# V101 and V111 GPS Compass

## User Guide

Part No. 875-0250-000 Rev B1

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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The Outback S™ and S-Lite™ automated navigation and steering guide systems are covered by U.S. Patents No. 6,539,303 and No. 6,711,501. The Outback Hitch™ automated hitch control system is covered by U.S. Patent No. 6,631,916. The Outback eDriveTC™ GPS assisted steering system is covered by U.S. Patent No. 7,142,956. Hemisphere GPS products may be covered by one or more of the following U.S. Patents:

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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.

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Hemisphere GPS
4110 9th Street S.E.
Calgary, Alberta, Canada T2G 3C4
Phone: 403-259-3311
Fax: 403-259-8866
precision@hemispheregps.com
www.hemispheregps.com

## Technical Support

If you need to contact Hemisphere GPS Technical Support:

8444 N 90th St, Suite 130
Scottsdale, AZ 85258 USA
Phone: (480) 348-9919
Fax: (480) 348-6370
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# Overview

The V101™ GPS Compass and V111™ GPS Compass are based on Hemisphere GPS' exclusive Crescent® and Crescent Vector™ II technology.

**Note:** When referring to both the V101 GPS Compass and the V111 GPS Compass this manual uses the term V101/111. When referring to either product this manual uses either V101 or V111, respectively.

The V101/111 is a complete GPS compass and positioning system in a single enclosure that requires only one power/data cable connection. The V101/111 is designed primarily for the marine market; however, it is also suitable for such markets as machine control and agriculture guidance. This user guide addresses the primary use of the V101/111 in the marine industry; however, the information provided is broad enough to satisfy the needs of V101/111 use in other markets.

The V101/111 is an integrated system that houses the following:

- Crescent Vector II OEM board
- Dual GPS antennas
- DGPS beacon module and H-field beacon antenna (V111 only)
- Power supply
- Single axis gyro
- Tilt sensor

The gyro and tilt sensor are present to improve system performance and to provide backup heading information in the event that a GPS heading is not available due to signal blockage.

**Note:** The V101 GPS Compass is identical to the V111 GPS Compass with the exception that it does not contain a DGPS beacon module. If you purchased the V101 GPS Compass, disregard the sections of this manual that discuss the beacon signal, receiver operation, and implications to installation relating to the beacon signal.

Crescent technology supports multiple RF front ends - enabling tighter coupling of measurements from separate antennas for use in heading-based products. Users will achieve excellent accuracy and stability due to Crescent's more accurate code phase measurements, improved multipath mitigation, and fewer components.

The V101/111's GPS antennas are separated by 0.5 m between their phase centers, resulting in better than 0.30° rms heading performance. The V101/111 provides heading and positioning updates of up to 20 Hz and delivers positioning accuracy of better than 0.6 m 95% of the time when using Differential GPS corrections from Space Based Augmentation Systems (SBAS) or its optional internal SBX beacon demodulator.

The V101/111 also features Hemisphere GPS' exclusive COAST™ technology that enables Hemisphere GPS receivers to utilize old differential GPS correction data for up to 40 minutes without significantly affecting the positioning quality. The V101/111 is less likely to be affected by differential signal outages due to signal blockages, weak signals, or interference when using COAST.

If you are new to GPS and SBAS, refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon) for further information on these services and technologies before proceeding.

# Parts List

**Note:** The V101/111's parts comply with IEC 60945's section 4.4: "exposed to the weather."

**Table 1-1: Parts list**

| Part Name | Qty | Part Number |
|---|---|---|
| Crescent receiver model<br>(one of the following models) | | |
| V101<br>V111 | 1<br>1 | 804-0067-000#<br>804-0066-000# |
| Base mount | 1 | 627-1106-000# |
| Pole mount | 1 | 627-1109-000# |
| Mounting hardware | | |
| Washer, flat, 2"OD, 1.062"ID, .16"thk, SS<br>Nut, hex, 1-14 UNF SS<br>Screw, 8-16 1/2" TPHC SS<br>Bit Torx, T-20 1/4 1 hex shk | 1<br>1<br>8<br>1 | 678-1083-000#<br>676-1021-000#<br>675-1078-000#<br>675-0037-000# |
| Power/data cable<br>(purchased separately) | | |
| 15 m<br>30 m | 1<br>1 | 051-0157-000#<br>051-0158-000# |

# Chapter 2: Installation

Mounting Location
Mounting Orientation
Mounting Options
Powering the V101/111
Connecting the V101/111 to External Devices
Default Parameters

# Mounting Location

When considering mounting locations, consider both GPS (and hence SBAS) and beacon reception. The following two sections provide information to help determine the best location for the V101/111.

## GPS Reception

When considering various locations to mount the V101/111, consider the following GPS reception recommendations closely.

- The V101/111 computes a position based upon the internal primary GPS antenna element. Mount the V101/111 in the location for which you desire a position with respect to the primary GPS antenna (located on the end opposite the recessed arrow on the underside of the enclosure).
- Ensure there is a clear view of the sky available to the V101/111 so the GPS and SBAS satellites are not masked by obstructions, which may reduce system performance.
- Locate any transmitting antennas away from the V101/111 by at least a few feet to ensure tracking performance is not compromised, giving you the best performance possible.
- Make sure that there is enough cable length to route into the vessel, in order to reach a breakout box or terminal strip.
- Do not locate the antenna where environmental conditions exceed those specified in Table B-6 on page 45.

## Beacon Reception

When using the V111's internal beacon receiver as the correction source, consider the possible mounting locations from the perspective of ambient noise within the beacon band. The following list provides guidelines for deciding upon a location with respect to maximizing beacon performance.

- Ensure that the antenna is as far as possible from all other equipment that emits electromagnetic interference (EMI), including DC motors, alternators, solenoids, radios, power cables, display units, and other electronic devices.
- If you are installing the antenna on a vessel, mount the V111 as high as possible, considering maintenance and accessibility. In addition, ensure that the antenna is higher than the highest metal object on the vessel.
- If a radar system is present, mount the antenna outside the path of the radar beam.

The V111's internal beacon receiver calculates a signal-to-noise ratio (SNR), measured in decibels (dB), that indicates the receiver's performance. The SNR is the height of the signal above the noise floor: the higher the SNR, the better your beacon receiver demodulates the signal. The optimum antenna location will be a position where your average SNR is highest. You should turn on all accessories that you intend to use during normal operation when locating the best position for the antenna. By monitoring the SNR, you can determine the optimum location with respect to beacon reception. The SNR is available in the $CRMSS NMEA message described in the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon).

### Environmental Considerations

The V101/111 is designed to withstand harsh environmental conditions; however, adhere to the following limits when storing and using the V101/111:

- Operating temperature: -30°C to +70°C (-22°F to +158°F)
- Storage temperature: -40°C to +85°C (-40°F to +185°F)
- Humidity: 95% non-condensing

## Mounting Orientation

The V101/111 outputs heading, pitch, and roll readings regardless of the orientation of the antennas. However, the relation of the antennas to the boat's axis determines whether you will need to enter a heading, pitch, or roll bias. The primary antenna is used for positioning and the primary and secondary antennas, working in conjunction, output heading, pitch, and roll values.

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**Note:** Regardless of which mounting orientation you use, the V101/111 provides the ability to output the heave of the vessel. This output is available via the $GPHEV message. For more information on this message refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon).

