PA300 GNSS Smart Antenna Module

Integrator Guide

Part No. 875-0335-000 Rev A1

Hemisphere GPS®

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

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

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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.

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Technical Support

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Contents

Chapter 1: Introduction

This chapter should help you get the PA300 running quickly; however, it is not intended to replace the balance of this manual and it assumes a reasonable amount of knowledge of GPS navigation system installation. Novice GPS and SBAS users should consult Chapter 4, "Operation" and the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon) for further information on these services and technologies.

Note: The term "machine" is used throughout this manual as a general term for a vessel, craft, boat, vehicle, etc.

Overview

The PA300™ (Figure 1-1) is a complete GNSS receiver and antenna OEM package for high precision applications where integration space is limited.

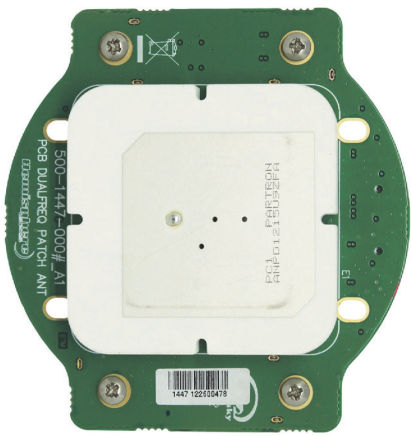


Figure 1-1: PA300

Integrated with Hemisphere GPS' multi-frequency GNSS Eclipse™ receiver and dual-frequency patch antenna, the PA300 is ideal for portable systems that require RTK or differential accuracy. The PA300 also features excellent noise and multipath rejection.

RTK performance is scalable with PA300—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 GNSS signals. Hemisphere GPS' exclusive SureTrack® technology ensures your RTK rover is making use of every satellite it is tracking, even satellites not tracked at the base. Benefit from fewer RTK dropouts in congested environments, faster reacquisitions, and more robust solutions due to better cycle slip detection. SureTrack also removes concerns with mixing GNSS data from various manufacturers. Even if your base is only L1/L2 GPS, PA300 with SureTrack delivers complete GNSS performance.

The PA300 also features Hemisphere GPS' exclusive COAST™ technology that enables Hemisphere GPS receivers to utilize aging differential GPS correction data for 40 minutes or more without significantly affecting positioning quality. The PA300 is less likely to be affected by differential signal outages due to signal blockages, weak signals, or interference when using COAST.

Configuring the PA300

The PA300 offers serial port functionality and comes preconfigured. You only need to do the following to begin using the PA300:

- Connect the PA300 to a power supply
  See "Powering the PA300" on page 12
- Set up your COM ports
  See "Ports" on page 14
- Make sure the PA300 has a clear view of the sky
- Connect the PA300 to a PC running PocketMax and then set up PocketMax (to track satellites set up the GPGGA and GPGSV messages)
  See "Using PocketMax to Communicate with the PA300" below

Note: The PA300 provides limited CAN support. For more information contact Hemisphere GPS Technical Support.

NMEA 0183 Message Interface

The PA300 uses a NMEA 0183 interface, allowing you to easily make configuration changes by sending text-type commands to the receiver. Refer to "Common Commands and Messages" on page 20 for information on relevant commands for making configuration changes.

For more information on commands and NMEA 0183 messages refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon).

Using PocketMax to Communicate with the PA300

Hemisphere GPS' PocketMax is a free utility program that runs on your Windows PC or Windows mobile device. Simply connect your Windows device to the PA300 via the COM port and open PocketMax. The menus and tabs within PocketMax allow you to easily interface with the PA300 to:

- Select the internal WAAS correction source and monitor reception
- Configure GPS message output and port settings
- Record various types of data
- Monitor the PA300's status and function

PocketMax is available for download from the OEM Software Downloads page on the Hemisphere GPS website (www.hemispheregps.com).

Chapter 2: Layout and Connectors

Mechanical Layout

Figure 2-1 shows the PA300's mechanical layout. All dimensions are in millimeters (inches).

