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VS101 and VS111 GPS Compass

User Guide

Part No. 875-0253-000 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.

Trademarks

Patents

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:

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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Technical Support

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Chapter 1: Introduction

Overview
What's Included
Parts List

Overview

Precise applications demand the heading and positioning performance of the VS101™ GPS Compass and VS111™ GPS Compass.

Note: When referring to both the VS101 GPS Compass and the VS111 GPS Compass this manual uses the term VS101/111. When referring to either product this manual uses either VS101 or VS111, respectively.

The VS101/111 GPS Compass is designed to provide a highly-accurate GPS heading that takes into account the pitch, roll, and speed of various vehicles and vessels. The VS101/111 features Hemisphere GPS' Crescent™ -based receiver and two separate antennas to achieve heading accuracy ranging from 0.1° to 0.3° rms, depending on the antenna separation. Ideal for professional machine control and navigation, the VS101/111 also offers differential positioning performance of less than 0.6 m 95% of the time.

The VS101/111 includes two versions, the VS101 and the VS111:

- The VS101 kit includes two A21™ antennas, and supports GPS and SBAS signals.
- The VS111 kit includes an A21 antenna and an A31™ antenna, and supports GPS, SBAS, and Beacon signals.

Figure 1-1: VS111 GPS Compass

Powered by Hemisphere GPS' Crescent receiver technology, the VS101/111 boasts:

- Higher update rates
- Noise-reduced raw measurements
- More memory
- More processor capacity
- Lower power consumption
- More advanced applications and sophisticated configurations
- Tighter coupling of measurements from separate antennas

With more accurate code phase measurements, improved multipath mitigation and fewer components than competing products, the VS101/111 offers superior accuracy and stability.

The VS101/111 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 VS101/111 is less likely to be affected by differential signal outages due to signal blockages, weak signals, or interference when using COAST.

What's Included

Your VS101 kit or VS11 kit includes the following parts (VS111 kit shown in Figure 1-2):

- VS101 or VS111 GPS Compass and related mounting hardware
- Antennas and related mounting hardware
- Power, data, and antenna cables

Table 1-1 on page 4 provides descriptions of the parts in your kit.

Review the parts shipped with your kit. If any part appears to have been damaged during shipping, contact your freight carrier. If any parts are missing, contact your dealer.

Figure 1-2: VS111 system parts diagram

Parts List

Table 1-1 lists the parts included in your VS101/111 kit. Refer to Figure 1-2 on page 3 for a photo of the parts listed in Table 1-1.

Table 1-1: Parts list

Diagram Letter	Part Name	Qty	Part Number
A	Crescent receiver model (one of the following models): VS101 VS111	 1 1	 803-3021-000# 803-3022-000#
B	Antenna VS101 A21 antenna VS111 A21 antenna A31 antenna	 2 1 1	 804-3036-000# 804-3036-000# 804-3043-000#
C	Power cable, circular	1	054-0118-000#
D	Receiver mounting kit (two brackets)	1	710-0056-000#
E	Antenna mounting kit VS101 A21 antenna mounting kit VS111 A21 antenna mounting kit A31 antenna mounting kit	 2 1 1	 710-0110-000# 710-0110-000# 710-0111-000#
F	Data cable, DB-9 female to DB-9 male, 3 m	2	050-0011-022#
G	Antenna cable, TNC male to TNC male, 10 m	2	052-0004-000#

Chapter 2: Understanding the VS101/111

GPS Overview
VS101/111 Overview

GPS Overview

For your convenience, both the GPS and SBAS operation of the VS101/111 features automatic operational algorithms. When powered for the first time, the VS101/111 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 VS101/111’s internal GPS receiver.

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 VS101/111’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 VS101/111 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 VS101/111 also tracks a differential correction. The VS101/111 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 VS101/111 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 VS101/111 will result in positioning accuracies of 2.5 m 95% of the time. In order to improve positioning quality to sub-meter levels, the VS101/111 is able to use differential corrections received through the internal SBAS demodulator or externally-supplied RTCM corrections.

In addition to these differential services the VS111 can also receive radiobeacon corrections. You can also purchase the VS101 and the VS111 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 VS101/111 automatically scans and tracks SBAS signals without the need to tune the receiver. The VS101/111 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 VS111 can operate in manual or automatic tuning mode, or, using database mode, will select the closest station in compliance with IEC 61108-4 standards.

RTK

Real Time Kinematic (RTK) technology is available on Crescent-based GPS receivers. RTK requires the use of two separate receivers: a stationary base station (primary receiver) that broadcasts corrections over a wireless link to the rover (secondary receiver). The localized corrections are processed on the rover to achieve superior accuracy and repeatability. Performance testing has shown positioning accuracy at the centimeter level.

VS101/111 Overview

The VS101/111 provides accurate and reliable heading and position information at high update rates. To accomplish this task, the VS101/111 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 VS101/111 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.

Fixed Baseline Moving Base Station RTK

The VS101/111'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 VS101/111 restricts the RTK solution by knowing that the secondary GPS antenna is a fixed distance from the primary GPS antenna. The default value is 0.50 m, but you may install the antennas with a different separation distance, then enter that value into the VS101/111. 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 centered on the location of the primary antenna (see Figure 2-1).

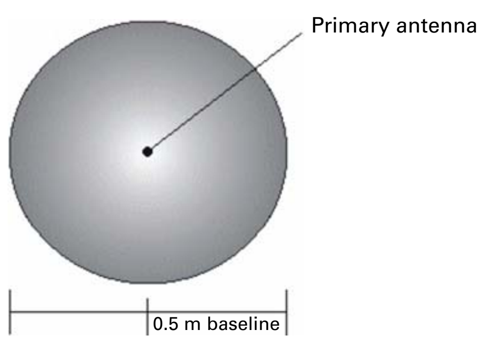

Figure 2-1: Secondary antenna's search volume

Note: The VS101/111 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 VS101/111 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 VS101/111.

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 VS101/111'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 VS101/111 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 2-2).

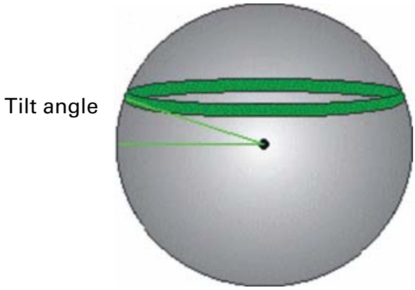

Figure 2-2: VS101/111's tilt aiding

Gyro Aiding

The VS101/111'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 2-3).

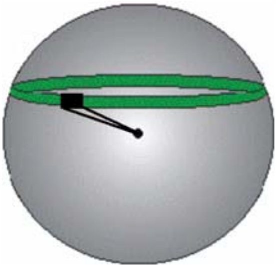

Figure 2-3: VS101/111's gyro aiding

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 VS101/111 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 VS101/111 on a high speed, maneuverable craft, it is essential that when gyro aiding in the VS101/111 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 VS101/111 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.

Chapter 3: Installation

Mounting the Antennas

Mounting the Receiver

Connecting the Cables

Powering the System

Mounting the Antennas

When mounting the antennas you need to consider the following:

- Mounting orientation (parallel or perpendicular)
- Proper antenna placement
- Magnetic, pole, or rail mounting

Mounting Orientation

The VS101/111 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.