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***Parallel Orientation:*** The most common installation is to orient the V101/111 parallel to, and along the centerline of, the axis of the boat. This provides a true heading. In this orientation:

- If you use a gyrocompass, you can enter a heading bias in the V101/111 to calibrate the physical heading to the true heading of the vessel.
- You may need to adjust the pitch/roll output to calibrate the measurement if the Vector is not installed in a horizontal plane.

***Perpendicular Orientation:*** You can also install the antennas so they are oriented perpendicular to the centerline of the boat's axis. In this orientation:

- You will need to enter a heading bias of +90° if the primary antenna is on the starboard side of the boat and -90° if the primary antenna is on the port side of the boat.
- You will need to configure the receiver to specify the GPS antennas are measuring the roll axis using $JATT,ROLL,YES.
- You will need to enter a roll bias to properly output the pitch and roll values.
- You may need to adjust the pitch/roll output to calibrate the measurement if the Vector is not installed in a horizontal plane.

See Figure 2-1 and Figure 2-2 for mounting orientation examples.

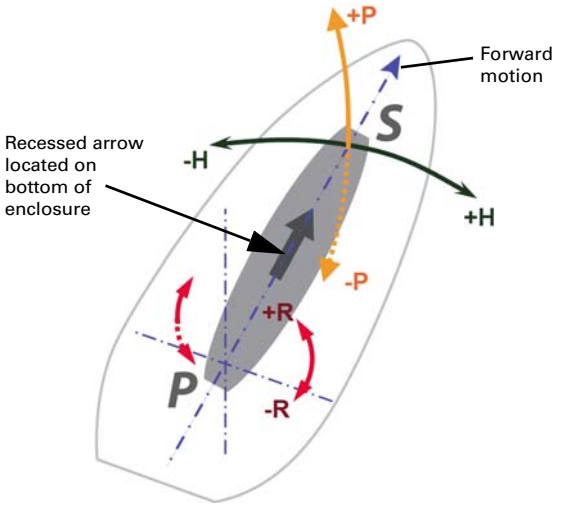


**Figure 2-1: Recommended orientation and resulting signs of HPR values**

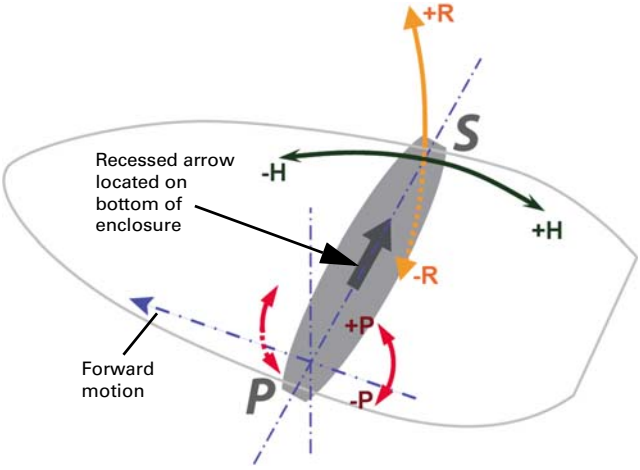


**Figure 2-2: Alternate orientation and resulting signs of HPR values**

## V101/111 Alignment

The top of the V101/111 enclosure incorporates a pair of sight design features to help you align the enclosure with respect to an important feature on your vessel (see Figure 2-3 and Figure 2-4).

To use the sights, center the small post on the opposite side of the enclosure from you, within the channel made in the medallion located in the center of the enclosure top as shown in the two following figures. Alignment accuracy when looking through the long site is approximately +/- 1°. Using the short site alignment is approximately accurate to +/- 2.5°.

**Figure 2-3: Lining up the alignment sight**

**Figure 2-4: Correctly lined-up alignment sight**

If you have another accurate source of heading data on your vessel, such as a gyrocompass, you may use its data to correct for a bias in V101/111 alignment within the V101/111 software configuration. Alternatively, you can physically adjust the heading of the V101/111 so that it renders the correct heading measurement; however, adding a software offset is an easier process.

# Mounting Options

The V101/111 allows for two different mounting options:

- Fixed-base mounting
- Pole-and-rail mounting

## Fixed-Base Mounting

The fixed base supplied with the V101/111 is intended to allow you to mount the system to a flat surface. This surface may be something that you fabricate for the sake of the installation or may be something that already exists on your vessel or an off-the-shelf item, such as a radar mounting plate.

Figure 2-5 below and Figure 2-6 on page 11 show the following features for the fixed base:

- Six holes for mounting onto the V101/111 enclosure
- Four slots used for fastening the mounted enclosure to the vessel
- Four tunnels that allow you to route the cable outside the base and along the mounting surface
- Two small keys that aid the alignment of the base to the enclosure
- Channel through the mount for the power/data cable

The slots on the bottom of the base allow for a degree of adjustment when the V101/111 is secured in its final location.

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**Note**: You do not necessarily need to orient the antenna precisely as you can enter a software offset to accommodate for any bias in heading measurement due to installation.

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The base has four tunnels that allow you to bring the power/data cable out from within the mount in order to route it along the surface of the plate beneath the V101/111. Alternatively, you may wish to route the power/data cable through the mounting surface rather than bringing it out through one of the tunnels (see Figure 2-5).

**Figure 2-5: Fixed mount base**

Figure 2-6 provides a bottom view of the fixed mount base.

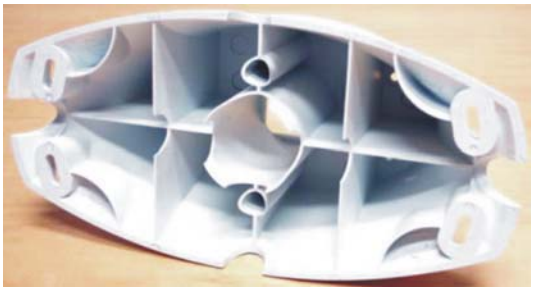

**Figure 2-6: Bottom view of fixed mount base**

Before mounting the antenna on the fixed base:

- Determine your mounting orientation. See “Mounting Orientation” on page 7 for more information.
- Choose a location that meets the mounting location requirements.
- Using the fixed base as a template, mark and drill the mounting holes as necessary for the mounting surface.

To install the V101/111 using the fixed base:

1. Insert either end of the power/data cable through the center of the fixed base.

**Figure 2-7: Running cable through fixed base mount**

**Figure 2-8: Running cable through fixed base**

2. Align the connector keyway of the cable to the key of the connector mounted on the V101/111 enclosure (see Figure 2-9) and insert the cable mount connector into the bulkhead connector, aligning the locking ring at the same time.

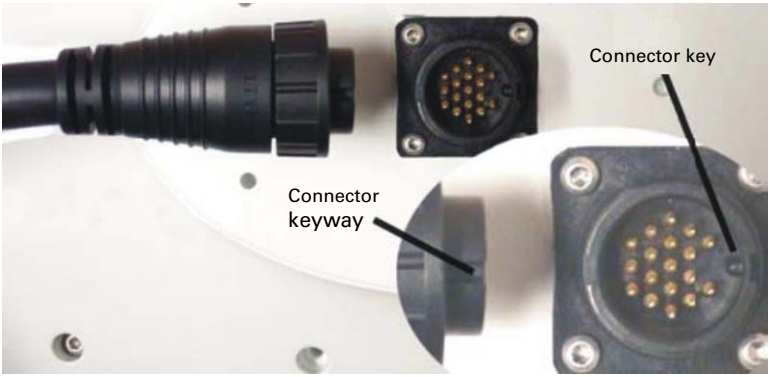


**Figure 2-9: Power/data cable and keyway**

3. Rotate the ring clockwise until it locks. The locking action is firm, but you will feel a positive “click” when it has locked.

