Vector 3D GPS

Satellite Compass

Installation & Operation Manual

Certified System
ISO 9001

his 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.

Copyright Notice

Chapter 1: Introduction

Overview

Note: Throughout this manual, the Vector 3D GPS Compass is referred to simply as the 3D.

The 3D is a complete GPS compass and positioning system in a single enclosure that requires only one power/data cable connection. With its CAN support and ease of installation, the 3D is the perfect solution for both marine and land base applications such as mine construction, earthworks and machine guidance.

The 3D is an integrated system that houses the following:

- Crescent Vector II technology
- Dual integrated GPS antennas
- Power supply
- Single axis gyro
- Tilt sensors (two)

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

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

The 3D's GPS antennas are separated by 27 cm between their phase centers, resulting in better than 0.60° rms heading performance. The 3D provides heading and positioning updates of up to 20 Hz and delivers positioning accuracy of better than 1.0 m 95% of the time when using differential GPS corrections from Space Based Augmentation Systems (SBAS).

The 3D GPS receivers may utilize old differential GPS correction data for 40 minutes or more without significantly affecting the positioning quality. The 3D is less likely to be affected by differential signal outages due to signal blockages, weak signals, or interference when using COAST.

If you are new to GPS and SBAS, refer to the GPS Technical Reference for further information on these services and technologies before proceeding.

Parts List

Note: The 3D's parts comply with IEC 60945 Section 4.4: "exposed to the weather."

Part Name	Qty	Part Number
3D receiver	1	31210010
Power/data cable, 15 m (accessory item)*	1	31110053
Serial-to-NMEA 2000 adapter	1	31210011
SI-TEX Tool Kit CD	1	29030052
User Manual	1	29010087

Table 1-1: Parts list

***Note:** if 3D system Part number 11210029 was ordered, use cable part number 31110052 for serial adapter 31210011, rather than cable part number 31110053.

Chapter 2: Installation

Mounting Location

This section provides information on determining the best location for the 3D.

Note: Mounting Template available -Vector 3D Satellite Compass part number 29030054

GPS Reception

When considering where to mount the 3D, consider the following GPS reception recommendations:

- Consider GPS (and hence SBAS) reception, ensuring there is a clear view of the sky available to the 3D so the GPS and SBAS satellites are not masked by obstructions that may reduce system performance
- Since the 3D computes a position based on the internal primary GPS antenna element, mount the 3D where you desire a position with respect to the primary GPS antenna (located on the end opposite the recessed arrow on the underside of the enclosure)

- Locate any transmitting antennas away from the 3D by at least a several feet to ensure tracking performance is not compromised, giving you the best performance possible
- Make sure there is enough cable length to route into the vessel to reach a breakout box or terminal strip
- Do not locate the antenna where environmental conditions exceed those specified in Table B-5 on page 54

3D Environmental Considerations

The 3D is designed to withstand harsh environmental conditions; however, adhere to the following limits when storing and using the 3D:

- Operating temperature: -30°C to +70°C (-22°F to +158°F)
- Storage temperature: -40°C to +85°C (-40°F to +185°F)
- Humidity: 100% non-condensing

VHF Interference

VHF interference from such devices as cellular phones and radio transmitters may interfere with GPS operation. Keep the following in mind regarding VHF interference:

- VHF marine radio working frequency (Channel 1 to 28) is from 156.05 to 157.40 MHz. The L1 GPS working center frequency is 1575.42 MHz. The bandwidth is +/- 2MHz to +/- 10 MHz, which is dependent on the GPS antenna and receiver design.
- VHF marine radios emit strong harmonics. The 10th harmonic of VHF radio, in some channels, falls into the GPS working frequency band, which may cause the SNR of GPS to degrade significantly.
- The radiated harmonic signal strength of different brands/ models varies.

- Follow VHF radio manufacturers' recommendations on how to mount their radios and what devices to keep a safe distance away.
- Handheld 5W VHF radios may not provide suitable filtering.

Before installing the 3D, use the following diagram to ensure there are no nearby devices that my cause VHF interference.

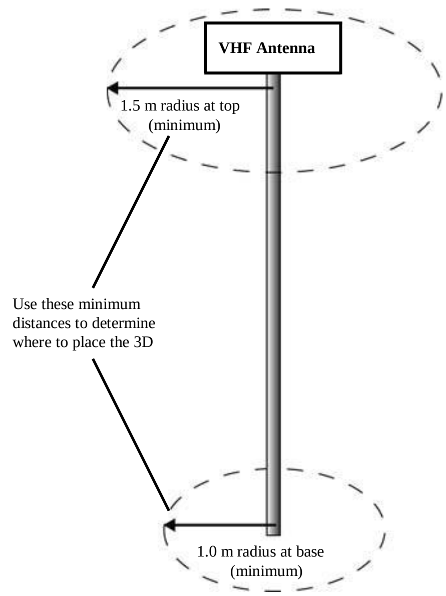

Figure 2-1: 3D distance from nearby VHF radios

Mounting Orientation

The 3D 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 3D provides the ability to output the heave of the vessel. This output is available via the $GPHEV message.

Parallel Orientation: The most common installation is to orient the 3D 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 3D 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.

Figure 2-2 and Figure 2-3 provide mounting orientation examples.

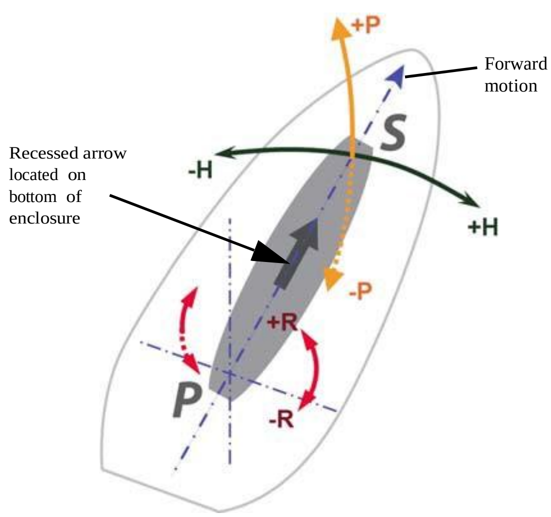

Figure 2-2: Recommended orientation and resulting signs of HPR values

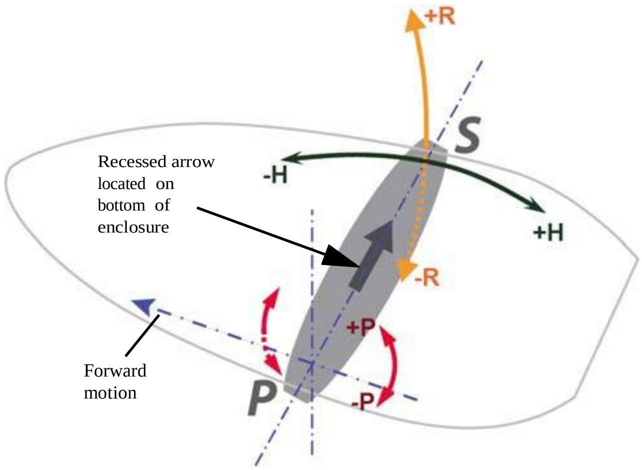

Figure 2-3: Alternate orientation and resulting signs of HPR values

3D Alignment

The top of the 3D enclosure incorporates sight design features to help you align the enclosure with respect to an important feature on your vessel.

