875-0360-0

P328 Eclipse

Integrator Guide

Revision A2
October 11, 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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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	
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Chapter 1: Introduction

Introduction

Product Overview and Features

This chapter provides an overview of the Eclipse P328 board key features and integration.

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

The P328 is our most advanced GNSS positioning board. Utilize the same centimeter-level accuracy in either single frequency mode, or employ the full performance and fast RTK initialization times over long distances with multi-frequency, multi-constellation GNSS signals. High accuracy L-band positioning from meter to sub-decimeter levels available via Atlas GNSS correction service. The latest technology platform enables simultaneous tracking of all satellite signals including GPS, GLONASS, Galileo, QZSS, and L-band making it the most robust and reliable solution for survey, mapping, and machine **control.**

P328 OEM Board Options

The Eclipse™ P328 OEM board is available in the hardware configuration shown in Table 1-1.

Table 1-1: P328 board options

Model	GNSS Systems	Compatibility	L-band
P328™	L1CA/L1P/L2P/L2C/L5 GPS G1/G2/P code (P1/P2) GLONASS B1/B2 B3 BEIDOU E1BC/E5a/E5b Galileo L1CA/ L2C/QZSS	Trimble BD970 Novatel OEM628	Yes

What's Included

The P328 is available in two configurations:

- P328 OEM board only - designed for integrators who are familiar with Eclipse board integration
- P328 OEM board and P328 adaptor board P/N 725-1521-0 (by request only).

For more information on requesting the P328 adaptor board, go to the HGNSS OEM Products page or contact your local dealer.

To access a pdf version of the OEM adapter board schematics, go to the HGNSS Home page/Products/OEM Boards/Position & Heading/ Eclipse™ P328 OEM Board/H328 Adapter Board Schematics, and click **Open**.

P328 Integration

Successful integration of the P328 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 P328 GNSS 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

Common features of P328 include:

- ✓ 394-channel GNSS engine
- ✓ Sub-meter horizontal accuracy 95%
- ✓ Raw measurement output (via documented binary messages)
- ✓ Position update rates of 50 Hz max
- ✓ Two CAN ports (NMEA2000, ISO-11783)
- ✓ One Ethernet 10/100 TCP/IP
- ✓ Tracer™ technology that provides consistent performance with correction data
- ✓ e-Dif®-ready - a base station-free way of differentially positioning
- ✓ Three full-duplex serial ports (1 3.3 V CMOS, 1 3.3V CMOS with flow control, 1 RS-232 with flow control)
- ✓ One PPS timing output
- ✓ One USB device port
- ✓ Event marker input

Message Interface

The P328 uses a NMEA 0183 interface, allowing you to easily make configuration changes by sending text-type commands to the receiver.

The P328 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.

Using PocketMax3 to Communicate with the P328

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

Simply connect your Windows device to the P328 via the COM port and open PocketMax3.

The screens within PocketMax3 allow you to easily interface with the P328 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 P328 status and function

PocketMax3 is available for download from the Hemisphere GNSS website.

Chapter 2: Board Overview

P328 OEM Board Key Features

Mechanical Layout

Connectors

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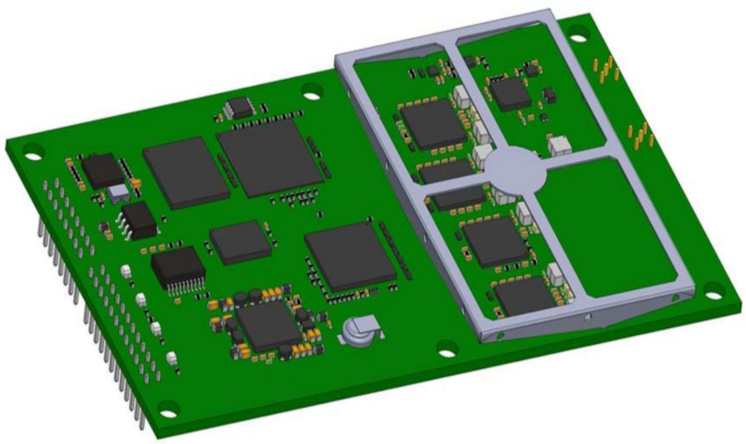
Board Overview

P328 OEM Board Key Features

With its small form factor, low power consumption, and simple on-board firmware the P328 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).