**Figure 2-10: Connecting the power/data connector to V101/111**

4. Once you have secured the connector, slide the fixed base up to the bottom of the V101/111 enclosure. There are two alignment keys on top of the base that just fit into two holes of the V101/111 enclosure.
5. Once you have aligned the base, use a screwdriver fitted with the supplied Torx T20 bit to fasten the base to the enclosure using the supplied screws. These screws self tap a thread in the blind screw holes of the enclosure. Fasten the screws firmly, but be careful not to strip the thread.

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**Note:** The base is not intended to be removed and refastened frequently. Frequent removal of the base from the enclosure may result in failure of the screw hole threads. Stripped threads are not covered under the product warranty.

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Figure 2-11 and Figure 2-12 show the location of the screw holes.

**Figure 2-11: Fastening the fixed base to the V101/111**

**Figure 2-12: Fastening the fixed base to the V101/111**

6. Once you fasten the fixed base to the V101/111 enclosure using six mounting screws, fasten the assembly to your mounting surface. It is recommended to use machine screws that have an hexagonal Allen key head and an "L-shaped" Allen key, as there may not be sufficient clearance between the bottom of the antenna and your mounting surface to use a normal screwdriver.

**Note:** Hemisphere GPS does not supply the mounting surface hardware. You will need to supply the appropriate fastening hardware required to complete the installation of the V101/111 and mount assembly.

## Pole and Rail Mount

**Note:** This pole and rail mount does not meet the IEC 60945, section 8.7 for vibration.

You may choose to pole-mount or rail-mount the V101/111 as opposed to the fixed base mounting approach. The pole mount incorporates a 1-14-UNS thread. To aid in the installation of the V101/111, we have supplied a hex jam nut and washer that are used to secure the antenna in a particular direction without bottoming out the system on the threaded pole. Additionally, the nut and washer distributes forces associated with vibration onto the bottom surface of the V101/111 pole mount.

**⚠WARNING:** Do not bottom out the V101/111 pole base on the threaded mount. Such manner can damage the system. Use of the jam nut and washer are mandatory for pole mounting. Any damage resulting from not using these pieces to mount the V101/111 is not covered under warranty.

**Before mounting the antenna or the pole mount bracket:**

- Decide if you need the roll measurement. If you need roll measurement, the V101/111 will need to be installed perpendicular to the vessel axis. If it you do not need roll measurement, install the V101/111 parallel with the vessel's axis.

- Choose a location that meets the mounting location requirements.
- Mark and drill the mounting holes as necessary for the threaded pole.
- Alternatively, you may rail mount the V101/111 with appropriate hardware.

**Pole mount installation and preparation:**

You must supply the pole or rail mount hardware. To install the pole mount:

1. After you install the pole or rail mount, thread the hexagonal jam nut onto the mount, followed by the stainless steel washer (both are supplied with the V101/111).
2. Thread the nut onto the nut approximately eight to ten full turns to provide adequate mounting thread for the pole mount base.

**Figure 2-13: Threading on the lock nut and washer**

**Routing the cable:**

1. When mounting the V101/111 using the pole mount, you first must run the cable through the center of the pole mount base from top to bottom, through the pole, and then through any bulkheads as needed. The power/data connector is too large to fit through the threaded portion of the pole mount base (see Figure 2-14 below through Figure 2-17 on page 16).

**Note:** Leave some slack to move the cable in and out of the pole mount by several centimeters to allow you to connect the cable to the V101/111 easily.

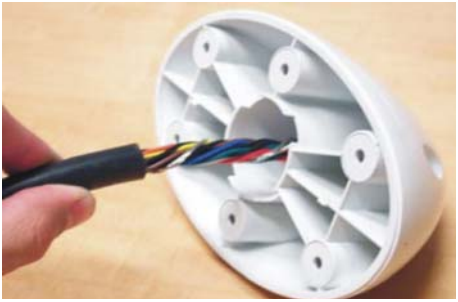

**Figure 2-14: Running cable through the pole base**

**Figure 2-15: Running cable through the pole base**

**Figure 2-16: Running cable through the mounting pole**

After you route the cable correctly through the pole mount base and the mounting pole, the mounting assembly should look like Figure 2-17.

**Figure 2-17: Completed cable run**

**Mounting to pole mount thread:**

1. Thread the pole mount base onto the pole mount four to five full turns.

**Figure 2-18: Threading the pole base onto the mount**

2. Ensure that there is a gap between the lock nut, washer, and pole mount base to allow you to orient the combination of the V101/111 and pole mount base to the vessel.

**Figure 2-19: Pole base threaded onto mount**

**To connect the cable to the V101/111:**

1. Fasten the cable to the V101/111 connector. The connector on the receiver enclosure has a key and the cable-mount connector has a keyway. The key and keyway need to align as you insert the cable-mount connector into the bulkhead connector.

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**Note:** The locking ring on the cable-mount connector may need to be aligned as it is inserted into the bulkhead connector to ensure that it seats properly.

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2. Once the cable-mount connector is fully seated, rotate the locking ring clockwise until it locks once the cable-mount connector is seated fully. You will feel the ring “click” when it is locked (see Figure 2-20 and Figure 2-21).

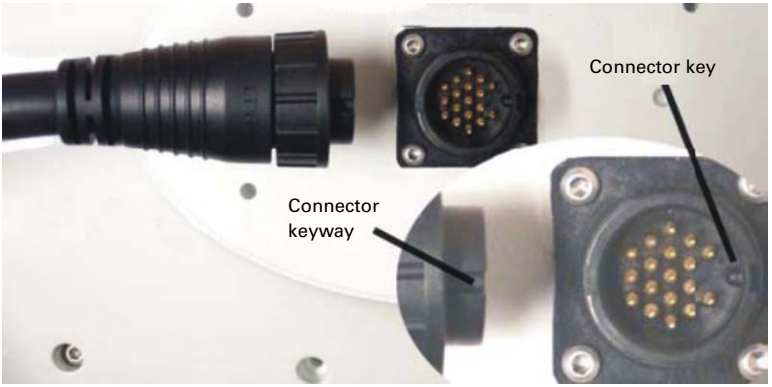


**Figure 2-20: Power/data cable key and keyway**

**Figure 2-21: Connected power/data cable**

**Fastening the V101/111 to the pole mount base with the supplied self-taping screws:**

1. Fasten the V101/111 enclosure to the pole mount base using the supplied self-tapping screws.
2. Align the two alignment keys on top of the base to the two holes on the V101/111 enclosure.
3. Use a screwdriver fitted with the supplied Torx T20 bit to fasten the base to the enclosure using the supplied screws. These screws self tap a thread in the blind screw holes of the enclosure. Fasten the screws firmly, but be careful not to strip the thread (see Figure 2-22 on page 19).