Note: Regardless of which mounting orientation you use, the VS101/111 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).

Parallel Orientation: The most common installation is to orient the antennas 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 VS101/111 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.

Planning the Optimal Antenna Placement

Proper antenna placement is important to obtain a high-precision GPS reading. Place the antennas:

- With a clear view of the horizon
- Away from other electronics and antennas
- Along the vessel's centerline

⚠WARNING: You must install the primary antenna along the vessel's centerline; you cannot adjust the position readings if the primary antenna is installed off the centerline. Positions are computed for the primary antenna.

- On a level plane
- With a 2.0 m maximum separation (default is 0.5 m)
- Away from radio frequencies
- As high as possible

For the best results, orient the antennas so the antennas' connectors face the same direction.

Note: In the VS111 kit, install the A31 antenna as the primary antenna as it is used for positioning.

See Figure 3-1 below through Figure 3-3 on page 16 for mounting orientation examples.

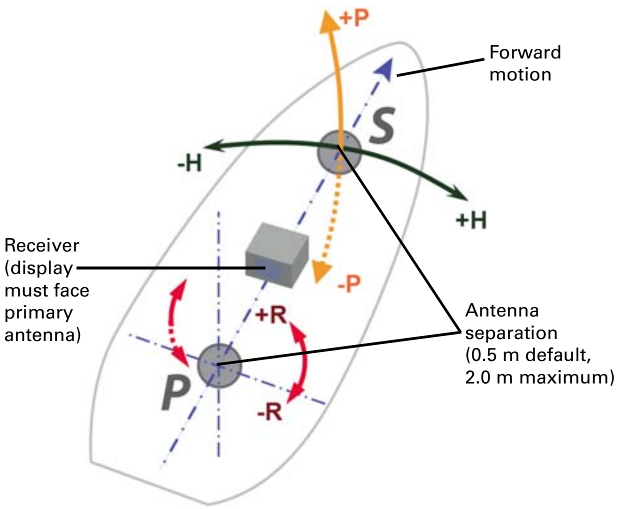

Figure 3-1: Recommended orientation and resulting signs of HPR values

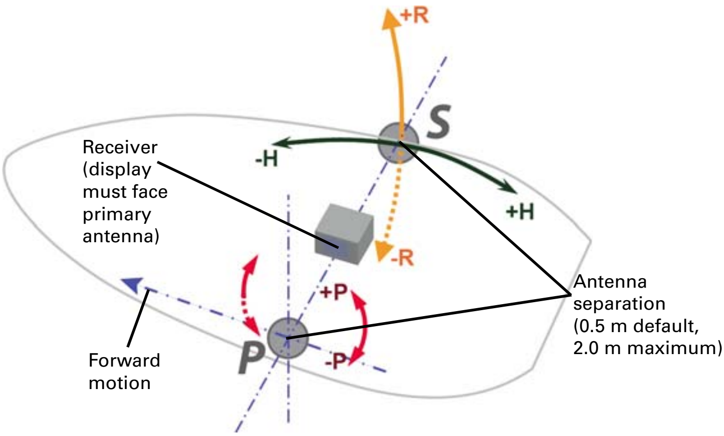

Figure 3-2: Alternate orientation and resulting signs of HPR values

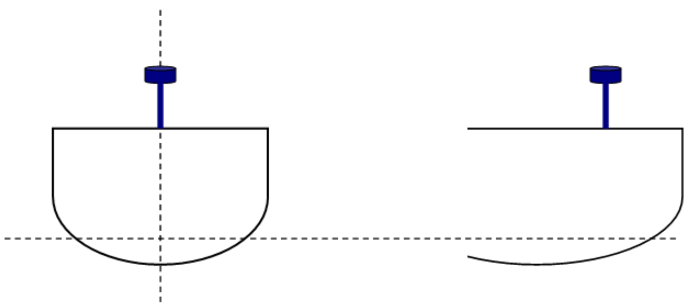

Figure 3-3: Antenna installation: Cross-section of boat

Mounting Options

You can mount the antennas with a magnetic mount, pole mount, or rail mount configuration. You can secure the antennas to a 5/8” threaded pole or a 1-14-UNS-2B threaded mount using the mounting adapters.

Note: The VS111 kit contains one A21 antenna, one A31 antenna, and an A21 height adapter. The A31 antenna has a slightly higher profile than the A21, so the A21 height adapter is used to bring the two antennas level. If the adapter is not used, you will need to enter a non-level bias calculation into the system (see “Q: I could not install my antennas so that they are the same height. How do I calibrate for the height offset?” on page 43 of Appendix B, “FAQs.”)

⚠WARNING: The maximum allowable antenna separation is 2.0 m. Any greater distance may result in an incorrect heading.

Magnetic Mounting: You can screw the magnetic mount into the bottom of the antenna and mount it to any metal surface.

If there are no metal surfaces, use the metal disc and foam adhesive included in your kit to mount the antenna.

To use the metal disc and foam adhesive:

1. Select a location and orientation that meets the requirements outlined in “Mounting Orientation” on page 14 and “Planning the Optimal Antenna Placement” on page 15.
2. Thread the magnetic mount into the mounting bracket on the bottom of the antenna. *Hand tighten only.*

⚠WARNING: When threading the magnetic mounts, hand tighten only. Damage resulting from over-tightening may void your warranty.

A21 antenna

A31 antenna

3. Clean and dry the mounting surface on the vessel.
4. Remove the backing from one side of the foam adhesive and press the metal plate onto the mounting surface on the vessel.
5. Remove the backing from the other side of the foam adhesive.
6. Press the metal plate onto the mounting surface on the vessel.
7. Apply firm pressure to ensure good adhesion.
8. Place the antenna on top of the metal disc.
9. Ensure the antenna is secure in its mounting position.

Pole Mounting: Alternately, you may pole-mount the antennas using existing hardware on your vessel.

To mount the antenna on a pole mount bracket:

1. Select a location and orientation that meets the requirements listed in “Mounting Orientation” on page 14 and “Planning the Optimal Antenna Placement” on page 15.
2. Thread the pole mount into the mounting bracket on the bottom of the antenna. *Hand tighten only. Poles shown in photos not included.*

A21 antenna

A31 antenna

⚠WARNING: When threading the pole mounts, hand tighten only. Damage resulting from over-tightening may void your warranty.

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3. Mark and drill any mounting holes necessary for the pole mounts.

Rail Mounting: Alternately, you may rail mount the antennas using existing hardware on your vessel.

To rail mount the antennas:

1. Select a location and orientation that meets the requirements listed in "Mounting Orientation" on page 14 and "Planning the Optimal Antenna Placement" on page 15.
2. Use appropriate hardware to securely attach the antenna to the railing.

Routing and Securing the Antenna Cable

⚠WARNING: The VS101/111 receiver provides 5 VDC across the antenna ports. Connection to incompatible devices may result in damage to equipment.

To route and secure the antenna cables, review the following guidelines. The two enclosed antennas each require a 50 Ω impedance antenna extension cable, such as RG-58U (up to a maximum of 15 m (49 ft.) in length), for proper operation.

