

**Hemisphere**  
GPS



# Crescent VS100 Series

## User Guide

Part No. 875-0179-000 Rev. C2

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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Hemisphere GPS Precision GPS Applications

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

Other U.S. and foreign patents pending.

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Contact your local dealer for technical assistance. To find the authorized dealer near you, call or write us at:

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Calgary, Alberta, Canada T2G 3C4

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Fax number: (403) 259-8866  
E-mail address: [sales@hemispheregps.com](mailto:sales@hemispheregps.com)

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Hemisphere GPS hereby warrants solely to the end purchaser of the Products, subject to the exclusions and procedures set forth herein below, that the Products sold to such end purchaser shall be free, under normal use and maintenance, from defects in material and workmanship for a period of 12 months from delivery to such end purchaser. Repairs and replacement components are warranted, subject to the exclusions and procedures set forth below, to be free, under normal use and maintenance, from defects in material and workmanship for 90 days from performance or delivery, or for the balance of the original warranty period, whichever is greater.

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The end purchaser's exclusive remedy under this warranty shall be limited to the repair or replacement, at the option of Hemisphere GPS, of any defective Products or components thereof. The end user shall notify Hemisphere GPS or a Hemisphere GPS approved service center immediately of any claimed defect. Repairs shall be made through a Hemisphere GPS approved service center only.

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- Specifications provided by the US Department of Defense for GPS Positioning,
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To the greatest extent possible, this warranty shall be governed by the laws of the State of Arizona. In the event that any provision hereof is held to be invalid by a court of competent jurisdiction, such provision shall be severed from this warranty and the remaining provisions shall remain in full force and effect.

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8444 N. 90th Street, Suite 130  
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Phone: 480-348-9919 Fax: 480-348-6370  
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## **Chapter 1: Introducing the VS100**

Overview

What's Included

Parts List



## Overview

Precise applications demand the heading and positioning performance of the VS100 Series GPS Compass. The VS100 Series is designed to provide a highly-accurate GPS heading which takes into account the pitch, roll and speed of various vehicles and vessels. It features our Crescent-based receiver and two separate antennas to achieve heading accuracy ranging from 0.1 to 0.3 degrees (rms), depending on the antenna separation. Ideal for professional machine control and navigation, the VS100 Series also offers a differential positioning performance of less than 60 centimeters, 95 percent of the time.

The VS100 Series includes two versions, the VS100 and the VS110. The VS100 kit comes with two A20 antennas, and supports GPS and SBAS signals.

The VS110 kit comes with an A20 and an A30 antenna, and supports GPS, SBAS, and Beacon signals.

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**Note:** The phrase “VS100 Series” is used throughout this manual as a generic name for both the VS100 and the VS110 versions.

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**Figure 1-1. VS100 GPS Compass.**

Powered by Hemisphere GPS' Crescent Receiver Technology, the VS100 Series GPS Compass 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 VS100 Series offers superior accuracy and stability.



## 1: Introducing the VS100

### What's Included

Please look over the parts shipped with your system. If any part appears to have been damaged during shipping, please contact your freight carrier. If any parts are missing, please contact your dealer.



**Figure 1-2. VS100 Series system parts diagram.**



## Parts List

**Table 1-1: VS100 Series Parts List**

Diagram Letter	Part Name	Qty	Part Number
Not pictured	Marketing CD (Includes user guide)	1	0132-0127
A	Crescent receiver model (one of the following):  VS100 VS110	1	803-3014 803-3015
B	Receiver mounting bracket (two brackets)	1	710-0056
C	*A20 antenna	2	804-3032
D	Antenna magnetic mount (with mounting plates)	2	
E	Antenna cable (TNC-TNC), 3 m	2	052-0004
F	Data serial cable (DB9-DB9), 3 m	2	050-0011
G	Power cable, 3 m	1	054-0009
H	Adapter, 5/8" male to 1" female, PVC	2	600-1213

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**Note:** The VS100 kit comes with two A20 antennas. The VS110 kit comes with one A20 antenna, one A30 antenna, and one A20 height adaptor. The basic mounting instructions apply to all antenna installations.

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## **Chapter 2: Understanding the VS100**

GPS Overview

VS100 Series Overview

## GPS Overview

The VS100 Series automatically tracks and calculates position information regardless of whether you are using GPS or differential GPS (DGPS) corrections.

When the VS100 Series is turned on for the first time, it attempts to acquire any available GPS satellites within view and to use the satellite-based augmentation system (SBAS) differential service.

If SBAS is not available in your area, you may be able to use Beacon corrections, depending on your model. Alternatively, you may use an external source of differential corrections.

### GPS Operation

The following sections give a general overview of the VS100 Series' internal GPS operations.

**Automatic Tracking** - The VS100 Series automatically searches for GPS satellites, acquires the signals and calculates the navigation information required for positioning and tracking. All this is done automatically without operator input.

**Receiver Performance** - The VS100 Series finds four or more GPS satellites in the visible sky and uses the information from those satellites to compute a position (within 2.5 meters).

There is a margin of error within the GPS data calculations. To compensate for that margin of error, the VS100 Series also tracks a differential correction. Using the differential corrections, the margin of error in the position calculation is decreased to less than 1 meter.

There are two main issues that affect GPS receiver performance: antenna positioning and satellite acquisition quality.

When the VS100 Series' antennas are properly positioned, with a clear view of the sky, the receiver uses the coded information transmitted



from the satellites to the GPS antennas in order to calculate a range to each satellite.

GPS is essentially a timing system. Ranges are calculated by timing how long it takes for the GPS signal to reach the GPS antenna. To calculate the geographic location, the GPS receiver uses a complex algorithm which includes the satellite locations and ranges to each satellite. Receiving signals from 4 or more of satellites allows the GPS receiver to compute more accurate 3-dimensional coordinates.

### **Differential Operation**

One of the benefits of Differential GPS (DGPS) is that it mitigates the effects of errors, including atmospheric errors, timing errors and satellite orbit errors, while at the same time enhancing system integrity.

When using only standard GPS signals (autonomous mode), the VS100 Series automatically tracks and calculates a position within 2.5m accuracy. In order to improve positioning quality to sub-meter levels, the VS100 Series receiver utilizes differential corrections from one of the following sources:

- SBAS (WAAS, EGNOS, MSAS and others)
- Hemisphere GPS' patented e-Dif<sup>®</sup> or L-Dif<sup>®</sup> applications (requires a subscription code)
- radio beacon corrections (model dependent)

For more information on available differential services and the associated commands, please refer to Hemisphere GPS' GPS Technical Reference manual.

**SBAS tracking** - The VS100 Series will automatically scan and track SBAS signals. In North America the SBAS network of satellite is referred to as WAAS, in Europe it is EGNOS, and in Japan it is MSAS. The VS100 Series features two-channel tracking. This enhances the VS100 Series ability to maintain a lock on an SBAS satellite when more than one satellite is in view. This redundant tracking approach provides more





## 2: Understanding the VS100

consistent tracking of SBAS signals when in an area where satellite signal blockage is possible.

**e-Dif** - In extended differential (e-Dif), the receiver can perform with differential-like accuracy for extended periods without an external differential service. e-Dif models the effects of various errors for extended periods by computing its own set of pseudo-corrections. e-Dif may be used in any geographic area and is especially useful where SBAS networks have not yet been installed, such as South America, Africa, Australia and Asia.