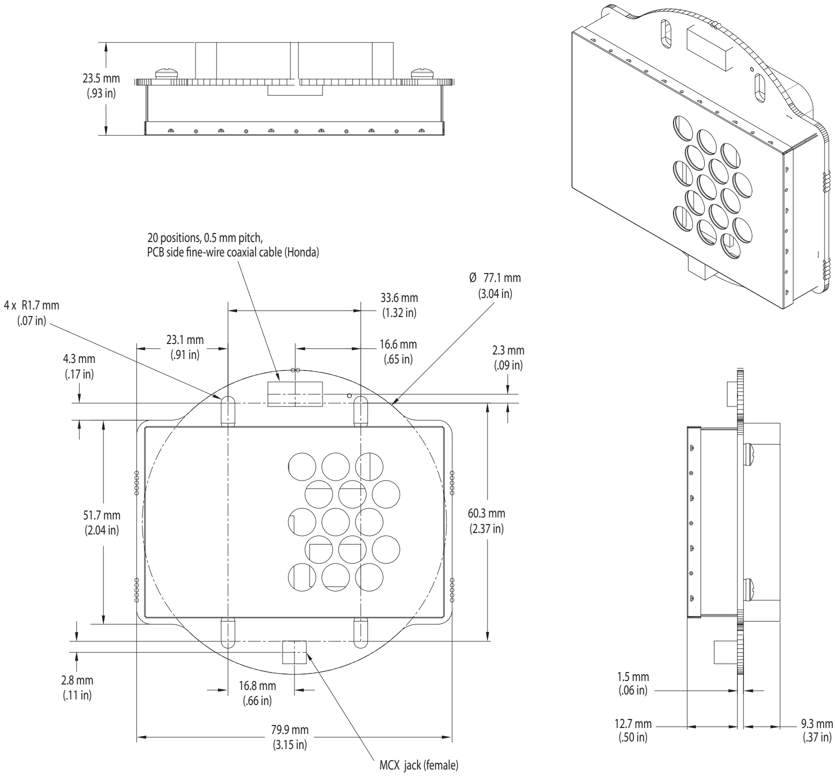


Figure 2-1: PA300 layout

Connectors

Table 2-1 provides information on the power/data connector as well as related mating connectors. You can use different compatible connectors; however, the requirements may be different.

Table 2-1: PA300 connectors

Power/Data Connector	Mating Connector
20-pin LVDS connector (Honda LVCD20SFYG3)	Use connectors at left as guidance for sourcing mating connector

⚠WARNING: Never add, remove, change, or short circuit any PA300 jumpers. Doing so may cause undesirable effects and may damage the board. Always leave jumpers in their default positions, as shipped from the factory.

Chapter 3: Installation

Creating an Enclosure

Mounting the Board

The PA300 has multiple mounting holes available for securing the PA300 to its enclosure (see Figure 3-1). Use all the mounting holes to make sure the PA300 is securely fastened to the enclosure and structurally rigid. Hemisphere GPS recommends using all the mounting holes for your installation.

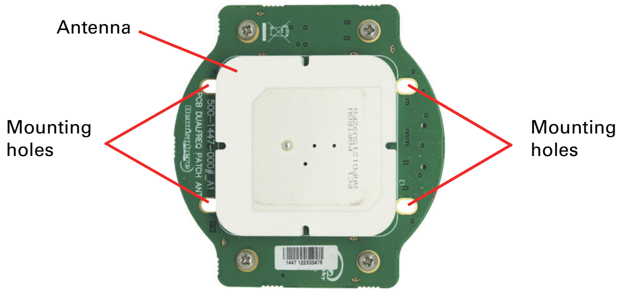


Figure 3-1: Board mounting

You can secure the board from the top or bottom. You must mount the board with the antenna facing upward (toward the sky).