1. The GPS receiver inside the VS101/111 requires a minimum input gain of 10 dB (and maximum of 40 dB before saturation will occur). The antennas offer 28 dB of gain, so the loss budget to accommodate for cable losses is 18 dB.
2. Regardless of the cable material and length you choose, ensure the cable losses are less than 18 dB of attenuation. Due to variances in the antenna gain and practical attenuation of cable materials and connectors, Hemisphere GPS recommends reducing this budget to 15 dB; this budget is present to overcome the resulting attenuation of a RF cable.
3. When deciding on an antenna location, consider the amount of cable required: a longer cable of the same material will result in a higher loss than a shorter one. If the overall loss of the longer cable exceeds 15 dB, change the cable material. This normally means a more expensive material that has a larger diameter and less flexibility. The standard cables included with the VS101/111 are of the RG58 material family and their attenuation is ~0.8 dB/m. Including connector losses, the nominal loss of these RF cables is ~10 dB, which is within the tolerable loss budget. If a 15 m or 20 m cable run is required, a RG8 variety is available. If lengths longer than 20 m are required, more sophisticated materials are required.

For more information on cable length or low-loss cable, contact your Hemisphere GPS dealer or Hemisphere GPS Technical Support. The following is a summary of other readily available cable materials that have 50 Ω impedance. Cable loss cited below does not include connector losses.

Table 3-1: Cable loss

Material	Loss at GPS L1 (1.575 GHz)
RG58	0.78 dB/m
RG8	0.36 dB/m
Times Microwave LMR400	0.15 dB/m

Adhere to the following warnings before routing the antenna extension 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.

Mounting the Receiver

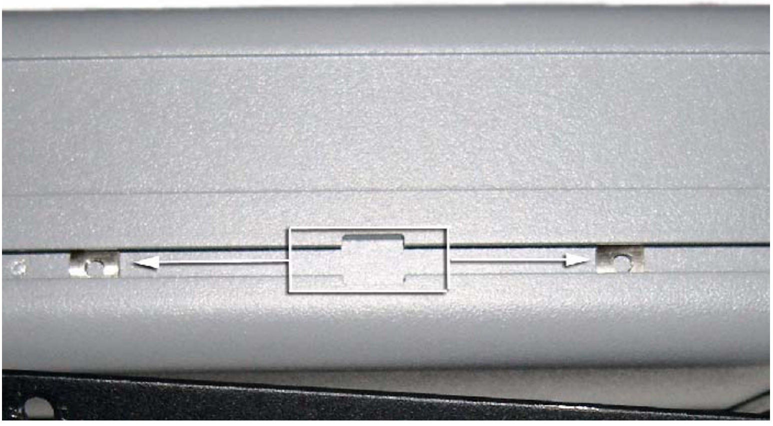
When mounting the VS101/111 receiver, adhere to the following guidelines:

- Install the receiver inside and away from the elements and in a location that minimizes vibration, shock, extreme temperatures, and moisture
- Position the receiver horizontally and with the face of the receiver facing the primary antenna
- Ensure the front panel (menu screen, LEDs, and buttons) is visible and accessible
- Ensure the back panel is easily accessible to switch out cables and turn power on and off

Use the enclosed kit to mount the receiver.

To install the mounting brackets:

1. Slide the nuts through the opening along both sides of the receiver.



2. Place the bracket alongside the receiver and insert the screws so that they screw into the nuts.

3. Screw down the brackets in your desired location.

Connecting the Cables

This section contains instructions for connecting the cables for the power and serial ports.

Adhere to the following warnings when connecting the cables:

- 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.

Connecting the Power Source

The power source for the VS101/111 must be between 9 V and 36 V. Attach the power cable to the connector labeled “Ground” to your power source.

Selecting a Port for GPS Data Message Output

The serial ports of the VS101/111 communicate at the RS-232 interface level with external data loggers, navigation systems and other devices. The two serial ports on the back panel of the receiver use a standard DB9 socket connection.

Figure 3-4: Port connections on the VS101/111

The available ports and associated default baud rates, NMEA message types, and update rates are shown in Table 3-2.

Table 3-2: Default Data Messages by Port

Port	Baud Rate	NMEA Messages	Update Rate
A, B	19200	GPGGA, GPGSV	1 Hz

Ports A and B have the connections detailed below on the DB9 socket.

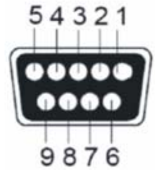


Figure 3-5: DB9 serial port

Table 3-3: Pin Connections for Ports A and B

Pin	Signal	Description
2	TXD	NMEA 0183, binary, and RTCM input
3	RXD	NMEA 0183, binary, and RTCM output
5	Signal Ground	Signal return
6	Mark Input	Event marker input
9	1 PPS	Timing output

If the NMEA data messages you desire are different from the default messages shown in Table 3-3, you will need to select those also.

Use the Configuration Wizard to select your NMEA message types and update rates by port (see Chapter 4, “Getting Started”).

Powering the System

Turn the VS101/111 “ON” or “OFF” using the ON/OFF power button on the rear panel.

Figure 3-6: Turn the VS101/111 on at the power toggle switch.

Chapter 4: Getting Started

Startup
Configuration Overview
Configuring the System
Disabling the Aiding Features
Adjusting the Time Constants

Startup

When you power on the VS101/111 the Hemisphere GPS splash screen appears followed by the main screen. The following main screen menus allow you to view and configure system data and settings:

- Vector
- GPS
- Differential Source (menu item will be the selected differential source, such as SBAS or Autonomous)
- Configuration Wizard
- System Setup

For a complete menu path of each main screen menu, see Appendix C, "Menu Map."

Configuration Overview

The Configuration Wizard of the VS101/111's interface guides you through the setup options. The Configuration Wizard allows you to save up to five different configurations, which is useful when using the VS101/111 on different vessels or for different applications.

If you use a personal computer, you can use Hemisphere GPS' PocketMax software to help configure the system. PocketMax is included on your CD.

PocketMax enables you to:

- Tune your beacon, WAAS, and OmniSTAR receivers and monitor reception
- Configure GPS message output and port settings
- Configure and monitor Vector related settings
- Record various types of data

PocketMax runs on PCs and PDAs The most current version of PocketMax software, the appropriate operating system requirements, and instructions on using PocketMax are available on the Hemisphere GPS website.

Configuring the System

The Configuration Wizard option appears in the display on the front panel of the VS101/111. See Figure 5-1 on page 34 for an overview of the VS101/111's display screen and selection buttons.

This section covers the basic items you need to set in the Configuration Wizard to get up and running. Figure 4-1 shows the Configuration Wizard.