The positioning performance of the receiver depends on how well e-Dif is able to model the environmental errors. The more accurately e-Dif is able to model the errors, the longer that e-Dif will provide reliable, accurate positioning. The accuracy of positioning will slowly drift over time, which limits use of e-Dif to approximately 30 to 40 minutes. However, if your application can tolerate a wider range of positioning accuracy and therefore certain amount of drift, e-Dif can be used for longer periods. Our testing has shown that accuracy will often be better than 1.0 m virtually 95% of the time after 30 minutes.

**L-Dif/RTK** - Local differential (L-Dif) (a technique exclusive to Hemisphere GPS) and Real Time Kinematic (RTK) technology are available on Crescent based GPS receivers. RTK and L-Dif require the use of two separate receivers. Both L-Dif and RTK make use of a stationary base station (primary receiver) unit that broadcasts corrections over a wireless link to the rover (secondary receiver) unit. The localized corrections are processed on the rover to achieve superior accuracy and repeatability. Performance testing has shown positioning accuracy at the centimeter level.

**Beacon Operation** - Many marine authorities, such as coast guards, have installed networks of radio beacons that broadcast DGPS corrections. There are nearly 200 beacon stations throughout the world. Increasingly, this radio beacon network is also being used for land based applications. The VS110 comes equipped with an integrated dual-channel beacon receiver. The VS110 can automatically use the signal



from the closest beacon station, or you can manually tune it to a specific signal.

**SBAS Satellite Signal Loss? No Problem.**

The exclusive Hemisphere GPS COAST™ software enables VS100 Series receivers to use old DGPS correction data for 40 minutes or more without significantly affecting the quality of positioning.



## VS100 Series Overview

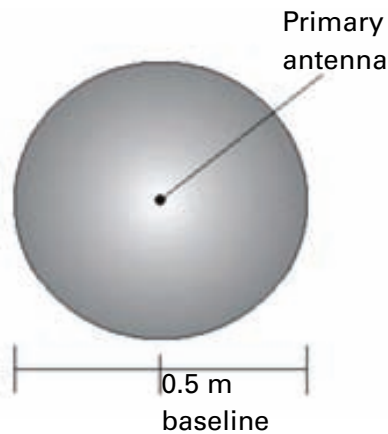
The VS100 Series provides accurate, reliable heading and position information at high update rates. It consists of a high performance GPS receiver and two multipath-resistant antennas for GPS signal processing.

The VS100 Series uses moving base station Real-Time Kinematic (RTK) technology to achieve very precise heading accuracies.

### Moving Base Station RTK

RTK technology uses two antennas. One antenna is designated as the primary GPS, while the other is designated as the secondary GPS.

The two antennas are mounted at a leveled fixed distance from each other. The default distance is 0.5 meters. Imagine a sphere surrounding the primary antenna. In theory, the secondary antenna will only fall on the surface of the sphere surrounding the primary antenna. Since the location of the secondary antenna is constrained to a particular area, the VS100 Series is able to limit one variable when computing GPS satellite positioning data.



**Figure 2-1. Primary antenna's search volume.**



Therefore, when the VS100 Series computes a position it is based on the center of the primary antenna. Using both L1 GPS C/A code and carrier phase data, the VS100 Series' receiver can calculate the location of the secondary antenna. This is calculated to a very highly precise, sub-centimeter level. The positions of the primary and secondary antennas in relations to each other are used to determine heading.

---

**Note:** The VS100 Series RTK algorithm only uses GPS to calculate heading. Differential corrections are not used in this calculation and will not affect heading accuracy.

---

### Supplemental Sensors

The VS100 Series contains an integrated tilt sensor and gyro. The tilt sensor and the gyro may be turned on or off individually; however, the functionality of the VS100 is fully optimized when both are used.

Both sensors act to reduce the RTK search range, which improves heading startup and re-acquisition times. This also improves heading reliability and accuracy by eliminating other possible errors.

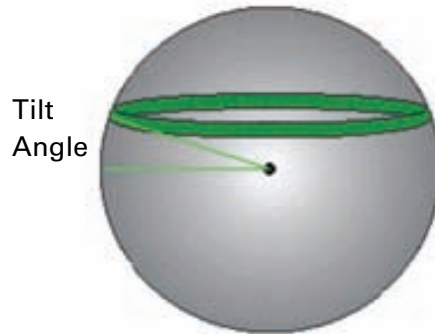
Please refer to the GPS Technical Reference manual for specific commands to re-calibrate, query or change the status of these sensors.

**Tilt aiding** - The VS100 Series' internal tilt sensor (accelerometer) comes factory calibrated and enabled. The tilt sensor is able to constrain the RTK search range because the VS100 knows the approximate inclination of the secondary antenna in relation to the primary antenna.



## 2: Understanding the VS100

The tilt sensor is able to limit the search space to a horizontal ring on the surface of the sphere. By reducing the search area, startup and re acquisition times are decreased considerably. (See Figure 2-2 .)



**Figure 2-2. VS100 Series' tilt aiding.**

**Gyro aiding** - The gyro automatically initializes and calibrates itself whenever power is turned on to the unit. If you would like to manually calibrate the gyro, commands are available in the GPS Technical Reference manual. When the gyro is first initializing, the gyro must calibrate itself under typical operating conditions.

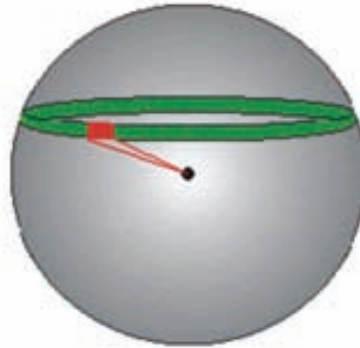
For example, if you will be using the VS100 Series on a high-speed, maneuverable craft, you must use the receiver under typical conditions for the first 5 to 10 minutes after turning on power, rather than sitting stationary.

The VS100 Series' internal gyro offers two benefits.

1. It decreases re acquisition times when satellite signals are obstructed and the GPS heading is lost. The gyro limits the search area required for RTK by providing a relative change in angle since the last computed heading. When used in conjunction with the tilt



sensor, the search area is reduced to a wedge-shaped range. (See Figure 2-3 .)



**Figure 2-3. VS100 Series' gyro aiding.**

2. It can provide an accurate substitute heading for a short period (depending on the roll and pitch of the vessel), ideally seeing the system through to re-acquisition. The gyro will provide an alternate heading source accurate to within  $1^\circ$  for up to 3 minutes if either antenna loses a GPS signal.

If the signal is lost for more than 3 minutes, the VS100 Series will assume the gyro readings have drifted too far and will no longer provide a heading output.

### **Time Constants**

The VS100 Series has custom time constants. Depending on the type of vessel you are using and how it performs, you may want to adjust the time constants. For instance, if you have a vessel that is very large and not able to turn or pitch quickly, you may want to increase the time constant to smooth the heading, course-over-ground, and speed measurements.

However, you must be careful not to increase or decrease this value if it is not warranted by the performance of the vehicle. The could cause



## 2: Understanding the VS100

incorrect measurements. If you are unsure if you need to adjust this value, it is best to leave it at the default value.

**Heading** - The \$SHEHDT and \$GPHDT messages provide the true heading measurements. The heading time constant allows you to adjust the level of responsiveness of the measurement. The default value of this constant is 2.0 seconds of smoothing when the gyro is enabled. If you turn off the gyro, the equivalent default value of the heading time constant is 0.5 seconds of smoothing. However, if you turn off the gyro, you will need to enter this heading constant manually. Increasing the time constant will increase the level of heading smoothing.