P328 is offered in the common industry form factor (100L x 60W mm), and has a mechanical design compatible with popular after-market products (24-pin and 12-pin) with integrated L-band. The reliable positioning performance of P328 is further enhanced by Athena RTK, Atlas corrections, aRTK, SureFix and TRACER™ technology.

With P328 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 that broadcasts corrections over a wireless link to the rover. The localized corrections are processed on the rover to achieve superior accuracy and repeatability. Performance testing has shown exceptional positioning accuracy even in harsh environments.

Athena RTK has the following benefits:
- Improved Initialization time - Performing initializations in less than 15 seconds at better than 99.9% of the time
- Robustness in difficult operating environments - Extremely high productivity under the most aggressive of geographic and landscape oriented environments
- Performance on long baselines - Industry-leading position stability for long baseline applications

Atlas L-band

Atlas L-band corrections are available worldwide. With Atlas, the positioning accuracy does not degrade as a function of distance to a base station, as the data content is not composed of a single base station's information, but an entire network's information. Atlas L-band is Hemisphere's industry leading correction service, and can be added as a subscription.

Atlas L-band has the following benefits:

- **Positioning accuracy -** Competitive positioning accuracies down to 4 cm RMS in certain applications
- **Positioning sustainability -** Cutting edge position quality maintenance in the absence of correction signals, using Hemisphere's patented technology
- **Scalable service levels -** Capable of providing virtually any accuracy, precision and repeatability level in the 4 to 100 cm range
- **Convergence time -** Industry-leading convergence times of 10-40 minutes

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

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

aRTK Position Aiding

aRTK is an innovative feature available in Hemisphere's P328 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.