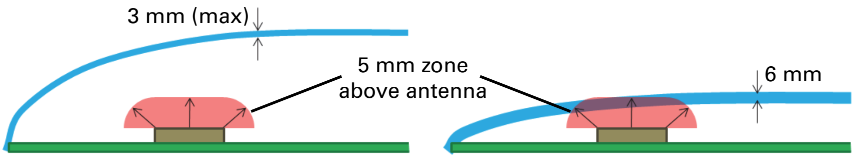
Use self-tapping Plastite® Torx screws, 4-20 x 0.375, with a metal washer when securing the PA300 to a plastic enclosure. If you are mounting the board to a material other than plastic, make sure you use an appropriate screw to properly secure the board.

Note: Make sure you properly ground the board on the mounting holes to signal ground.

Plastic Cover

For the plastic cover, Hemisphere GPS recommends using a high quality ASA copolymer (with no metal) with excellent weatherability, good flow, aesthetics, and high impact resistance. You can paint the plastic, but do not use a metallic paint.

A plastic cover over the antennas is mandatory when designing the enclosure. The enclosure must be within the antennas' reactive near field (see Figure 3-2 on page 11). The plastic cover over the antennas shifts the center frequency of the antennas to the GPS L1 frequency. The PA300's GPS antennas are tuned to a frequency higher than the GPS L1 central frequency and require the plastic cover to be placed over the antennas no closer than 5 mm, with plastic no thicker than 3 mm. With the appropriate plastic enclosure the PA300 will be properly tuned to track GPS.



Correct
Enclosure is no more than 3 mm thick and does not pass through zone that is 5 mm from antenna

Incorrect
Enclosure is more than 3 mm thick and passes through zone that is 5 mm from antenna

Figure 3-2: Plastic cover

In very benign RF environments, there may be no perceived positioning or heading performance difference between a system with or without a proper cover over the antennas. The broadcast GPS L1 signal has a 20 MHz bandwidth and the antennas capture only about 8 MHz of that signal. It is possible to achieve a functioning system with an offset central frequency; however, there will be reduced signal-to-noise (SNR) values as compared to an optimally designed system.

Mounting Considerations

This section provides information on determining the best location and orientation for the PA300.

Note: The PA300 provides the ability to output the heave of the machine via the $GPHEV message. For more information on this message refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon).

GPS Reception

When considering where to mount the PA300, consider the following GPS reception recommendations:

- Consider GPS (and hence SBAS) reception, making sure the PA300 has a clear view of the sky so the GPS and SBAS satellites are not masked by obstructions that may reduce system performance
- Locate any transmitting antennas at least several feet away from the PA300 to ensure tracking performance is not compromised, providing the best performance possible
- Make sure there is enough cable length to reach a breakout box or terminal strip
- Do not locate the PA300 where environmental conditions exceed those specified in Table B-5 on page 27

PA300 Environmental Considerations

The PA300 is designed to withstand harsh environmental conditions; however, adhere to the limits indicated in Table B-5, “Environmental specifications” on page 27 when storing and using the PA300.

Shielding the PA300

The PA300 is provided with all the required shielding; however, care should still be taken when determining the mounting location of the board to avoid any potential interference issues.

⚠WARNING: Under NO circumstances should you remove, mangle, destroy, tamper with, or otherwise pierce, puncture, or open any of these shields. Doing so can dramatically reduce receiver performance and will void the warranty.

Always follow proper electrostatic discharge protocols when handling the device. Avoid touching the PCB and its components directly with your fingers. Always grab onto the large metal shields on the device when handling the board.

Powering the PA300

The PA300 is powered by a 3.3 VDC power source. Once you connect appropriate power the PA300 is active. Although the PA300 proceeds through an internal startup sequence upon application of power, it is ready to communicate immediately.

Connecting to External Devices

The power/data connector (J4) allows you to connect to other devices to the PA300. For connector J4, Figure 3-3 shows the pin layout and the actual connector on the board, while Table 3-1 describes the pinouts.