To use the sights, center the small post on the opposite side of the enclosure from you, within the channel made in the medallion located in the center of the enclosure top as shown in Figure 2-4 and Figure 2-5. Alignment accuracy when looking through the long site (Figure 2-4) is approximately +/- 1°, while alignment through the short site (Figure 2-5) is approximately +/- 2.5°.

Figure 2-4: Long site alignment

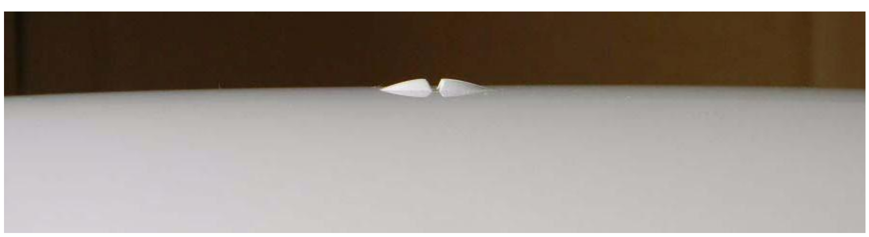

Figure 2-5: Short sight alignment

If you have another accurate source of heading data on your vessel, such as a gyrocompass, you may use its data to correct for a bias in 3D alignment within the 3D software configuration. Alternatively, you can physically adjust the heading of the 3D so that it renders the correct heading measurement; however, adding a software offset is an easier process.

Mounting Options

The 3D allows for two different mounting options: flush mount and pole mount.

- Flush mount - The bottom of the 3D contains four M8 holes for flush mounting the unit to a flat surface (see Figure 2-6).
- Pole mount - The bottom of the 3D contains a mounting hole (1" thread, 0.9" depth) for easy pole mounting. Hand tighten until snug (donot overtighten). The set screws on the long sides of the base (see diagram below) allow you to secure the 3D in place (3/16" Allen wrench not included).

3D Dimensions

Figure 2-6 illustrates the physical dimensions of the 3D.

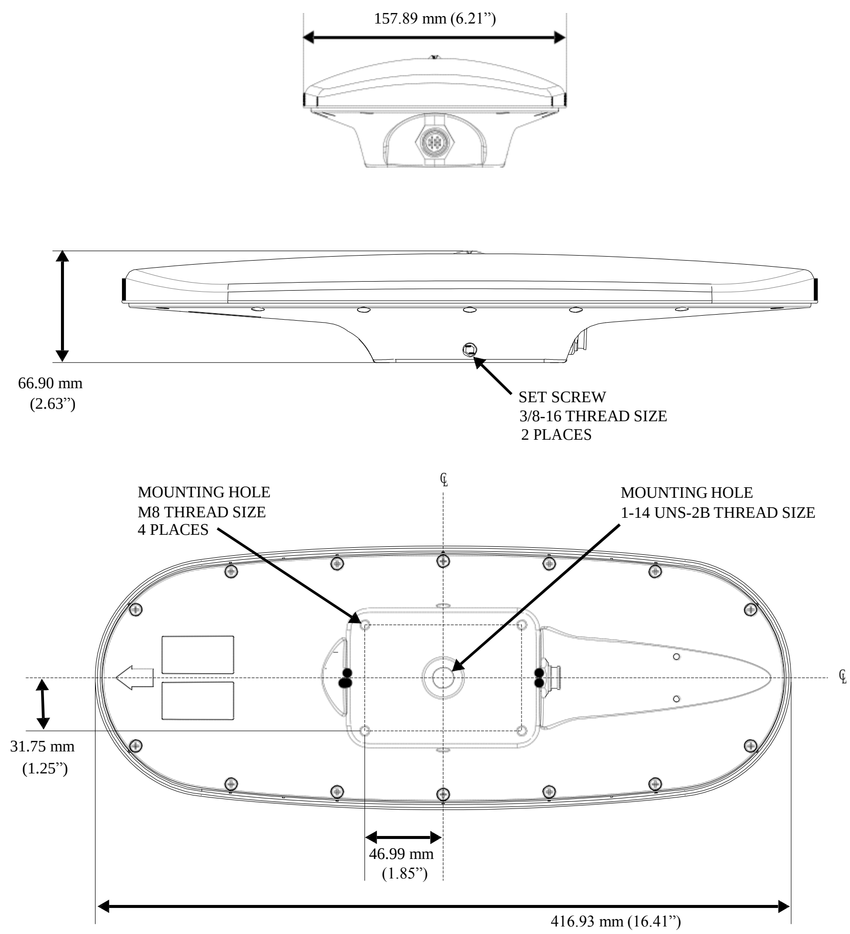

Figure 2-6: 3D dimensions

Power/Data Cable Considerations

Before mounting the 3D consider the following regarding power/data cable routing:

- Cable must reach an appropriate power source
- Cable may connect to a data storage device, computer, or other device that accepts GPS data
- Avoid running the cable in areas of excessive heat
- Keep cable away from corrosive chemicals
- Do not run the cable through door or window jams
- Keep cable away from rotating machinery
- Do not crimp or excessively bend the cable
- Avoid placing tension on the cable
- Remove unwanted slack from the cable at the 3D end
- Secure along the cable route using plastic wraps

⚠WARNING: Improperly installed cable near machinery can be dangerous

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Flush Mount

The bottom of the 3D contains four holes for flush mounting the unit to a flat surface (Figure 2-7). The flat surface may be something you fabricate per your installation, an off-the-shelf item (such as a radar mounting plate), or an existing surface on your vessel.

Note: SI-TEX does not supply the mounting surface hardware. You must supply the appropriate fastening hardware required to complete the installation of the 3D.

Figure 2-7: Flush mounting holes on bottom of 3D

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

Before flush mounting the 3D:

- Determine your mounting orientation. See “Mounting Orientation” on page 7 for more information.

- Choose a location that meets the mounting location requirements.
- Using the fixed base as a template, mark and drill the mounting holes as necessary for the mounting surface.

Flush mounting the 3D:

1. Photocopy the section of the 3D that contains the four mounting holes for use as a template to plan the mounting hole locations.

⚠WARNING: Make sure the photocopy is scaled one to one with the mounting holes on the bottom of the 3D.

2. Mark the mounting hole centers on the mounting surface.
3. Place the 3D over the marks to ensure the planned hole centers align with the true hole centers (adjusting as necessary).
4. Use a center punch to mark the hole centers.
5. Drill the mounting holes with a 9 mm bit appropriate for the surface.
6. Place the 3D over the mounting holes and insert the mounting screws through the bottom of the mounting surface and into the 3D.

⚠WARNING: When installing the 3D, hand tighten only. Damage resulting from overtightening is not covered by the warranty.

Pole Mount

Keep the following in mind when using a pole mount:

- Mounting hole is 1" thread, 0.9" depth
- Hand tighten until snug (donot overtighten) while ensuring correct orientation
- Use the set screws on the long sides of the base (see Figure 2-6) to secure the 3D in place (3/16" Allen wrench not included)

⚠WARNING: Overtightening may damage the system. This is not covered under warranty.

Before pole mounting the 3D:

- Decide if you need the roll measurement. If you need roll measurement, the 3D will need to be installed perpendicular to the vessel axis. If it you do not need roll measurement, install the 3D parallel with the vessel's axis.
- Choose a location that meets the mounting location requirements.

Connecting the power/data cable:

Note: This procedure is for connecting the serial 12-pin power/data cable to the 3D. To connect the serial-to-NMEA 2000 adapter to the 3D, connect in a similar manner. See “NMEA 2000 Port” on page 14 for more information on the adapter.