P328 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

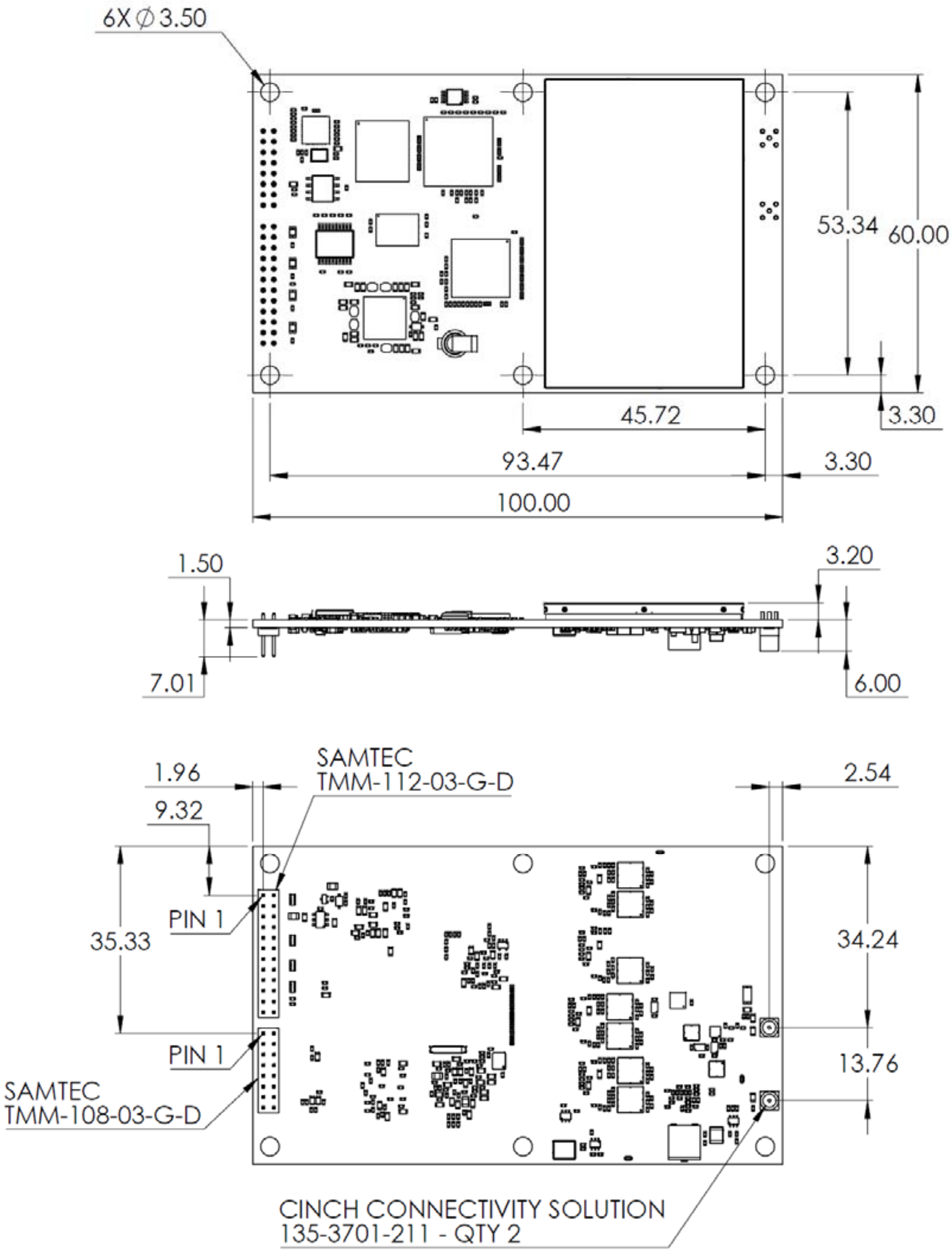


Figure 2-1: Eclipse P328 Mechanical Layout

Connectors

Table 2-1 describes P328 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: P328 Connectors

P328 Board and Connector Type		SMT Connector	Mating Connector
P328	RF	MMCX, female straight jack Emerson (Johnson) 133-3711-202	MMCX, male straight plug Samtec RSP-127824-01
	Power / data	24-pin (12x2) male header, 0.078 in (2 mm) pitch Samtec TMM-112-03-T-D	Board Mates: CLT, ESQT, MMS, SMM, SQT, SQW, TLE Cable Mates: TCSD

Mounting Options

There are two methods for mounting the P328:

- Direct Electrical Connection
- Indirect Electrical Connection (Cable)

Direct Electrical Connection Method

Place an RF connector, heading connector, and mounting holes on the carrier board and then mount the P328 on the standoffs and RF and header connectors. This method is very cost effective as it does not use cable assemblies to interface the P328.

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

The P328 uses a standoff height of 7.93 mm (0.3125 in). With this height, there should be no washers between either the standoff and the P328 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 for P328 connector information.

The mounting holes of the P328 have a standard inner diameter of 3.50 mm (0.138 in).

Indirect Electrical Connection (Cable) Method

The second method is to mount the P328 mechanically so you can connect a ribbon power/data cable to the P328. 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 P328 uses a dual-row header connector to interface with power, communications, and other signals.

