



A325 GNSS Smart Antenna User Guide

Part No. 875-0318-000 Rev A1



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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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Hemisphere GPS Precision GPS Applications

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6,111,549	6,397,147	6,469,663	6,501,346	6,539,303
6,549,091	6,631,916	6,711,501	6,744,404	6,865,465
6,876,920	7,142,956	7,162,348	7,277,792	7,292,185
7,292,186	7,373,231	7,400,956	7,400,294	7,388,539
7,429,952	7,437,230	7,460,942		

Other U.S. and foreign patents pending.

Notice to Customers

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

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Chapter 1: Introducing the A325 Smart Antenna

A325 Overview

Key Features

Multi-Function Application (MFA) Software

Parts List

Product Support

A325 Overview

The A325™ Smart Antenna offers an affordable, portable solution with professional level accuracy for agricultural, marine, GIS mapping, and other applications powered by Hemisphere GPS' Eclipse™ multifrequency GNSS receiver technology.

Note: Throughout the rest of this manual, the A325 Smart Antenna is referred to simply as the A325.



Figure 1-1: A325 smart antenna

A325 allows you to focus on the job at hand with fast startup and reacquisition times as well as an easy-to-see LED status indicator for power, GNSS, and Bluetooth. With a durable enclosure that houses both antenna and receiver, the A325 can be powered through various sources making it ideal for a variety of applications. Dual-serial, CAN, and pulse output options make this GNSS receiver compatible with almost any interface.

RTK performance is scalable with A325—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, SureTrack with GLONASS at your rover delivers complete GNSS performance.

You can use the A325 as an individual antenna or as either a base or rover in a base/rover setup:

- Mount the A325 on a variety of roving machines and vehicles for kinematic positioning and navigation applications
- A325 can be used as a fixed or portable base station mounted on a tripod or riser

Key Features

Key features of the A325 include:

- Centimeter-level accuracy using Eclipse technology in a rugged, all-in-one enclosure
- Improved GNSS performance—particularly with RTK and GLONASS applications—through the implementation of SureTrack technology
- Long range RTK baselines of up to 50 km
- Very fast RTK fix and reacquisition times
- Supports CAN, NMEA 2000, binary for communication with external devices
- Bluetooth® capability for wireless data transfer
- Wide operating voltage range of 7-36 VDC, providing high transient protection for any power source
- L-band* capable receiver (DGPS and high precision services)
**requires L-band subscription*
- Integrated 2D tilt sensor enables offset corrections

A325 supports a variety of communication protocols for communicating with navigation systems, data loggers, CAN systems, and other devices. See Appendix B, “Technical Specifications” for a list of communication protocols supported by the A325 (Table B-4 on page 23) as well other technical specifications.

Multi-Function Application (MFA) Software

A325 includes MFA software that allows you to set the positioning (mode) hierarchy of your device. The hierarchy is the path your device follows to determine what differential source to use depending on available sources. The hierarchy is as follows:

1. RTK
2. L-band (high precision, and high precision with GLONASS services)
3. SBAS
4. L-band (DGPS)
5. Beacon
6. External RTCM
7. Autonomous

If you are running RTK and you lose your RTK radio link, the device defaults to the next highest mode, being either L-band high precision service or high precision service with GLONASS (if subscribed) or SBAS (if available). If the new signal becomes unusable, the next mode will be selected (for example, L-band DGPS, or Beacon or External RTCM). Finally, if no correction signals are available, the device defaults to Autonomous.

You can include or exclude specific sources. For example, you can exclude sources that you do not want your device to use, such as if you want to use only beacon. If you do not exclude the other sources your device may use SBAS instead. Another example is if you want to exclude L-band (when you do not have an L-band subscription) to conserve power. You include and exclude sources using the \$JDIFFX,INCLUDE and \$JDIFFX,EXCLUDE commands, respectively. Refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and

click the GPS Reference icon) for information on these and other commands you can use with your device.

Parts List

Table 1-1 provides a description, quantity, and part number for each part in the kit.