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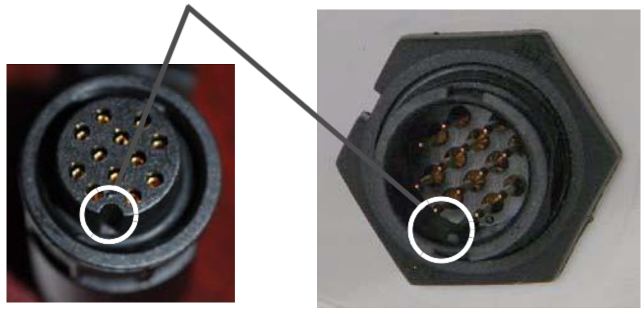
1. Align the cable connector keyway with the 3D connector key.

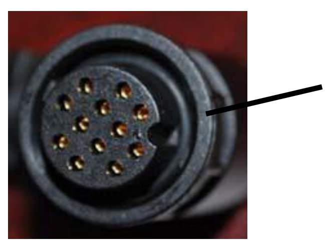
Make sure the connector keyway on the cable matches up with the connector key on the 3D



Cable connector keyway

3D connector key

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



Cable ring

Ports

The 3D offers either serial port or NMEA 2000 port functionality.

Serial Ports

The 3D offers position and heading data via two full-duplex (bi-directional) RS-232 serial ports. In addition to outputting data, these ports are used for firmware upgrades.

Selecting Baud Rates and Message Types

When selecting your baud rate and message types, use the following calculation to determine your baud rate for your required data throughput.

Messages * Message output rate * Message length (bytes) * bits in byte
Ex: 5 * 20Hz * 40 bytes * 10 = 40,000 bits/sec

Configuring the Ports

System PN 11210030 default as follows: PORT A set for NMEA 0183 @ 4800 Baud. PORT C set for NMEA 2000.
System PN 11210029 default as follows: PORT A set for NMEA 0183 @ 4800 Baud. PORT C set for NMEA 2000.

You may configure Port A or Port C of the GPS receiver to output any combination of data that you want. Port A can have a different configuration from Port C in terms of data message output, data rates, and the baud rate of the port. This allows you to configure the ports independently based upon your needs.

Port A is always a serial port. To configure Port C as a serial port refer to Table 2-1 on page 16.

If you want one generalized port and one heading-only port, you can configure the ports as follows:

- Port A to have GPGGA, GPVTG, GPGSV, GPZDA, and GPHDT all output at 1 Hz over a 9600 baud rate
- Port C to have GPHDT and GPROT output at their maximum rate of 20 Hz over a 19200 baud rate

A personal computer (PC) typically uses a DB9-male connector for RS-232 serial port communications.

Note: For successful communications use the 8-N-1 protocol and set the baud rate of the 3D's serial ports to match that of the devices to which they are connected. Flow control is not supported.

Recommendations for Connecting to Other Devices

When interfacing to other devices, ensure the transmit data output from the 3D is connected to the data input of the other device. The signal grounds must also be connected.

The 3D input ports are designed to work with the Navigator G2 compass display or PC SI-TEX Toolkit for configuration purpose. There is likely little reason to connect the receive data input of the 3D to another device. Unused input line can be left open.

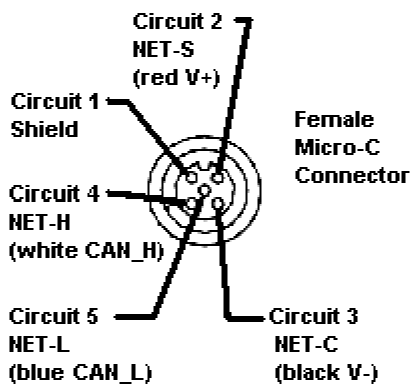
Detailed wiring diagram for connections to SI-TEX autopilots and GPS display units are given in Appendix D.

NMEA 2000 Port

By default, Port C is configured as a NMEA 2000 port with the default baud rate of 57600.

To use 3D for NMEA 2000 you have to connect the included serial-to-NMEA 2000 adapter (P/N 676-0026-000#) to the unit. Figure 2-8 shows the adapter. Insert the 12-pin connector of the adapter into the male end of the 12-pin connector on the 3D by aligning the keys. You can then attach the adapter to the unit using the supplied screws (machine, 8-32, ½", PPHC, SS) and washer (washer, flat, #8, SS). The 5-pin male Micro-C connector connects to your NMEA 2000 drop cable.

Figure 2-8: Serial-to-NMEA 2000 adapter



NMEA 2000 Standard pinout

Table 2-1 lists the commands used to configure Port C back to serial or NMEA 2000 when necessary. You can only send these commands using Port A.

Table 2-1: Commands for changing Port C (must be sent through Port A)

Command	Reply	Description
$JRELAY,PORTC,$JSERIALMODE	$>JSERIALMODE,ENABLED $>resetting	Switch Port C to serial
$JRELAY,PORTC,$JN2KMODE	$>JN2KMODE,ENABLED $>resetting	Switch Port C to NMEA 2000

Table 2-2 shows the requested PGNs with the 3D in NMEA 2000 mode.

Table 2-2: Received messages based on a request

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
059392	ISO Acknowledgement Used to acknowledge the status of certain requests addressed to a specific ECU.	B	On Request	On Request

Table 2-2: Received messages based on a request (*continued)*

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
059904	ISO Request Request the transmission of a specific PGN, addressed or broadcast.	B	On Request	On Request
060928	ISO Address Claim Used to identify to other ECUs the address claimed by an ECU.	B	On Request	On Request
126996	Product Information NMEA 2000 database version supported, manufacturer’s product code, NMEA 2000 certification level, Load Equivalency number, and other product-specific information.	B	On Request	On Request
126464	Receive/Transmit PGNs group function The Transmit / Receive PGN List Group type of function is defined by first field. The message will be a Transmit or Receive PGN List group function.	B	On Request	On Request
129538	GNSS Control Status GNSS common satellite receiver parameter status.	B	On Request	On Request
129545	GNSS RAIM Output Used to provide the output from a GNSS receiver's Receiver Autonomous Integrity Monitoring (RAIM) process. The Integrity field value is based on the parameters set in PGN 129546 GNSS RAIM Settings.	B	On Request	On Request
129546	GNSS RAIM Settings Used to report the control parameters for a GNSS Receiver Autonomous Integrity Monitoring (RAIM) process.	B	On Request	On Request

Table 2-3 shows the transmitted PGNs with their default update rate with the 3D in NMEA 2000 mode.