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

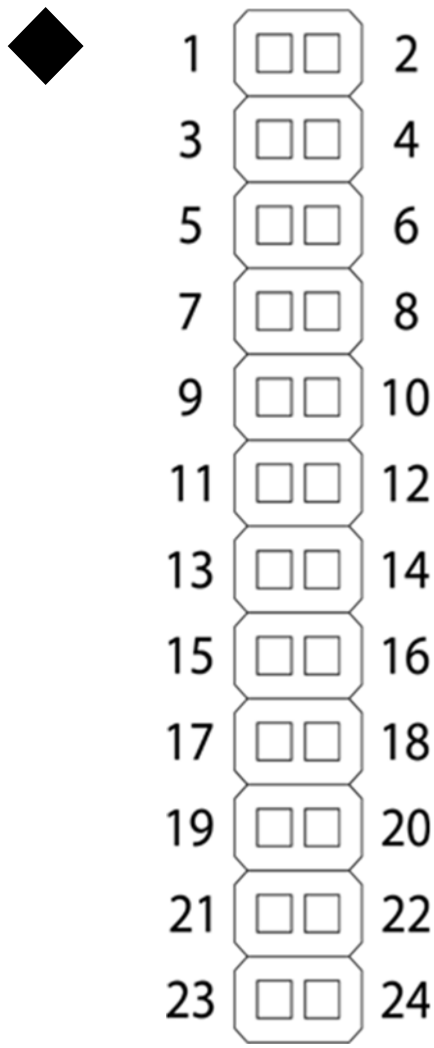


Figure 2-2: Identifying the first pin on the header connector

P328 24-Pin Header Layout/Pinout

The P328 boards have a 24-pin header. Figure 2-3 shows the P328 24-pin header layout and Table 2-2 provides the 24-pin header pin-out.

