating RTK positions in case the land-based RTK correction source becomes unavailable for a period of time.

SureFix RTK Position

In order to provide high fidelity quality indicators to the users, Hemisphere created an additional processor that runs in combination with the RTK engine, called the SureFix processor. The SureFix processor takes several inputs, such as GNSS data, data preprocessing results, and generated RTK solutions. The SureFix processor takes all available information and, by using functional and stochastic analysis methods, it determines the quality of the current RTK engine solution. The SureFix indicators are then combined with the RTK solution before being provided to the user. At the end of the process, the user has access to high fidelity information about the quality of the RTK solution.

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. One of the limitations in those positioning methods is the need for constant connectivity with the correction source. In most cases, the user receiver needs to receive correction data with very low data interruption in order to maintain a reasonable position accuracy. For instance, 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 being provided to the user.

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 of fundamental importance in environment where connectivity over satellite, radio, or Internet is not stable, as it will for the most part allow users to operate with negligible loss of accuracy during outage periods. The length of the outage during and associate performance loss will vary with the positioning technique used, as well as satellite geometry and interference environment.

Mechanical Layout

Figure 2-1 shows the mechanical layout for the P326 OEM board.

Figure 2-2 shows the mechanical layout for the P327 OEM board.

Dimensions are in millimeters (inches) for all three layouts.

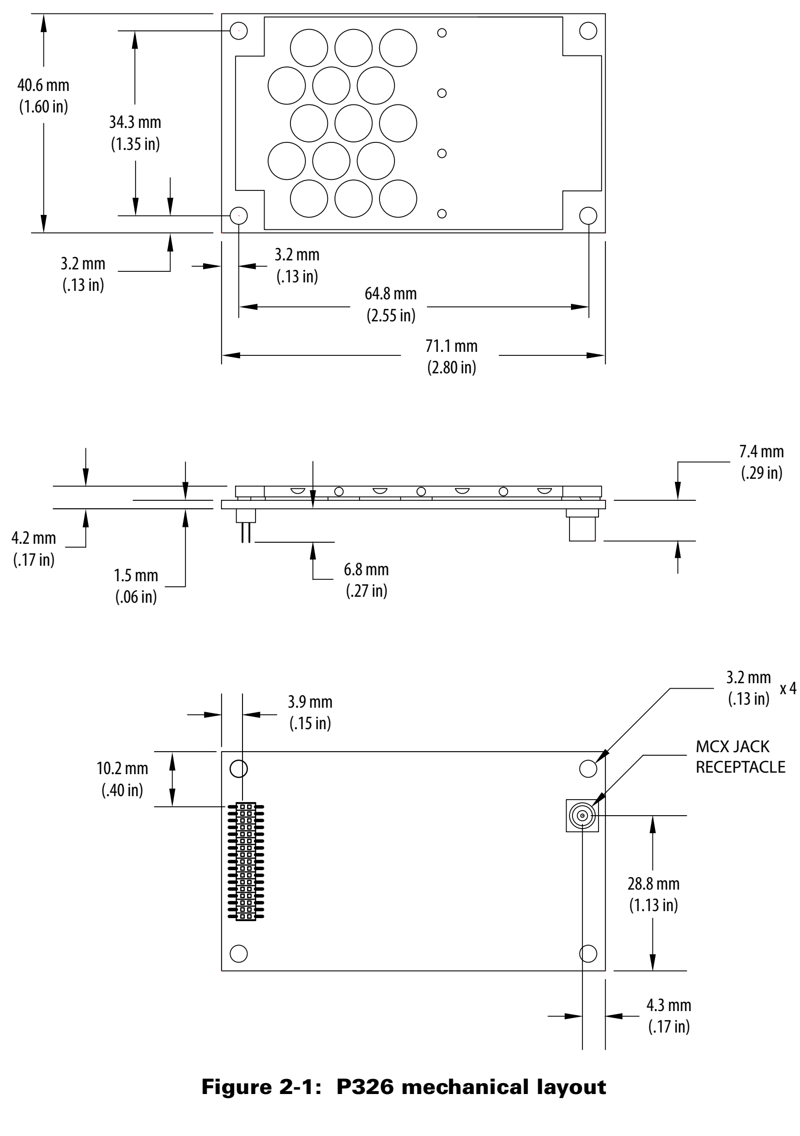


Figure 2-1: P326 mechanical layout

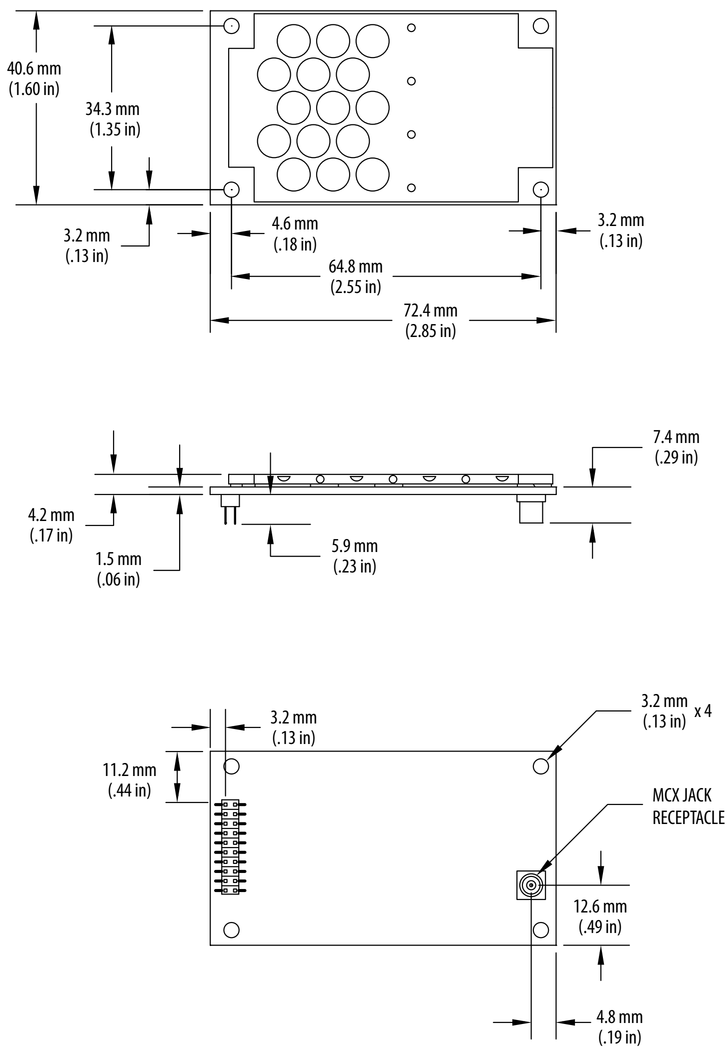


Figure 2-2: Eclipse P327 mechanical layout

Connectors

Table 2-1 describes P326 and P327 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: P326 and P327 connectors