Table 2-3: Transmitted messages

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
126992	System Time The purpose of this PGN is twofold: To provide a regular transmission of UTC time and date. To provide synchronism for measurement data.	B	1000	1
127250	Vessel Heading Heading sensor value with a flag for True or Magnetic. If the sensor value is Magnetic, the deviation field can be used to produce a Magnetic heading, and the variation field can be used to correct the Magnetic heading to produce a True heading.	B	100	10

Table 2-3: Transmitted messages (*continued)*

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
127251	Rate of Turn Rate of change of the Heading.	B	100	10
127257	Attitude Provides a single transmission that describes the position of a vessel relative to both horizontal and vertical planes. This would typically be used for vessel stabilization, vessel control and onboard platform stabilization.	B	1000	1
127258	Magnetic Variation Message for transmitting variation. The message contains a sequence number to allow synchronization of other messages such as Heading or Course over Ground. The quality of service and age of service are provided to enable recipients to determine an appropriate level of service if multiple transmissions exist.		1000	1
128259	Speed Provides a single transmission that describes the motion of a vessel.	B	1000	1
129025	Position, Rapid Update Provides latitude and longitude referenced to WGS84. Being defined as single frame message, as opposed to other PGNs that include latitude and longitude and are defined as fast or multi-packet, this PGN lends itself to being transmitted more frequently without using up excessive bandwidth on the bus for the benefit of receiving equipment that may require rapid position updates.	B	100	10
129026	COG & SOG, Rapid Update Single frame PGN that provides Course Over Ground (COG) and Speed Over Ground (SOG).	B	250	4
129027	Position Delta, High Precision Rapid Update The "Position Delta, High Precision Rapid Update" Parameter Group is intended for applications where very high precision and very fast update rates are needed for position data. This PGN can provide delta position changes down to 1 mm with a delta time period accurate to 5 msec.	B	100	10
129028	Altitude Delta, High Precision Rapid Update The "Altitude Delta, High Precision Rapid Update" Parameter Group is intended for applications where very high precision and very fast update rates are needed for altitude and course over ground data. This PG can provide delta altitude changes down to 1 millimeter, a change in direction as small as 0.0057°, and with a delta time period accurate to 5 msec.	B	100	10
129029	GNSS Position Data Conveys a comprehensive set of Global Navigation Satellite System (GNSS) parameters, including position information.	B	1000	1

Table 2-3: Transmitted messages (*continued)*

PG No. (PGN)	Description	Level	Default Update Rate (msec)	Freq (Hz)
129033	Time & Date Single transmission that provides UTC time, UTC Date, and Local Offset.	B	1000	1
129539	GNSS DOPs Provides a single transmission containing GNSS status and dilution of precision components (DOP) that indicate the contribution of satellite geometry to the overall positioning error. There are three DOP parameters reported: horizontal (HDOP), Vertical (VDOP), and time (TDOP).	B	1000	1
129540	GNSS Sats in View GNSS information on current satellites in view tagged by sequence ID. Information includes PRN, elevation, azimuth, SNR, defines the number of satellites; defines the satellite number and the information.	B	1000	1

Powering the 3D

Power Considerations

For best performance use a clean and continuous power supply. The 3D power supply features reverse polarity protection but will not operate with reverse polarity.

See Table B-3 on page 53 for complete power specifications.

Connecting to a Power Source

Note: This section refers to powering the unit via serial connection. To power the unit via NMEA 2000 connection, following the standard procedure for powering up via NMEA 2000.

Before you power up the 3D you must terminate the wires of the power cable as required. There are a variety of power connectors and terminals on the market from which to choose, depending on your specific requirements.

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

To interface the 3D power cable to the power source:

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

The 3D's smart antenna will start when an acceptable voltage is applied to the power leads of the extension cable.

Electrical Isolation

The 3D's power supply is isolated from the communication lines and the PC-ABS plastic enclosure isolates the electronics mechanically from the vessel (addressing the issue of vessel hull electrolysis).

Connecting the 3D to External Devices

Note: This section refers to a serial connection. For connecting external NMEA 2000 devices, plug the serial-to-NMEA 2000 adapter into the 3D and then attach a standard NMEA 2000 dropline cable to the adapter.

Power/Data Cable Considerations

The 3D uses a single 15 m (49 ft) cable for power and data input/output.

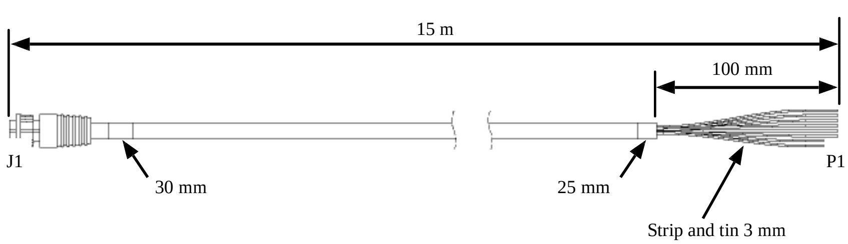


Figure 2-9: Power/data cable, 15 m

The receiver end of the cable is terminated with an environmentally sealed 12-pin connection while the opposite end is unterminated and requires field stripping and tinning.

Depending on the application and installation needs, you may need to shorten this cable. However, if you require a longer cable run than 15 m, you can bring the cable into a break-out box that incorporates terminal strips, within the vessel.

When lengthening the cable keep the following in mind:

- To lengthen the serial lines inside the vessel, use 20-gauge twisted pairs and minimize the additional wire length.
- When lengthening the power input leads to the 3D, ensure the additional voltage drop is small enough that your power system can continue to power the system above the minimum voltage of the system. Wire of 18-gauge or larger should also be used.
- Length limits for RS-232 cables

Power/Data Cable Pinout Specifications

Figure 2-10 show the power/data cable plug pinout while Table 2-4 shows the cable's pinout specifications.

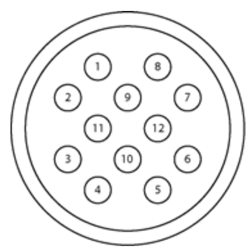


Figure 2-10: Power/data cable pin assignment

Table 2-4: Power/data cable pinout

Pin	Function	Wire Color
1	Port C, RS-232 female DB9 pin 2, device out (Tx)	White
2	Port C, RS-232 female DB9 pin 3, device in (Rx)	Green
3	N/C	N/C
4	N/C	N/C
5	Power input	Red
6	N/C	N/C
7	Signal ground	Yellow
8	Port A, RS-232 female DB9 pin 3, device in (Rx)	Brown
9	Port A, RS-232 female DB9 pin 2, device out (Tx)	Blue
10	Power ground	Black
11	CH_GND	Drain
12	N/C	N/C

Chapter 3: Operation

PS Overview

For your convenience, both the GPS and SBAS operation of the Vector 3D features automatic operational algorithms. When powered for the first time, the Vector 3D 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 3D's internal GPS receiver.

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

Automatic Tracking

The 3D'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 3D works by finding four or more GPS satellites in the visible sky. It uses information from the satellites to compute a position within 4.0 m (8.2 ft). Since there is some error in the GPS data calculations, the 3D also tracks a differential correction. The 3D uses these corrections to improve its position accuracy to better than 1.0 m (1.97 ft).

There are two main aspects of GPS receiver performance:

- Satellite acquisition
- Positioning and heading calculation

When the 3D 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 3D will result in positioning accuracies of 4.0 m (8.2 ft) 95% of the time. In order to improve positioning quality to better than 1.0 m (1.97 ft), the 3D is able to use differential corrections received through the internal SBAS demodulator or externally-supplied RTCM corrections.

Automatic SBAS Tracking

The 3D automatically scans and tracks SBAS signals without the need to tune the receiver. The 3D 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.

Vector 3D Overview

The 3D provides accurate and reliable heading and position information at high update rates. To accomplish this task, the 3D 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 3D are referenced to the phase center of the primary GPS antenna. Heading data references the vector formed from the primary GPS antenna phase center to the secondary GPS antenna phase center.

The heading arrow located on the bottom of the 3D enclosure defines system orientation. The arrow points in the direction the heading measurement is computed (when the antenna is installed parallel to the fore-aft line of the vessel). The secondary antenna is directly above the arrow.