**Pitch** - The \$PSAT,HPR message provides the pitch measurement. The pitch time constant allows you to adjust the level of responsiveness of this measurement. The default value of this constant is 0.5 seconds of smoothing. Increasing the time constant will increase the level of pitch smoothing.

**Heading rate** - The \$HEROT message provides the heading change measurement. The heading rate time constant allows you to adjust the responsiveness level of this measurement. The default value of this constant is 2.0 seconds of smoothing. Increasing the time constant will increase the level of heading smoothing.

**Course-over-ground (COG)** - The \$GPVTG message provides the course-over-ground (COG) measurement. The COG time constant allows you to adjust the level of responsiveness of this measurement. The default value of this constant is 0.0 seconds of smoothing. Increasing the time constant will increase the level of COG smoothing. COG is computed using the primary GPS antenna only, and its accuracy is dependant upon the speed of the vessel (noise is proportional to 1/speed). When stationary, this value is invalid.

**Speed** - The \$GPVTG message provides the speed measurement. The speed time constant allows you to adjust the level of responsiveness of this measurement. The default value of this parameter is 0.0 seconds of



smoothing. Increasing the time constant will increase the level of speed measurement smoothing.









## **Chapter 3: Installing the Hardware**

Mounting the Antennas

Mounting the Receiver

Connecting the Cables

Powering Up the System

## Mounting the Antennas

### Selecting the Antenna Orientation

The VS100 Series GPS compass can be installed to provide heading and either pitch or roll.

The relation of the antennas to the boat's axis determine whether the VS100 Series will output pitch or roll readings.

---

**Note:** The primary antenna is used for positioning and the primary and secondary antennas, working in conjunction, can output heading and pitch/roll values.

---

**Pitch** - The most common installation is for heading and pitch. Orienting the antennas parallel to, and along the centerline of the axis of the boat will provide a true heading.

If you are using a gyrocompass, you can enter a heading bias in the VS100 Series to calibrate the physical heading to the true heading of the vessel.

**Roll** - You can also install the antennas for heading and roll readings. Orienting the antennas perpendicular to the centerline of the boat's axis will provide roll readings.

---

**Note:** If you choose this installation, you will need to enter a heading bias in the VS100 Series. The heading bias will be  $+90^{\circ}$  if the primary antenna is on the starboard side and  $-90^{\circ}$  if the primary antenna is on the port side of the boat.

---

### Planning the Optimal Antenna Placement

Proper antenna placement is important to obtain a high-precision GPS reading. Antennas must be placed:

- with a clear view of the horizon



- away from other electronics and antennas
- along the centerline of the vessel



**Warning!** The primary antenna must be installed along the centerline of the vessel. There is no way to adjust the position readings if the primary antenna is installed off the centerline. The positions are computed for the primary antenna.

---

- on a level plane
- at a maximum separation of 2.0 m (default is 0.5 m)
- away from radio frequencies
- as high as possible

For the best results, the antennas should be oriented so that the antennas' connectors face the same direction

See Figure 3-1 through Figure 3-3 for examples.

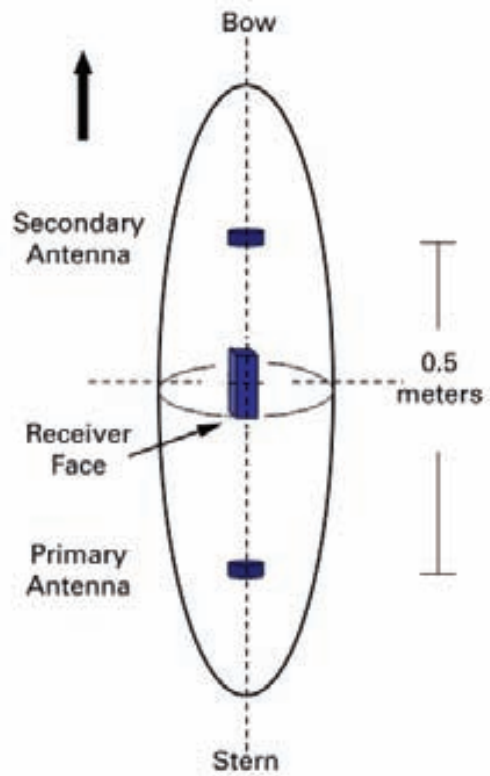
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**Note:** In the VS110 kit, the A30 antenna is used for positioning, and should be mounted as the primary antenna.

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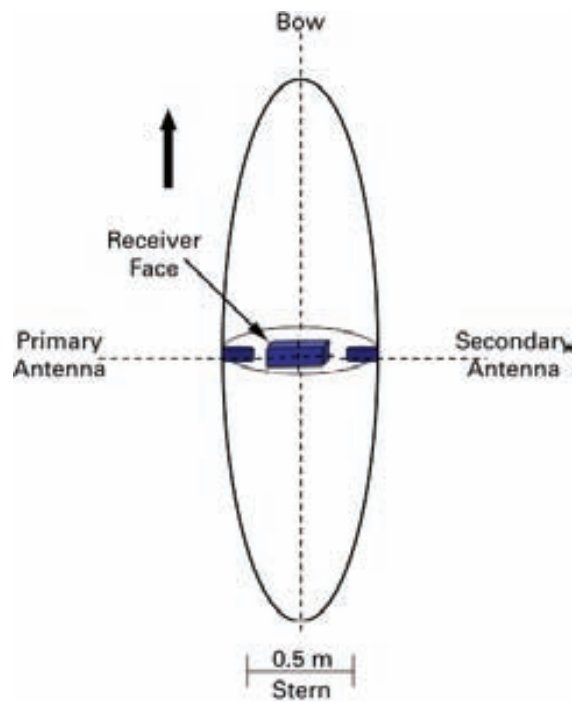


### 3: Installing the Hardware

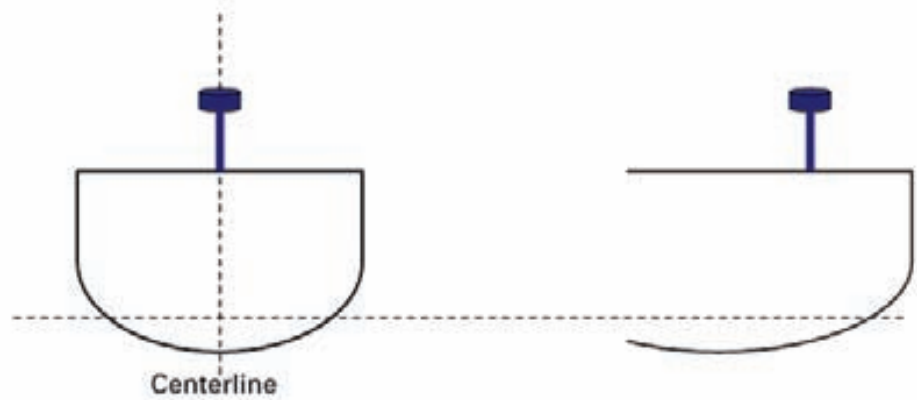


**Figure 3-1. Mounting the Antennas**





**Figure 3-2. Heading and roll installation: top-down view of boat.**



**Figure 3-3. Antenna Installation: Cross-section of boat.**



### 3: Installing the Hardware

#### Mounting the Antennas

The antennas may be mounted with a magnetic mount, pole mount or rail mount configuration.