P326 Board and Connector Type		SMT Connector	Mating Connector
P326	RF	MCX, female straight jack Emerson (Johnson) 133-3711-202	MCX, male straight plug Samtec RSP-127824-01
	Power/ data	34-pin (17x2) male header, 0.05 in (1.27 mm) pitch Samtec FTSH-117-04-L-DV	17x2 female SMT header socket, 0.05 in (1.27 mm) pitch Samtec FLE-117-01-G-DV
P327	RF	MCX, female straight jack Emerson (Johnson) 133-3711-202	MCX, male straight plug Samtec RSP-127824-01
	Power/ data	20-pin (10x2) male header, 0.08 in (2 mm) pitch Samtec TMM-110-01-T-D-SM	10x2 female SMT header socket, 0.08 in (2 mm) pitch Samtec TLE-110-01-G-DV
Note: For the Samtec FTSH headers, '-04' indicates 0.150" posts.			

Mounting Options

There are two options for mounting the P326 and P327:

- 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 P326 and P327 on the standoffs and RF and header connectors. This method is very cost effective as it does not use cable assemblies to interface the P326 and P327.

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 you fasten it down.

The P326 and P327 uses a standoff height of 7.9 mm (0.3125 in). With this height there should be no washers between either the standoff and the P326 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 suggested in this guide. 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 page 11 for P326 and P327 connector information.

The mounting holes of the P326 and P327 have a standard inner diameter of 3.2 mm (0.125 in).

Indirect Electrical Connection (Cable) Method

The second method is to mount the P326 and P327 mechanically so you can connect a ribbon power/data cable to the P326 and P327. This requires cable assemblies and there is a reliability factor present with cable assemblies in addition to increased expense.

Header Layouts and Pin-outs

The P326 and P327 use 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 2-3). The pins are then sequentially numbered per row from top to bottom.

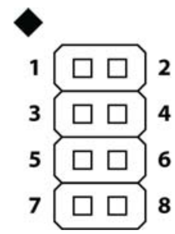


Figure 2-3: Identifying the first pin on the header connector

P326 34-Pin Header Layout/Pin out

The P326 boards have a 34-pin header. Figure 2-4 shows the header layout and Figure 2-2 provides the header pin-out.

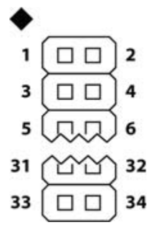


Figure 2-4: P326 34-pin header layout

Table 2-2: P326 34-pin 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, 15 V max
4	Batt Backup	Power	Power, 1.5 to 5.5 V, 500 nA typical
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	Active high, rising edge, 3.3 V CMOS
16	Manual Mark	Input	Active low, falling edge, 3.3 V CMOS
17	GPS Lock	Output	Status indicator, 3.3 V CMOS, active low
18	Diff Lock	Output	Status indicator, 3.3 V CMOS, active low
19	DGPS Lock	Output	Status indicator, 3.3 V CMOS, active low
20	n/c	n/c	n/c
21*	TX CAN A (default) /GPIO0	Output*	Selectable between, CAN A transmit (default) / General purpose (input/output)
22*	TX CAN B (default) /GPIO1	Output*	Selectable between, CAN B transmit (default) / General purpose (input/output)

Table 2-2: P326 34-pin header pin-out (*continued)*

Pin	Name	Type	Description
23*	RX CAN A/GPIO2	Input*	Selectable between, CAN A receive (default) / General purpose (input/output)
24*	RX CAN B/GPIO3	Input*	Selectable between, CAN B receive (default) / General purpose (input/output)
25	Speed Output	Output	0 - 3 V variable clock output
26	Speed Ready	Output	Active low, speed valid indicator, 3.3 V CMOS
27	GND	Power	Receiver ground
28	GND	Power	Receiver ground
29	USB HOST +	I/O	USB HOST data +
30	USB HOST -	I/O	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	n/c	n/c	n/c
34	Reset	Input	Reset, 3.3 V typical, not required
**Selectable pin with input/out option*			

Note: P*ins 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.*

P327 20-Pin Header Layout/Pin out

The P327 board has a 20-pin header. Figure 2-5 shows the header layout and Table 2-3 provides the header pin-out.

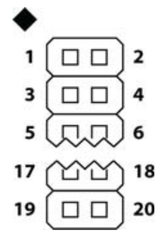


Figure 2-5: Eclipse 20-pin header layout

Table 2-3: Eclipse 20-pin header pin-out

Pin	Name	Type	Description
1	Antenna Pwr	Power	Antenna power, DC, 15 V max
2	3.3 V	Power	Receiver power supply, 3.3 V
3	USB DEV–	I/O	USB device data -
4	USB DEV+	I/O	USB device data +
5	Reset	Open collector	Reset, open collector, 3.3 V typical, not required
6	PCRX	Input	Port C serial input, 3.3 V CMOS, idle high
7	PCTX	Output	Port C serial output, 3.3 V CMOS, idle high
8	PDRX	Input	Port D serial input, 3.3 V CMOS, idle high
9	PDTX	Output	Port D serial output, 3.3 V CMOS, idle high
10	GND	Power	Receiver ground
11	PATX	Output	Port A serial output, 3.3 V CMOS, idle high
12	PARX	Input	Port A serial input, 3.3 V CMOS, idle high
13	GND	Power	Receiver ground
14	PBTX	Output	Port B serial output, 3.3 V CMOS, idle high
15	PBRX	Input	Port B serial input, 3.3 V CMOS, idle high
16	GND	Power	Receiver ground
17	Manual Mark	Input	Active low, falling edge, 3.3 V CMOS
18	GND	Power	Receiver ground
19	1 PPS	Output	Active high, rising edge, 3.3 V CMOS
20	Position Valid Indicator	Output	Status indicator, 3.3 V CMOS, active low

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.*

\Signals

This section provides information on the signals available via connectors.