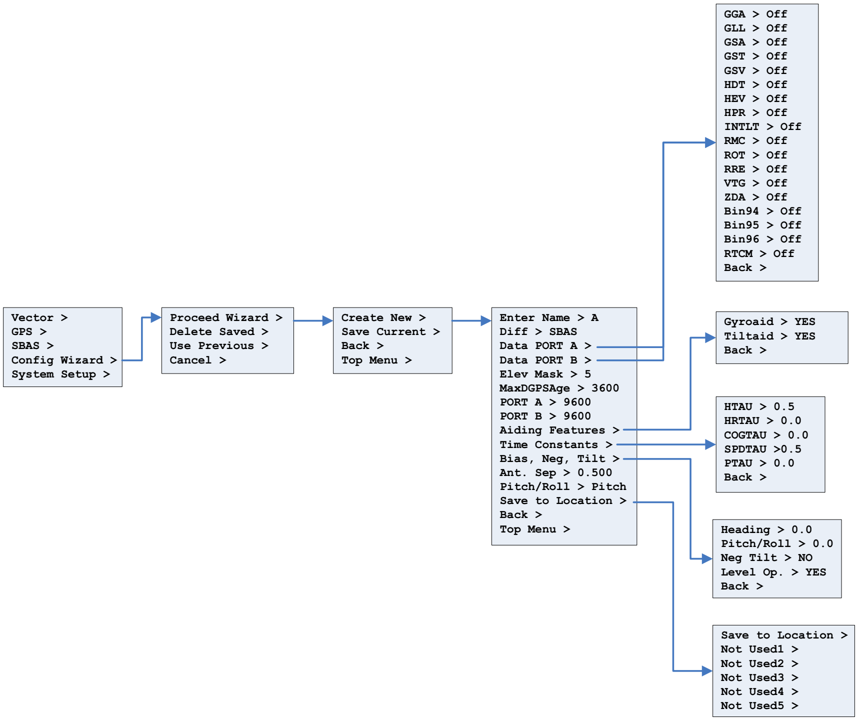


Figure 4-1: Configuration Wizard

Using the Configuration Wizard

The basic setup instructions outlined in this section assume that the antennas are:

- Installed parallel to, and along the centerline of, the vessel's axis
- Separated by 0.5 m

If this is not the case, you will need to enter the actual antenna separation and bias in the Configuration Wizard.

1. Select **Config Wizard > Proceed Wizard**. The Proceed Wizard menu appears.
2. Select **Create New** to create a new configuration. You are prompted to enter a name for your configuration.
3. Use the arrow buttons to select a letter and then press the **Enter** button to save the letter. The cursor moves to the right.

Enter a blank character at the end of your name until the ">" character appears at the end of the name. Press the **Enter** button again.

4. From the same menu, select **DIFF** to set a DGPS source. The options are:
    - SBAS (default)
    - Beacon
    - Autonomous
    - External RTCM
    - e-Dif
    - L-Dif

Note: Beacon is only available with the VS111; e-Dif and L-Dif require a subscription.

5. To change the type of GPS data message that is sent to the data ports, select either **Data Port A** or **Data Port B** from the menu list.
6. You can configure the elevation cutoff angle, by selecting **Elev Mask**. You may set the elevation cutoff angle between 0° and 45°. The default value is 5°.
7. You also have the option to set the maximum DGPS age. The maximum DGPS age is 2700 seconds (45 minutes) by default.
8. If the default baud rate on the selected port does not match that of the external device you are connecting to, you will need to configure the Baud Rate, using the Port A or Port B entries.

    4800, 9600, 19200, 38400, 57600, and 115200 are the available baud rates.

Note: The VS111 has maximum baud rate of 38400. Higher baud rates will impair beacon signal tracking.

9. The Aiding Features menu enables you to turn the Gyroaid and Tiltaid features on or off. For more information on disabling the aiding features, see "Disabling the Tilt Aid" on page 30 or "Disabling the Gyro Aid" on page 30.
10. While the default Time Constants settings will work for most users, if you have a large, slow turning vessel or a small, quick moving vessel you may want to adjust the time constants to reduce heading start up and re acquisition times.
11. For details on configuring the time constants, see "Adjusting the Time Constants" on page 31.
12. If you did not install the antenna's parallel to and along the vessel's centerline, you will need to enter a heading bias in the Heading field of the Bias, Neg, Tilt menu. The heading bias (-180° to +180°) compensates for any offset from the centerline.

Note: If you installed the antennas for roll (perpendicular to the boat's axis), rather than pitch, you must enter the heading bias (+/-90°). You must also enter the bias for roll (see below).

13. Enter the bias for pitch or roll (-15° - +15°) to compensate for any offset from the boat's centerline. Enter this bias in the Pitch/Roll field of the Bias, Neg, Tilt menu.
14. If you did not install the antennas 0.5 m apart, enter the actual antenna separation In the Ant. Sep field. The available range is 0 - 2.0 m.
15. Most users install the antennas for pitch; however, if you install the antennas for roll, you will need to configure the VS101/111 for roll. In the Create New menu set the Pitch/Roll setting to Roll.
16. To save your new configuration, select the Save to Location field. You will be prompted for a location to save your configuration.

    Select one of the empty slots, noted by the name Not Used or select a slot with an existing configuration to overwrite it.

    After your configuration is saved, you must select it from the Configuration Wizard in order to activate it. You may then continue to enter different receiver configurations without upsetting the current operation of the receiver. Re-enter the Configuration Wizard and select the configuration to use.

Disabling the Aiding Features

While the default settings will work for most users, you can configure the aiding features to further reduce heading start up and re-acquisition times.

Disabling the Tilt Aid

The VS101/111' tiltaid (accelerometer) is enabled by default and constrains the RTK heading solution to reduce startup and re acquisition times.

The tiltaid is pre-calibrated at the factory. However, if you experience any tilt measurement offset, you can re calibrate the tilt sensor by using the Calibrate Tilt option in the Vector menu. See "Vector menu" on page 47 for a menu map on how to access this feature. Be sure that the receiver is perfectly level before recalibrating the tiltaid.

The only times you might need to disable the tiltaid feature are:

- If you were unable to install the VS101/111 on a level plane with the antennas. The tilt sensor is located inside of the VS101/111, so it is important that the VS101/111 be installed on a level horizontal plane.

  ⚠WARNING: If you were unable to install the VS101/111 in a horizontal plane with the antennas, you must disable tiltaid.

- If troubleshooting, to ensure the receiver is working properly.

You can turn the tiltaiding feature off either through the Configuration Wizard or through the Vector menu.

Disabling the Gyro Aid

The VS101/111's internal gyro-aid is enabled by default. The gyro:

- Shortens re-acquisition times when satellites are obstructed and heading is lost, by reducing the search volume required for the RTK solution, and
- Provides accurate substitute headings for a short period (depending on the roll and pitch of the vessel) ideally seeing you through to re-acquisition.

The only time you might need to disable the gyro-aid is during troubleshooting, to ensure the receiver is working properly.

⚠WARNING: Do not exceed turn rates of 90 degrees-per-second! The VS101/111 uses gyro measurements to obtain a heading rate measurement and the gyro cannot measure beyond this rate.

You can turn the gyroaid feature off either through the Configuration Wizard or through the Vector menu.

Adjusting the Time Constants

The VS101/111's default settings are fine for most users. If desired, you can set the following time constants to further smooth heading, course-over-ground and speed measurements.

Table 4-1 below provides an overview of the time constant values you can set in the Configuration Wizard, including the formulas for finding the optimal value of each time constant for your vessel.