The antennas can be secured to a 5/8th threaded pole, or a 1-14-UNS-2B threaded mount using the mounting adapters.

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**Note:** The VS110 kit contains one A30 antenna, one A20 antenna, and an A20 height adapter. The A30 antenna has a slightly higher profile than the A20, so the A20 height adapter is used to bring the two antennas level. If the adapter is not used, a non level bias calculation will have to be entered into the system. (See page 56.)

---



**Warning!** The maximum allowable antenna separation is 2.0 meters. Any greater distance may result in an incorrect heading.

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**Magnetic Mounting** - The magnetic mount can be screwed into the bottom of the antenna and mounts 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 "Selecting the Antenna Orientation" on page 20 and "Planning the Optimal Antenna Placement" on page 20.
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 is not covered by the warranty.

---



3.



4. Clean and dry the mounting surface on the vessel.
5. Remove the backing from one side of the foam adhesive and press the metal plate onto the mounting surface on the vessel.
6. Remove the backing from the other side of the foam adhesive.
7. Press the metal plate onto the mounting surface on the vessel.
8. Apply firm pressure to ensure good adhesion.
9. Place the antenna on top of the metal disc.
10. Ensure that 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 "Selecting the Antenna Orientation" on page 20 and "Planning the Optimal Antenna Placement" on page 20.
2. Thread the pole mount into the mounting bracket on the bottom of the antenna. *Hand tighten only.*





### 3: Installing the Hardware



**Warning!** When threading the pole mounts, hand tighten only. Damage resulting from over-tightening is not covered by the warranty.

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**Note:** The pole shown in the photos is not included.

---

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 "Selecting the Antenna Orientation" on page 20 and "Planning the Optimal Antenna Placement" on page 20.
2. Use appropriate hardware to securely attach the antenna to the railing.

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**Note:** The primary antenna is used for positioning and the primary and secondary antennas, working in conjunction, can output heading and pitch/roll values.

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### **Routing and Securing the Antenna Cable**

To route and secure the antenna cables, please review the following guidelines.

The two enclosed antennas each require a 50  $\Omega$  impedance antenna extension cable such as RG-58U (up to a maximum of 15 m (49 ft.) in length) for proper operation.

3. The GPS receiver inside the VS100 Series 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.
4. Regardless of the cable material and length that you choose, you must ensure that cable losses are less than 18 dB of attenuation. Due to variances in the antenna gain and practical attenuation of cable materials and connectors, we recommend reducing this budget to 15 dB. This budget of 15 dB is present to overcome the resulting attenuation of a RF cable.
5. When deciding on an antenna location, consider the amount of cable required. Keep in mind that 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, the cable material will need to be changed. This normally means a more expensive material that has a larger diameter and less flexibility. The standard cables that come with the VS100 Series are of the RG58 material family. Their attenuation is approximately 0.8 dB/m. Including connector losses, the nominal loss of these RF cables is approximately 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 will be required.

For more information on cable length or low-loss cable, please contact your Hemisphere GPS dealer or Hemisphere GPS Technical Support. The following is a short summary of other readily available cable



### 3: Installing the Hardware

materials that have 50  $\Omega$  impedance. Cable loss cited below does not include any 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



**Warning!** When choosing a route for the antenna extension cable:

- Avoid running cables in areas of excessive heat.
- Keep cables away from corrosive chemicals.
- Do not run the cable through door or window jams.
- Keep cables away from rotating machinery.
- Do not bend excessively or crimp the cable.
- Avoid placing tension on the cable.
- Remove unwanted slack from the cable at the receiver end.
- Secure along the cable route using plastic tie wraps.



**Warning!** The VS100 Series receiver provides 5 VDC across the antenna ports. Connection to incompatible devices may result in damage to equipment.



**Warning!** Improperly installed cables near machinery can be dangerous.

---



## Mounting the Receiver

When mounting the VS100 Series receiver, please keep the following guidelines in mind.

- The receiver must be installed inside and away from the elements, and in a location that minimizes vibration, shock, extreme temperatures and moisture.
- It should be positioned horizontally, and with the face of the receiver facing the primary antenna.
- The front panel (menu screen, LEDs and buttons) must be visible and accessible.
- The back panel should be easily accessible in order to switch out cables and turn power on and off.

### Mounting the VS100 Series

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.



### 3: Installing the Hardware

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.

Please review the following warnings before connecting the cables.



**Warning!** Do not run cables in areas of excessive heat. And:

- Keep cables away from corrosive chemicals.
  - Do not run the extension cable through door or window jams.
  - Keep cables away from rotating machinery.
  - Do not bend excessively or crimp cables.
  - Avoid placing tension on cables.
  - Remove unwanted slack from the extension cable at the receiver end.
  - Secure along the cable route using plastic wraps.
- 

## Connecting the Power Source

The power source for the VS100 Series must be between 9 - 36 Volts. Attach the power cable (Part no. 054-0009) to the connector labeled "Ground" to your power source.

## Selecting a Port for GPS Data Message Output

The serial ports of the VS100 Series communicates at the RS-232C interface level with external data loggers, navigation systems and other devices.



There are two serial ports on the back panel of the receiver. These port use a standard DB9 socket connection.



**Figure 3-4. Port connections on the VS100 Series.**

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	19,200	GGA, GSV	1 Hz

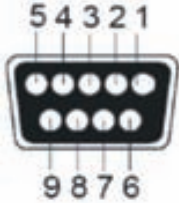




### 3: Installing the Hardware

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

**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.

Select the your NMEA message types and update rates by port using the Configuration Wizard (see “Getting Started” on page 37).



## Powering Up the System

Turn the VS100 Series “ON” or “OFF” using the ON/OFF Power toggle switch on the rear panel.



**Figure 3-5. Turn the VS100 on at the Power toggle switch.**







## **Chapter 4: Getting Started**

Overview

Configuring the System

Disabling the Aiding Features

Adjusting the Time Constants

## 4: Getting Started

### Overview

When you are configuring the VS100 Series, a Configuration Wizard on the receiver interface walks you through the setup options.

The Configuration Wizard allows you to save up to five different configuration settings. These different configurations are useful when using this product on different vessels or for different applications.

If you are using a personal computer, you may also 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, and
- record various types of data.

PocketMax runs on PDA, and PocketMax PC runs on any PC or laptop computer. The most current version of the PocketMax software and the appropriate operating system requirements can be found on the Hemisphere GPS website, or you can contact Hemisphere GPS. For help using PocketMax, please refer to the PocketMax User Guide



## Configuring the System

The Configuration Wizard option appears in the display on the front panel of the VS100 Series. See Table 5-1 on page 48 for an overview of the VS100 Series' 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.