Fixed Baseline Moving Base Station RTK

The 3D'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 3D restricts the RTK solution. It does this knowing that the secondary GPS antenna is 0.27 m (0.89 ft) from the primary GPS antenna. This is called a fixed baseline and it defines the search volume of the secondary antenna as the surface of a sphere with radius 0.27 m (0.89 ft) centered on the location of the primary antenna (see Figure 3-1).

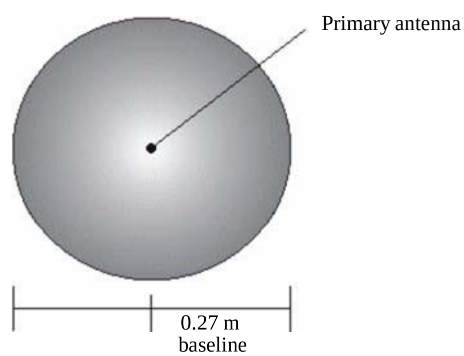


Figure 3-1: Secondary antenna's search volume

Note: The Vector 3D 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 3D has an integrated gyro and two tilt sensors. The gyro and tilt sensors 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 3D.

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. Table 3-1 on page 24 provides a sensor operation summary.

Feature	Normal Operation	Coasting (no GPS)
Heading	GPS	Gyro
Heave	GPS	None
Pitch	GPS	Inertial sensor
Roll	Inertial sensor	Inertial sensor

Table 3-1: Sensor operation summary

Sensors can be recalibrated, queried, or disabled by some NMEA-like sentences. See descriptions in Messages and Configuration Commands.

Tilt Aiding

The 3D'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 3D knows the approximate inclination of the secondary antenna with respect to the primary antenna. The search space defined by the tilt sensor will be reduced to a horizontal ring on the sphere's surface by reducing the search volume. This considerably decreases startup and reacquisition times. (See Figure 3-2)

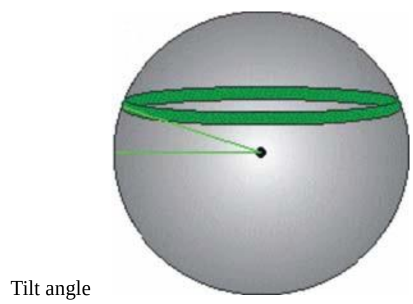


Figure 3-2: Vector 3D's tilt aiding

Gyro Aiding

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

Figure 3-3: Vector 3D'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° 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 3D begins outputting null fields in the heading output messages. There is no user control over the timeout period of the gyro.

Calibration, which is set at the factory, is required for the gyro to remove latency from the heading solution as well as provide backup heading when GPS is blocked. The receiver will calibrate itself after running for a while but it may be important to follow the manual calibration instructions if you want to guarantee performance quickly after powering up the receiver.

The gyro initializes itself at powerup and during initialization, or you can calibrate it using $JATT. 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 3D on a high speed, maneuverable craft, it is essential that when gyro aiding in the 3D 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. Setting an appropriate HTAU value for the application is further discussion later.

Time Constants

The 3D incorporates user-configurable time constants that can provide a degree of smoothing to the heading, 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. If you are unsure on how to set this value, it is best to be conservative and leave it at the default setting.

Note: There is no lag once the gyro is calibrated and enabled.

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. You can use the following formula to determine level of heading smoothing required when the gyro is in use:

htau (in seconds) = 40 / maximum rate of turn (in /sec).

When the gyro is disabled, the formula is: htau (in seconds) = 10 / maximum rate of turn (in /sec)

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. you can use the following formula to determine the level of pitch smoothing required: ptau (in seconds) = 10 / maximum rate of pitch (in /sec)

Heading Rate time constant: Use the $JATT,HRTAU command to adjust the level of responsiveness of the rate of heading change 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 heading smoothing. You can use the following formula to determine the level of smoothing: hrtau (in seconds) = 10 / maxiumum rate of the rate of turn (in /sec).

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, as tiny movements due to calculation inaccuracies are not representative of a vessel's movement. You can use the following formula to determine COGTAU: cogtau (in seconds) = 10 / maximum rate of change of course (in degree/sec).

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 constant is 0.0 seconds of smoothing. Increasing the time constant increases the level of speed measurement smoothing.

Watchdog

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

Messages and Configuration Commands

Table 3-2: Commands

Command	Description
$JAGE	Specify maximum DGPS (COAST) correction age (6 to 8100 seconds)
$JAPP	Query or specify receiver application firmware
$JASC	Specify ASCII messages to output to specific ports (see ASCII messages in Table 3-3)
$JBAUD	Specify RS-232 (output) communication rate
$JBIN	Specify binary messages to output to specific ports (see Table 3-4)
$JDIFF	Query or specify differential correction mode
$JGEO	Query or specify SBAS for current location and SBAS satellites
$JI	Query unit's serial number and firmware versions
$JOFF	Turn off all data messages
$JQUERY,GUIDE	Query accuracy suitability for navigation
$JRESET	Reset unit's configuration to firmware defaults **Note:** $JRESET clears all parameters. For the 3D you will have to issue the $JATT, FLIPBRD,YES command to properly redefine the circuitry orientation inside the product once the receiver has reset. Failure to do so will cause radical heading behavior.
$JSAVE	Save session's configuration changes

NMEA Output

The following NMEA 0183 & proprietary data output messages are the ones most commonly used on the Vector 3D (for others, see the next 3 pages). Factory enabled messages are shown in Grey, and the default repeat rate is shown in the default column. Factory disabled sentences are shown with an X. Once the Vector 3D is installed and setup correctly, record in the User column any changes you made for future reference.

In Table 3-3 the Info Type value is one of the following:

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

Table 3-3: NMEA 0183 and other messages

Message	Info Type	Description	IEC Approved Message	Enabled				Max Rate
				Port A		Port C		
				Default	User	Default	User	
$GPDTM	P	Datum reference	Yes	X		X		1
$GPGGA	P	GPS position and fix data	Yes	X		X		20**
$GPGLL	P	Geographic position - lat/long	Yes	1		X		20**
$GPGNS	P	GNSS position and fix data	Yes	X		X		20**
$GPGRS	S	GNSS range residual (RAIM)	Yes	X		X		20**
$GPGSA	S	GNSS DOP and active satellites	Yes	X		X		1

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

Message	Info Type	Description	IEC Approved Message	Enabled				Max Rate
				Port A		Port C		
				Default	User	Default	User	
$GPGST	S	GNSS pseudo range error statistics and position accuracy	Yes	X		X		1
$GPGSV	S	GNSS satellites in view	Yes	X		X		1
*$GPHDG	H	Provides magnetic deviation and variation for calculating magnetic or true heading	Yes	X		X		20**
*$GPHDM	H	Magnetic heading (based on GPS-derived heading and magnetic declination)	No	1		10		20**
*$GPHDT	H	GPS-derived true heading	Yes	1		10		20**
$GPHEV	H	Heave value (in meters)	Yes	X		X		20**
$GPRMC	P	Recommended minimum specific GNSS data	Yes	X		X		20**
*$GPROT	H	GPS-derived rate of turn (ROT)	Yes	1		X		20**
$GPRRE	S	Range residual and estimated position error message	Yes	X		X		1
$GPVTG	V	COG and ground speed	Yes	1		1		20**
$GPZDA	V	Time and date	Yes	1		X		20**
$PASHR	H	Time, heading, roll, and pitch data in one message	No					1
$PSAT, GBS	S	Satellite fault detection (RAIM)	Yes					1
$PSAT, HPR	H	Proprietary NMEA message that provides heading, pitch, roll, and time in single message	No	X		X		20**
$PSAT, INTLT	H	Proprietary NMEA message that provides the pitch and roll measurements from the internal inclinometers (in degrees)	Yes	X		X		1
$RD1	S	SBAS diagnostic information	Yes	X		X		1
$TSS1	H	Heading, pitch, roll, and heave message in the commonly used TSS1 message format	No	X		X		20**

Notes:

- The GP of the message is the talker ID.
- GPGRS, GPGSA, GPGST and GPGSV support external integrity checking. They are to be synchronized with corresponding fix data (GPGGA or GPGNS).
- *You can change the message header for the HDG, HDM, HDT and ROT messages to either GP or HE using the $JATT,NMEAHE command.
- ** Optional maximum rate. Fees may apply.