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

Table 4-1: Time Constants

Time Constant	Purpose	Range	Formula
COGTAU (Course-Over-Ground)	Adjusts the responsiveness to the course-over-ground measurement. If vessel is small and dynamic, leave this value at 0.0 s to be conservative. If the vessel is large and resistant to motion, you may want to increase this value.	0.0 s (default) 0.0 to 60 s	cogtau (s) = 10 / max rate of change of course (°/sec)
HRTAU (Heading Rate) change to (Rate of Turn)?	Adjusts the responsiveness to the rate of heading change. If vessel is large and unable to turn quickly, you may want to increase this value.	2.0 s with gyro enabled (default) 0.0 to 60 s	hrtau (s) = 10 / max rate of the rate of turn ($°/s^2$)
HTAU (Heading)	Adjusts the responsiveness to true heading. If vessel is large and unable to turn quickly, you may want to increase this value.	2.0 s with gyro enabled (default) 0.0 to 60 s	htau (s) = 40 / max rate of turn (°/s) (with gyro ON) htau (s) = 10 / max rate of turn (°/s) (with gyro OFF)
PTAU (Pitch)	Adjusts the responsiveness to pitch. If vessel is large and unable to pitch quickly, may want to increase this value.	0.5 s (default) 0.0 to 60 s	ptau (s) = 10 / max rate of pitch (°/s)

Table 4-1: Time Constants (*continued)*

Time Constant	Purpose	Range	Formula
SPDTAU (Speed)	Adjusts the responsiveness to speed. If vessel is small and dynamic, leave this value at 0.0 s to be conservative. If the vessel is large and resistant to motion, you may want to increase this value.	0.0 s (default) 0.0 to 60 s	spdtau (s) = 10 / max acceleration (m/s^2)

Chapter 5: Operating Basics

Overview
Viewing GPS/DGPS Status

Overview

Most users connect the VS101/111 to their existing navigation system during installation. These users will receive the VS101/111's position and heading updates through the interface of their existing system.

The interface on the front panel of the VS101/111 is helpful for configuring or changing system settings. In addition, the LEDs on the panel will notify you in the event of a GPS or DGPS signal loss.

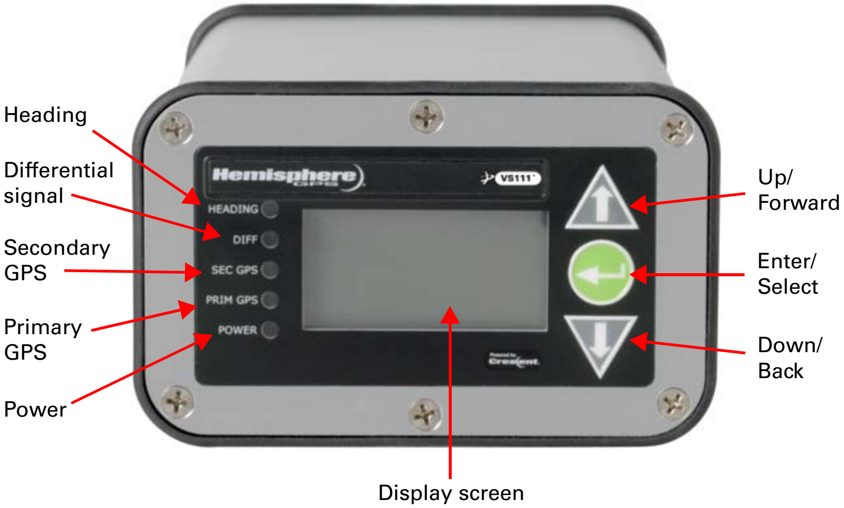


Figure 5-1: LED indicators, display screen, and selection buttons

Viewing GPS/DGPS Status

Most users will receive position and heading information through their on-board navigation system. If you have not connected the VS101/111 to an existing navigation system, or are troubleshooting your unit, you may need to view GPS, DGPS or Beacon status on the VS101/111's display screen.

Do I Have a Signal?

Figure 5-1 shows which LEDs on the VS101/111 will indicate GPS, DGPS or Beacon signal lock when illuminated.

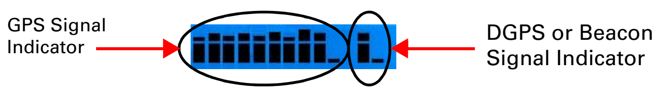
If you do lose the differential signal lock, the Hemisphere GPS COAST technology allows the VS101/111 to perform well for up to 40 minutes with old correction data. The amount of time you can "coast" depends on the degree of tolerable drift.

Note: To obtain a full set of SBAS corrections, the VS101/111 must receive the ionospheric map over a period of a few minutes. After this, the receiver can "coast" until the next set of corrections has been received.

How Good is the Quality of My Signal?

In addition to the LED indicators for signal lock, the VS101/111's display screen indicates the quality of your signal.

The bar chart shows an indication of the quality of the GPS and DGPS (or if applicable, Beacon) signal. The first group of bars shows the GPS signal; the second group of bars shows the DGPS or Beacon signal.



Each bar represents a distinct channel and its associated signal quality. The higher the bar, the better the signal.

Note: If using autonomous or external correction mode, the DGPS signal indicator will not appear in the display.

DGPS (SBAS): The differential correction (or SBAS) signal indicator reflects the quality of each satellite signal, or the Bit Error Rate (BER). A full bar height reflects a signal lock and a BER of 0. A bar height only 2 pixels tall reflects a signal loss, or a BER of 500 or greater. Bar heights in between reflect intermediate degrees of signal quality. For example, when using WAAS two satellites available, so two BERs are provided.

Beacon: The Beacon indicator reflects the quality of the Beacon signal, or the signal strength (SS) and the signal-to-noise ratio (SNR). A full bar height reflects a signal lock and an SS of 35 or greater, and an SNR of 24 or greater. A bar height only 2 pixels tall reflects a signal loss, or SS and SNR values of 0. Bar heights in between reflect intermediate degrees of signal quality. If using Beacon, the first bar indicates SS signal quality; the second bar indicates SNR signal quality.

Appendix A: Troubleshooting

Table A-1 provides troubleshooting for common problems.