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**Note:** The base is not intended to be removed and refastened frequently. Frequent removal of the base from the enclosure may result in failure of the screw hole threads. Stripped threads are not covered under the product warranty.

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**Figure 2-22: Fastening the pole base to the V101/111**

4. Rotate the hex nut and washer up to the bottom of the pole mount base surface. Do not tighten them at this point; you will first align the V101/111.

**Figure 2-23: Threading the lock nut against the pole base**

5. Orient the V101/111 using the sights on the top of the enclosure.
6. Use an adjustable wrench to tighten the lock nut against the V101/111 while ensuring accurate alignment of the antenna system.

**Figure 2-24: Locking the V101/111 once aligned**

**Note:** Make sure the locking nut is tightly secured to the pole mount base, but not overtightened. Periodically verify the antenna system is securely tightened, as mounted on the pole. If it is loose, tighten the lock nut further until you cannot move it.

**Routing and securing the power/data cable**

A 15 m or 30 m power/data cable (purchased separately) is available for the V101/111. Consider the following when routing the cable:

- Do not run cable in areas of excessive heat
- Do not expose cable to corrosive chemicals
- Do not crimp or excessively bend cable
- Do not place tension on cable
- Coil up excess cable near unit
- Secure along the cable route using plastic tie wraps as necessary
- Do not run cable near high Voltage or strong RF noise and transmitter sources

**WARNING:** Improperly installed cables near machinery can be dangerous.

# Powering the V101/111

## Power Considerations

For best performance use a clean and continuous power supply. The V101/111 power supply features reverse polarity protection but will not operate with reverse polarity.

See Table B-4 on page 45 for complete power specifications.

## Connecting to a Power Source

Before you power up the V101/111 you must terminate the wires of the power cable as required. There are a variety of power connectors and terminals on the market from which to choose, depending on your specific requirements.

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

To interface the V101/111 power cable to the power source:

- Connect the red wire of the cable's power input to DC positive (+)
- Connect the black wire of the cable's power input to DC negative (-)

The V101/111 will start when an acceptable voltage is applied to the power leads of the extension cable.

## Electrical Isolation

The V101/111's power supply is isolated from the communication lines. Further, the PC-ABS plastic enclosure isolates the electronics mechanically from the vessel. This addresses the issue of vessel hull electrolysis.

# Connecting the V101/111 to External Devices

## Interfacing the V101/111

The V101/111 uses a single cable for application of power and to facilitate the input and output operations. The cable (purchased separately) is 15 m in length and is terminated on the receiver end with an environmentally sealed 18-pin connection. The opposite end is unterminated and requires field stripping and tinning.

Depending on the application and installation needs, you may need to shorten this cable. However, if you require a longer cable run than 15 m, you may purchase a 30 m cable through your equipment dealer, or alternatively, bring the cable into a break-out box that incorporates terminal strips, within the vessel. To lengthen the serial lines inside the vessel, ensure that you use 20-gauge twisted pairs and minimize the additional wire length. The RS-422 signal should be used for longer cable runs as compared to the RS-232 ports, as it is more resistant to noise and attenuation.

When lengthening the power input leads to the V101/111, ensure the additional voltage drop is small enough that your power system can continue to power the system above the minimum voltage of the system. Wire of 18-gauge or larger should be used.

## Power/Data Cable Schematic, Wiring, and Pinout

Figure 2-25 shows the schematic of the power/data cable (15 m or 30 m).

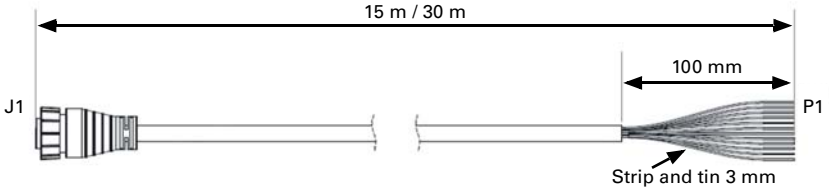


**Figure 2-25: Power/data cable (15 m or 30 m)**

Table 2-1 provides the wiring specifications of the power/data cable (15 m or 30 m).

**Table 2-1: Power/data cable (15 m or 30 m) wiring specifications**

| Pair | Color code | AWG | J1 | Function |
|---|---|---|---|---|
| | Bare | | 10 | RF SHIELDED DRAIN |
| 1 | BLK<br>RED | 18<br>18 | 2<br>1 | Power GRND<br>Power input |
| 2 | BLK with BLU stripe<br>BLU | 24<br>24 | 4<br>3 | RS-232, port A RX<br>RS-232, port A TX |
| 3 | GRY | 24 | 12 | Sig GRND |
| 4 | BLK with GRN stripe<br>GRN | 24<br>24 | 11<br>6 | RS-422-, port A<br>RS-422+, port A |
| 5 | BLK with BRN stripe<br>BRN | 24<br>24 | 8<br>7 | RS-232, port B RX<br>RS-232, port B TX |
| 6 | YEL with BLK stripe<br>YEL | 24<br>24 | 15<br>16 | RS-422-, port B<br>RS-422+, port B |

**Table 2-1: Power/data cable (15 m or 30 m) wiring specifications (*continued)***

| Pair | Color code | AWG | J1 | Function |
|---|---|---|---|---|
| 7 | WHT with RED stripe<br>WHT | 24<br>24 | 14<br>13 | Alarm<br>Alarm |
| **Note:** PPS is supported on pins 17 and 18 on the V101/111, but not connected in the standard cables. | | | | |

Figure 2-26 shows the pinout of J1 of the power/data cable (15 m or 30 m).

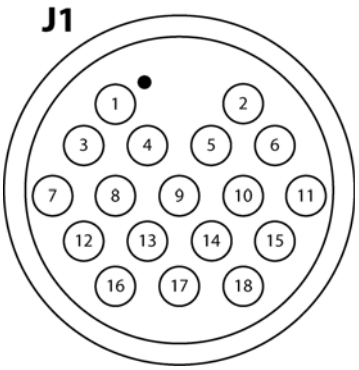


**Figure 2-26: Power/data cable (15 m or 30 m) J1 pinout**

Table 2-2 provides signal, wire color, and wire gauge specifications of J1 of the power/data cable (15 m or 30 m).

**Table 2-2: Power/data cable (15 m or 30 m) J1 pinout specifications**

| Pin Number | Signal Name | Wire Color | Wire Gauge |
|---|---|---|---|
| 1 | Power input + | RED | 18 AWG |
| 2 | Power input - | BLK | 18 AWG |
| 3 | Port A TX RS-232 | BLU | 24 AWG |
| 4 | Port A RX RS-232 | BLK with BLU stripe | 24 AWG |
| 5 | Not connected | | |
| 6 | Port A RS-422 + | GRN | 24 AWG |
| 7 | Port B TX RS-232 | BRN | 24 AWG |
| 8 | Port B RX RS-232 | BLK with BRN stripe | 24 AWG |
| 9 | Not connected | | |
| 10 | RF shield drain | Bare | 24 AWG |
| 11 | Port A RS-422 - | BLK with GRN stripe | 24 AWG |
| 12 | Signal ground | GRY | 24 AWG |
| 13 | Alarm 1 | WHT | 24 AWG |
| 14 | Alarm 2 | WHT with RED stripe | 24 AWG |

**Table 2-2: Power/data cable (15 m or 30 m) J1 pinout specifications (*continued)***

| Pin Number | Signal Name | Wire Color | Wire Gauge |
|---|---|---|---|
| 15 | Port B RS-422+ | YLW with BLK stripe | 24 AWG |
| 16 | Port B RS-422- | YLW | 24 AWG |
| 17 | 1PPS + | | |
| 18 | 1PPS - | | |

## Serial Ports

The V101/111 offers position and heading data via both RS-232 and RS-422 level serial ports. The answer of which serial port level to use resides with the serial port level(s) supported by the other electronics involved. You may find that the other electronics need either serial port level or a mixture of both.