Table 3-4: Binary messages

$JBIN Message	Description
1	GPS position
2	GPS DOPs
80	SBAS
93	SBAS ephemeris data
94	Ionosphere and UTC conversion parameters

Table 3-4: Binary messages (*continued)*

$JBIN Message	Description
95	Satellite ephemeris data
96	Code and carrier phase
97	Processor statistics
98	Satellites and almanac
99	GPS diagnostics

Table 3-5: Parameters specific to $JATT command

Parameter	Description	Query	Specify	Default
COGTAU	Set/query COG time constant (0.0 to 3600.0 sec)	X	X	0.00
CSEP	Query antenna separation	X		X
EXACT	Enable/disable internal filter reliance on the entered antenna separation	X	X	X
FLIPBRD	Turn the flip feature on/off	X	X	YES
GYROAID	Enable/disable gyro	X	X	YES
HBIAS	Set/query heading bias (-180.0º to 180.0º)	X	X	0.00
HELP	Show the available commands for GPS heading operation and status	X		X
HIGHMP	Set/query the high multipath setting for use in poor GPS environments	X	X	X
HRTAU	Set/query time constant (0.0 to 3600.0 sec)	X	X	2.00
HTAU	Set/query heading time constant (0.0 to 3600.0 sec)	X	X	10.00
LEVEL	Enable/disable level operation	X	X	NO
MSEP	Manually set or query antenna separation	X	X	X
NEGTILT	Enable/disable negative tilt	X	X	NO
NMEAHE	Change the HDG, HDM, HDT, and ROT message headers between GP and HE	X	X	NO
PBIAS	Set/query pitch/roll bias (-15.0º to 15.0º)	X	X	0.00
PTAU	Set/query pitch time constant (0.0 to 3600.0 sec)	X	X	0.50
ROLL	Configure for roll or pitch GPS orientation	X	X	NO
SEARCH	Force a new GPS heading search		X	X
SPDTAU	Set/query speed time constant (0.0 to 3600.0 sec)	X	X	0.00
SUMMARY	Display a summary of the current Crescent Vector settings	X		X
TILTAID	Enable/disable accelerometer, pre-calibrated	X	X	YES
TILTCAL	Calibrate accelerometers		X	X

NMEA Configuration commands

The following NMEA-like input sentences can be used to configure the Vector 3D.

To query what is the current value of most parameters, leave off the last ",value" portion of the sentence.

For those sentences that enable the output of repeating NMEA data sentences, the range of valid repeat rates is shown in parentheses; "0" causes the sentence to be disabled. Some sentences may only be disabled or enabled - with a NO or YES parameter value.

The optional parameter PORTX (without the square brackets), where applicable, causes the configuration parameter to be applied to the other port these sentences are NOT sent from. For example, if you send this command from Port A to configure Port C, you should add "PORTC" to the command; if you send this command from Port C to configure Port A, you should add PORTA.

Caution! These commands will affect the performance of the Vector 3D. Improper settings may result in degradation of system output that can affect the overall safety of vessels and personnel.

Table 3-6: NMEA Configuration Sentences

Command	Description
$JAGE,age[,PORTX]	Set Differential Age Timeout (6 to 8100 seconds)
$JASC,D1,rate[,PORTX]	Output SBAS diagnostic information (rate = 0 or 1 Hz)
$JASC,GPDTM,rate[,PORTX]	Output Datum Reference information (rate = 0 or 1 Hz)
$JASC,GPGGA,rate[,PORTX]	Output GPS Fix data (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPGLL,rate[,PORTX]	Output Geographic position (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPGNS,rate[,PORTX]	Output GNSS Fix data (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPGRS,rate[,PORTX]	Output GNSS Range Residual data (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPGSA,rate[,PORTX]	Output GNSS DOP and Active Satellites (rate = 0 or 1 Hz)
$JASC,GPGST,rate[,PORTX]	Output Pseudorange Error Statistics (rate = 0 or 1 Hz)
$JASC,GPGSV,rate[,PORTX]	Output Satellites in View (rate = 0 or 1 Hz)
$JASC,GPHDG,rate[,PORTX]	Output Generic Heading (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPHDM,rate[,PORTX]	Output Magnetic Heading (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPHDT,rate[,PORTX]	Output True Heading (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPROT,rate[,PORTX]	Output Rate Of Turn (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPRMC,rate[,PORTX]	Output Recommended Minimum Specific GNSS data (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPRRE,rate[,PORTX]	Output Range Residual Error data (rate = 0 or 1 Hz)
$JASC,GPVTG,rate[,PORTX]	Output Course Over Ground and Speed Over Ground data (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,GPZDA,rate[,PORTX]	Output Time and Date (rate = 0, 0.2, 1, 5, 10 or 20 Hz)

Table 3-6: NMEA Configuration Sentences

Command	Description
$JASC,PASHR,rate[,PORTX]	Output time, heading, roll, and pitch data in one message (rate = 0 or 1 Hz)
$JASC,GPHPR,rate[,PORTX]	Output heading and pitch (or roll) data (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JASC,INTLT,rate[,PORTX]	Output Internal Tilt sensor measurement (rate = 0 or 1 Hz)
$JASC,GPGBS,rate[,PORTX]	Output Receiver Autonomous Integrity Monitoring (RAIM) (rate = 0 or 1 Hz)
$JASC,PTSS1,rate[,PORTX]	Output Heading, pitch, roll, and heave in TSS1 message format (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JATT,COGTAU,cogtau	Query or Set Course Smoothing Time (cogtau = 0.0 to 3600.0 seconds)
$JATT,CSEP	Query Current Antenna Separation
$JATT,EXACT,NO/YES	Query or Disable/enable the internal filter reliance on the entered antenna separation
$JATT,FLIPBRD,NO/YES	Query the current flip feature status or turn off/on it. When the flip feature is turned off, the board is installed right side up (default mode).
$JATT,GYROAID,NO/YES	Query or Disable/Enable the Gyro-Aid function
$JATT,HBIAS,hbias	Query or Set Heading Output Offset (range is -180° to +180°) *
$JATT,HELP	Provide a short list of commands available
$JATT,HIGHMP,NO/YES	Query or Disable/enable the high multipath setting for use in poor GPS environment
$JATT,HRTAU,hrtau	Query or Set Rate of Turn Smoothing Time (hrtau = 0.0 to 3600.0 seconds)
$JATT,HTAU,htau	Query or Set Heading Smoothing Time (htau = 0.0 to 3600.0 seconds)
$JATT,LEVEL,NO/YES	Query or Disable/Enable Level Mode Operation
$JATT,MSEP,sep	Manually set antenna separation (this cannot be changed on the Vector 3D)
$JATT,NEGTILT,NO/YES	Query or Set Normal/Reverse Pitch/Roll sign convention
$JATT,NMEAHE,0	Set Talker ID for HDG, HDM & HDT sentences to GP
$JATT,NMEAHE,1	Set Talker ID for HDG & HDT sentences to HE, and HDM to HC
$JATT,PBIAS,pbias	Query or Set Pitch/Roll Bias (range is -15° to +15°)
$JATT,PTAU,ptau	Query or Set Pitch Smoothing Time (ptau = 0.0 to 3600.0 seconds)
$JATT,ROLL,NO/YES	Query or Set Pitch/Roll function to measure Pitch or Roll *
$JATT,SEARCH	Force a new RTK Search
$JATT,SPDTAU,spdtau	Query or Set Speed Smoothing Time Constant (spdtau = 0.0 to 200.0 seconds)
$JATT,SUMMARY	Query Current Settings
$JATT,TILTAID,NO/YES	Query or Disable/Enable the Tilt-Aid function