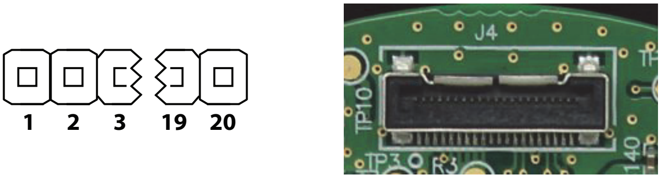


Figure 3-3: Power/data connector (J4) on the board

Table 3-1: J4 pinout descriptions

Pin	Name	Type	Description
1	Antenna Pwr	Power	Antenna power, DC, 5 V
2	Antenna Pwr	Power	Antenna power, DC, 5 V
3	Antenna Pwr	Power	Antenna power, DC, 5 V
4	GND	Power	Receiver ground
5	GND	Power	Receiver ground
6	3.3 V	Power	Receiver power supply, 3.3 V
7	3.3 V	Power	Receiver power supply, 3.3 V
8	3.3 V	Power	Receiver power supply, 3.3 V
9	3.3 V	Power	Receiver power supply, 3.3 V
10	GND	Power	Receiver ground
11	n/c	n/c	n/c
12	GND	Power	Receiver ground
13	PARX	Input	Port A TTL input, 3.3 V CMOS, idle high
14	PATX	Output	Port A TTL output, 3.3 V CMOS, idle high
15	GND	Power	Receiver ground
16	GND	Power	Receiver ground
17	PBRX	Input	Port B TTL input, 3.3 V CMOS, idle high
18	PBTX	Output	Port B TTL output, 3.3 V CMOS, idle high
19	GND	Power	Receiver ground
20	GND	Power	Receiver ground

Note:

- Pins are not 5 V tolerant. The pin voltage range is 0 to 3.3 VDC, unless otherwise noted.
- Leave any data or I/O pins that will not be used unconnected.
- Hemisphere GPS strongly recommends using a shielded cable assembly to reduce system noise on the communications lines of the final assembly when designing a cable to connect to the PA300.

Ports

The PA300 offers data via two full-duplex (bidirectional) 3.3V CMOS serial ports. These ports are also used for firmware upgrades.

Selecting Baud Rates and Message Types

When selecting your baud rate and message types use the following formula to calculate the bits/sec for each message and then sum the results to determine the baud rate for your required data throughput.

> Message output rate * Message length (bytes) * bits in byte = Bits/second
> (1 character = 1 byte, 8 bits = 1 byte, use 10 bits/byte to account for overhead)

See "Common Commands and Messages" on page 20 for an example of this calculation. For information on message output rates refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon).

Configuring the Ports

You may configure Port A or Port B of the GPS receiver to output any combination of data you want. Port A can have a different configuration from Port B in terms of data message output, data rates, and the port baud rate; this allows you to configure the ports independently based upon your needs.

For example, if you want one generalized port and one position-only port, you can configure the ports as follows:

- Port A to have GPGLL and GPZDA both output at 1 Hz over a 9600 baud rate
- Port B to have GPGAA output at its maximum rate of 20 Hz over a 19200 baud rate (assuming a 20 Hz subscription)

Note: For successful communications use the 8-N-1 protocol and set the baud rate of the PA300's serial ports to match that of the devices to which they are connected. Flow control is not supported.

Communicating with Other Devices

When communicating with other devices, ensure the transmit data output from the PA300 is connected to the data input of the other device. The signal grounds must also be connected.

There is likely little reason to connect the receive data input of the PA300 to another device unless it is able to send configuration commands to the PA300. Since the PA300 uses proprietary NMEA 0183 commands for control over its configuration, the vast majority of electronics will not be able to configure its settings unless the other device has a terminal setting where you can manually issue commands.

Interfacing to a PC

PCs typically use a DB9-male connector for RS-232 serial port communications. If you will use serial Ports A and/or B (see Table 3-2 below) to communicate to external devices (such as PCs) you must translate the signal level from 3.3 V CMOS to RS-232.