---

**Note:** The basic setup instructions outlined in this section assumes that:

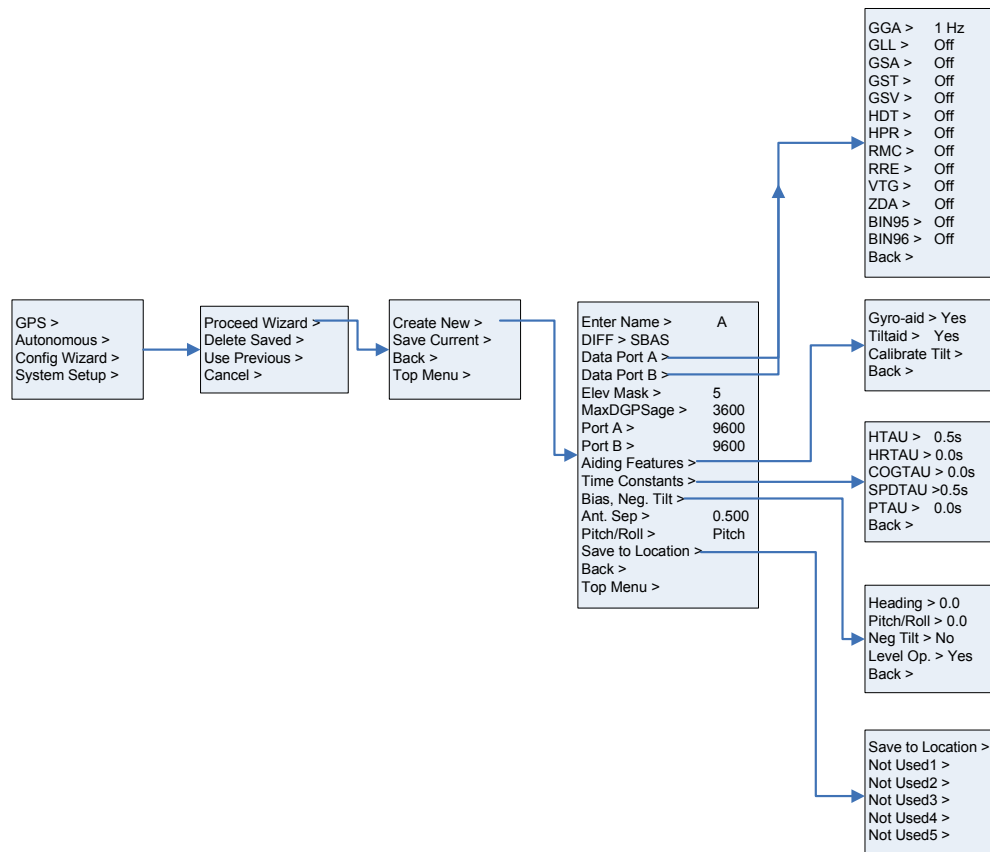
- the antennas are installed parallel to, and along the centerline of, the boat's axis, and
- the antennas are separated by 0.5 meters.

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

---



## 4: Getting Started



**Figure 4-1. Configuration Wizard.**

### Using the Configuration Wizard

1. Select the "Config Wizard" option from the main menu.
2. In the "Config Wizard" submenu, select "Proceed Wizard."
3. Select "Create New" to create a new configuration. You are prompted to enter a name for your configuration.

If you have modified the current receiver setup, you can also save the configuration in this submenu.



4. Use the arrow buttons to select a letter and then press the enter button to save the letter. The cursor will move 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.
5. In the same menu, select "DIFF" to set a DGPS Source. SBAS is the default. The options are SBAS, Beacon, Autonomous, External RTCM, e-Dif, and L-Dif.

---

**Note:** Beacon is only available with the VS110. e-Dif and L-Dif require a subscription.

---

6. 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.
7. 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°.
8. You also have the option to set the maximum DGPS age. The maximum DGPS age is 2700 seconds (45 minutes) by default.
9. 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.

4,800; 9,600; 19,200; 38,400; 57,600; and 115,200 are the available baud rates.

---

**Note:** PocketMax does not support a 115,200 baud rate.

---

10. The "Aiding Features" menu enables you to turn the Gyro-aid and Tiltaid features on or off. For more information on disabling the aiding features, please see "Disabling the Tilt Aid" on page 43 or "Disabling the Gyro-aid" on page 44.
11. 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.





## 4: Getting Started

For details on configuring the time constants, see “Adjusting the Time Constants” on page 45.

12. If you did not install the antenna’s parallel to and along the boat’s centerline, you will need to enter a heading bias in the “Heading” field of the “Bias, Neg. Tilt” menu. The heading bias ( $-180^{\circ}$  –  $+180^{\circ}$ ) 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 ( $\pm 90^{\circ}$ ). You must also enter the bias for roll (see below).

---

13. Enter the bias for pitch or roll ( $-15^{\circ}$  -  $+15^{\circ}$ ) to compensate for any offset from the boat’s centerline. Enter this bias in the “Pitch/Roll” field of the “Bias, Neg. Tilt” sub-menu.
14. If you did not install the antennas 0.5 meters apart, enter the actual antenna separation in the “Ant. Sep” field. The available range is 0 - 2.0 meters
15. Most users install the antennas for pitch. However if you install the antennas for roll, you will need to configure the Crescent VS100 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. (This way, you may 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 VS100 Series' 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 58 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 VS100 Series on a level plane with the antennas. The tilt sensor is located inside of the VS100 Series, so it is important that the VS100 Series be installed on a level horizontal plane.



**Warning!** If you were unable to install the VS100 Series 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 VS100 Series' 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 VS100 Series uses gyro measurements to obtain a heading rate measurement, and the gyro cannot measure beyond this rate.

---

You can turn the gyro-aiding feature off either through the Configuration Wizard or through the Vector menu.



## Adjusting the Time Constants

The VS100 Series 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 that you can set in the Configuration Wizard, including the formulas for finding the optimal value of each time constant for your particular vessel.

For further details, please consult Hemisphere GPS' GPS Technical Reference.

**Table 4-1: Time Constants**

<b>Time Constant</b>	<b>Purpose</b>	<b>Range</b>	<b>Formula</b>
HTAU (Heading)	Adjusts the responsiveness to true heading.	2.0 s with gyro enabled (default)	$htau (s) = 40/\text{max rate of turn } (^{\circ}/s) \text{ (with gyro ON)}$
	If vessel is large and unable to turn quickly, you may want to increase this value.	0.0 to 60 s	$htau (s) = 20/\text{max rate of turn } (^{\circ}/s) \text{ (with gyro OFF)}$
HRTAU (Heading Rate)	Adjusts the responsiveness to the rate of heading change.	2.0 s with gyro enabled (default)	$hrtau (s) = \text{max rate of turn } (^{\circ}/s^2)/10$
	If vessel is large and unable to turn quickly, you may want to increase this value.	0.0 to 60 s	



#### 4: Getting Started

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

<b>Time Constant</b>	<b>Purpose</b>	<b>Range</b>	<b>Formula</b>
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	$\text{cogtau (s)} = \text{max rate of change of course (}^\circ/\text{sec)}/10$
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	$\text{spdtau (s)} = \text{max acceleration (m/s}^2\text{)}/10$
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	$\text{ptau (s)} = 10/\text{max rate of pitch (}^\circ/\text{s)}$





## **Chapter 5: Operating Basics**

Overview

Viewing GPS/DGPS Status

## Overview

Operating the VS100 Series is simple. Turn it on and you are ready to go.

Most users connect the VS100 Series to their existing navigation system during installation. These users will receive the VS100 Series' position and heading updates through the interface of their existing system.

The interface on the front panel of the VS100 Series 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 VS100 Series to an existing navigation system, or are troubleshooting your unit, you may need to view GPS, DGPS or Beacon status on the VS100 Series' display screen.

### Do I Have a Signal?

Figure 5-1 shows which LEDs on the VS100 Series 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 VS100 Series to perform well for up to 45 minutes with old correction data. The amount of time you can "coast" depends on the degree of tolerable drift.

---

**Note:** In order to obtain a full set of SBAS corrections, the VS100 Series 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 VS100 Series' 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.