Table 3-6: NMEA Configuration Sentences

Command	Description
$JATT,TILTCAL	Calibrate the Tilt-Aid sensor (the Vector 3D must be level, and all satellite signals be blocked, when this command is issued)
$JBAUD,4800[,PORTX]	Set Baud rate to 4800
$JBAUD,9600[,PORTX]	Set Baud rate to 9600
$JBAUD,19200[,PORTX]	Set Baud rate to 19200
$JBAUD,38400[,PORTX]	Set Baud rate to 38400
$JBIN,1,rate	Output Binary GPS Position (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JBIN,2,rate	Output Binary GPS DOPs (rate = 0 or 1 Hz)
$JBIN,80,rate	Output Binary GPS SBAS information (rate = 0 or 1 Hz)
$JBIN,93,rate	Output Binary SBA ephemeris data (rate = 0 or 1 Hz)
$JBIN,94,rate	Output Ionosphere & UTC conversion parameters (rate = 0 or 1 Hz)
$JBIN,95,rate	Output Binary GPS ephemeris information (rate = 0 or 1 Hz)
$JBIN,96,rate	Output Binary code & carrier phase information (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JBIN,97,rate	Output Binary process statistics (rate = 0, 0.2, 1, 5, 10 or 20 Hz)
$JBIN,98,rate	Output Binary GPS Satellite & Almanac information (rate = 0 or 1 Hz)
$JBIN,99,rate	Output Binary GPS diagnostic information (rate = 0 or 1 Hz)
$JDIFF,NONE	Operate in autonomous mode
$JDIFF,PORTX[,SAVE]	Use corrections input through PORT C or PORT A. Save the configuration if 'SAVE' is appended to the command
$JDIFF,WAAS[,SAVE]	Use SBAS corrections; save the configuration if 'SAVE' is appended to the command
$JGEO	Queries frequency and location of SBAS satellites
$JI	Query the 3D's serial number & firmware revisions
$JOFF	Turn off all data output
$JQUERY,GUIDE	Query whether the Vector 3D is providing suitable performance or not
$JRESET	Reset to default settings** **DO NOT USE!!**
$JSAVE	Save current Configuration **wait until the Vector replies with "$> Save Complete" before powering it down!**
$JSHOW	Show current Configuration
$JSMOOTH,time	Query or Set Carrier Smoothing Time time = SHORT ==> 300 seconds time = LONG ==> 900 seconds time = 15 to 6000 seconds
$JWAASPRN	Query PRNs of SBAS satellites currently being used

* *Use the $JATT,HBIAS & $JATT,ROLL commands if the Vector is installed athwartships:*

$JATT,ROLL,YES
and then (if you have mounted the Vector pointing to Port)
$JATT,HBIAS,90.0
or (if you have mounted the Vector pointing to Starboard)
$JATT,HBIAS,-90.0

** *This command sets the configuration parameters to the ComNav factory default values.*
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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 (6 to 36 VDC) • Check current restrictions imposed by power source (minimum available should be > 1.0 A)
No data from 3D	• Check receiver power status to ensure the receiver is powered (an ammeter can be used for this) • Verify desired messages are activated (using SI-TEX Toolkit or $JSHOW in any terminal program) • Ensure the baud rate of the 3D matches that of the receiving device • Check integrity and connectivity of power and data cable connections
Random data from 3D	• Verify the RTCM or binary messages are not being output accidentally (send a $JSHOW command) • Ensure the baud rate of the 3D matches that of the remote device • Potentially, the volume of data requested to be output by the 3D 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 3D has a clear view of the sky • Verify the lock status of GPS satellites (this can be done with SI-TEX Toolkit)

Table A-1: Troubleshooting (*continued*)

Symptom	Possible Solution
No SBAS lock	• Verify the 3D has a clear view of the sky • Verify the lock status of SBAS satellites (this can be done with SI-TEX Toolkit - monitor BER value) • SBAS lock can only get if you are in an appropriate SBAS region (currently, there is limited SBAS availability in the southern hemisphere) • Set SBAS mode to automatic with the $JWAASPRN,AUTO command
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 • 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, so the arrow on the underside of the 3D should be directed to the bow side • $JATT,SEARCH command forces the 3D 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 SI-TEX Toolkit—at least four satellites should have strong SNR values • Potentially, the volume of data requested to be output by the 3D 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,PORTC command on Port A will cause the receiver to expect the corrections to be input through Port C

Appendix B: Specifications

Table B-1 through Table B-5 provide the 3D’s GPS sensor, communication, power, mechanical, and environmental specifications.

Table B-1: GPS sensor specifications

Item	Specification
Receiver type	L1, C/A code with carrier phase smoothing
Channels	Two 12-channel, parallel tracking (Two 10-channel when tracking SBAS)
SBAS tracking	2-channel, parallel tracking
Update rate	Standard 10 Hz, optional 20 Hz (position and heading)
Horizontal accuracy	< 1.0 m 95% confidence (DGPS[1]) < 4.0 m 95% confidence (autonomous, no SA[2])
Heading accuracy	< 0.75° rms Normal operation: GPS Coasting (no GPS): Gyro
Heave accuracy	< 30 cm rms[5] Normal operation: GPS Coasting (no GPS): None
Pitch accuracy	< 1.5° rms Normal operation: GPS Coasting (no GPS): Inertial sensor
Roll accuracy	< 1.5° rms using accelerometer Normal operation: Inertial sensor Coasting (no GPS): Inertial sensor
Rate of turn	90°/s maximum
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)
Compass safe distance	30 cm (11.8 in)[4]
Maximum speed	1,850 kph (999 kts)
Maximum altitude	18,288 m (60,000 ft)

Table B-2: Communication specifications

Item	Specification
Serial ports	2 full-duplex RS-232
Baud rates	4800, 9600, 19200, 38400, 57600, 115200
Correction I/O protocol	RTCM SC-104
Data I/O protocol	NMEA 0183, NMEA 2000

Table B-3: Power specifications

Item	Specification
Input voltage	6 to 36 VDC
Power consumption	~ 3 W nominal
Current consumption	320 mA @ 9 VDC 240 mA @ 12 VDC 180 mA @ 16 VDC
Power isolation	Isolated to enclosure
Reverse polarity protection	Yes

Table B-4: Mechanical specifications

Item	Specification
Enclosure	UV resistant, white plastic, AES HW 600G, non-corrosive, self extinguishing
Dimensions (not including mounts)	41.7 L x 15.8 W x 6.9 H (cm) 16.4 L x 6.2 W x 2.7 H (in)
Weight	~ 1.50 kg (3.3 lb)

Table B-5: Environmental specifications

Item	Specification
Operating temperature	-30°C to +70°C (-22°F to +158°F)
Storage temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	100% non-condensing
Vibration	IEC 60945
EMC	FCC Part 15, Subpart B; CISPR22; IEC 60945 (CE)

[1]Depends on multipath environment, number of satellites in view, satellite geometry, ionospheric activity, and use of SBAS

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

[4]IEC 60945 Standard

[5]Based on a 40 second time constant

Appendix C: Using Vector 3D with NMEA 2000 Commands

NMEA 2000 cable with pinouts – we supply the cable

NMEA 2000 Messages

Table C-1 describes the NMEA 2000 messages.