Table 3-2: Port A and Port B CMOS interface configuration

J4 Pin	Signal (Port A)
13	Port A receive CMOS
14	Port A transmit CMOS
15	Signal ground

J4 Pin	Signal (Port B)
17	Port B receive CMOS
18	Port B transmit CMOS
19	Signal ground

PA300 Default Configuration

The following represents the standard configuration for the PA300. For more information on these commands refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon).

```
$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,51.0,-114.0
$JSMOOTH,LONG900
$JAIR,AUTO
$JALT,NEVER

$JNP,7
$JWAASPRN,AUTO
$JTAU,COG,0.00
$JTAU,SPEED,0.00

$JSAVE
```

Chapter 4: Operation

GPS Overview

PA300 Overview

Common Commands and Messages

GPS Overview

For your convenience, both the GPS and SBAS operation of the PA300 features automatic operational algorithms. When powered for the first time, the PA300 performs a 'cold start' that involves acquiring the available GPS satellites in view and the SBAS differential service.

If SBAS is not available in your area, an external source of RTCM SC-104 differential corrections may be used. If you use an external source of correction data, it must support an eight data bit, no parity, one stop bit configuration (8-N-1).

GPS Operation

The GPS receiver is always operating, regardless of the DGPS operation mode. The following sections describe the general operation of the PA300's internal GPS receiver.

Note: For successful communications use the 8-N-1 protocol and set the baud rate of the PA300's serial ports to match that of the devices to which they are connected. Flow control is not supported.

Automatic Tracking

The PA300's internal GPS receiver automatically searches for GPS satellites, acquires the signals, and manages the navigation information required for positioning and tracking.

Receiver Performance

The PA300 works by finding four or more GPS satellites in the visible sky. It uses information from these satellites to compute a position within 2.5 m 95%. Since there is some error in the GPS data calculations, the PA300 also tracks a differential correction. The PA300 uses these corrections to improve its position accuracy to better than 1.0 m 95%.

There are two main aspects of GPS receiver performance:

- Satellite acquisition
- Positioning and heading calculation

When the PA300 is properly positioned, the satellites transmit coded information to the antennas on a specific frequency. This allows the receiver to calculate a range to each satellite from both antennas. GPS is essentially a timing system. The ranges are calculated by timing how long it takes for the signal to reach the GPS antenna. The GPS receiver uses a complex algorithm incorporating satellite locations and ranges to each satellite to calculate the geographic location and heading. Reception of any four or more GPS signals allows the receiver to compute three-dimensional coordinates and a valid heading.

⚠WARNING: If you are using a reradiator to rebroadcast GPS signals indoors, the PA300 may be able to calculate a position solution but it will not be able to compute an accurate heading solution. This is due to the heading algorithms essentially receiving the same measurements at both antennas and is unrelated to the quality or operation of either the PA300 or the reradiator.

Differential Operation

The purpose of differential GPS (DGPS) is to remove the effects of selective availability (SA), atmospheric errors, timing errors, and satellite orbit errors, while enhancing system integrity. Autonomous positioning capabilities of the PA300 will result in positioning accuracies of 2.5 m 95% of the time. In order to improve positioning quality to better than 1.0 m 95%, the PA300 is able to use differential corrections received through the internal SBAS demodulator or externally-supplied RTCM corrections.

Automatic SBAS Tracking

The PA300 automatically scans and tracks SBAS signals without the need to tune the receiver. The PA300 features two-channel tracking that provides an enhanced ability to maintain a lock on an SBAS satellite when more than one satellite is in view. This redundant tracking approach results in more consistent tracking of an SBAS signal in areas where signal blockage of a satellite is possible.

PA300 Overview

The PA300 provides accurate and reliable heading and position information at high update rates. To accomplish this task, the PA300 uses a high performance GPS receiver and two antennas for GPS signal processing. One antenna is designated as the primary GPS antenna and the other is the secondary GPS antenna. Positions computed by the PA300 are referenced to the phase center of the primary GPS antenna. Heading data references the vector formed from the primary GPS antenna phase center to the secondary GPS antenna phase center.