RF Input

The P326 and P327 is designed to work with active GNSS antennas with an 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; otherwise, you will compromise the tracking performance of the P326 and P327.

Serial Ports

The P326 and P327 have four serial communication ports:

- Port A, Port B, Port C - main ports
- Port D - Exclusively used to interface with the SBX beacon board or an external corrections source or RTK communications. This port will not output normal GPS-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" below for more information on Port D.

The P326 and P327 serial ports' 3.3 V CMOS signal level can be translated to interface to other devices. For example, if serial Ports A, B, and/or C are used to communicate to external devices (such as PCs) you must translate the signal level from 3.3 V CMOS to RS-232.

Communication Port D

Port D is exclusively for external DGPS correction input to the P326 and P327, such as from Hemisphere GNSS' SBX beacon board and RTK communication.

USB Ports

The P326 has both a USB host port and a USB device port while P327 has only a USB device port, where:

- USB device port (data communication) shown in Figure 2-6 on page 16 serves as a high speed data communications port, such as for a PC
- USB host port (data storage) shown in Figure 2-7 on page 17 serves as a data storage port, such as with a USB flash drive

The USB data lines are bidirectional and are differential pairs. 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. 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.

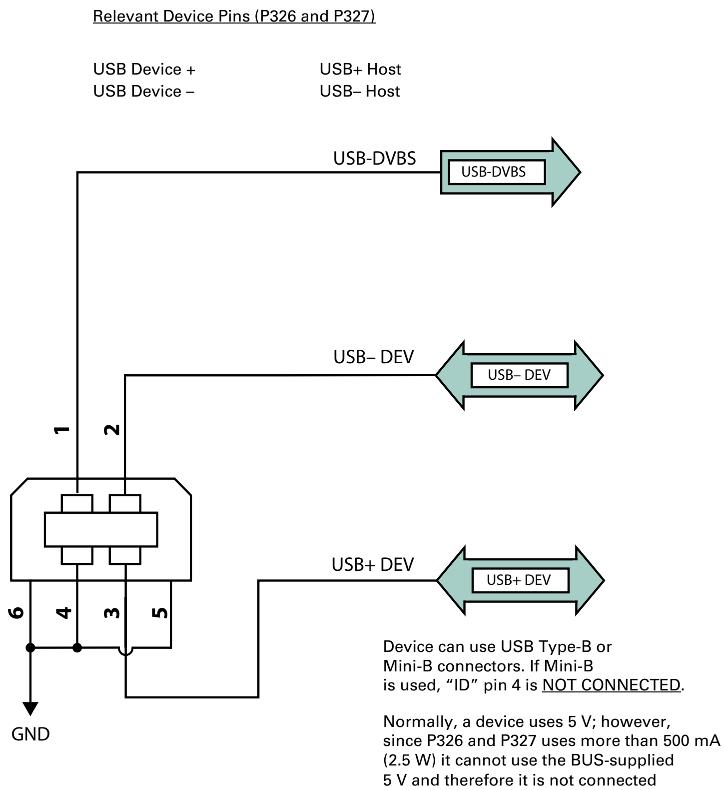


Figure 2-6: P326 and P327 USB device design example

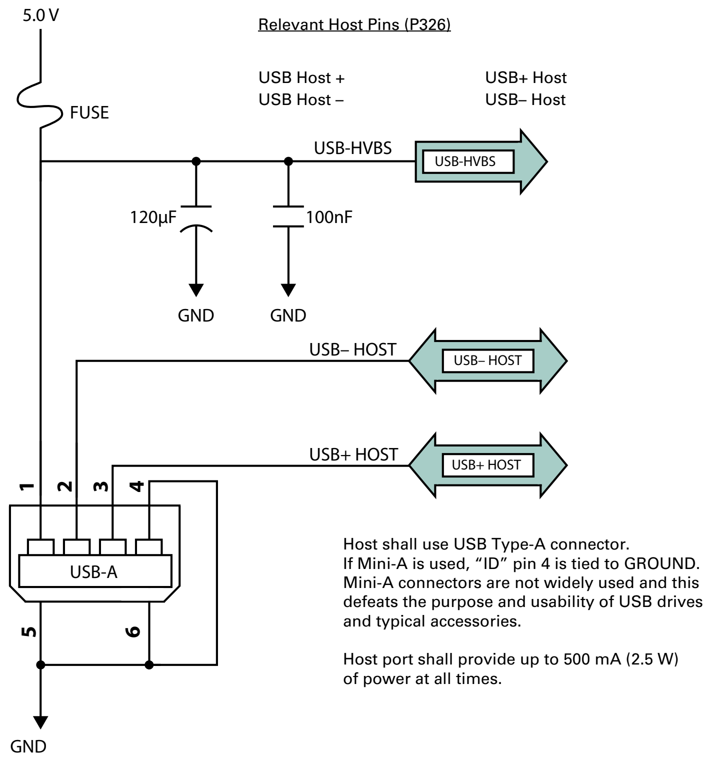


Figure 2-7: P326 USB host design example

CAN

A CAN Transceiver is required. The P326 CAN RX and CAN TX are 3.3V CMOS pins. The P326 connects to the transceiver on the single ended CMOS port. CANH and CANL are CAN standard pins on the physical bus side of the transceiver, the P326 does not connect to this portion of the transceiver. Example devices are the TI SN65HVD233 (see Figure 2-8) . CAN TX shall be connected to the CAN transceiver “CAN Transmit Data Input”. CAN RX shall be connected to the CAN transceiver “CAN Receive Data Output”. Slope control is not a design parameter determined by the P326 and is dependent on Integrator’s application.