The following bullets describe the two serial port levels supported by the V101/111.

- **RS-232 Interface Level** - The V101/111 features two full-duplex (bi-directional) RS-232 serial ports. In addition to outputting data, these ports are used for firmware upgrades.

  Data output from both RS-232 Ports A and B are also output on the RS-422 ports.

- **RS-422 Interface Level** - The RS-422 standard allows for one device to communicate with many other devices simultaneously; therefore, the RS-422 ports are only talkers. These ports are in accordance with international marine standard IEC 61162. See Annex C of the standard for a description.

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**Note:** The V111 has maximum baud rate of 38400. Higher baud rates will impair beacon signal tracking.

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### Serial Port Configuration

You may configure Port A or Port B of the GPS receiver to output any combination of data that you wish. Port A can have a different configuration from Port B in terms of data message output, data rates, and the baud rate of the port. This allows you to configure the ports independently, based upon your needs. For example, if you want one generalized port and one heading-only port, you can configure Port A to have GPGGA, GPVTG, GPGSV, GPZDA, and GPHDT all output at 1 Hz over a 9600 baud rate. You can also configure Port B for GPHDT and GPROT message output at their maximum rate of 20 Hz over a 19200 baud rate.

The messages you configure each port to output and the rate of the port will be the same for both RS-232 and RS-422 interface levels. For example, the RS-232 Port A and RS-422 Port A output the same data messages at the same baud rate. If the baud rate or messages for the RS-422 port need to be changed, this needs to be commanded through the RS-232 port.

Both RS-232 and RS-422 output signals may be used simultaneously.

### 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 34 for an example of this calculation. For information on message output rates refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon).

### Interfacing to a PC

A personal computer (PC) typically uses a DB9-male connector for RS-232 serial port communications. To terminate either port for connection to a PC serial port, connect the wires to a DB9 female connector according to Table 2-3.

**Table 2-3: Port A and Port B DB9 RS-232 interface configuration**

| Port A | | |
|---|---|---|
| **Pin** | **Wire Color** | **Signal** |
| 2 | Blue | Port A transmit RS-232 |
| 3 | Black/blue striped | Port A receive RS-232 |
| 5 | Gray | Signal ground |

| Port B | | |
|---|---|---|
| **Pin** | **Wire Color** | **Signal** |
| 2 | Brown | Port B transmit RS-232 |
| 3 | Black/brown striped | Port B receive RS-232 |
| 4 | Gray | Signal ground |

Figure 2-27 displays the numbering scheme for a DB9 socket connector (female). The associated numbering for the plug connector (male) on a PC is a mirror reflection of scheme shown in this figure.

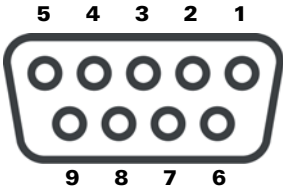


**Figure 2-27: DB9 female socket numbering**

**Note:** For successful communications, the baud rate of the V101/111’s serial ports must be set to match that of the devices to which they are connected.

When interfacing to other devices, ensure the transmit data output from the V101/111 is connected to the data input of the other device. The signal grounds must also be connected.

Since RS-422 is a balanced signal with positive and negative signals referenced to ground, ensure you maintain the correct polarity. For example, when connecting the

transmit data output positive signal to the receive line of the other device, it should be connected to the receive positive terminal. The negative transmit data signal from the V101/111 is then connected to the receive data negative input of the other device.

There is likely little reason to connect the receive data input of the V101/111 to another device unless it is able to send configuration commands to the V101/111. Since the V101/111 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.

# Default Parameters

Table 2-4 through Table 2-8 on page 26 provide details on the default port settings, available baud rates, differential age, elevation mask, default differential mode, and beacon receiver settings.

**Note:** Use the $JSAVE command to save changes you make to the V101/111's configuration for the changes to be present in subsequent power cycles.

**Table 2-4: Default port settings**

| Port | Baud Rate | NMEA Messages | Default Update Rate | Wires |
|---|---|---|---|---|
| Port A (RS-232) | 19200 | GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT | 1 Hz | BLU<br>BLK with BLU |
| Port B (RS-232) | 19200 | GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT | 1 Hz | BRN<br>BLK with BRN |
| Port A (RS-422) output only | 19200 | GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT | 1 Hz | GRN<br>BLK with GRN |
| Port B (RS-422) output only | 19200 | GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT | 1 Hz | YLW<br>BLK with YLW |
| Power | 9 - 36 VDC | | | RED (+)<br>BLK (-) |
| **Note:** The default update rate for NMEA 0183 messages is 1 Hz. 10 Hz is the standard maximum rate, but you can purchase a subscription to upgrade the output rate to 20 Hz. | | | | |

**Table 2-5: Available baud rates**

| Baud Rates |
|---|
| 4800 |
| 9600 |
| 19200 |
| 38400 |
| 57600 |

**Table 2-5: Available baud rates**

| Baud Rates |
|---|
| 115200 |

**Table 2-6: Correction age and elevation mask defaults**

| Max DGPS Age | Elevation Mask |
|---|---|
| 2700 seconds | 5° |

**Table 2-7: Default differential mode**

| V101 Differential Mode | V111 Differential Mode |
|---|---|
| SBAS (WAAS/EGNOS) | Beacon |

The internal beacon module operates in full automatic mode by default as shown in Table 2-8.

**Table 2-8: Frequency selection**

| Frequency Selection | MSK Rate Selection |
|---|---|
| Automatic | Automatic |

# Chapter 3: Operation

GPS Overview
V101/111 Overview
Alarm Functionality
Common Commands and Messages

# GPS Overview

For your convenience, both the GPS and SBAS operation of the V101/111 features automatic operational algorithms. When powered for the first time, the V101/111 performs a "cold start," which 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 mode of operation. The following sections describe the general operation of the V101/111's internal GPS receiver.

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**Note:** Differential source and status have no impact on heading, pitch, or roll. They only have an impact on positioning and heave.

---

### Automatic Tracking

The V101/111'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 V101/111 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 V101/111 also tracks a differential correction. The V101/111 uses these corrections to improve its position accuracy to better than 0.6 m.

There are two main aspects of GPS receiver performance:

- Satellite acquisition
- Positioning and heading calculation

When the V101/111 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.

## 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 V101/111 will result in positioning accuracies of 2.5 m 95% of the time. In order to improve positioning quality to sub-meter levels, the V101/111 is able to use differential

corrections received through the internal SBAS demodulator or externally-supplied RTCM corrections.

In addition to these differential services the V111 can also receive radiobeacon corrections. You can also purchase the V101 and the V111 with an RTK rover option, which enables 0.02 m positioning performance when paired with a suitable Hemisphere GPS RTK base receiver product.