## 5: Operating Basics

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, there are 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.





## **Appendices**

A: Troubleshooting

B: FAQs

C: Menu Map

D: Specifications

## A: Troubleshooting

### Troubleshooting a Signal Loss

With the Hemisphere GPS COAST and e-Dif technologies, you should be able to continue working in the event of a GPS or DGPS signal loss.

#### General Troubleshooting Checklist (GPS, DGPS, and Beacon) -

1. Check antenna connections.
2. Verify that antennas have an unobstructed view of the sky.
3. Verify the lock status of the satellites.
4. Confirm baud rates match external sources.
5. Verify the differential source.

**Beacon** - When using Beacon signals, also check the following:

1. Verify that the receiver is tuned to the correct frequency and bit rate.
2. Verify antennas are away from potential sources of interference.
3. Ensure Beacon signal coverage is available in your area.

**External RTCM** - When using an external RTCM, also check the following:

1. Verify the pin-out between the RTCM source and the RTCM input port (The "ground" pin and pin-out must be connected, and from the "transmit" from the source must connect to the "receive" of the RTCM input port).
2. Verify that the baud rate of the RTCM input port matches the baud rate of the external source.
3. Ensure corrections are being transmitted to the correct port.

### Troubleshooting Heading

In the event that you don't receive any heading or incorrect heading values, use the following checklist:



1. Verify that the primary antenna faces the stern, and the secondary antenna faces the bow (The primary antenna determines heading).
2. Check the measurement of the antenna separation. The Measured Separation (MSEP) and Calculated Separation (CSEP) values are in meters, and should agree (+/- 1 centimeter.) CSEP will continuously change, so you should average this reading over a few minutes to obtain an approximate value.

---

**Note:** The standard antenna mounting configuration provides a  $0.5^{\circ}$  heading accuracy at 95% confidence. If you require more performance, you will need to increase the antenna separation (maximum recommended separation is 2.0 meters).

---

3. Reduce antenna separation – the separation between the antennas must remain below 2 meters for accurate and timely heading reading output.
4. Verify that the gyro-aid is enabled this will give heading for up to 3 minutes in times of GPS signal loss.
5. Verify that tiltaid is enabled to reduce heading search times.
6. Monitor the number of satellites and the signal-to-noise ratio (SNR) values for both antennas. At least 3 of the satellites should have SNR values above 20.
7. Verify antenna connectors are facing in the same direction.



## B: FAQs

This section covers power, communication and external RTCM questions. For GPS and Heading troubleshooting, please see "Operating Basics" on page 47.

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

*A: Yes, the VS100 Series 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 VS100 Series 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 VS100 Series doesn't 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 in-line 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 equipment.*



**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 4,800 and the other to 19,200 or vice versa.*

**Q: Am I able to have the VS100 Series 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 VS100 Series 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 VS100 Series doesn't 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. You should 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 VS100 Series matches that of the external correction source.*
- 3. The external correction source should be using an 8 data bit, no parity, 1 stop bit 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 VS100 Series' 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 VS100 Series?**

*A: There are several possible reasons for this. Please check the following items.*

- 1. Check receiver power status LED to ensure that the receiver is powered.*



2. Verify that VS100 Series is locked to a valid DGPS signal (this can often be done on the receiving device or with PocketMAX).
3. Verify that VS100 Series 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 VS100 Series?**

*A: There are three possible reasons for this. Please check the following items.*

1. Verify that the RTCM or the Bin95 and Bin96 messages are not being output accidentally (send a \$JSHOW command)
2. Verify baud rate settings of VS100 Series and remote device match correctly
3. Potentially, the volume of data requested to be output by the VS100 Series could be higher than the current baud rate supports. Try increasing the baud rate to 38,400 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 a non-level bias calculation. This calculation adjusts the pitch/roll output in order to calibrate the measurement if the antenna array is not installed on a horizontal plane. The following NMEA message allows you to calibrate the pitch/roll reading.*

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

*Where x is a bias that will be added to the pitch/roll measurement, in degrees. The acceptable range for the pitch bias is -15.0 to 15.0 degrees. The default value is 0.0 degrees.*

*To determine what the current pitch compensation angle is, send the following message.*

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

---

**Note:** The pitch/roll bias is added after the negation of the pitch / roll measurement (if so invoked with the \$JATT,NEGILT command).

---



## **C: Menu Map**

There are five main menus available from the start-up screen of the VS100 Series:

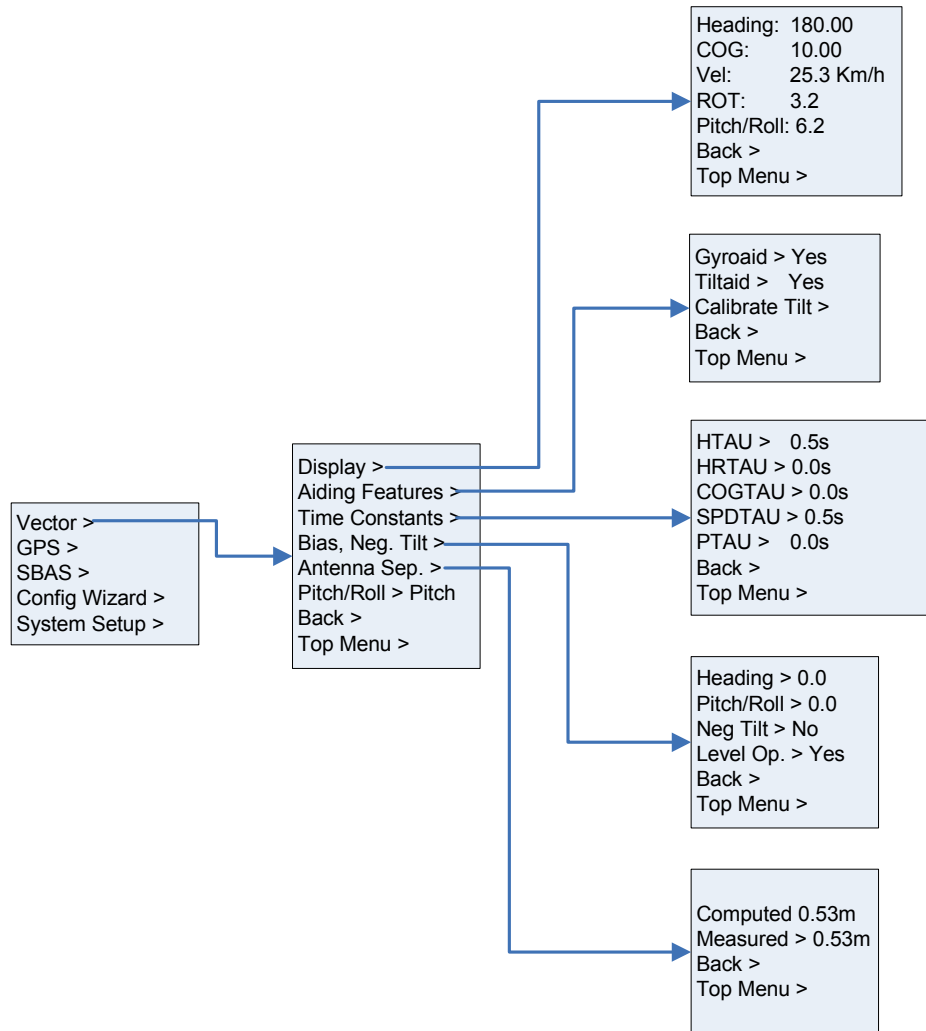
- Vector
- GPS
- SBAS
- Configuration Wizard
- System Setup





## Vector

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



**Figure 6-1. Vector menu.**



### GPS

The GPS menu allows you 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.