The heading is defined by the orientation from primary to secondary antenna. See Figure 3-1 on page 10 for locations of the primary and secondary antennas.

Common Commands and Messages

Note: When selecting your baud rate and message types use the following formula and example to calculate the bits/sec for each message and then sum the results to determine the baud rate for your required data throughput.

*Message output rate * Message length (bytes) * bits in byte = Bits/second*
(1 character = 1 byte, 8 bits = 1 byte, use 10 bits/byte to account for overhead)

Example:

Message	*Rate*	*Bytes*	*Bits in byte*	*Bits/sec*
GPGGA	*1*	*83*	*10*	*830*
GPZDA	*1*	*38*	*10*	*380*
			Total	*1210*

For information on message output rates refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon).

Table 4-1 below through Table 4-3 provide brief descriptions of common commands and messages for the PA300. Refer to the Hemisphere GPS Technical Reference for more detailed information.

Table 4-1: Commands

Command	Description
$JAGE	Specify maximum DGPS (COAST) correction age (6 to 8100 seconds)
$JAPP	Query or specify receiver application firmware
$JASC	Specify ASCII messages to output to specific ports (see ASCII messages in Table 4-2)
$JBAUD	Specify RS-232, RS-422 (output) communication rate
$JBIN	Specify binary messages to output to specific ports (see Table 4-3)
$JDIFF	Query or specify differential correction mode
$JGEO	Query or specify SBAS for current location and SBAS satellites
$JI	Query unit's serial number and firmware versions
$JOFF	Turn off all data messages
$JQUERY,GUIDE	Query accuracy suitability for navigation

Table 4-1: Commands (*continued)*

Command	Description
$JRESET	Reset unit's configuration to firmware defaults $JRESET clears all parameters. For the PA300 you will have to issue the $JATT, FLIPBRD,YES command to properly redefine the circuitry orientation inside the product once the receiver has reset. Failure to do so will cause radical heading behavior. You can also issue the $JRESET command with an optional field: • $JRESET,ALL does everything $JRESET does, plus it clears almanacs • $JRESET,BOOT does everything $JRESET,ALL does, plus clears use of the real-time clock at startup, clears use of backed-up ephemeris and almanacs, and reboots the receiver when done
$JSAVE	Save session's configuration changes

In Table 4-2 the Info Type value is one of the following:

- P = Position
- V = Velocity, Time
- S = Sats, Stats, Quality

Table 4-2: NMEA 0183 messages

Message	Info Type	Max Output Rate	Description	IEC Approved Message
$GPDTM	P	1 Hz	Datum reference	Yes
$GPGGA	P	20 Hz	GPS position and fix data	Yes
$GPGLL	P	20 Hz	Geographic position - lat/long	Yes
$GPGNS	P	20 Hz	GNSS position and fix data	Yes
$GPGRS	S	1 Hz	GNSS range residual (RAIM)	Yes
$GPGSA	S	1 Hz	GNSS DOP and active satellites	Yes
$GPGST	S	1 Hz	GNSS pseudo range error statistics and position accuracy	Yes
$GPGSV	S	1 Hz	GNSS satellites in view	Yes
$GPZDA	V	20 Hz	Time and date	Yes

Table 4-3: Binary messages

$JBIN Message	Description
1	GPS position
2	GPS DOPs
80	SBAS

Table 4-3: Binary messages (*continued)*

$JBIN Message	Description
93	SBAS ephemeris data
94	Ionosphere and UTC conversion parameters
95	Satellite ephemeris data
96	Code and carrier phase
97	Processor statistics
98	Satellites and almanac
99	GPS diagnostics

Appendix A: Troubleshooting

Table A-1 provides troubleshooting for common problems.