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

### Automatic SBAS Tracking

The V101/111 automatically scans and tracks SBAS signals without the need to tune the receiver. The V101/111 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.

### Beacon Operation

Many marine authorities, such as coast guards, have installed networks of radiobeacons that broadcast DGPS corrections to users of this system. With the increasing utility of these networks for terrestrial applications, there is an increasing trend toward densification of these networks inland. The dual channel beacon receiver in the V111 can operate in manual or automatic tuning mode, or, using database mode, will select the closest station in compliance with IEC 61108-4 standards.

# V101/111 Overview

The V101/111 provides accurate and reliable heading and position information at high update rates. To accomplish this task, the V101/111 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 V101/111 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 arrow located on the bottom of the V101/111 enclosure defines system orientation. The arrow points in the direction that the heading measurement is computed (when the antenna is installed parallel to the fore-aft line of the vessel). The secondary antenna is directly above the arrow.

## Fixed Baseline Moving Base Station RTK

The V101/111's internal GPS receiver uses both the L1 GPS C/A code and carrier phase data to compute the location of the secondary GPS antenna in relation to the primary GPS antenna with a very high sub-centimeter level of precision. The technique of computing the location of the secondary GPS antenna with respect to the primary antenna, when the primary antenna is moving, is often referred to as moving base station Real Time Kinematic (or moving base station RTK).

Generally, RTK technology is very sophisticated and requires a significant number of possible solutions to be analyzed where various combinations of integer numbers of L1 wavelengths to each satellite intersect within a certain search volume. The integer number of wavelengths is often referred to as the "ambiguity" as they are initially ambiguous at the start of the RTK solution.

The V101/111 restricts the RTK solution by knowing that the secondary GPS antenna is 0.50 m (1.64 ft) from the primary GPS antenna. This is called a fixed baseline and it defines the search volume of the secondary antenna as the surface of a sphere with radius 0.50 m (1.64 ft) centered on the primary antenna location (see Figure 3-1).

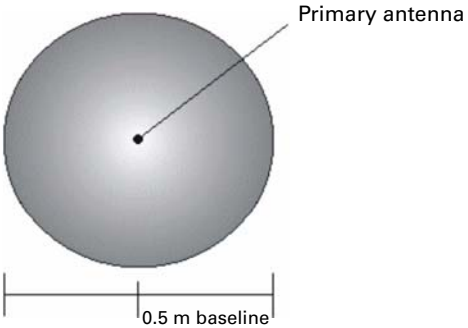


**Figure 3-1: Secondary antenna's search volume**

**Note:** The V101/111 moving base station algorithm only uses GPS to calculate heading. Differential corrections are not used in this calculation and will not affect heading accuracy.

## Supplemental Sensors

The V101/111 has an integrated gyro and two tilt sensors, which are enabled by default. Each supplemental sensor may be individually enabled or disabled. Both supplemental sensors are mounted on the printed circuit board inside the V101/111.

The sensors act to reduce the RTK search volume, which improves heading startup and reacquisition times. This improves the reliability and accuracy of selecting the correct heading solution by eliminating other possible, erroneous solutions.

The Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon) describes the commands and methodology required to recalibrate, query, or change the sensors status.

### Tilt Aiding

The V101/111's accelerometers (internal tilt sensors) are factory calibrated and enabled by default. This constrains the RTK heading solution beyond the volume associated with just a fixed antenna separation. This is because the V101/111 knows the approximate inclination of the secondary antenna with respect to the primary antenna. The search space defined by the tilt sensor will be reduced to a horizontal ring on the sphere's surface by reducing the search volume. This considerably decreases startup and reacquisition times (see Figure 3-2).

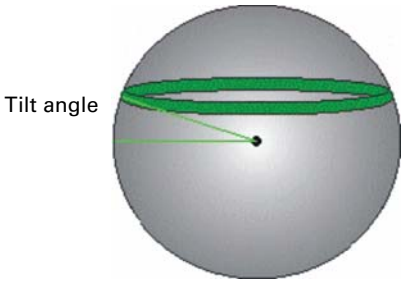


**Figure 3-2: V101/111's tilt aiding**

### Gyro Aiding

The V101/111's internal gyro offers several benefits. It reduces the sensor volume for an RTK solution. This shortens reacquisition times when a GPS heading is lost because the satellite signals were blocked. The gyro provides a relative change in angle since the last computed heading, and, when used in conjunction with the tilt sensor, defines the search space as a wedge-shaped location (see Figure 3-3).

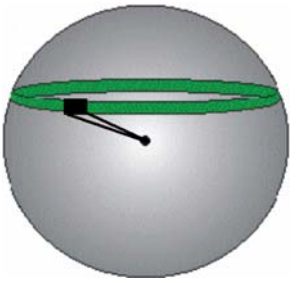

**Figure 3-3: V101/111's gyro aiding**

The gyro aiding accurately smoothes the heading output and the rate of turn. It provides an accurate substitute heading for a short period depending on the roll and pitch of the vessel, ideally seeing the system through to reacquisition. The gyro provides an alternate source of heading, accurate to within 1° per minute for up to three minutes, in times of GPS loss for either antenna. If the outage lasts longer than three minutes, the gyro will have drifted too far and the V101/111 begins outputting null fields in the heading output messages. There is no user control over the timeout period of the gyro.

The gyro initializes itself at powerup and during initialization, or you can calibrate it as outlined in the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon). When the gyro is first initializing, it is important that the dynamics that the gyro experiences during this warmup period are similar to the regular operating dynamics. For example, if you use the V101/111 on a high speed, maneuverable craft, it is essential that when gyro aiding in the V101/111 is first turned on, use it in an environment that has high dynamics for the first five to ten minutes instead of sitting stationary.

With the gyro enabled, the gyro is also used to update the post HTAU smoothed heading output from the moving base station RTK GPS heading computation. This means that if the HTAU value is increased while gyro aiding is enabled, there will be little to no lag in heading output due to vehicle maneuvers. The Hemisphere GPS Technical Reference includes information on setting an appropriate HTAU value for the application.

## Time Constants

The V101/111 incorporates user-configurable time constants that can provide a degree of smoothing to the heading, pitch, rate of turn (ROT), course over ground (COG), and speed measurements. You can adjust these parameters depending on the expected dynamics of the vessel. For example, increasing the time is reasonable if the vessel is very large and is not able to turn quickly or would not pitch quickly. The resulting values would have reduced "noise," resulting in consistent values with time. However, if the vessel is quick and nimble, increasing this value can create a lag in measurements. Formulas for determining the level of smoothing are located in the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon). If you are unsure on how to set this value, it is best to be conservative and leave it at the default setting.

***Heading time constant:*** Use the $JATT,HTAU command to adjust the level of responsiveness of the true heading measurement provided in the $GPHDT message. The default value of this constant is 2.0 seconds of smoothing when the gyro is enabled. The gyro is enabled by default, but can be turned off. By turning the gyro off, the equivalent default value of the heading time constant would be 0.5 seconds of smoothing. This is not automatically done and therefore you must manually enter it. Increasing the time constant increases the level of heading smoothing and increases lag.

***Pitch time constant:*** Use the $JATT,PTAU command to adjust the level of responsiveness of the pitch measurement provided in the $PSAT,HPR message. The default value of this constant is 0.5 seconds of smoothing. Increasing the time constant increases the level of pitch smoothing and increases lag.