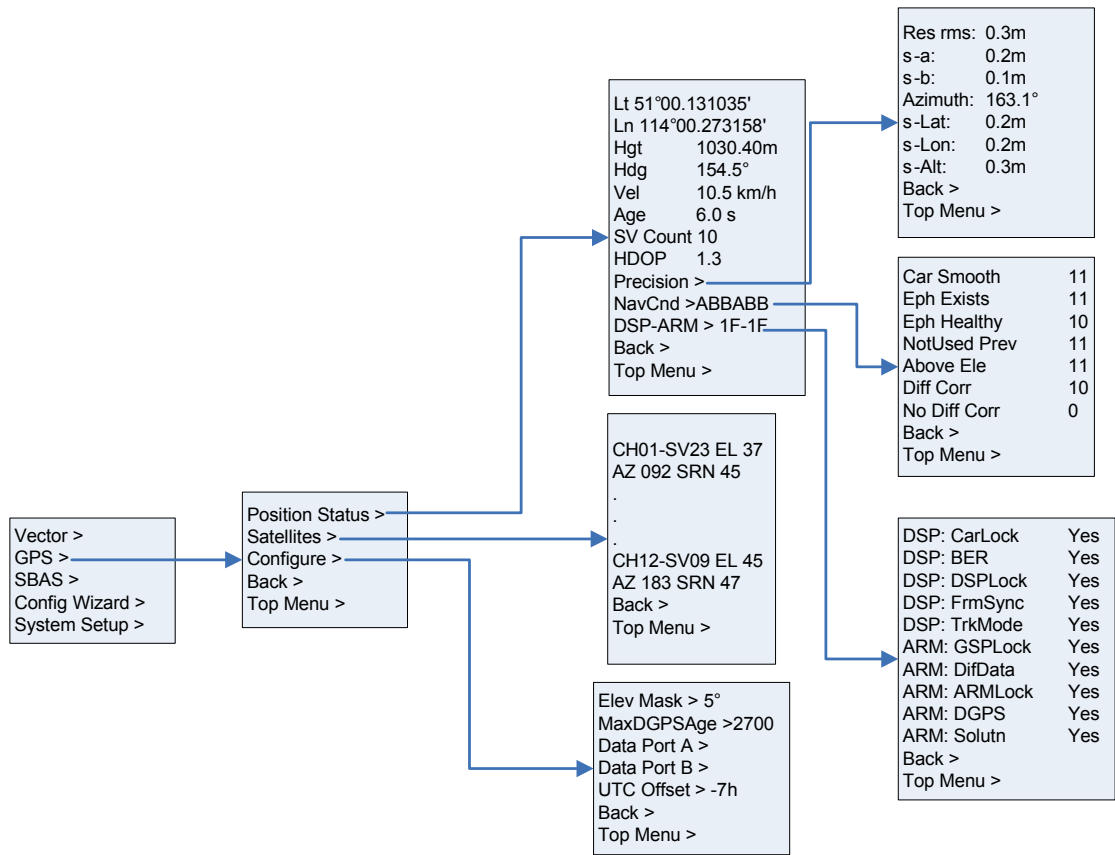


Figure 6-2. GPS menu.

### SBAS

The SBAS menu allows you to view your differential settings. The name of the differential menu shown in the display reflects your current differential source. So, for example, if you are using SBAS, you will see "SBAS" and the associated menu.

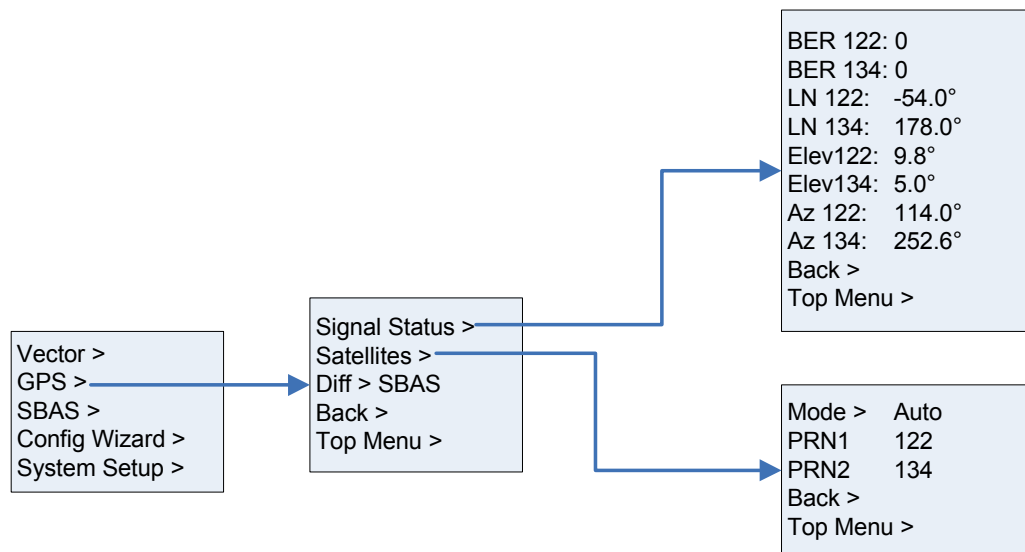


## Appendices

Please find your differential source, below, for available menu options. Differential sources available vary by model and the purchased configuration. Potential options include:

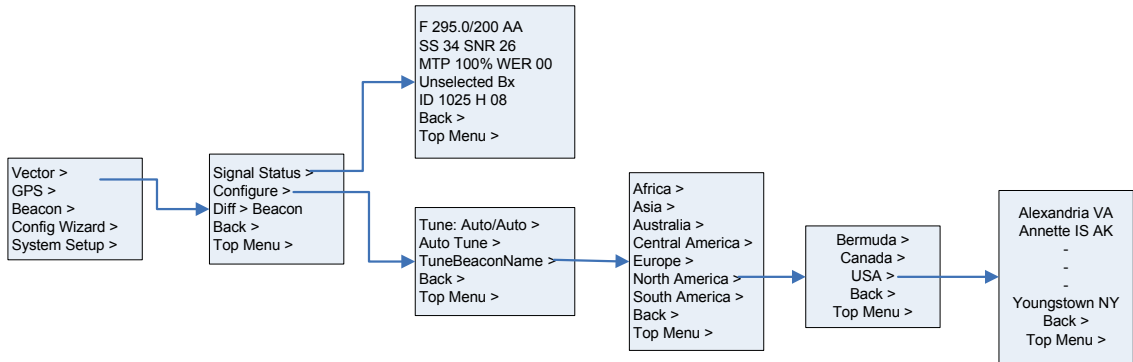
- SBAS
- Beacon
- External RTCM
- Autonomous