Table 1-1: A325 parts list

Item	Part	Qty	Part Number
A	A325 GNSS Smart Antenna	1	804-0079-000
B	Antenna mounting kit	1	710-0111-000#
<i>All the following are accessory items available for purchase separately for your A325.</i>			
Not shown	Power/data cable (single DB9), 3 m	1	051-0129-002#
	Power/data cable (unterminated), 4.6 m	1	051-0169-000#
	Radio cable, 2 m	1	051-0313-000#

Product Support

If you have questions on the setup, configuration, or operation of this product, please contact your local dealer. For additional support information see “Technical Support” on page ii (just before the Contents page).



Chapter 2: Installing the A325

Mounting the A325

Powering the A325

Connecting to External Devices

Ports and Connections

All connections and ports are located on the bottom of the unit, as shown in Figure 2-1. Table 2-1 provides additional information about each port/connection.

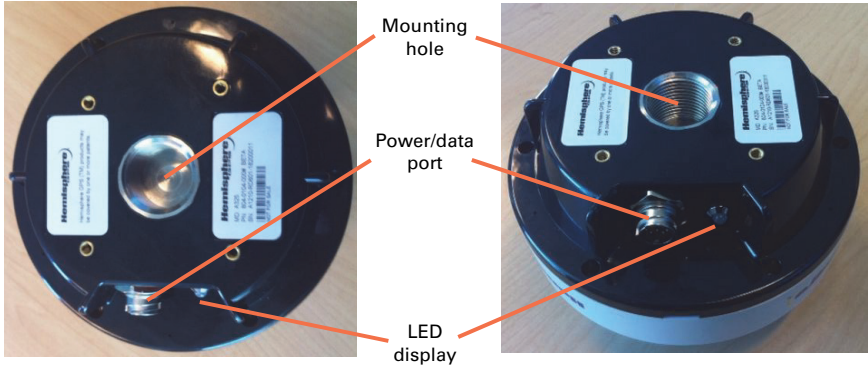


Figure 2-1: A325 ports and connectors

Table 2-1: A325 ports and connections

Port/Feature	Description
Mounting hole	Pole or tripod mount, marine 1" standard, adaptable to 5/8" (adapter in mounting kit)
Power, data port (12-pin)	External power/data cable; allows you to supply power to the A325 as well as communicate with external devices via CAN, NMEA 0183 serial, and binary
LED	Provides system information based on color and pulse of LED

LED Display

The A325 uses a single LED to indicate the following:

- Red LED = power on
- Amber LED = GPS lock
- Green LED = DGPS position
- Blinking LED (any color) = Bluetooth connected

Communication

Radar-Simulated Pulse Output

The radar-simulated pulse output provides accurate ground speed. The A325 uses pin 12 for the speed out pin. Pin 12 will output a square wave with a 50% duty cycle. The frequency of the square wave varies directly with speed. 94 Hz represents a speed of 1 m/sec (or a 28.65 pulse/foot traveled).

Note: Pin 12 does not have any form of isolation or surge protection. Hemisphere GPS strongly recommends that you incorporate some form of isolation circuitry into your supporting hardware if you want to utilize the Speed Radar Pulse output.

CAN

The A325 supports a number of NMEA 2000 messages that can be transmitted on a CAN bus. Table 2-2 shows the PGN, level, default update rate, and frequency of each message.

Table 2-2: Transmitted NMEA 2000 messages

PGN	Description	Level	Default Update Rate (msec)	Freq (Hz)
126992	System Time The purpose of this PGN is twofold: To provide a regular transmission of UTC time and date. To provide synchronism for measurement data.	B	1000	1
127257	Attitude Provides a single transmission that describes the position of a vessel relative to both horizontal and vertical planes. This would typically be used for vessel stabilization, vessel control and onboard platform stabilization.	B	1000	1
129025	Position, Rapid Update Provides latitude and longitude referenced to WGS84. Being defined as single frame message, as opposed to other PGNs that include latitude and longitude and are defined as fast or multi-packet, this PGN lends itself to being transmitted more frequently without using up excessive bandwidth on the bus for the benefit of receiving equipment that may require rapid position updates.	B	100	10
129026	COG & SOG, Rapid Update Single frame PGN that provides Course Over Ground (COG) and Speed Over Ground (SOG).	B	250	4