***Rate of Turn (ROT) time constant:*** Use the $JATT,HRTAU command to adjust the level of responsiveness of the ROT measurement provided in the $GPROT message.

The default value of this constant is 2.0 seconds of smoothing. Increasing the time constant increases the level of ROT smoothing.

***Course Over Ground (COG) time constant:*** Use the $JATT,COGTAU command to adjust the level of responsiveness of the COG measurement provided in the $GPVTG message. The default value of this constant is 0.0 seconds of smoothing. Increasing the time constant increases the level of COG smoothing. COG is computed using only the primary GPS antenna and its accuracy depends upon the speed of the vessel (noise is proportional to 1/speed). This value is invalid when the vessel is stationary.

***Speed time constant:*** Use the $JATT,SPDTAU command to adjust the level of responsiveness of the speed measurement provided in the $GPVTG message. The default value of this parameter is 0.0 seconds of smoothing. Increasing the time constant increases the level of speed measurement smoothing.

# Alarm Functionality

A relay is located on the Transmit Heading Device (THD) circuit board. The relay contacts are isolated from all circuitry in the THD. The THD is connected to the coil side of the relay, but not to the contacts that are connected to the external pins through the main IO connector. If the THD loses power or heading, the coil voltage is lost and the relay opens and activates the notification method employed by the user. When the heading is valid, the relay contacts remain closed, completing the circuit as an indication that the V101/111 is operational.

## Alarm Signal

There are two wires (24 AWG multistrands) on the output cable that are used for the external alarm function. The color codes for the two wires are white and white/red stripe and are the output of a relay. When this relay closes, the connection is complete on the user-defined external notification device.

## Watchdog

The watchdog is a timer that is controlled by the software that monitors if the heading is lost. The watchdog software is compliant with IEC 60495.

# 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 |
|---|---|---|---|---|
| GPHDT | 10 | 18 | 10 | 1800 |
| GPROT | 5 | 17 | 10 | 850 |
| GPHDG | 1 | 31 | 10 | 310 |
| GPGGA | 1 | 81 | 10 | 810 |
| GPVTG | 1 | 45 | 10 | 450 |
| GPZDA | 1 | 36 | 10 | 360 |
| GPHEV | 1 | 15 | 10 | 150 |
| | | | Total | 4730 |

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

Table 3-1 below through Table 3-4 on page 37 provide brief descriptions of common commands and messages for the V101/111. Refer to the Hemisphere GPS Technical Reference for more detailed information.

**Table 3-1: Commands**

| Command | Description |
|---|---|
| $GPMSK | Tune beacon to specific frequency |
| $J4STRING | Output GPGGA, GPVTG, GPGSA and GPZDA (1Hz max) |
| $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 3-2 on page 35) |
| $JBAUD | Specify RS-232, RS-422 (output) communication rate |
| $JBIN | Specify binary messages to output to specific ports (see Table 3-3 on page 36) |
| $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 3-1: Commands (*continued)***

| Command | Description |
|---|---|
| $JRESET | Reset unit's configuration to firmware defaults<br>**Note:** $JRESET clears all parameters. For the V101/111 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. |
| $JSAVE | Save session's configuration changes |
| $JSHOW | Show current configuration |
| $JT | Query receiver type |
| $JATT,SUMMARY | Show current TAU configuration |
| $JWAASPRN | Query or specify specific SBAS PRN numbers |

In Table 3-2 on page 35 the Info Type value is one of the following:

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

**Table 3-2: NMEA 0183 and other messages**

| Message | Info Type | Description | IEC Approved Message |
|---|---|---|---|
| $GPDTM | P | Datum reference | Yes |
| $GPGGA | P | GPS position and fix data | Yes |
| $GPGLL | P | Geographic position - lat/long | Yes |
| $GPGNS | P | GNSS position and fix data | Yes |
| $GPGRS | S | GNSS range residual (RAIM) | Yes |
| $GPGSA | S | GNSS DOP and active satellites | Yes |
| $GPGST | S | GNSS pseudo range error statistics and position accuracy | Yes |
| $GPGSV | S | GNSS satellites in view | Yes |
| *$GPHDG | H | Provides magnetic deviation and variation for calculating magnetic or true heading<br>*see last bullet in Note at end of this table | Yes |
| *$GPHDM | H | Magnetic heading (based on GPS-derived heading and magnetic declination)<br>*see last bullet in Note at end of this table | No |
| *$GPHDT | H | GPS-derived true heading<br>*see last bullet in Note at end of this table | Yes |
| $GPHEV | H | Heave value (in meters) | Yes |

**Table 3-2: NMEA 0183 and other messages (*continued*)**

| Message | Info Type | Description | IEC Approved Message |
|---|---|---|---|
| $GPRMC | P | Recommended minimum specific GNSS data | Yes |
| *$GPROT | H | GPS-derived rate of turn (ROT)<br>*see last bullet in Note at end of this table | Yes |
| $GPRRE | S | Range residual and estimated position error message | Yes |
| $GPVTG | V | COG and ground speed | Yes |
| $GPZDA | V | Time and date | Yes |
| $PCSI,1 | S | Beacon status | No |
| $PSAT,GBS | S | Satellite fault detection (RAIM) | Yes |
| $PSAT,HPR | H | Proprietary NMEA message that provides heading, pitch, roll, and time in single message | No |
| $PSAT,INTLT | H | Proprietary NMEA message that provides the pitch and roll measurements from the internal inclinometers (in degrees) | Yes |
| $RD1 | S | SBAS diagnostic information | Yes |

**Notes:**

- The GP of the message is the talker ID.
- GPGRS, GPGSA, GPGST, and GPGSV support external integrity checking. They are to be synchronized with corresponding fix data (GPGGA or GPGNS).
- For information on outputting roll, pitch, and heave data in one message refer to the Hemisphere GPS Technical Reference (go to www.hemispheregps.com/support and click the GPS Reference icon).
- * You can change the message header for the HDG, HDM, HDT, and ROT messages to either GP or HE using the $JATT,NMEAHE command. For more information refer to the Hemisphere GPS Technical Reference.

**Table 3-3: Binary messages**

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

**Table 3-4: Parameters specific to $JATT command**

| Parameter | Description | Query | Specify |
|---|---|---|---|
| COGTAU | Set/query COG time constant (0.0 to 3600.0 seconds) | X | X |
| CSEP | Query antenna separation | X | |
| GYROAID | Enable/disable gyro | X | X |
| HBIAS | Set/query heading bias (-180.0° to 180.0°) | X | X |
| HIGHMP | Set/query the high multipath setting for use in poor GPS environments | X | X |
| HRTAU | Set/query time constant (0.0 to 3600.0 seconds) | X | X |
| HTAU | Set/query heading time constant (0.0 to 3600.0 seconds) | X | X |
| LEVEL | Enable/disable level operation | X | X |
| MSEP | Manually set or query antenna separation | X | X |
| NEGTILT | Enable/disable negative tilt | X | X |
| NMEAHE | Change the HDG, HDM, HDT, and ROT message headers between GP and HE | X | X |
| PBIAS | Set/query pitch/roll bias (-15.0° to 15.0°) | X | X |
| PTAU | Set/query pitch time constant (0.0 to 3600.0 seconds) | X | X |
| ROLL | Configure for roll or pitch GPS orientation | X | X |
| SEARCH | Force a new GPS heading search | | X |
| SPDTAU | Set/query speed time constant (0.0 to 3600.0 seconds) | X | X |
| TILTAID | Enable/disable accelerometer, pre-calibrated | X | X |
| TILTCAL | Calibrate accelerometers | | X |