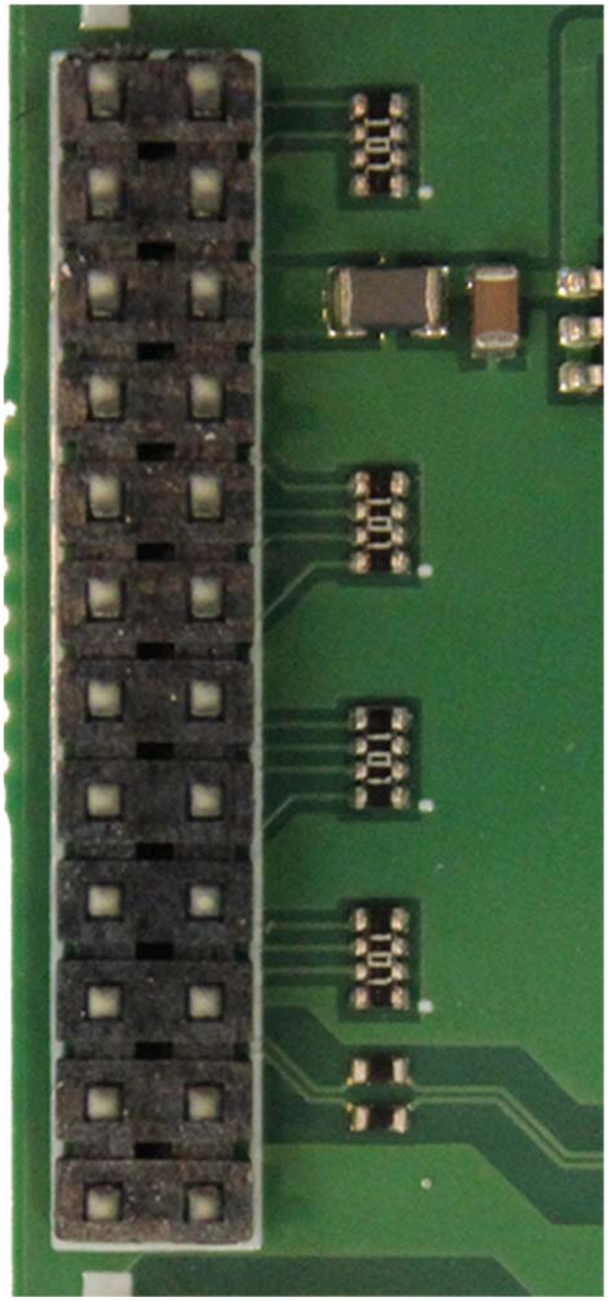


Figure 2-3: P328 24-pin Header Layout

Table 2-2: P328 24-Pin Header Pin-out

Pin	Name	Type	Description
1	Ground	Power	Ground
2	User1 CMOS	3.3V CMOS	GPIO Active high
3	SPEED PULSE CMOS	3.3V CMOS	VARF
4	PPS Output, Rising Edge	3.3V CMOS	PPS
5	PWR IN	POWER	PWR
6	PWR IN	POWER	PWR
7	Receive Port C	3.3V CMOS	COM 3_RX
8	Manual Mark, Falling Edge	3.3V CMOS	MMARK
9	ERROR	3.3V CMOS	PWR ACT HIGH
10	PValid	3.3V CMOS	PValid High
11	CTS Port B	3.3V CMOS	COM2 CTS
12	RESET, Active Low	OPEN DRAIN	RESET
13	RTS Port B	3.3V CMOS	COM2 RTS
14	Receive Port B	3.3V CMOS	COM2 RX
15	CTS Port A RS-232	RS-232	COM1 232 CTS
16	Transmit Port B	3.3V CMOS	COM2 TX
17	RTS Port A RS-232	RS-232	COM1 232 RTS
18	Receive Port A	RS-232	COM1 232 RX
19	Transmit Port C	3.3V CMOS	COM3 TX
20	Transmit Port A	RS-232	COM1 232 TX
21*	USB-	USB	USB-
22*	USB+	USB	USB+
23	Ground	Power	Ground
24	Ground	Power	Ground
*Selectable pin with input/out option			

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.

P328 16-Pin Header Layout/Pinout

The P328 board has a 16-pin header. Figure 2-4 shows the Eclipse 16-pin header layout and Table 2-3 provides the Eclipse 16-pin header pin-out.

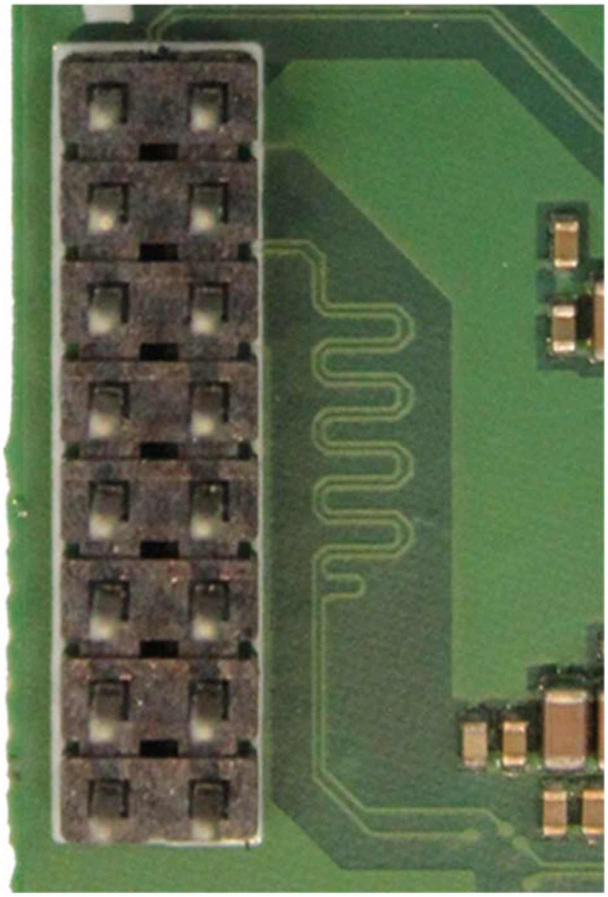


Figure 2-4: Eclipse 16-Pin Header Layout

Table 2-3: Eclipse 16-pin header pinout

Pin	Name	Type	Description
1	Ethernet Receive -	Ethernet	ENET RX-
2	Ethernet Receive +	Ethernet	ENET RX-
3	RDCT	POWER	RX Magnetic Cap
4	Ethernet Transmit +	Ethernet	ENET TX+
5	Ethernet Transmit -	Ethernet	ENET TX-
6	RDCT	POWER	TX Magnetic Cap
7	Ethernet LED	3.3V CMOS	LED A
8	n/c	n/c	LED B
9	Ground	Power	GND
10	CAN Transmit Port A	3.3V CMOS	CAN1TX
11	CAN Receive Port A	3.3V CMOS	CAN1RX
12	CAN Transmit Port B	3.3V CMOS	CAN2TX
13	CAN Receive Port B	3.3V CMOS	CAN2RX
14	USB OTG ID	ANALOG	USB ID
15	USB OTG 5V	POWER	VBus
16	Ground	Power	Ground
Note: Pins are not 5 V tolerant. The pin voltage range is 0 to 3.3 VDC, unless otherwise noted. Leave any data or I/O pins that will not be used disconnected.			

