A101 Smart Antenna

User Guide

Part No. 875-0324-000 Rev B1

Hemisphere GPS®

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A101 Overview

The A101™ Smart Antenna offers an affordable, portable L1 GPS solution with professional level accuracy for agricultural, marine, survey, construction, GIS mapping, and other applications powered by Hemisphere GPS' Crescent™ receiver technology.

Note: Throughout the rest of this manual, the A101 Smart Antenna is referred to simply as the A101.

Figure 1-1: A101 smart antenna

The A101 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 and GPS. With a durable enclosure that houses both antenna and receiver, the A101 can be powered through various sources making it ideal for a variety of applications. Dual-serial, CAN, and pulse output options make this GPS receiver compatible with almost any interface. Mount the A101 on a variety of roving machines and vehicles for kinematic positioning and navigation applications.

The reliable positioning performance of Crescent is further enhanced through RTK and COAST™ DGPS technology. Patented COAST software enables select Hemisphere GPS receivers to utilize aging DGPS correction data during times of interference, signal blockage, and weak signal. The receiver will coast and continue to maintain sub-meter positioning for 40 minutes or more without a DGPS signal.

Key Features

Key features of the A101 include:

- Centimeter-level accuracy using Crescent technology in a rugged, all-in-one enclosure
- RTK baselines of up to 5 km
- Supports CAN, NMEA 0183, NMEA 2000*, binary for communication with external devices
  ** To use the A101 in a NMEA 2000 network requires NMEA certification and a NMEA2000 adapter cable*
- Wide operating voltage range of 7-32 VDC, providing high transient protection for any power source
- Integrated 2D tilt sensor enables offset corrections
- 1 PPS timing output

A101 supports a variety of 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 A101 (Table B-3 on page 20) as well other technical specifications.

Parts List

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

Table 1-1: A101 parts list

Part	Qty	Part Number
A101 Smart Antenna	1	804-0107-000
Mounting adapter (part of kit part no. 710-0111-000#) Mounting adapter, low profile *Note: Your kit will include one of the above mounting adapters, depending on your order.*	1 1	676-0016-000# 676-0024-000#
Magnetic mount *Note: Your kit may not include a magnetic mount.*	1	720-0033-00A
The following accessory items are available for purchase separately for your A101.		
Power/data cable (single DB9), 3 m	1	051-0129-002#
Power/data cable (unterminated), 4.6 m	1	051-0169-000#

Product Support

If you have questions regarding the setup, configuration, or operation of A101, contact your local dealer. For additional support information see "Technical Support" on page i (just before the Contents page).

Chapter 2: Installing the A101

Ports and Connections
Communication
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Powering the A101
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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.

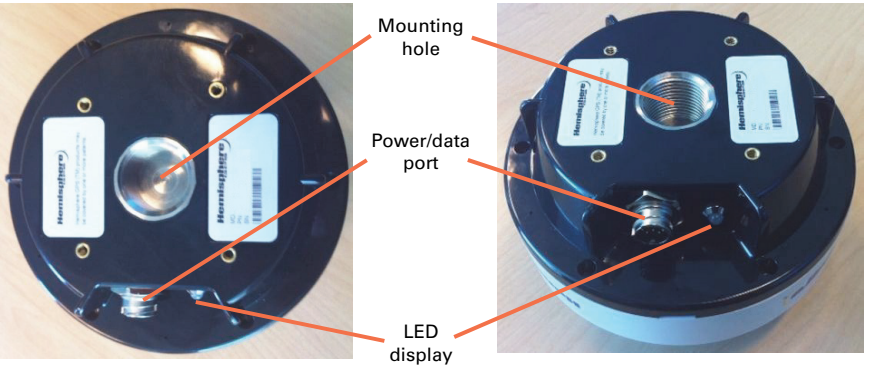

Figure 2-1: A101 ports and connectors

Table 2-1: A101 ports and connections

Port/Connection	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 A101 as well as communicate with external devices via CAN, NMEA 0183 serial, and binary

LED Display

The A101 uses a single LED (see Figure 2-1) that provides system information based on the color and pulse of the LED as follows:

- Red LED = power on
- Amber LED = GPS lock
- Green LED = DGPS position

Communication

The A101 supports radar-simulated pulse output and various NMEA 2000 messages.

Radar-Simulated Pulse Output

The radar-simulated pulse output provides accurate ground speed. The A101 uses pin 12 for the speed out pin. Pin 12 will output a square wave with a 50% duty cycle and the frequency of the square wave varies directly with speed. 94 Hz represents a speed of 1 m/sec (or 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 A101 supports a number of NMEA 2000 messages that can be transmitted on a CAN bus. Contact your Hemisphere GPS Sales Representative or Hemisphere GPS Technical Support for more information.