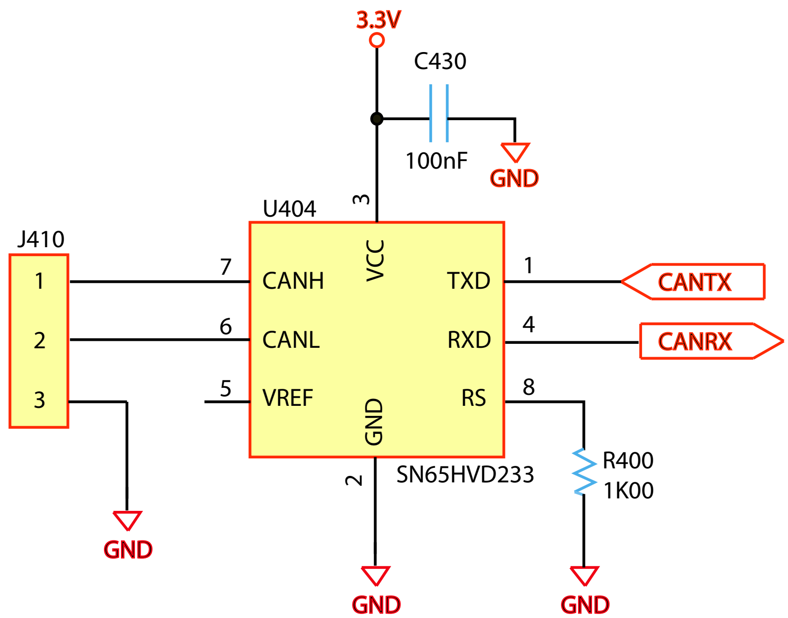


Figure 2-8: P326 CAN design example

LED Indicators

The P326 and P327 features the following surface-mounted diagnostic LEDs that indicate board status (see Figure 2-9):

- PWR - Power
- GNSS - GNSS lock
- DIFF - Differential lock
- DGNSS - DGNSS position

Figure 2-9: Onboard LEDs

With the exception of the power LED the signals that drive the LEDs are available via the header connector. Refer to Table 2-1 through Table 2-2 for pin number descriptions for the P326 and P327.

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.

1PPS 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 impendance greater than 10 kΩ in parallel with 10 pF. The pulse is approximately 1 ms. The pulse width can be adjusted by 100 ns.

Event Marker Input

A GPS solution may need to be forced at a particular instance, not synchronized with GPS time depending on the application, such as indicating to the GPS receiver when a photo is taken from a camera used for aerial photography.

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 P326 and P327. These are not separate analog and digital grounds that require separate attention. Refer to Table 2-1 through Table 2-2 pin-out ground information for the P326 and P327.

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 P326 relate to the Speed Radar.

- 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).
- Speed Radar Ready Signal - Indicates when the speed signal on the *Speed Radar Pulse* pin is valid. In static situations, such as when the vehicle has stopped, the GPS 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 GPS 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.

Figure 2-4 provides the location of the Speed Radar Pulse and Speed Radar Ready Signal on the P326 and P327.

Table 2-4: P326 and P327 speed radar output availability

Eclipse Boards	Speed Radar Pulse	Speed Radar Ready Signal
P326	Pin 25	Pin 26
P327	N/A	N/A

Note: Neither pin has any 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 P326 and P327 are sensitive instruments. When integrated into an enclosure, the P326 requires shielding from other electronics to ensure optimal operation. The P326 and P327 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 P326 and P327 are precision instruments. To ensure optimal operation, consider mounting the receiver in a way to minimize vibration and shock.

When mounting the P326 or P327, immediately adjacent to the GPS antenna, Hemisphere GNSS highly recommends shielding the board from the LNA of the antenna. 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.

Thermal Concerns

The P326 and P327 receiver consumes a few watts of power, which ultimately will generate heat. Since this may raise the ambient temperature inside an enclosure consider managing the heat inside the enclosure to ensure the internal temperature does not exceed the maximum operating temperature for the P326/P327. Some suggestions for heat management are heat sinks or heat conductive foam.

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 P326 and P327.

Chapter 3: Operation

This chapter provides P326 and P327 operation information, such as communicating with the P326 and P327, 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, for example, you will likely not track a sufficient number of satellites. With a properly installed antenna the P326 and P327 provides a position within approximately 60 sec.

Powering the P326 and P327

The P326 and P327 is powered by a 3.3 VDC power source. Once you connect appropriate power the P326 and P327 is active. Although the P326 and P327 proceeds through an internal startup sequence upon application of power, it is ready to communicate immediately.

Communicating with the P326 and P327

The P326 and P327 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.

Note: You may use the three serial ports to separate the different data types and output different rates. If the P326 and P327 is required to output different data types simultaneously, ensure data logging and the processing software used can correctly parse the different data from a single stream.

Configuring the P326 and P327

You can configure all aspects of P326 and P327 operation through any serial port using proprietary commands. For information on these commands refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.comand follow the links to Resources, GPS 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 rate of each message
- Set various receiver operating parameters

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

To issue commands to the P326 and P327 you will need to connect it to a terminal program such as HyperTerminal or either of Hemisphere GNSS' software applications (SLXMon or PocketMax). See "What is the best software tool to use to communicate with the P326 or P327 and configure it?" on page 33 for descriptions of HyperTerminal, SLXMon, and PocketMax.

Firmware

The software that runs the P326 and P327 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 P326 and P327 currently ships with the Athena based firmware 5.5.0 or higher. Refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide) for information on the querying and talking to the P326 and P327 board.

Configuring the Data Message Output

The P326 and P327 features three primary bidirectional ports (Ports A, B and C) and a differential-only port (Port D). You can configure messages for all ports by sending proprietary commands to the P326 and P327 through any port. For a complete lists of commands and messages refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GNSS 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 be 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 P326 and P327 Configuration

Each time you change the P326 and P327'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 P326 and P327 using a terminal program such as HyperTerminal or either of Hemisphere GNSS' applications (SLXMon or PocketMax). The P326 and P327 will take approximately five seconds to save the configuration to non-volatile memory and will indicate when the configuration has been saved. Refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide)

Using Port D for RTCM Input

Port D has been optimized to interface with Hemisphere GNSS' SBX-4 beacon board and operates at 9600 baud (8 data bits, no parity and 1 stop bit – 8-N-1).

To configure the P326 and P327 to use Port D, issue the following command:

```
$JDIFF,BEACON<CR><LF>
```

To return to using SBAS as the correction source, send the following command to the P326 and P327:

```
$JDIFF,WAAS<CR><LF>
```

For a complete lists of commands and messages refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide).