Table 2-2: Transmitted NMEA 2000 messages (continued)

PGN	Description	Level	Default Update Rate (msec)	Freq (Hz)
129027	Position Delta, High Precision Rapid Update The 'Position Delta, High Precision Rapid Update' Parameter Group is intended for applications where very high precision and very fast update rates are needed for position data. This PGN can provide delta position changes down to 1 mm with a delta time period accurate to 5 msec.	B	100	10
129028	Altitude Delta, High Precision Rapid Update The 'Altitude Delta, High Precision Rapid Update' Parameter Group is intended for applications where very high precision and very fast update rates are needed for altitude and course over ground data. This PG can provide delta altitude changes down to 1 millimeter, a change in direction as small as 0.0057°, and with a delta time period accurate to 5 msec.	B	100	10
129029	GNSS Position Data Conveys a comprehensive set of Global Navigation Satellite System (GNSS) parameters, including position information.	B	1000	1
129033	Time & Date Single transmission that provides UTC time, UTC Date, and Local Offset.	B	1000	1
129539	GNSS DOPs Provides a single transmission containing GNSS status and dilution of precision components (DOP) that indicate the contribution of satellite geometry to the overall positioning error. There are three DOP parameters reported: horizontal (HDOP), Vertical (VDOP), and time (TDOP).	B	1000	1
129540	GNSS Sats in View GNSS information on current satellites in view tagged by sequence ID. Information includes PRN, elevation, azimuth, SNR, defines the number of satellites; defines the satellite number and the information.	B	1000	1
129542	GNSS Pseudorange Noise Statistics GNSS pseudorange measurement noise statistics can be translated in the position domain in order to give statistical measures of the quality of the position solution. Intended for use with a Receiver Autonomous Integrity Monitoring (RAIM) application.	B	1000	1

This table contains information found in the NMEA 2000® Standard manual. NMEA 2000 is a registered trademark of the National Marine Electronics Association.

Mounting the A325

This section provides information on where to mount your antenna and the different mounting options available.

Selecting the Proper Antenna Location

Proper antenna placement is critical to positioning accuracy.

To select the proper antenna location:

- **Place the antenna with an unobstructed view of the sky.** An obstructed view of the sky may impair system performance. The GPS engine computes a position based on measurements from each satellite to the internal GPS receiver.
- **Mount the antenna on, or as close as possible to, the center of your point of measurement.** For example, ideal antenna placement on a vehicle is the center of the cab roof, assuming there is a clear view of the sky.
- **Position the antenna as high as possible.**

Routing and Securing the Cables

Consider the following when routing cables:

- Power/data cable must reach an appropriate power source
- Power/data cable may connect to a data storage device, computer, or other device that accepts GPS data
- Do not run cables in areas of excessive heat
- Do not expose cables to corrosive chemicals
- Do not crimp or excessively bend cables
- Do not place tension on cables
- Coil up excess cable in the cab of the vehicle or near the antenna
- Secure along the cable route using plastic tie wraps as necessary
- Do not run cables near high voltage or strong RF noise and transmitter sources

▲WARNING: Improperly installed cables near machinery may cause injury or death.

Mounting Options

The A325 allows for the following mounting options:

- Magnetic mount
- Surface mount
- Pole mount

Magnetic Mount

The magnetic mount can be screwed into the bottom of the A325 and mounts to metal surfaces. A metal disc and foam adhesive are included with each magnetic mount. Use the foam adhesive to bond the metal disc to the desired mounting location if there are no metal surfaces.

To mount the A325 using the magnetic mount:

1. Clean and dry the mounting surface on the vehicle.
2. Remove the backing from one side of the foam adhesive and press the metal plate onto the mounting surface on the vehicle.
3. Remove the backing from the other side of the foam adhesive
4. Press the metal plate onto the mounting surface on the vehicle.
5. Apply firm pressure to ensure good adhesion.
6. Place the A325 on top of the metal disc.