Table A-1: Troubleshooting

Symptom	Possible Solution
Receiver fails to power	• Verify polarity of power leads • Check integrity of power cable connectors • Check power input voltage (9 to 36 VDC) • Check current restrictions imposed by power source (minimum available should be > 1.0 A)
No data from VS101/111	• Check receiver power status to ensure the receiver is powered (an ammeter can be used for this) • Verify desired messages are activated (using PocketMax or $JSHOW in any terminal program) • Ensure the baud rate of the VS101/111 matches that of the receiving device • Check integrity and connectivity of power and data cable connections
Random data from VS101/111	• Verify the RTCM or binary messages are not being output accidentally (send a $JSHOW command) • Ensure the baud rate of the VS101/111 matches that of the remote device • Potentially, the volume of data requested to be output by the VS101/111 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 VS101/111 has a clear view of the sky • Verify the lock status of GPS satellites (this can be done with PocketMax)
No beacon lock	• Beacon reception capability is only present on VS111 model • Verify the receiver is tuned to the correct frequency and bit rate • Ensure beacon signal coverage is expected in your area • Ensure environmental noise is not masking the signal, reducing the SNR reading
No SBAS lock	• Verify the VS101/111 has a clear view of the sky • Verify the lock status of SBAS satellites (this can be done with PocketMax - monitor BER value) • Set SBAS mode to automatic with the $JWAASPRN,AUTO command **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 **Note:** The standard antenna mounting configuration provides a 0.5° heading accuracy at 95% confidence. If you require more performance, you will need to increase the antenna separation (maximum recommended separation is 2.0 m). See Table D-1 on page 54 for antenna separation specifications. • Recalibrate the tilt sensor with $JATT,TILTCAL command if heading is calculated then lost at consistent time intervals • Heading is from primary GPS antenna to secondary GPS antenna • $JATT,SEARCH command forces the VS101/111 to acquire a new heading solution (unless gyro is enabled) • Enable GYROAID to provide heading for up to three minutes during GPS signal loss • Enable TILTAID to reduce heading search times • Monitor the number of satellites and SNR values for both antennas within PocketMax—at least four satellites should have strong SNR values • Potentially, the volume of data requested to be output by the VS101/111 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 • 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) • 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: FAQs

This appendix covers power, communication and external RTCM questions. For GPS and Heading troubleshooting, see Chapter 5, “Operating Basics.”

Q: Can the COAST technology work with corrections from an external source?

A: Yes, the VS101/111 will operate in a similar fashion with the COAST technology as when using SBAS or Beacon corrections. However, SBAS corrections have the advantage that they are separated into separate error components, allowing the VS101/111 to anticipate how errors will change over the coasting period with more consistent accuracy and for a longer period than regular RTCM range corrections.

Q: My VS101/111 does not appear to be communicating, what do I do?

A: This could be one of a few issues. You should check the following items.

1. Examine the power cable and its connector for signs of damage.
2. Ensure that you are properly powering the system with the correct voltage (9 to 36 Volts) by measuring the voltage at the receiver end of the power cable when the cable is connected to the power source.
3. Check current restrictions imposed by power source (minimum available should be > 1.0 A).
4. Verify that the LCD has turned on, that time is incrementing in the upper right-hand corner of the display and configure the COM port baud rates appropriately through the menu system.
5. Verify polarity of power leads.
6. Check 1.0 A inline power cable fuse.
7. Since you are required to terminate the power input with your choice of connector, ensure that you have made a good connection to the power supply.
8. Consult the troubleshooting section of the other device’s reference manual to determine if there may be a problem with that device.

Q: Am I able to configure the two serial ports with different baud rates?

A: Yes, the ports are independent. For instance, you may have one port set to 4800 and the other to 19200 or vice versa.

Q: Am I able to have the VS101/111 output different NMEA messages through the two ports?

A: Yes, you may have different NMEA messages turned on for the two serial ports. Further, these NMEA messages may also be at different update rates.

Q: How can I determine what the current configuration of the VS101/111 is?

A: You can view the current configuration from various screens of the menu which show all configurable items of the receiver. Alternately, you may return the receiver to a previously saved configuration by selecting “Config Wizard> Use Previous” to return to a known configuration.

Q: My VS101/111 does not appear to be using corrections from an external correction source. What could be the problem?

A: This could be due to a number of issues. Check the following items.

1. Make sure that the corrections are of an RTCM SC-104 protocol.
2. Check to see that the baud rates of the port used by the VS101/111 matches that of the external correction source.
3. The external correction source should be using an 8 data bit, no parity, 1 stop bit (8-N-1) serial port configuration.
4. Inspect the cable connection to ensure there's no sign of damage.
5. Check the pin-out information for the cables to ensure that the transmit line of the external correction source is connected to the receive line of the VS101/111's serial port and that the signal grounds are connected.

   Save the configuration as the profile named "RTCM" in the Configuration Wizard, cycle the power and load the RTCM profile.

Q: Why am I not getting data from the VS101/111?

A: There are several possible reasons for this. Check the following items.

1. Check receiver power status LED to ensure the receiver is powered.
2. Verify the VS101/111 is locked to a valid DGPS signal (this can often be done on the receiving device or with PocketMax).
3. Verify the VS101/111 is locked to GPS satellites (this can often be done on the receiving device or with PocketMax).
4. Check integrity and connectivity of power and data cable connections.

Q: Why am I getting random data from VS101/111?

A: There are three possible reasons for this. Check the following items.

1. Verify the RTCM or the Bin95 and Bin96 messages are not being output accidentally (send a $JSHOW command).
2. Verify baud rate settings of VS101/111 and remote device match correctly.
3. Potentially, the volume of data requested to be output by the VS101/111 could be higher than the current baud rate supports. Try increasing the baud rate to 38400 for all devices or reduce the amount of data being output.

Q: I could not install my antennas so that they are the same height. How do I calibrate for the height offset?

A: You may enter an non-level bias calculation that adjusts the pitch/roll output in order to calibrate the measurement if the antenna array is not installed on a horizontal plane. To calibrate the pitch/roll reading, send the following command:

$JATT,PBIAS,x<CR><LF>

where x is a bias (in degrees) that will be added to the pitch/roll measurement. The acceptable pitch bias range is -15.0° to 15.0° (default is 0.0°).

To determine the current pitch compensation angle, send the following command:

$JATT,PBIAS<CR><LF>

The pitch/roll bias is added after the negation of the pitch / roll measurement (if so invoked with the $JATT,NEGTILT command).

Appendix C: Menu Map

This appendix shows the complete menu map for each menu (listed below) on the VS101/111 main screen.

- Vector
- GPS
- Differential Source (menu item will be the selected differential source, such as SBAS or Autonomous)
- Configuration Wizard
- System Setup

Vector Menu

Use the Vector menu to view and adjust Vector settings. Options vary depending on whether you select Pitch or Roll and include such items as aiding features, time constants, heading bias, and antenna separation.