Configuration Defaults

Below is the standard configuration for the P326 and P327. For more information on these commands refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide).

```
$JOFF,PORTA
$JOFF,PORTB
$JOFF,PORTC
$JBAUD,19200,PORTA
$JBAUD,19200,PORTB
$JBAUD,19200,PORTC
$JAGE,2700
$JLIMIT,10.0
$JMASK,5
$JDIFF,WAAS
$JPOS,33.0,-111.0
$JSMOOTH,LONG900
$JAIR,AUTO
$JALT,NEVER

$JNP,7
$JWAASPRN,AUTO
$JTAU,COG,0.00
$JTAU,SPEED,0.00
$JASC,GPGGA,1,PORTA
$JASC,GPGGA,1,PORTB

$JSAVE
```

Appendix A: Frequently Asked Questions

Integration

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

No, these are not necessary for P326 and P327 operation.

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

This signal will be strobing at 1 Hz, so it should not be connected.

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 P326 and P327?

Not necessarily...but you may need to if there are RF interference issues, such as if the P326 and P327 interferes with other devices. A shield-can would be a good start in terms of investigating the benefit. If you are designing a smart antenna system, one is likely needed. Hemisphere GNSS recommends that you always conduct an RF prescan 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

What type of assistance can I expect from Hemisphere GNSS when integrating P326 or P327?

Integration of a GNSS board has such benefits as:

- Lower system cost
- Improved branding (rather than relabeling an existing product)
- Better control of system design among others

As an integrator, you are responsible for ensuring that the correct resources are in place to technically complete it. Hemisphere GNSS will provide reasonable assistance. However, Hemisphere GNSS does not have dedicated engineering resources for in-depth integration support. Hemisphere GNSS will do its best to provide support as necessary, but you should expect to have reasonable expertise to use this Integrators Guide.

Support and Repair

How do I solve a problem I cannot isolate?

Hemisphere GNSS recommends contacting the 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” on page i (just before the Contents page) for Technical Support contact information.

What do I do 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” on page i (just before the Contents page) 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 would be the local support. They may be able to solve the problem quickly, due to their closer location and experience with our equipment.

Power, Communication, and Configuration

My P326 or P327 system does not appear to be communicating. What do I do?

This could be one of a few issues:

- Examine the P326 or P327 cables and connectors for signs of damage or offset.
- Ensure the P326 or P327 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 P326 or P327 is connected to the receive line of the other device. Also, ensure the signal grounds are connected.
- If the P326 or P327 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 P326 or P327 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 P326 or P327 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 P326 or P327?

The $JSHOW command will request the configuration information from the P326 and P327. 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 P326 or P327 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 P326 or P327 and configure it?

Hemisphere GNSS uses three different software applications:

- HyperTerminal™ - Available on all Windows® 95, 98, ME, and XP. This tool allows you to configure the P326 or P327 by directly typing commands into the terminal window. The output from the P326 or P327 is simultaneously shown. When using HyperTerminal, ensure it is configured to use the correct PC communication port and baud rate, and that the local echo feature is on (to see what is being typed).
- SLXMon - Available at www.hemispheregnss.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.
- PocketMax - Available at www.hemispheregnss.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. PocketMax runs on multiple Windows platforms using the Windows .NET framework.

GNSS Reception and Performance

How do I know what the P326 or P327 is doing?

The P326 and P327 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 P326 and P327 has surface-mounted status LEDs that indicate receiver status.

Do I have to be careful when using the P326 or P327 to ensure it tracks properly?

For best performance, the P326 and P327's antenna must have a clear view of the sky for satellite tracking. The P326 and P327 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 P326 or P327 has acquired an SBAS signal?

The P326 and P327 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 P326 and P327 performs well up to 150 BER. The SLXMon and PocketMax utilities provide this information without needing to use NMEA commands.

How do I know if the P326 or P327 is offering a differentially-corrected or RTK-corrected position?

The P326 and P327 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 PocketMax utilities provide this information without needing to use NMEA commands.

How do I select an SBAS satellite?

By default the P326 and P327 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—refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GNSS Reference Guide) for more information; however, this is not recommended.

Do I need a dual frequency antenna for SBAS?

Hemisphere GNSS recommends using a dual frequency antenna with the P326 and P327. While some receiver function is possible with an L1-only antenna, full receiver performance will only be realized with a dual frequency antenna.

External Corrections

My P326 or P327 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 a number of 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 P326 and P327 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 pinout information for the cables to ensure the transmit line of the external correction source is connected to the receive line of the P326 and P327's serial port and that the signal grounds are connected.
- Make sure the P326 and P327 has been set to receive external corrections by issuing the $JDIFF command. Refer to the Hemisphere GNSS Technical Reference (go to www.hemispheregnss.com and follow the links to Resources, GPS Reference Guide) for more information.

Installation

Does it matter where I mount the P326 or P327's antenna?

Yes, the mounting location must provide a clear view of the sky for satellite tracking. Additionally, the position that it computes is based on the center of the antenna. It should be placed in the location for which the user would like a position. Often antennas are mounted on the centerline of a vehicle or on a pole-mount for georeference.

How will the antenna selection and mounting affect P326 or P327 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 multipath

Using a magnetic mount for the antenna will not affect performance.

Appendix B: Troubleshooting

Use the following checklist to troubleshoot anomalous P326 and P327 operation. Table B-1 provides a list of issues with possible solutions. Refer to Appendix C, “Technical Specifications” if necessary.

Table B-1: Troubleshooting

Issue	Possible Solution
What do I do initially if I have a problem with the operation of the P326 or P327?	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 It is important to review each category in detail in order to eliminate it as a problem.
Receiver fails to power	• Verify polarity of power leads • Check 1.0 A in-line power cable fuse connection • Check integrity of power cable connections • Check power input voltage • Check current restrictions imposed by power source (minimum available should be > 1.0 A)
No data from the P326 or P327 1. No communication 2. No valid data	• (1) Check receiver power status (this may be done with an ammeter) • (2) Verify P326 and P327 is locked to a valid DGPS signal (this can often be done on the receiving device or by using SLXMon) • (2) Verify that P326 and P327 is locked to GPS satellites (this can often be done on the receiving device or by using SLXMon) • (2) Check integrity and connectivity of power and data cable connections
Random binary data from the P326 and P327	• Verify that the RCTM or Bin messages are not being accidentally output (send a $JSHOW command) • Verify that the baud rate settings of P326 and P327 and remote device match • Potentially, the volume of data requested to be output by the P326 and P327 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

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)
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 pinout must be connected, and from the “transmit” from the source must connect to the “receiver” of the RTCM input port).
Non-DGPS output	• Verify P326 and P327 SBAS and lock status (or external source is locked)

Appendix C: Technical Specifications

P326 and P327 Specifications

P326 and P327 Specifications

Table C-1 through Table C-6 provide specifications for the P326.