Surface Mount

As an alternative to the magnetic mount, the A325 is easily attached to the surface with four machine screws (no. 8-32).

To surface mount the A325:

1. Photocopy, or remove, Appendix E and use its line drawing as a template to plan the mounting hole locations.
2. Mark the mounting hole centers, as necessary, on the mounting surface.
3. Place the A325 over the marks to ensure that the planned hole centers agree with the true hole centers, then adjust.
4. Use a center punch on the hole centers in order to guide the drill bit.
5. Drill the mounting holes with a 3/16" bit appropriate for the surface mount.
6. Place the A325 over the mounting holes and insert the mounting screws through the bottom of the mounting surface and into the antenna.

⚠ WARNING: Hand tighten only. Damage resulting from overtightening is not covered by the warranty.

Pole Mount

The center thread on the bottom of the A325 is 1". The mounting assembly included with the A325 includes an 5/8" adapter compatible with common survey poles. Simply thread the riser/pole into the antenna until snug.

⚠ WARNING: Hand tighten only. Damage resulting from overtightening is not covered by the warranty.

Powering the A325

Power Considerations

The A325 accepts an input voltage of 7-36 VDC. For best performance use a clean and continuous power supply. See Table B-5 on page 23 for complete power specifications.

Connecting to a Power Source

The A325 uses a single cable for power and data input/output.

Note: A power/data cable is not supplied with the antenna but is available as an accessory item. See Table 1-1 on page 4 for a list of accessory items. The following information refers to using the accessory item cables available from Hemisphere GPS.

The antenna end of the cable is terminated with an environmentally sealed 12-pin connection and the opposite end is either DB9 or unterminated (requires field stripping and tinning).

To power the A325:

- Connect the A325 to a 12 VDC source. Selecting the right power connector will depend on your specific installation requirements.

⚠ WARNING: Do not apply a voltage higher than 36 VDC. This will damage the receiver and void the warranty.

The A325 features reverse polarity protection to prevent excessive damage if the power leads are accidentally reversed. With the application of power, the A325 automatically proceeds through an internal startup sequence; however, it is ready to communicate immediately.

Connecting to External Devices

Figure 2-2 shows the power/data port (12-pin) pinout, while Table 2-3 shows the power/data port pinout specifications.

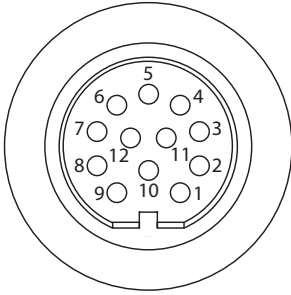


Figure 2-2: Power/data port pinout assignment

Table 2-3: Power/data port pinouts

Pin	Description
1	Manual mark in
2	Port B Tx
3	Port B Rx
4	CAN high
5	Signal ground
6	Port A Tx
7	1 PPS
8	Port A Rx
9	CAN low
10	Power in (12 V)
11	Power ground
12	Speed out

Note: For successful communication, the baud rate of the A325 serial ports (Port A and Port B) must be set to match that of the devices to which they are connected.

Default Parameters

Table 2-4 lists the default A325 configuration.

Table 2-4: Factory parameters

Setting	Description
DGPS	Application 1: MFA Application 2: RTK rover
Serial ports A and B	Baud rate: 4800, 9600, 19200, 57600, 115200 Data bits: 8 Parity: None Stop bit: 1 Interface level: RS-232
GPS messages	Type: Hemisphere GPS binary, NMEA 2000 Update rate: 1 Hz to 20 Hz Max DGPS age: 259,200 sec Elevation mask: 5°

Configuring the A325

You can configure the A325 through the serial port with the use of Hemisphere GPS commands. For example, you can:

- Select one of the two on-board applications
- Select the baud rate
- Choose which NMEA 2000 data message to output on the dual serial ports and the update rate of each message

Note: Use the \$JSAVE command to save changes you make to the A325's configuration for the changes to be present in subsequent power cycles.