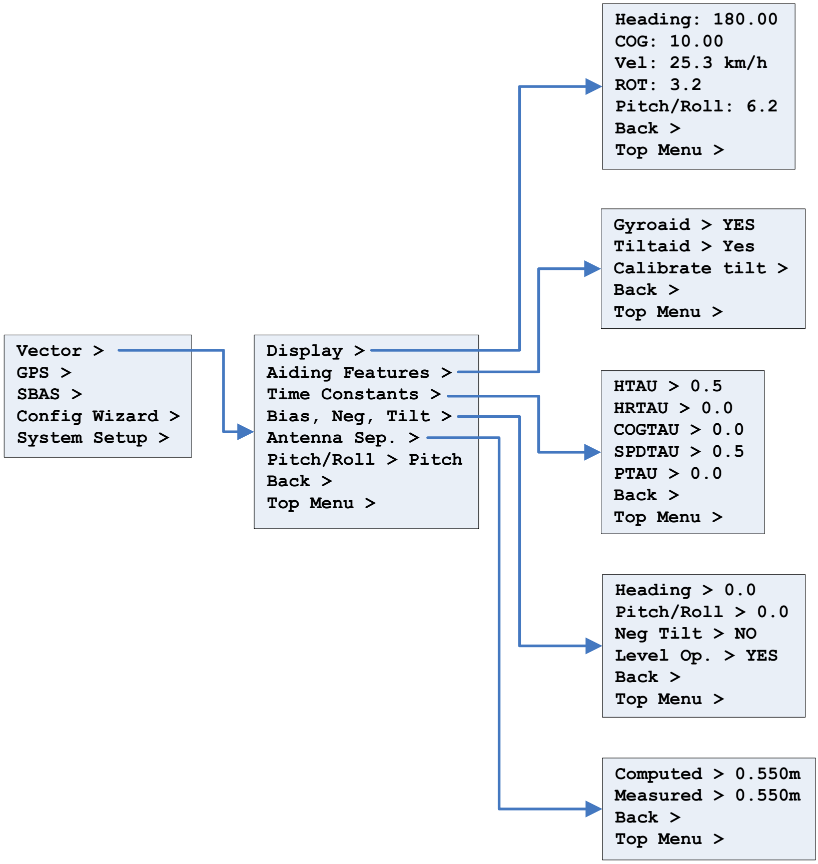


Figure C-1: Vector menu

GPS Menu

Use the GPS menu to view and edit your GPS settings. Settings include the data port outputs, specific positioning parameters, UTC time offset, and satellite visibility and positioning information.

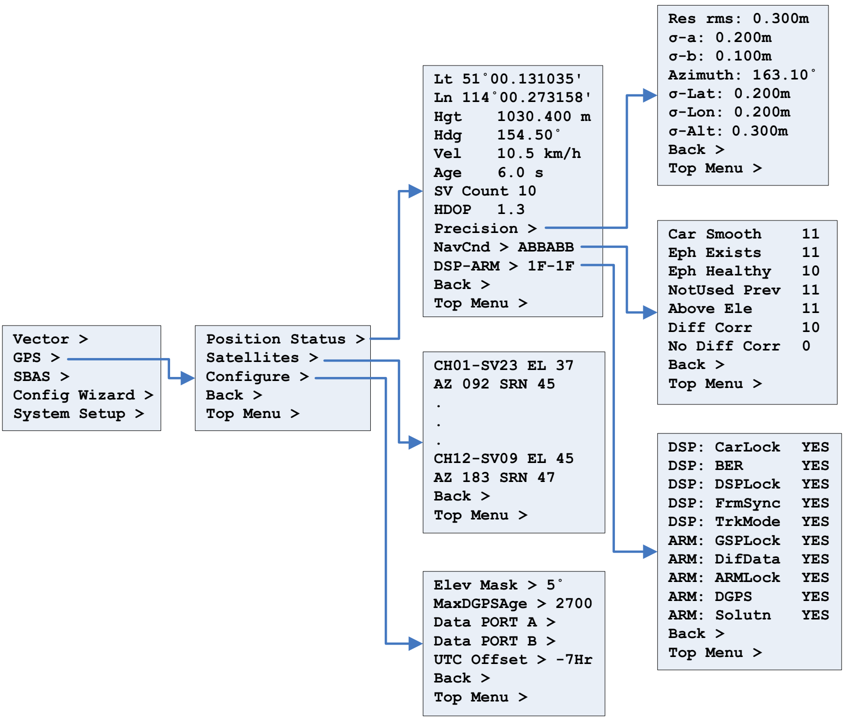


Figure C-2: GPS menu

Differential Source Menu

Use the Diff menu to view your differential settings. The name of the differential menu shown in the display reflects your current differential source. For example, if you are using SBAS, then SBAS appears as the third menu item on the main screen and the associated SBAS submenus are available, as shown in Figure C-3.

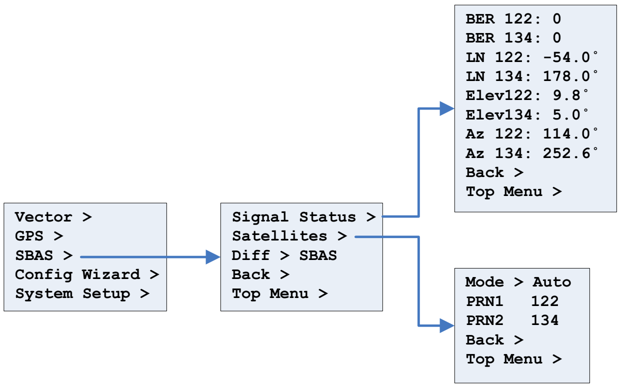


Figure C-3: SBAS menu

The following available differential sources depend on the VS101/111 model (VS101 or VS111) and the configuration you purchased.

- SBAS
- Beacon
- External RTCM
- Autonomous

From this menu, you can view your current status or adjust satellites tracked.

Figure C-4 through Figure C-6 show the complete menu maps for the Beacon, External RTCM, and Autonomous differential sources, respectively.

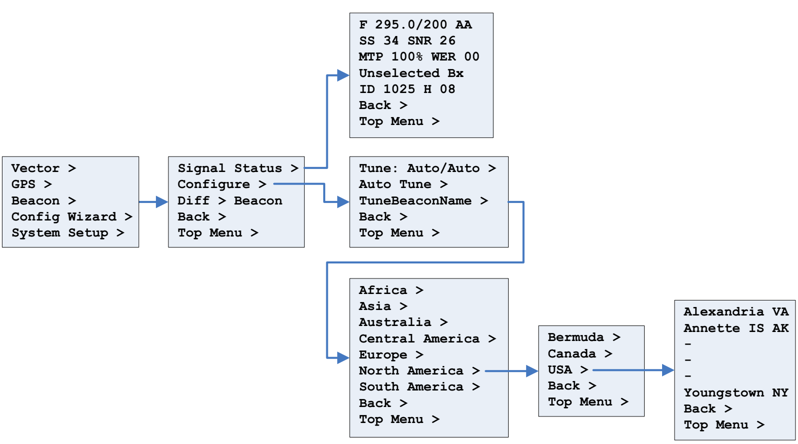


Figure C-4: Beacon menu

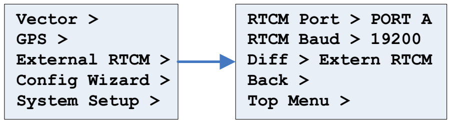


Figure C-5: External RTCM menu

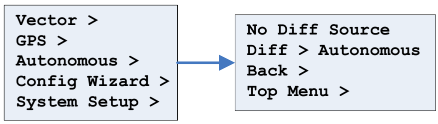


Figure C-6: Autonomous menu

Configuration Wizard Menu

The Configuration Wizard walks you through basic settings to get up and running. See “Configuration Wizard” on page 27 to view the Configuration Wizard menu map.

System Setup Menu

The System Setup menu allows you quickly view and edit current system settings. General settings include such items as current applications, units, baud rates, logs, LED contrast, subscription code, display orientation (you can flip the display 180° by selecting "YES" under FLIP DISPLAY), and language.