Table C-1: P326 sensor specifications

Item	Specification		
Receiver type	GPS, GLONASS, BeiDou, and Galileo RTK with carrier phase and L-Band		
Channels	*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 *3 SBAS or 3 additional L1CA GPS* *2 L-Band*		
GPS sensitivity	-142 dBm		
SBAS tracking	3-channel, parallel tracking		
Update rate	1 Hz standard, 10 Hz and 20 Hz available		
Horizontal accuracy		RMS (67%)	2DRMS (95%)
	RTK[1,2]	8 mm + 1 ppm	15 mm + 2 ppm
	SBAS (WAAS)[1]	0.3 m	0.6 m
	Autonomous, no SA[1]	1.2 m	2.4 m
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 kph (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		

Table C-2: P326 communication specifications

Item	Specification
Serial ports	4 full-duplex 3.3 V CMOS (3 main serial ports, 1 differential-only port) 2 CAN
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+[4], 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 Host, 1 USB Device

Table C-3: P326 power specifications

Item	Specification
Input voltage	3.3 VDC +/- 5%
Power consumption	1.0 W (GPS L1) 1.6 W (GPS/GLONASS L1/L2 G1/G2) 2.3 W (All Signals + L-Band)
Current consumption	303 mA nominal (GPS L1) 484 mA nominal (GPS/GLONASS L1/L2 G1/G2) 696 mA nominal (All Signals + L-Band)
Antenna voltage input	15 VDC maximum
Antenna short circuit protection	Yes
Antenna gain input range	10 to 40 dB
Antenna input impedance	50 Ω

Table C-4: P326 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[5]	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: P326 mechanical specifications

Item	Specification
Dimensions	71.1 L x 40.6 W x 10.1 H mm (2.81 L x 1.60 W x 0.40 H in)
Weight	< 23 g (< 0.81 oz)
Status indication (LED)	Power, GNSS lock, Differential lock, DGNSS position
Power/Data connector	34-pin (17x2) male header 0.05” (1.27 mm) pitch
Antenna connector	MCX, female, straight

Table C-6: P326 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)

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

2 Depends also on baseline length

3 Requires an L-band subscription

4 Receive only, does not transmit this format

5 When integrated in conjunction with the recommended shielding and protection as outlined in this manual

P327 Specifications

Table C-7 through Table C-12 provide specifications for the P327.

Table C-7: P327 sensor specifications

Item	Specification
Receiver type	GPS, GLONASS, BeiDou, and Galileo RTK with carrier phase and L-Band
Channels	*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 *3 SBAS or 3 additional L1CA GPS* *2 L-Band*
GPS sensitivity	-142 dBm
SBAS tracking	3-channel, parallel tracking
Update rate	1 Hz standard, 10 Hz and 20 Hz available
Horizontal accuracy	RMS (67%) / 2DRMS (95%) RTK[1,2]: 8 mm + 1 ppm / 15 mm + 2 ppm SBAS (WAAS)[1]: 0.3 m / 0.6 m Autonomous, no SA[1]: 1.2 m / 2.4 m
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 kph (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

Table C-8: P327 communication specifications

Item	Specification
Serial ports	4 full-duplex 3.3 V CMOS (3 main serial ports, 1 differential-only port)
Baud rates	4800 - 115200
Data I/O protocol	NMEA 0183, Hemisphere GPS binary
Correction I/O protocol	Hemisphere GNSS’ ROX, RTCM v2.3 (DGPS), RTCM v3 (RTK), CMR, CMR+[4], 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

Table C-9: P327 power specifications

Item	Specification
Input voltage	3.3 VDC +/- 5%
Power consumption	1.0 W (GPS L1) 1.6 W (GPS/GLONASS L1/L2 G1/G2) 2.3 W (All Signals + L-Band)
Current consumption	303 mA nominal (GPS L1) 484 mA nominal (GPS/GLONASS L1/L2 G1/G2) 696 mA nominal (All Signals + L-Band)
Antenna voltage input	15 VDC maximum
Antenna short circuit protection	Yes
Antenna gain input range	10 to 40 dB
Antenna input impedance	50 Ω

Table C-10: P327 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[5]	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-11: P327 mechanical specifications

Item	Specification
Dimensions	72.4 L x 40.6 W x 10.1 H mm (2.81 L x 1.60 W x 0.40 H in)
Weight	< 23 g (< 0.81 oz)
Status indication (LED)	Power, GNSS lock, Differential lock, DGNSS position
Power/Data connector	20-pin (10x2) male header 0.08” (2 mm) pitch
Antenna connector	MCX, female, straight

Table C-12: P327 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)

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

2 Depends also on baseline length

3 Requires an L-band subscription

4 Receive only, does not transmit this format

5 When integrated in conjunction with the recommended shielding and protection as outlined in this manual

End User License Agreement

IMPORTANT - This is an agreement (the "**Agreement**") between you, the end purchaser ("**Licensee**") and Hemisphere GNSS Inc. ("**Hemisphere**") which permits Licensee to use the Hemisphere software (the "**Software**") that accompanies this Agreement. This Software may be licensed on a standalone basis or may be embedded in a Product. Please read and ensure that you understand this Agreement before installing or using the Software Update or using a Product.

In this agreement any product that has Software embedded in it at the time of sale to the Licensee shall be referred to as a "**Product**". As well, in this Agreement, the use of a Product shall be deemed to be use of the Software which is embedded in the Product.

BY INSTALLING OR USING THE SOFTWARE UPDATE OR THE PRODUCT, LICENSEE THEREBY AGREES TO BE LEGALLY BOUND BY THE TERMS OF THIS AGREEMENT. IF YOU DO NOT AGREE TO THESE TERMS, (I) DO NOT INSTALL OR USE THE SOFTWARE, AND (II) IF YOU ARE INSTALLING AN UPDATE TO THE SOFTWARE, DO NOT INSTALL THE UPDATE AND PROMPTLY DESTROY IT.