Signals

This section provides information on the signals available via connectors.

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

RF Input

The P328 is designed to work with active GNSS antennas with an Low Noise Amplifier (LNA) gain range of 10 to 40dB. The purpose of the range is to accommodate for losses in the cable system.

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

When designing the internal and external cable assemblies and choosing the RF connectors, do not exceed the loss budget; otherwise, you will compromise the tracking performance of the P328.

Serial Ports

The P328 has three serial communication ports:
Port A- RS-232 with flow control
Pin 18 (RX), input
Pin 20 (TX), output
Pin 15 (CTS), input
Pin 17 (RTS), output

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

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

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

The P328 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.

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

USB Ports

The P328 USB device port: serves as a high-speed data communications port, such as for a PC.

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

The P328 USB data line is bi-directional and is a differential pair. The USB data lines should be laid out on printed wire board (PWB) with 90 Ω±15% differential impedance.

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

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

CAN

A CAN Transceiver is required. The P328 CAN RX and CAN TX are 3.3V CMOS signals. The P328 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 P328 does not connect to this portion of the transceiver).

LED Indicators

The P328 features the following surface-mounted diagnostic LEDs that indicate board status (see Figure 2-5):

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

Figure 2-5: Onboard LEDs

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

1 PPS Timing Signal

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

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

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

The P328 supports a programmable PPS. Users can select the frequency to be 1,2,5 or 10Hz. The P328 can support widths as wide as 900ms.

The width command parameter is in usec (microseconds).

$JPSS,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

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

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

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

Event Marker Input

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

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

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

Grounds

You must connect all grounds together when connecting the ground pins of the P328. 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 P328.

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 P328 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).

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

- **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 periodic variations. 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.

Table 2-4 provides the location of the Speed Radar Pulse and Speed Radar Ready Signal on the P328.

Table 2-4: P328 Speed Radar Output Availability

Eclipse Boards	Speed Radar Pulse	Speed Radar Ready Signal
P328	Pin 25	Pin 26

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 P328 is a sensitive instrument. When integrated into an enclosure, the P328 requires shielding from other electronics to ensure optimal operation. The P328 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 P328 is a precision instrument. To ensure optimal operation, consider mounting the receiver in a way to minimize vibration and shock.

When mounting the P328 immediately adjacent to the GPS antenna, Hemisphere GNSS highly recommends shielding the board from the LNA of the antenna.

Chapter 3: Setup and Configuration

Powering the P328

Communicating with the P328

Configuring the P328

Firmware

Configuring the Data Message Output

“THIS’’ Port and the ‘OTHER’ Port

Saving the P328 Configuration

Configuration Defaults

Setup and Configuration

This chapter provides P328 operation information, such as communicating with the P328, 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 enough satellites. With a properly installed antenna the P328 provides a position within approximately 60 seconds.

Powering the P328

The P328 is powered by a 3.3 VDC power source. Once you connect appropriate power, the P328 is active. Although the P328 proceeds through an internal startup sequence upon application of power, it is ready to communicate immediately.

Communicating with the P328

The P328 features three primary serial ports (Port A, Port B, Port C) that you can configure independently from each other. You can configure the ports for any combination of NMEA 0183, binary, and RTCM SC-104 data. The usual data output is limited to NMEA data messages as these are industry standard.

Configuring the P328

You can configure all aspects of P328 operation through any serial port using proprietary commands. For information on these commands refer to the Hemisphere GNSS Technical Reference.

You can configure the following:

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

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

To issue commands to the P328 you will need to connect it to a terminal program or Hemisphere GNSS' software applications (SLXMon or PocketMax3).

Firmware

The software that runs the P328 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 P328 currently ships with the Athena based firmware. Refer to the Hemisphere GNSS Technical Reference for information on querying and talking to the P328 board.

Configuring the Data Message Output

The P328 features three primary bi-directional ports (Ports A, B and C. You can configure messages for all ports by sending proprietary commands to the P328 through any port. For a complete list of commands and messages refer to the Hemisphere GNSS Technical Reference.