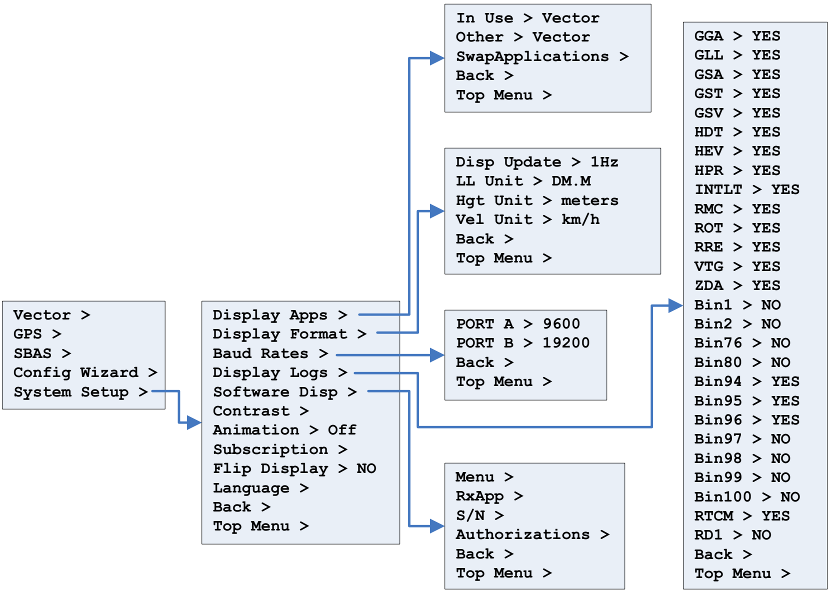


Figure C-7: System Setup menu

Appendix D: Technical Specifications

VS101/111 Receiver Specifications
A21 Antenna Specifications
A31 Antenna Specifications

VS101/111 Receiver Specifications

Table D-1 below through Table D-6 on page 55 list the technical specifications of the VS101/111.

Table D-1: VS101/111 GPS sensor specifications

Item	Specification
Receiver type	L1, C/A code with carrier phase smoothing
Channels	Two 12-channel, parallel tracking (Two 10-channel when tracking SBAS)
Update rate	Standard 10 Hz; optional 20 Hz (position and heading)
Horizontal accuracy	< 0.02 m 95% confidence (RTK[1,4]) < 0.6 m 95% confidence (DGPS[1]) < 2.5 m 95% confidence (autonomous, no SA[2])
Heading accuracy	< 0.30° rms @ 0.5 m antenna separation < 0.15° rms @ 1.0 m antenna separation < 0.10° rms @ 2.0 m antenna separation
Pitch/roll accuracy	< 1° rms
Heave accuracy	30 cm
Timing (1PPS) accuracy	50 ns
Rate of turn	90°/s max
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)
Antenna input impedance	50 Ω
Maximum speed	1,850 kph (999 kts)
Maximum altitude	18,288 m (60,000 ft)

Table D-2: VS101/111 beacon sensor specifications (VS111)

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 D-3: VS101/111 communication specifications

Item	Specification
Serial ports	2 full-duplex RS-232
Baud rates	4800 - 115200

Table D-3: VS101/111 communication specifications (*continued)*

Item	Specification
Correction I/O protocol	RTCM SC-104, L-Dif[3], RTK[3]
Data I/O protocol	NMEA 0183, Crescent binary[3], L-Dif[3], RTK[3]
Timing output	1 PPS CMOS, active low, falling edge sync, 10 kΩ, 10 pF load
Event marker input	HCMOS, active low, falling edge sync, 10 kΩ

Table D-4: VS101/111 power specifications

Item	Specification
Power input voltage	9 to 36 VDC
Power consumption	~ 5 W nominal
Current consumption	~ 360 mA @ 12 VDC
Power Isolation	Isolated power supply
Antenna voltage	~ 5 VDC
Antenna short circuit protection	Yes
Antenna gain input range	10 to 40 dB
Antenna input impedance	50 Ω

Table D-5: VS101/111 mechanical specifications

Item	Specification
Dimensions	18.9 cm L x 11.4 cm W x 7.1 cm H (7.4” L x 4.5” W x 2.8” H)
Weight	~ 0.86 kg (1.9 lb)
Status indication (LED)	Power, primary GPS lock, secondary GPS lock, DGPS lock, and heading lock
Power switch	Miniature push-button
Power connector	2-pin, micro-Conxall
Data connectors	DB9-female (x2)
Antenna connectors	TNC-female (x2)

Table D-6: VS101/111 environmental specifications

Item	Specification
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Operating temperature	-30°C to +70°C (-22°F to +158°F)
Enclosure rating	IP69K
Shock and vibration	EP 455
Humidity	95%, non-condensing

A21 Antenna Specifications

Table D-7 below through Table D-11 on page 56 list the technical specifications of the A21 antenna.

Table D-7: A21 GNSS sensor specifications

Specification	Description
GNSS reception	GPS, SBAS, and OmniSTAR®
GNSS frequency	1.575 GHz (L1)
LNA gain	30 dB
LNA noise	< 2.0 dB

Table D-8: A21 L-Band sensor specifications

Specification	Description
L-Band frequency	1.525 - 1.585 GHz
L-Band LNA gain	30 dB

Table D-9: A21 power specifications

Specification	Description
Input voltage	3.3 to 12 VDC
Input current	24 mA, typical

Table D-10: A21 mechanical specifications

Specification	Description
Enclosure	Aluminum base with ASA plastic cap
Dimensions	7.0 H x 13.0 D (cm) 2.8 H x 5.1 D (in)
Weight	380 g (13.4 oz)
Mounting thread	5/8" female thread
RF connector	TNC

Table D-11: A21 environmental specifications

Specification	Description
Operating temperature	-30°C to +70°C (-22°F to +158°F)
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Enclosure rating	IP69K
Shock and vibration	EP455
Humidity	96% non condensing

A31 Antenna Specifications

Table D-12 below through Table D-17 on page 58 list the technical specifications of the A31 antenna.

Table D-12: A31 GNSS sensor specifications

Specification	Description
GNSS reception	GPS, SBAS, OmniSTAR, and Beacon
GNSS frequency	1.575 GHz (L1)
LNA gain	30 dB
LNA noise	< 2.0 dB

Table D-13: A31 L-Band sensor specifications

Specification	Description
L-Band frequency	1.525 - 1.585 GHz
L-Band LNA gain	30 dB

Table D-14: A31 Beacon sensor specifications

Specification	Description
Beacon frequency	283.5 - 325 KHz
Beacon LNA gain	30 dB

Table D-15: A31 power specifications

Specification	Description
Input voltage	5 to 12 VDC
Input current	50 to 60 mA

Table D-16: A31 mechanical specifications

Specification	Description
Enclosure	Lexan
Dimensions	10.4 H x 14.5 D (cm) 4.1 H x 5.7 D (in)
Weight	734 g (25.9 oz)
Mounting thread	1" coarse thread (5/8" adapter available)
Connector	TNC

Table D-17: A31 environmental specifications

Specification	Description
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Operating temperature	-30°C to +70°C (-22°F to +158°F)
Enclosure rating	IP69K
Shock and vibration	EP 455
Humidity	95%, non-condensing

[1]Depends on multipath environment, antenna selection, 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]Hemisphere GPS proprietary

[4]Up to 10 km baseline length

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