HEMISPHERE PROVIDES LIMITED WARRANTIES IN RELATION TO THE SOFTWARE. AS WELL, THOSE WHO USE THE EMBEDDED SOFTWARE DO SO AT THEIR OWN RISK. YOU SHOULD UNDERSTAND THE IMPORTANCE OF THESE AND OTHER LIMITATIONS SET OUT IN THIS AGREEMENT BEFORE INSTALLING OR USING THE SOFTWARE OR THE PRODUCT.

1. **LICENSE**. Hemisphere hereby grants to Licensee a non-transferable and non-exclusive license to use the Software as embedded in a Product and all Updates (collectively the "**Software**"), solely in binary executable form.
2. **RESTRICTIONS ON USE**. Licensee agrees that Licensee and its employees will not directly or indirectly, in any manner whatsoever:
    a. install or use more copies of the Software than the number of copies that have been licensed;
    b. use or install the Software in connection with any product other than the Product the Software was intended to be used or installed on as set out in the documentation that accompanies the Software.
    c. copy any of the Software or any written materials for any purpose except as part of Licensee's normal backup processes;
    d. modify or create derivative works based on the Software;
    e. sub-license, rent, lease, loan or distribute the Software;
    f. permit any third party to use the Software;
    g. use or operate Product for the benefit of any third party in any type of service outsourcing, application service, provider service or service bureau capacity;
    h. reverse engineer, decompile or disassemble the Software or otherwise reduce it to a human perceivable form;
    i. Assign this Agreement or sell or otherwise transfer the Software to any other party except as part of the sale or transfer of the whole Product.
3. **UPDATES**. At Hemisphere's discretion Hemisphere may make Updates available to Licensee. An update ("**Update**") means any update to the Software that is made available to Licensee including error corrections, enhancements and other modifications. Licensee may access, download and install Updates during the Warranty Period only. All Updates that Licensee downloads, installs or uses shall be deemed to be Software and subject to this Agreement. Hemisphere reserves the right to modify the Product without any obligation to notify, supply or install any improvements or alterations to existing Software.
4. **SUPPORT.** Hemisphere may make available directly or through its authorized dealers telephone and email support for the Software. Contact Hemisphere to find the authorized dealer near you. As well, Hemisphere may make available user and technical documentation regarding the Software. Hemisphere reserves the right to reduce and limit access to such support at any time.
5. **BACKUPS AND RECOVERY.** Licensee shall back-up all data used, created or stored by the Software on a regular basis as necessary to enable proper recovery of the data and related systems and processes in the event of a malfunction in the Software or any loss or corruption of data caused by the Software. Licensee shall assume all risks of loss or damage for any failure to comply with the foregoing.
6. **OWNERSHIP.** Hemisphere and its suppliers own all rights, title and interest in and to the Software and related materials, including all intellectual property rights. The Software is licensed to Licensee, not sold.
7. **TRADEMARKS**. "Hemisphere", "Hemisphere GPS", "Hemisphere GNSS", "Crescent", "Eclipse" and the associated logos are trademarks of Hemisphere. Other trademarks are the property of their respective owners. Licensee may not use any of these trademarks without the consent of their respective owners.
8. **LIMITED WARRANTY**. Hemisphere warrants solely to the Licensee, subject to the exclusions and procedures set forth herein below, that for a period of one (1) year from the original date of purchase of the Product in which it is embedded (the "Warranty Period"), the Software, under normal use and maintenance, will conform in all material respects to the documentation provided with the Software and any media will be free of defects in materials and workmanship. For any Update, Hemisphere warrants, for 90 days from performance or delivery, or for the balance of the original Warranty Period, whichever is greater, that the Update, under normal use and maintenance, will conform in all material respects to the documentation provided with the Update and any media will be free of defects in materials and workmanship. Notwithstanding the foregoing, Hemisphere does not warrant that the Software will meet Licensee's requirements or that its operation will be error free.
9. **WARRANTY EXCLUSIONS**. The warranty set forth in Section (8) will not apply to any deficiencies caused by (a) the Product not being used as described in the documentation supplied to Licensee, (b) the Software having been altered, modified or converted in any way by anyone other than Hemisphere approved by Hemisphere, (c) any malfunction of Licensee's equipment or other software, or (d) damage occurring in transit or due to any accident, abuse, misuse, improper installation, lightning (or other electrical discharge) or neglect other than that caused by Hemisphere. Hemisphere does not warrant or guarantee the precision or accuracy of positions obtained when using the Software (whether standalone or embedded in a Product). The Product and the Software is not intended and should not be used as the primary means of navigation or for use in safety of life applications. The potential

positioning and navigation accuracy obtainable with the Software as stated in the Product or Software documentation serves to provide only an estimate of achievable accuracy based on specifications provided by the US Department of Defense for GPS positioning and DGPS service provider performance specifications, where applicable.

10. **WARRANTY DISCLAIMER.** EXCEPT AS EXPRESSLY SET OUT IN THIS AGREEMENT, HEMISPHERE MAKES NO REPRESENTATION, WARRANTY OR CONDITION OF ANY KIND TO LICENSEE, WHETHER VERBAL OR WRITTEN AND HEREBY DISCLAIMS ALL REPRESENTATIONS, WARRANTIES AND CONDITIONS OF ANY KIND INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, ACCURACY, RELIABILITY OR THAT THE USE OF THE SOFTWARE WILL BE UNINTERRUPTED OR ERROR-FREE AND HEREBY DISCLAIMS ALL REPRESENTATIONS, WARRANTIES AND CONDITIONS ARISING AS A RESULT OF CUSTOM, USAGE OR TRADE AND THOSE ARISING UNDER STATUTE.

11. **LIMITS ON WARRANTY DISCLAIMER.** Some jurisdictions do not allow the exclusion of implied warranties or conditions, so some of the above exclusions may not apply to Licensee. In that case, any implied warranties or conditions which would then otherwise arise will be limited in duration to ninety (90) days from the date of the license of the Software or the purchase of the Product. The warranties given herein give Licensee specific legal rights and Licensee may have other rights which may vary from jurisdiction to jurisdiction.