Note: To use the A101 in a NMEA 2000 network requires NMEA certification and a NMEA2000 adapter cable.

Mounting the A101

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 A101 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 A101 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 A101 using the magnetic mount:

1. Clean and dry the surface where you will attach the metal disc.
2. Remove the backing from one side of the foam adhesive and press the adhesive onto the mounting surface.
3. Remove the backing from the other side of the foam adhesive and press the metal disc onto the mounting surface, applying firm pressure to ensure good adhesion.
4. Place the magnetic mount on top of the metal disc.

Surface Mount

You can surface mount the A101 with four machine screws (no. 8-32).

To surface mount the A101:

1. Determine the desired location for the A101 (see “Selecting the Proper Antenna Location” on page 8).
2. Photocopy the bottom of the A101 for use as a template to plan the mounting hole locations. Use the outer four holes per your installation.

   If using a photocopy make sure it is scaled one-to-one with the mounting holes on the bottom of the A101.
3. Mark the mounting hole centers on the mounting surface.
4. Place the A101 over the marks to ensure the planned hole centers align with the true hole centers (adjusting as necessary).
5. Use a center punch to mark the hole centers.
6. Drill the mounting holes with a 9 mm bit appropriate for the surface.
7. Place the A101 over the mounting holes and insert the mounting screws through the bottom of the mounting surface into the A101.

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

Pole Mount

The center thread on the bottom of the A101 is 1″. The mounting assembly included with the A101 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 A101

Power Considerations

The A101 accepts an input voltage of 7-32 VDC. For best performance use a clean and continuous power supply. See Table B-4 on page 21 for complete power specifications.

Connecting to a Power Source

The A101 uses a single cable for power and data input/output.

Note: A power/data cable is not supplied with the A101 but is available as an accessory item. See Table 1-1 on page 3 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 A101:

- Connect the A101 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 32 VDC. This will damage the receiver and void the warranty.

The A101 features reverse polarity protection to prevent excessive damage if the power leads are accidentally reversed. With the application of power, the A101 automatically proceeds through an internal startup sequence; however, it is ready to communicate immediately.

Connecting to External Devices

Figure 2-2 shows the 12-pin power/data port pinout and Table 2-2 provides the pinout specifications.

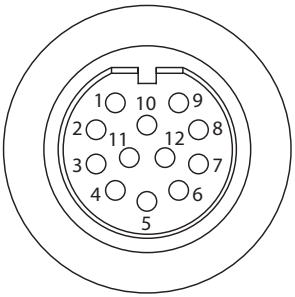

Figure 2-2: Power/data port pin-out assignment

Table 2-2: 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 A101 serial ports (Port A and Port B) must be set to match that of the devices to which they are connected.

Default Parameters

Table 2-3 lists the default A101 configuration.

Table 2-3: Default parameters

Setting	Description
DGPS	Application 1: Rover Application 2: Base
Serial ports A and B	Baud rate: 4800, 9600, 19200, 38400, 57600, 115200 (default is 19200) Data bits: 8 Parity: None Stop bit: 1 Interface level: RS-232
GPS messages	Type: Hemisphere GPS binary, NMEA 0183, NMEA 2000 Update rate: 1 Hz to 20 Hz Elevation mask: 5°

Configuring the A101

You can configure the A101 through the serial ports using Hemisphere GPS commands. For more information on the tilt commands below as well as other Hemisphere GPS commands refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com and click the GPS Reference icon).

For example, you can:

- Select one of the two on-board applications:
  $JAPP,other or
  $JAPP,app
- Select the baud rate:
  $JBAUD,r
- Configure the setup and output of tilt commands as follows (note that all commands are preceded with $JRELAY,PORTC, to direct them through internal Port C):
  - $JRELAY,PORTC,$JTILT,CALIBRATE[,RESET]
    Output the tilt offset values for the X and Y axes. If performing a reset, ensure the A101 is on a flat surface.
  - $JRELAY,PORTC,$JTILT,TAU[,value]
    Output the filter constant for tilt value smoothing.
  - $JRELAY,PORTC,$JTILT,COMPENSATION[,[ON|OFF],[height offset]]
    Turn positioning tilt compensation on/off (currently only the GPGGA data log is supported for tilt compensated position output).
  - $JRELAY,PORTC,$JASC,GPGGA,rate[,port]
    Turn tilt compensated GPGGA message on.
  - $JRELAY,PORTC,$JTILT,COGBIAS[,value]
    Set a COG bias to be used in the tilt compensation algorithms (for use when the A101 is not mounted with the connector facing the forward direction of travel).
  - $JRELAY,PORTC,$JASC,INTLT,rate[,port] or
    $JRELAY,PORTC,$JASC,PSAT,INTLT,rate[,port]
    Log tilt information from the A101
- Set/query the receiver mode—serial or NMEA2000 (commands must be sent over Port A):
  - $JRELAY,PORTC,$JQUERYMODE
    Query the receiver for the current mode
  - $JRELAY,PORTC,$JSERIALMODE
    Set the receiver mode to serial
  - $JRELAY,PORTC,$JN2KMODE
    Set the receiver mode to NMEA2000