For information on Hemisphere GPS commands refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon).



Chapter 3: GPS Overview

GPS Operation
Differential Operation

This chapter describes the various modes of operation and features of your A325 and internal sensors.

For your convenience, both the GPS and differential correction of the A325 are pre-configured. The receiver will work out of the box, and for most applications, little user set up is necessary. When powered for the first time, the A325 will perform a “cold start,” which involves acquiring the available GPS satellites in view and the SBAS differential service.

GPS Operation

The GPS receiver is always operating, regardless of the DGPS mode of operation. The following sections describe the general operation of the A325's internal GPS receiver.

Automatic Tracking

The A325'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 A325 works by finding four or more GPS satellites in the visible sky. It uses information from the satellites to compute a position within 2.5 m. Since there is some error in the GPS data calculations, the A325 also tracks a differential correction. The A325 uses these corrections to improve its position accuracy to better than 0.6 m.

The two main aspects of GPS receiver performance are 1) satellite acquisition, and 2) positioning and heading calculation.

When the A325 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.

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 A325 will result in positioning accuracies of 2.5 m 95% of the time. In order to improve positioning quality to better than 0.6 m 95%, the A325 is able to use differential corrections received through the internal SBAS demodulator or beacon receiver, or through externally-supplied RTCM corrections.

Automatic SBAS Tracking

The A325 automatically scans and tracks SBAS signals without the need to tune the receiver. The A325 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.



Appendix A: Troubleshooting

Use the following checklist to troubleshoot anomalous A325 operation. Table A-1 provides a list of issues with possible solutions. Refer to Appendix B, “Technical Specifications” if necessary.

Table A-1: Troubleshooting

Issue	Possible Solution
Receiver fails to power	<ul style="list-style-type: none"> • Verify polarity of power leads • Check 1.0 A in-line power cable fuse connection (only if the cable has a built in fuse) • Check integrity of power cable connections • Check power input voltage (7 - 36 VDC) • Check current restrictions imposed by power source (maximum is 350 mA)
No data from the A325 <ul style="list-style-type: none"> • 1. No communication • 2. No valid data 	<ul style="list-style-type: none"> • (1) Check receiver power status • (2) Verify it is locked to a valid DGPS signal • (2) Verify that it is locked to 4 or more GPS satellites • (2) Check integrity and connectivity of power and data cable connections • Verify that the baud rate settings match • If trying to connect over Bluetooth, ensure Bluetooth module is powered ON and device is paired prior to opening the port
Random binary data from Eclipse OEM board	<ul style="list-style-type: none"> • Verify the RCTM or the Bin messages are not being accidentally output (send a \$JSHOW command) • Verify the baud rate settings match • Potentially, the volume of data requested to be output could be higher than the current baud rate supports. Try using a higher baud rate for communications.
No GPS lock	<ul style="list-style-type: none"> • 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 PocketMax)
No SBAS	<ul style="list-style-type: none"> • 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)

Table A-1: Troubleshooting (continued)

Issue	Possible Solution
No GNSS position	<ul style="list-style-type: none"> • Verify the antenna's view of the sky, especially toward SBAS satellites, south in the northern hemisphere • Verify the bit error rate (BER) and lock status of SBAS satellites (this can often be done on the receiving device or by using SLXMon - monitor BER value) • Verify the proper application is running on the Eclipse (SBASRTKB) • Set the satellite selection to automatic mode \$JFREQ,AUTO • Set the differential mode to \$JDIFF,WAAS • Ensure there is SBAS coverage in your area
No DGPS position in external RTCM mode	<ul style="list-style-type: none"> • Verify 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 the "transmit" from the source must connect to the "receiver" of the RTCM input port)
Non-DGPS output	<ul style="list-style-type: none"> • If using RTK, ensure receiver is properly authorized for RTK by sending a \$JI command or a \$JK command



Appendix B: Technical Specifications

Table B-1 through Table B-7 provide the GNSS sensor, horizontal accuracy, L-band sensor, communication, power, environmental, and mechanical specifications for the A325.