12. **CHANGE TO WARRANTY.** No employee or agent of Hemisphere is authorized to change the warranty provided or the limitation or disclaimer of warranty provisions. All such changes will only be effective if pursuant to a separate agreement signed by senior officers of the respective parties.

13. **WARRANTY CLAIM.** In the event Licensee has a warranty claim Licensee must first check for and install all Updates that are made available. The warranty will not otherwise be honored. Proof of purchase may be required. Hemisphere does not honor claims asserted after the end of the Warranty Period.

14. **LICENSEE REMEDIES.** In all cases which involve a failure of the Software to conform in any material respect to the documentation during the Warranty Period or a breach of a warranty, Hemisphere's sole obligation and liability, and Licensee's sole and exclusive remedy, is for Hemisphere, at Hemisphere's option, to (a) repair the Software, (b) replace the Software with software conforming to the documentation, or (c) if Hemisphere is unable, on a reasonable commercial basis, to repair the Software or to replace the Software with conforming software within ninety (90) days, to terminate this Agreement and thereafter Licensee shall cease using the Software. Hemisphere will also issue a refund for the price paid by Licensee less an amount on account of amortization, calculated on a straight-line basis over a deemed useful life of three (3) years.

15. LIMITATION OF LIABILITY. IN NO EVENT WILL HEMISPHERE BE LIABLE TO LICENSEE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES INCLUDING ARISING IN RELATION TO ANY LOSS OF DATA, INCOME, REVENUE, GOODWILL OR ANTICIPATED SAVINGS EVEN IF HEMISPHERE HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH LOSS OR DAMAGE. FURTHER, IN NO EVENT WILL HEMISPHERE'S TOTAL CUMULATIVE LIABILITY HEREUNDER, FROM ALL CAUSES OF ACTION OF ANY KIND, EXCEED THE TOTAL AMOUNT PAID BY LICENSEE TO HEMISPHERE TO PURCHASE THE PRODUCT. THIS LIMITATION AND EXCLUSION APPLIES IRRESPECTIVE OF THE CAUSE OF ACTION, INCLUDING BUT NOT LIMITED TO BREACH OF CONTRACT, NEGLIGENCE, STRICT LIABILITY, TORT, BREACH OF WARRANTY, MISREPRESENTATION OR ANY OTHER LEGAL THEORY AND WILL SURVIVE A FUNDAMENTAL BREACH.

16. LIMITS ON LIMITATION OF LIABILITY. Some jurisdictions do not allow for the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply to Licensee and Licensee may also have other legal rights which may vary from jurisdiction to jurisdiction.

17. BASIS OF BARGAIN. Licensee agrees and acknowledges that Hemisphere has set its prices and the parties have entered into this Agreement in reliance on the limited warranties, warranty disclaimers and limitations of liability set forth herein, that the same reflect an agreed-to allocation of risk between the parties (including the risk that a remedy may fail of its essential purpose and cause consequential loss), and that the same forms an essential basis of the bargain between the parties. Licensee agrees and acknowledges that Hemisphere would not have been able to sell the Product at the amount charged on an economic basis without such limitations.

18. PROPRIETARY RIGHTS INDEMNITY. Hemisphere shall indemnify, defend and hold harmless Licensee from and against any and all actions, claims, demands, proceedings, liabilities, direct damages, judgments, settlements, fines, penalties, costs and expenses, including royalties and attorneys' fees and related costs, in connection with or arising out of any actual infringement of any third party patent, copyright or other intellectual property right by the Software or by its use, in accordance with this Agreement and documentation, PROVIDED THAT: (a) Hemisphere has the right to assume full control over any action, claim, demand or proceeding, (b) Licensee shall promptly notify Hemisphere of any such action, claim, demand, or proceeding, and (c) Licensee shall give Hemisphere such reasonable assistance and tangible material as is reasonably available to Licensee for the defense of the action, claim, demand or proceeding. Licensee shall not settle or compromise any of same for which Hemisphere has agreed to assume responsibility without Hemisphere's prior written consent. Licensee may, at its sole cost and expense, retain separate counsel from the counsel utilized or retained by Hemisphere.

19. INFRINGEMENT. If use of the Software may be enjoined due to a claim of infringement by a third party then, at its sole discretion and expense, Hemisphere may do one of the following: (a) negotiate a license or other agreement so that the Product is no longer subject to such a potential claim, (b) modify the Product so that it becomes non-infringing, provided such modification can be accomplished without materially affecting the performance and functionality of the Product, (c) replace the Software, or the Product, with non-infringing software, or product, of equal or better performance and quality, or (d) if none of the foregoing can be done on a commercially reasonable basis, terminate this license and Licensee shall stop using the Product and Hemisphere shall refund the price paid by Licensee less an amount on account of amortization, calculated on a straight-line basis over a deemed useful life of three (3) years.

    The foregoing sets out the entire liability of Hemisphere and the sole obligations of Hemisphere to Licensee in respect of any claim that the Software or its use infringes any third party rights.

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

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

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

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

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

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

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

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

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

Warranty Notice

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

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

EXCLUSION OF ALL OTHER WARRANTIES. The LIMITED WARRANTY shall apply only if the Product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Hemisphere GNSS' relevant User's Manual and Specifications, AND the Product is not modified or misused. The Product is provided "AS IS" and the implied warranties of MERCHANTABILITY and FITNESS FOR A PARTICULAR PURPOSE and ALL OTHER WARRANTIES, express, implied or arising by statute, by course of dealing or by trade usage, in connection with the design, sale, installation, service or use of any products or any component thereof, are EXCLUDED from this transaction and shall not apply to the Product. The LIMITED WARRANTY is IN LIEU OF any other warranty, express or implied, including but not limited to, any warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE, title, and non-infringement.

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

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

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

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

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

Hemisphere GNSS
8515 E. Anderson Drive
Scottsdale, AZ 85255
Phone: 480-348-6380 Fax: 480-270-5070
techsupport@hemispheregnss.com

Hemisphere GNSS, Inc.
8515 E. Anderson Drive
Scottsdale, AZ 85255, USA

Phone: +1 (480) 348-6380
Fax: +1 (480) 270-5070
Precision@HGNSS.com
www.HGNSS.com