Table A-1: Troubleshooting

Symptom	Possible Solution
Receiver fails to power	• Verify polarity of power leads • Check integrity of power cable connectors • Check power input voltage (3.3 V maximum) • Check current restrictions imposed by power source (minimum available should be > 1.0 A)
No data from PA300	• Check receiver power status to ensure the receiver is powered (an ammeter can be used for this) • Verify desired messages are activated (using PocketMax or $JSHOW in any terminal program) • Ensure the baud rate of the PA300 matches that of the receiving device • Check integrity and connectivity of power and data cable connections
Random data from PA300	• Verify the RTCM or binary messages are not being output accidentally (send a $JSHOW command) • Ensure the baud rate of the PA300 matches that of the remote device • Potentially, the volume of data requested to be output by the PA300 could be higher than the current baud rate supports (try using 19200 as the baud rate for all devices or reduce the amount of data being output)
No GPS lock	• Verify the PA300 has a clear view of the sky • Verify the lock status of GPS satellites (this can be done with PocketMax)
No SBAS lock	• Verify the PA300 has a clear view of the sky • Verify the lock status of SBAS satellites (this can be done with PocketMax - monitor BER value) • SBAS lock can only get if you are in an appropriate SBAS region (currently, there is limited SBAS availability in the southern hemisphere) • Set SBAS mode to automatic with the $JWAASPRN,AUTO command

Appendix B: Technical Specifications

Table B-1 through Table B-5 provide the PA300's GNSS sensor, communication, power, mechanical, and environmental specifications.

Table B-1: GNSS sensor specifications

Item	Specification		
Receiver type	L1/L2 GPS and L1/L2 GLONASS, RTK with carrier phase		
Signals received	GPS, GLONASS, and GALILEO[1]		
Channels	270		
GPS sensitivity	-142 dBm		
SBAS tracking	3-channel, parallel tracking		
Update rate	1 Hz standard, 10 Hz and 20 Hz optional		
Horizontal accuracy		RMS (67%)	2DRMS (95%)
	RTK[2,3]	10 mm + 1 ppm	20 mm + 2 ppm
	SBAS (WAAS)[2]	0.3 m	0.6 m
	Autonomous, no SA[2]	1.2 m	2.5 m
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)		

Table B-2: Communication specifications

Item	Specification
Serial ports	2 full-duplex 3.3 V CMOS
Baud rates	4800 - 115200
Correction I/O protocol	Hemisphere GPS' ROX, RTCM v2 (DGPS), RTCM v3 (RTK), CMR (RTK), CMR+ (RTK)[4]
Data I/O protocol	NMEA 0183, Hemisphere GPS binary[5]

Table B-3: Power specifications

Item	Specification
Input voltage	3.3 VDC +/- 5%
Power consumption	< 1.9 W nominal GPS (L1/L2) and GLONASS (L1/L2)
Current consumption	550 mA nominal GPS (L1/L2) and GLONASS (L1/L2)
Antenna voltage	3.3 V
External antenna voltage	3.3 V 50 mA
Antenna short circuit protection	Yes
Antenna gain input range	24 dB gain at L1, 29 dB for L2
Antenna input impedance	50 Ω

Table B-4: Mechanical specifications

Item	Specification
Dimensions	8.0 L X 5.2-7.7 W X 2.35 H (cm) 3.14 L X 2.04-3.03 W X 0.92 H (in)
Weight	< 133 g (< 4.7 oz)
Status indicators (LED)	Power, GPS lock, differential lock, DGPS position
Power/data connector	20-pin LVDS connector (Honda LVCD20SFYG3)
Antenna connectors	MCX, female, straight

Table B-5: Environmental specifications

Item	Specification
Operating temperature	-40°C to +70°C (-40°F to +158°F)
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% non-condensing[6]
Shock and vibration	Mechanical Shock: EP455 Section 5.14.1 Operational[7] Vibration: EP455 Section 5.15.1 Random
EMC	CE (IEC 60945 Emissions and Immunity) FCC Part 15, Subpart B, CISPR22[6]

[1]Upgrade required

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

[3]Depends also on baseline length

[4]Receive only, does not transmit this format

[5]Hemisphere GPS proprietary

[6]When installed in an appropriate enclosure

[7]When mounted in an enclosure with screw mounting holes utilized

Index

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