'THIS' Port and the 'OTHER' Port

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

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

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

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

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

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

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

Saving the P328 Configuration

Each time you change the P328'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 P328 using a terminal program or Hemisphere GNSS' applications (SLXMon or PocketMax3).

The P328 will take approximately several 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.

Configuration Defaults

Below is the standard configuration for the P328. For more information on these commands refer to the Hemisphere GNSS Technical Reference.

$JOFF,PORTA
$JOFF,PORTB
$JOFF,PORTC
$JBAUD,19200,PORTA
$JBAUD,19200,PORTB
$JBAUD,19200,PORTC
$JAGE,2700
$JLIMIT,10.0
$JMASK,5
$JDIFF,SBAS
$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

Appendix A: Frequently Asked Questions

Integration

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

No, these are not necessary for P328 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 P328?

Not necessarily. But you may need to if there are RF interference issues, such as if the P328 interferes with other devices. A shield-can is a good start in terms of investigating the benefit. If you are designing a smart antenna system, a shield can is likely needed. Hemisphere GNSS recommends that you always conduct an RF pre-scan when integrating OEM boards.

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

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

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

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

Support and Repair

How do I solve a problem I cannot isolate?
Hemisphere GNSS recommends contacting your HGNSS dealer first. With their experience with this product, and other products from Hemisphere GNSS, they should be able to help isolate a problem. If the issue is beyond the capability or experience of the dealer, Hemisphere GNSS Technical Support is available from 8:00 AM to 5:00 PM Mountain Standard Time, Monday through Friday.
See "Technical Support" for Technical Support contact information.

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

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

See "Technical Support" for Technical Support contact information.

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

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

Power, Communication, and Configuration

My P328 system does not appear to be communicating. What do I do?

This could be one of a few issues:
- Examine the P328 cables and connectors for signs of damage or offset.
- Ensure the P328 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 P328 is connected to the receive line of the other device. Also, ensure the signal grounds are connected.
- If the P328 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 P328 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 P328 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 P328?

The $JSHOW command will request the configuration information from the P328. 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 P328 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 P328 and configure it?
Hemisphere GNSS uses two different software applications:

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

GNSS Reception and Performance

How do I know what the P328 is doing?

The P328 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 P328 has surface-mounted status LEDs that indicate receiver status.

Do I have to be careful when using the P328 to ensure it tracks properly?

For best performance, the P328 antenna must have a clear view of the sky for satellite tracking. The P328 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 P328 has acquired an SBAS signal?

The P328 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 P328 performs well up to 150 BER. The SLXMon and PocketMax3 utilities provide this information without needing to use NMEA commands.

How do I know if the P328 is offering a differentially-corrected or RTK-corrected position?

The P328 outputs the $GPGGA message as the main positioning data message. This message contains a quality fix value that describes the GPS status. If this value is 2, the position is differentially corrected; if this value is 5, the position is RTK-corrected. The SLXMon and PocketMax3 utilities provide this information without needing to use NMEA commands.

How do I select an SBAS satellite?

By default, the P328 will automatically attempt to track the appropriate SBAS satellites. If multiple satellites are available, the one with the lowest BER value is selected to be used to decode the corrections.

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

External Corrections

My P328 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 P328 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 P328's serial port and that the signal grounds are connected.
- Make sure the P328 has been set to receive external corrections by issuing the $JDIFF command. Refer to the Hemisphere GNSS Technical Reference.

How will the antenna selection and mounting affect P328 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

Appendix B: Troubleshooting

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Use the following checklist to troubleshoot anomalous P328 operation. Table B-1 provides a list of issues with possible solutions. Refer to Appendix C, "Technical Specifications" if necessary.