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

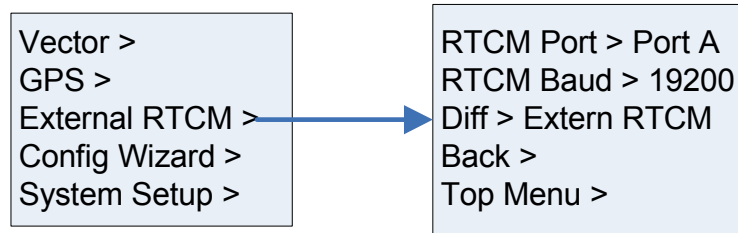


**Figure 6-3. SBAS menu.**

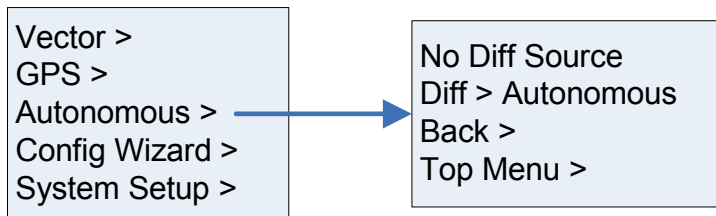




**Figure 6-4. Beacon menu.**



**Figure 6-5. External RTCM menu.**



**Figure 6-6. Autonomous menu.**

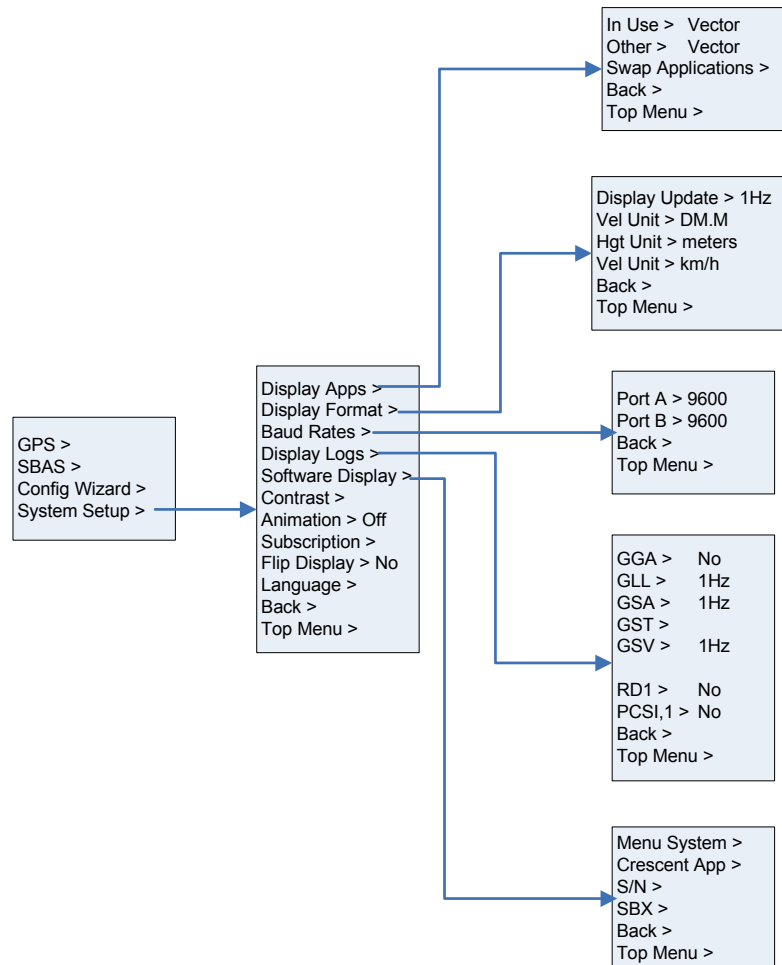
### Configuration Wizard

The Configuration Wizard walks you through basic settings to get up and running. Please see Chapter 4, "Getting Started" to view the Configuration Wizard menu map.



## System Setup

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 6-7. System Setup menu.**



## D: Specifications

### VS100 Series Receiver Specifications

**Table 6-1: GPS Sensor Specifications**

Receiver type	L1, C/A code, with carrier phase smoothing
Channels	Two 12-channel, parallel tracking (Two 10-channel when tracking SBAS)
Horizontal accuracy	< 0.6 m 95% confidence (DGPS)* < 2.5 m 95% confidence (autonomous, no SA)**
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
Update rate (position and heading)	Up to 20 Hz
Pitch/roll accuracy	< 1° rms @ 0.5 m antenna separation
Rate of turn	90° / s max
Start up time	< 60 s typical
Heading fix	< 20 s
Satellite reacquisition	< 1 s

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#### Notes:

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

\*\*Depends on multipath environment, number of satellites in view, and satellite geometry

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**Table 6-2: Beacon Sensor Specifications (VS110)**

Channels	2-channel, parallel tracking
Frequency range	283.5 to 325 kHz
Operating modes	Automatic (signal strength or range), manual and database
Compliance	IEC 61108-4 beacon standard

**Table 6-3: Communication Specifications**

Serial ports	2 full duplex
Interface level	RS-232C
Baud rates	4,800 - 115,200
Correction I/O protocol	RTCM SC-104, L-Dif (Hemisphere GPS proprietary)
Data I/O protocol	NMEA 0183, Crescent binary, L-Dif (Hemisphere GPS proprietary)
Timing output	1 PPS (HCMOS, active high, rising edge sync, 10 k, 10 pF load)
1 PPS accuracy	50 ns

**Table 6-4: Environmental Specifications**

Operating Temperature	-30°C to +70°C
Storage Temperature	-40°C to +85°C
Humidity	95%, non-condensing

**Table 6-5: Power Specifications**

Power Input Voltage	9 to 36 VDC
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**Table 6-5: Power Specifications**

Power Consumption	< 5 W
Current Consumption	< 360 mA @ 12 VDC
Antenna Voltage Output	5 VDC
Antenna Short Circuit Protection	Yes

**Table 6-6: Mechanical Specifications**

Dimensions	189 mm L x 114 mm W x 71 mm H (7.4" L x 4.5" W x 2.8" H)
Weight	0.86 kg (1.9 lb.)
Status indication	Power, primary GPS lock, secondary GPS lock, differential lock, and heading lock
Power switch	Miniature push-button
Power connector	2-pin, micro-Conxall
Data connectors	DB9-female
Antenna connectors	TNC-female

## A20 Antenna Specifications

**Table 6-7: GPS Sensor Specifications**

GPS Frequency Range	1.575 GHz (L1)
GPS Bandwidth	20 MHz
GPS LNA Gain	34 dB
GPS LNA Noise	1.4 dB typical





**Table 6-8: Power Specifications**

Input Voltage	5-12 VDC
Input Current	20-30 mA

**Table 6-9: Mechanical Specifications**

Enclosure Polycarbonate Dimensions	130 mm dia. X 55 mm high (5.1" dia. X 2.2" high)
Weight	363 g (0.8 lb.)
Mounting Thread	5/8" female
Connector	TNC female
Storage Temperature	-40° C to +85°C
Operating Temperature	-30° C to +70°C
Humidity	100% condensing

### **A30 Antenna Specifications**

**Table 6-10: GPS Sensor Specifications**

GPS Frequency Range	1.575 GHz (L1)
GPS Bandwidth	20 MHz
GPS LNA Gain	34 dB
GPS LNA Noise	1.4 dB typical

**Table 6-11: Power Specifications**

Input Voltage	5-12 VDC
Input Current	50-60 mA



**Table 6-12: Mechanical Specifications**

Enclosure Polycarbonate Dimensions	130 mm dia. X 69 mm high (5.1" dia. X 2.7" high)
Weight	590 g (1.31 lb.)
Mounting Thread	5/8"
Connector	TNC female
Storage Temperature	-40° C to +85°C
Operating Temperature	-30° C to +70°C
Humidity	100% condensing





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