Table B-1: GNSS sensor specifications

Item	Specification
Receiver type	GNSS L1 and L2 RTK with carrier phase
Channels	12 L1CA GPS 12 L1P GPS 12 L2P GPS (with subscription code) 12 L2C GPS (with subscription code) 12 L1 GLONASS (with subscription code) 12 L2 GLONASS (with subscription code) 3 SBAS or 3 additional L1CA GPS 1 L-Band (with subscription code)
Signals received	GPS, GLONASS, and GALILEO ¹
GPS sensitivity	-142 dBm
SBAS tracking	3-channel, parallel tracking
Update rate	10 Hz standard, 20 Hz available (with subscription)
Pitch/roll accuracy	1° using tilt sensor
Timing (1PPS) accuracy:	20 ns
Cold start	< 60 s typical (no almanac or RTC)
Warm start	< 30 s typical (almanac and RTC)
Hot start	< 10 s typical (almanac, RTC, and position)
Maximum speed	1,850 kph (999 kts)
Maximum altitude	18,288 m (60,000 ft)

Table B-2: Horizontal accuracy

Item	Specification	
	RMS (67%)	2DRMS (95%)
RTK ^{2,3}	10 mm+1 ppm	20 mm+2 ppm
L-band high precision service ^{2,4}	0.1 m	0.2 m
SBAS (WAAS) ²	0.3 m	0.6 m
Autonomous, no SA ²	1.2 m	2.5 m

Table B-3: L-band sensor specifications

Item	Specification
Sensitivity	-130 dBm
Channel spacing	7.5 kHz
Satellite selection	Manual and Automatic
Reacquisition time	15 seconds (typical)
Rejection	15 kHz spacing > 30 dB 300 kHz spacing > 60 dB

Table B-3: L-band sensor specifications (continued)

Item	Specification
Processor	DSP for demodulation and protocol decoding module provides processing for the differential algorithms
Command support	Reports L-band region and satellite information Allows input and status of L-band subscription bit error rate (BER) output for reception quality indication and manual frequency tuning

Table B-4: Communication specifications

Item	Specification
Serial	2 full-duplex RS-232, Bluetooth, CAN
Baud rates	4800 - 115200
Data I/O protocol	NMEA 0183, NMEA 2000, Hemisphere GPS binary, Bluetooth 2.0 (Class 2)
Correction I/O protocol	Hemisphere GPS proprietary, RTCM v2.3 (DGPS), RTCM v3 (RTK), CMR, CMR+ ⁵
Timing output	1 PPS CMOS, active low, falling edge sync, 10 k Ω , 10 pF load
Event marker input	CMOS, active low, falling edge sync, 10 k Ω , 10 pF load

Table B-5: Power specifications

Item	Specification
Input voltage	7- 36 VDC with reverse polarity operation
Power consumption	< 4.6 W nominal GPS (L1/L2), GLONASS (L1/L2), and L-band
Current consumption	334 mA nominal GPS (L1/L2), GLONASS (L1/L2), and L-band
Power isolation	No
Reverse polarity protection	Yes
Antenna voltage	Internal antenna

Table B-6: 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
Shock and Vibration	Vibration: EP455 Section 5.15.1 Random Mechanical Shock: EP455 Section 5.14.1 Operational
EMC	CE (ISO 14982 Emissions and Immunity), FCC Part 15, Subpart B, CISPR 22
Enclosure	IP67

Table B-7: Mechanical specifications

Item	Specification
Dimensions	104.0 H x 145.0 D (mm) 4.09 H x 5.71 D (in)
Weight	<558 g (<19.7 oz)
Status indicators (LED)	Power, GNSS lock, and Bluetooth communication
Serial port extension	Bluetooth communication
Power/data connector	12-pin male (metal)
Antenna mounting	1-14 UNS-2A female, 5/8-11 UNC-2B adapter, and mag-mount available

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 Requires a subscription from L-band service provider

⁵ Receive only, does not transmit this format

Note: Eclipse receiver technology is not designed or modified to use the GPS Y-Code.

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