Use the following checklist to troubleshoot anomalous P328 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 is the first thing I do if I have a problem with the operation of the P328?	Try to isolate the source of the problem. Problems are likely to fall within one of the following categories: • Power, communication, and configuration • GPS reception and performance • Beacon reception and performance • SBAS reception and performance • External corrections • Installation • Shielding and isolating interference **Note:** It is important to review each category in detail to eliminate it as a problem.
• No data from the P328 • No communication	• Check receiver power status (this may be done a Multimeter • Confirm communication with P328 via Hemisphere query command **$JI, $JSHOW** • Verify that P328 is locked to GPS satellites (this can often be done on the receiving device or by using SLXMon) • Check integrity and connectivity of power and data cable connections
Random binary data from the P328	• Verify that the RCTM or Bin messages are not being accidentally output (send a $JSHOW command) • Verify that the baud rate settings of P328 and remote device match • Potentially, the volume of data requested to be output by the P328 could be higher than the current baud rate supports. Try using 19200 or higher for the baud rate for all devices

Table B-1: Troubleshooting (continued)

Issue	Possible Solution
No GPS lock	• Check integrity of antenna cable • Verify antenna's view of the sky • Verify the lock status and signal to noise ratio of GPS satellites (this can often be done on the receiving device or by using SLXMon)
No SBAS	• Check antenna cable integrity • Verify antenna's view of the sky, especially towards that SBAS satellites, south in the northern hemisphere • Verify the bit error rate and lock status of SBAS satellites (this can often be done on the receiving device or by using SLXMon - monitor BER value)
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 P328 SBAS and lock status (or external source is locked) • Confirm baud rates match the external source correctly • Issue a $JDIFF command and see if the expected differential mode is in fact the current mode.

Appendix C: Technical Specifications

P328 Specifications

Appendix C: Technical Specifications

P328 Specifications

Table C-1 through Table C-6 provide specifications for the P328.

Table C-1: P328 Sensor Specifications

Item	Specification
Receiver type	GPS, GLONASS, BeiDou, Galileo and QZSS, 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 4 QZSS 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, 20 Hz and 50Hz available
Horizontal accuracy	RMS (67%) 2DRMS (95%) RTK [1,2] 8 mm + 1 ppm 15 mm + 2 ppm Atlas: 0.04m 0.08m SBAS (WAAS)[1] 0.3 m 0.6 m Autonomous, no SA[1] 1.2 m 2.4 m
Timing (1PPS) accuracy	20 ns
Cold start time	< 60 s typical (no almanac or RTC)
Warm start time	< 30 s typical (almanac and RTC)
Hot start time	< 10 s (almanac, RTC, and position)
Maximum speed	1,850 km/h (999 kts)
Maximum altitude	18,288 m (60,000 ft)
Differential options	SBAS, Autonomous, External RTCM v2.3, RTK v3, L-band (Atlas), and DGPS

Table C-2: P328 Communication Specifications

Item	Specification
Serial ports	3 full-duplex 3.3 V CMOS (3 main serial ports, 1 differential-only port) 2 CAN
CAN	2 CAN ports NMEA2000, ISO-11783
Baud rates	4800 - 115200
Data I/O protocol	NMEA 0183, CAN, Hemisphere GPS binary
Correction I/O protocol	Hemisphere GNSS' ROX, RTCM v2.3 (DGPS), RTCM v3 (RTK), CMR, CMR+[3], and Atlas
Timing output	1 PPS CMOS, active high, rising edge sync, 10 kΩ, 10 pF load
Event marker input	CMOS, active low, falling edge sync, 10 kΩ 10 pF load
USB	1 USB Device

Table C-3: P328 Power Specifications

Item	Specification
Input voltage	3.3 VDC +/- 5%
Power consumption	1.1 W (GPS L1) 1.8 W (GPS/GLONASS L1/L2 G1/G2) 2.9 W (All Signals + L-band)
Current consumption	303 mA nominal (GPS L1) 484 mA nominal (GPS/GLONASS L1/L2 G1/G2) 880 mA nominal (All Signals + L-band)
Antenna voltage input	5 VDC maximum
Antenna short circuit	Yes
Antenna gain input	10 to 40 dB
Antenna input	50 Ω

Table C-4: P328 Environmental Specifications

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

Table C-5: P328 Mechanical Specifications

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

Table C-6: P328 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 Receive only, does not transmit this format

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

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23. **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.

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

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

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

27. **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's 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's applicable specifications for the Product, for 90 days from performance or delivery, or for the balance of the original Warranty Period, whichever is greater.

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

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

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

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

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

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