Note: Use the $JSAVE command to save changes you make to the A101's configuration for the changes to be present in subsequent power cycles.

Chapter 3: GPS Overview

GPS Operation

Differential Operation

This chapter describes the various modes of operation and features of your A101 and internal sensors.

For your convenience, both the GPS and differential correction of the A101 are pre-configured. The receiver will work out of the box, and for most applications, little user setup is necessary. When powered for the first time, the A101 will perform a 'cold start' that 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 A101's internal GPS receiver.

Automatic Tracking

The A101'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 A101 works by finding four or more GPS satellites in the visible sky uses information from the satellites to compute a position within 2.5 m. Since there is some error in the GPS data calculations, the A101 also tracks a differential correction. The A101 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 A101 is properly positioned, the satellites transmit coded information to the antenna on a specific frequency. This allows the receiver to calculate a range to each satellite. 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 A101 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 A101 is able to use differential corrections received through the internal SBAS demodulator or through externally-supplied RTCM corrections (potentially from an external beacon receiver).

Automatic SBAS Tracking

The A101 automatically scans and tracks SBAS signals without the need to tune the receiver. The A101 features three-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

Table A-1 provides a list of issues with possible solutions to help you troubleshoot anomalous A101 operation. Refer to Appendix B, “Technical Specifications” if necessary.

Table A-1: Troubleshooting

Issue	Possible Solution
Receiver fails to power	• 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 - 32 VDC) • Check current restrictions imposed by power source (maximum is 350 mA)
No data from the A101 • (1) No communication • (2) No valid data	• (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 the baud rate settings match
Random binary data from A101	• 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	• 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	• Check antenna cable integrity • 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 antenna (SBAS) • Set the satellite selection to automatic mode $JFREQ,AUTO • Set the differential mode to $JDIFF,WAAS • Ensure there is SBAS coverage in your area

Table A-1: Troubleshooting (*continued)*

Issue	Possible Solution
No DGPS position in external RTCM mode	• 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	• 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-6 provide the GPS sensor, horizontal accuracy, L-band sensor, communication, power, environmental, and mechanical specifications for the A101.

Table B-1: GPS sensor specifications

Item	Specification
Receiver type	L1 GPS
Channels	12 L1CA GPS 12 L1P GPS 3 SBAS or 3 additional L1CA GPS
GPS sensitivity	-142 dBm
SBAS tracking	3-channel, parallel tracking
Update rate	10 Hz standard, 20 Hz optional (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[1,2]	10 mm+1 ppm	20 mm+2 ppm
SBAS (WAAS)[1]	0.3 m	0.6 m
Autonomous, no SA[1]	1.2 m	2.5 m

Table B-3: Communication specifications

Item	Specification
Serial	2 full-duplex RS-232, CAN
Baud rates	4800 - 115200
Data I/O protocol	NMEA 0183, NMEA 2000*, Hemisphere GPS binary **To use the A101 in a NMEA 2000 network requires NMEA certification and a NMEA2000 adapter cable*
Correction I/O protocol	Hemisphere GPS proprietary, RTCM v2.3 (DGPS), RTCM v3 (RTK), CMR (RTK), CMR+ (RTK)[3]
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

Table B-4: Power specifications

Item	Specification
Input voltage	7- 32 VDC with reverse polarity operation
Power consumption	< 3 W @ 12 VDC typical
Current consumption	134 mA @ 12 VDC typical
Power isolation	No
Reverse polarity protection	Yes
Antenna voltage	Internal antenna

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

Table B-6: 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, GPS lock
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] Depends on multipath 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

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Hemisphere GNSS
8444 N. 90th Street, Suite 120
Scottsdale, AZ 85258
Phone: 480-348-9919 Fax: 480-348-6370
techsupport@hemispheregps.com

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