# 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<br>• Check integrity of power cable connectors<br>• Check power input voltage (9 to 36 VDC)<br>• Check current restrictions imposed by power source (minimum available should be > 1.0 A) |
| No data from V101/111 | • Check receiver power status to ensure the receiver is powered (an ammeter can be used for this)<br>• Verify desired messages are activated (using PocketMax or $JSHOW in any terminal program)<br>• Ensure the baud rate of the V101/111 matches that of the receiving device<br>• Check integrity and connectivity of power and data cable connections |
| Random data from V101/111 | • Verify the RTCM or binary messages are not being output accidentally (send a $JSHOW command)<br>• Ensure the baud rate of the V101/111 matches that of the remote device<br>• Potentially, the volume of data requested to be output by the V101/111 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 V101/111 has a clear view of the sky<br>• Verify the lock status of GPS satellites (this can be done with PocketMax) |
| No beacon lock | • Beacon reception capability is only present on V111 model<br>• Verify the receiver is tuned to the correct frequency and bit rate<br>• Ensure beacon signal coverage is expected in your area<br>• Ensure environmental noise is not masking the signal, reducing the SNR reading |
| No SBAS lock | • Verify the V101/111 has a clear view of the sky<br>• Verify the lock status of SBAS satellites (this can be done with PocketMax - monitor BER value)<br>• Set SBAS mode to automatic with the $JWAASPRN,AUTO command<br>**Note:** SBAS lock is only possible if you are in an appropriate SBAS region; currently, there is limited SBAS availability in the southern hemisphere. |

**Table A-1: Troubleshooting (*continued)***

| Symptom | Possible Solution |
|---|---|
| No heading or incorrect heading value | • Check CSEP value is fairly constant without varying more than 1 cm (0.39 in)—larger variations may indicate a high multipath environment and require moving the receiver location<br>• Recalibrate the tilt sensor with $JATT,TILTCAL command if heading is calculated then lost at consistent time intervals<br>• Heading is from primary GPS antenna to secondary GPS antenna, so the arrow on the underside of the V101/111 should be directed to the bow side<br>• $JATT,SEARCH command forces the V101/111 to acquire a new heading solution (unless gyro is enabled)<br>• Enable GYROAID to provide heading for up to three minutes during GPS signal loss<br>• Enable TILTAID to reduce heading search times<br>• Monitor the number of satellites and SNR values for both antennas within PocketMax—at least four satellites should have strong SNR values<br>• Potentially, the volume of data requested to be output by the V101/111 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 DGPS position in external RTCM mode | • Verify the baud rate of the RTCM input port matches the baud rate of the external source<br>• Verify the pinout between the RTCM source and the RTCM input port (transmit from the source must go to receive of the RTCM input port and grounds must be connected)<br>• Ensure corrections are being transmitted to the correct port—using the $JDIFF,PORTB command on Port A will cause the receiver to expect the corrections to be input through Port B |

# Appendix B: Technical Specifications

Table B-3 through Table B-6 on page 45 provide the V101/111's sensor, beacon, communication, power, mechanical, and environmental specifications.

**Table B-1: GPS sensor specifications**

| Item | Specification |
|---|---|
| Receiver type | L1, C/A code with carrier phase smoothing |
| Channels | Two 12-channel, parallel tracking<br>(Two 10-channel when tracking SBAS) |
| SBAS tracking | 2-channel, parallel tracking |
| Update rate | Standard 20 Hz (position and heading) |
| Horizontal accuracy | < 0.6 m 95% confidence (DGPS[1])<br>< 2.5 m 95% confidence (autonomous, no SA[2]) |
| Heading accuracy | < 0.30° rms |
| Pitch/roll accuracy | < 1° rms |
| Heave accuracy | 30 cm[3] |
| Timing (1PPS) accuracy | 50 ns |
| Rate of turn | 90°/s maximum |
| Compass safe distance | 125 cm (49.2 in)[4] |
| Cold start | < 60 s typical (no almanac or RTC) |
| Warm start | < 20 s typical (almanac and RTC) |
| Hot start | < 1 s typical (almanac, RTC, and position) |
| Heading fix | < 10 s typical (valid position) |
| Maximum speed | 1,850 kph (999 kts) |
| Maximum altitude | 18,288 m (60,000 ft) |

**Table B-2: Beacon specifications (V111)**

| Item | Specification |
|---|---|
| Channels | 2-channel, parallel tracking |
| Frequency range | 283.5 to 325 kHz |
| Operating modes | Manual, automatic, and database |
| Compliance | IEC 61108-4 beacon standard |

**Table B-3: Communication specifications**

| Item | Specification |
|---|---|
| Serial ports | 2 full-duplex RS-232<br>2 half-duplex RS-422 |

**Table B-3: Communication specifications (*continued)***

| Item | Specification |
|---|---|
| Baud rates | V101: 4800 to 115200<br>V111: 4800 to 38400 |
| Correction I/O protocol | RTCM SC-104, L-Dif[5] |
| Data I/O protocol | NMEA 0183, Crescent binary[5], L-Dif[5] |
| Timing output | 1PPS CMOS, active low, falling edge sync, 10 kΩ, 10 pF load |
| Heading warning I/O | Open relay system indicates invalid heading |

**Table B-4: Power specifications**

| Item | Specification |
|---|---|
| Input voltage | 9 to 36 VDC |
| Power consumption | ~ 5 W nominal |
| Current consumption | ~ 360 mA @ 12 VDC |
| Power isolation | Isolated power supply |
| Reverse polarity protection | Yes |

**Table B-5: Mechanical specifications**

| Item | Specification |
|---|---|
| Enclosure | AES Resin high weather resistant, exceptional UV stability and cold weather impact strength retention |
| Dimensions<br>(not including mounts) | 60 L x 16 W x 18 H (cm)[6]<br>23.6 L x 6.3 W x 7.1 H (in)[6] |
| Weight | V101: ~1.7 kg (3.7 lb)[6]<br>V111: ~ 2.1 kg (4.6 lb)[6] |
| Power/data connector | 18-pin, environmentally sealed |

**Table B-6: Environmental specifications**

| Item | Specification |
|---|---|
| Operating temperature | -30°C to +70°C (-22°F to +158°F) |
| Storage temperature | -40°C to +85°C (-40°F to +185°F) |
| Humidity | 95% non-condensing |
| Shock and vibration | IEC 60945 |
| EMC | FCC Part 15, Subpart B, CISPR22, CE |
| IMO Wheelmark certification | Yes |

[1]Depends on multipath environment, number of satellites in view, satellite geometry, baseline length (for local services), and ionospheric activity

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

[3]Based on a 40 second time constant

[4]This is the minimum safe distance measured when the product is placed in the vicinity of the steering magnetic compass. The ISO 694 defines “vicinity,” relative to the compass as within 5 m (16.4 ft) separation.

[5]Hemisphere GPS proprietary

[6]Not including mounts

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## V



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