Table C-1: NMEA 2000 Messages

PG Number (PGN)	Description	Level	Default Update Rate	Freq
059392	ISO Acknowledgement – Used to acknowledge the status of certain requests addressed to a specific ECU	B	On Request	On Request
059904	ISO Request – Request the transmission of a specific PGN, addressed or broadcast	B	On Request	On Request
060928	ISO Address Claim – Used to identify to other ECUs the address claimed by an ECU	B	On Request	On Request
126996	Product Information – NMEA 2000® Database Version Supported, Manufacturer's Product Code, NMEA 2000® Certification Level, Load Equivalency Number, and other product-specific information	B	On Request	On Request
126464	Receive/Transmit PGNs group function -The Transmit / Receive PGN List Group type of function is defined by first field. The message will be a Transmit or Receive PGN List group function.	B	On Request	On Request
126992	System Time- The purpose of this PGN is twofold: To provide a regular transmission of UTC time and date. To provide synchronism for measurement data.	B	1000	1
127250	Vessel Heading - Heading sensor value with a flag for True or Magnetic. If the sensor value is Magnetic, the deviation field can be used to produce a Magnetic heading, and the variation field can be used to correct the Magnetic heading to produce a True heading.	B	100	10
127251	Rate of Turn - Rate of Turn is the rate of change of the Heading.	B	100	10

Table C-1: NMEA 2000 Messages

PG Number (PGN)	Description	Level	Default Update Rate	Freq
127257	Attitude -is PGN provides a single transmission that describes the position of a vessel relative to both horizontal and vertical planes. This would typically be used for vessel stabilization, vessel control and onboard platform stabilization.	B	1000	1
127258	Magnetic Variation - Message for transmitting variation. The message contains a sequence number to allow synchronization of other messages such as Heading or Course over Ground. The quality of service and age of service are provided to enable recipients to determine an appropriate level of service if multiple transmissions exist.		1000	1
128259	Speed - The purpose of this PGN is to provide a single transmission that describes the motion of a vessel.	B	1000	1
129025	Position, Rapid Update - This PGN provides latitude and longitude referenced to WGS84. Being defined as single frame message, as opposed to other PGNs that include latitude and longitude and are defined as fast or multi-packet, this PGN lends itself to being transmitted more frequently without using up excessive bandwidth on the bus for the benefit of receiving equipment that may require rapid position updates.	B	100	10
129026	COG & SOG, Rapid Update - This PGN is a single frame PGN that provides Course Over Ground (COG) and Speed Over Ground (SOG).	B	250	4

Table C-1: NMEA 2000 Messages

PG Number (PGN)	Description	Level	Default Update Rate	Freq
129027	Position Delta, High Precision Rapid Update- The "Position Delta, High Precision Rapid Update" Parameter Group is intended for applications where very high precision and very fast update rates are needed for position data. This PGN can provide delta position changes down to 1 millimeter with a delta time period accurate to 5 milliseconds.	B	100	10
129028	Altitude Delta, High Precision Rapid Update - The "Altitude Delta, High Precision Rapid Update" Parameter Group is intended for applications where very high precision and very fast update rates are needed for altitude and course over ground data. This PG can provide delta altitude changes down to 1 millimeter, a change in direction as small as 0.0057 degrees, and with a delta time period accurate to 5 milliseconds.	B	100	10
129029	GNSS Position Data- This PGN conveys a comprehensive set of Global Navigation Satellite System (GNSS) parameters, including position information.	B	1000	1
129033	Time & Date - This PGN has a single transmission that provides: UTC time, UTC Date and Local Offset.	B	1000	1
129538	GNSS Control Status - GNSS common satellite receiver parameter status.	B	On Request	On Request
129539	GNSS DOPs - This PGN provides a single transmission containing GNSS status and dilution of precision components (DOP) that indicate the contribution of satellite geometry to the overall positioning error. There are three DOP parameters reported, horizontal (HDOP), Vertical (VDOP) and time (TDOP).	B	1000	1

Table C-1: NMEA 2000 Messages

PG Number (PGN)	Description	Level	Default Update Rate	Freq
129540	GNSS Sats in View - GNSS information on current satellites in view tagged by sequence ID. Information includes PRN, elevation, azimuth, SNR, defines the number of satellites; defines the satellite number and the information.	B	1000	1

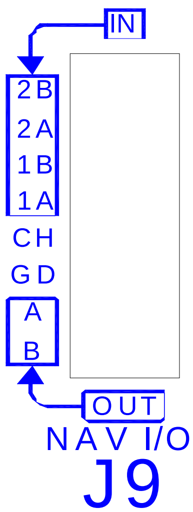
Appendix D: Interfacing to SI-TEX Autopilot and Compass Display

Commander P2 or Admiral P3 and Navigation 3D

Figure 1 shows the typical connections used with a SI-TEX Commander P2 Autopilot System (an Admiral P3 would be wired identically), a Navigator G2 GPS Compass Display System, and a generic Chartplotter or other type of Navigation System.

> **Note**: this wiring information assumes that the 3D is in its factory-default configuration: Autopilot data on Port A. Port C defaults to NMEA 2000. Use SI-TEX toolkit software to convert to 0183 if required. (CD included)

The wiring from 3D to commander P2 and Admiral P3, SPU J9 - NAV I/O connector, is as follows:



J9 Pin	Wire Color	Signal	Signal	Data Carried
IN-2B	user-supplied ☞	RS-422, 'B'	from Chartplotter, etc.	Navigation: Waypoints, Position, etc.
IN-2A	user-supplied ☞	RS-422, 'A'		
IN-1B	Yellow	Port A, Tx	from 3D, Port A* Transmit	Heading, Speed
IN-1A	White	Signal ground		
OUT-1A	user-supplied ☞	RS-422, 'A'	to Chartplotter, etc.	Autopilot status
OUT-1B	user-supplied ☞	RS-422, 'B'		

* Port C when configured to NMEA 0183

Table 3 - Commander P2 Connection Detail

In addition to the above wiring, the Commander P2 must be configured to look for both heading and speed data from its NAV1 input port, and for Navigation data from NAV2; for details, see the respective Source selection descriptions for the Standby, Auto & Nav menus, in the P2 Installation & Operation manual.

Other SI-TEX Autopilot Systems

All other SI-TEX autopilots require the use of an optional Sine-Cosine Interface Box (PN 21010004), with matching interface cable (PN 31110023 or 31110051), to use them with a Vector 3D.

See the instructions included with the Sine-Cosine Box for wiring and setup information. Note that the 3D's Port C Tx and the signal ground wires are the ones to be connected to the Convertor.

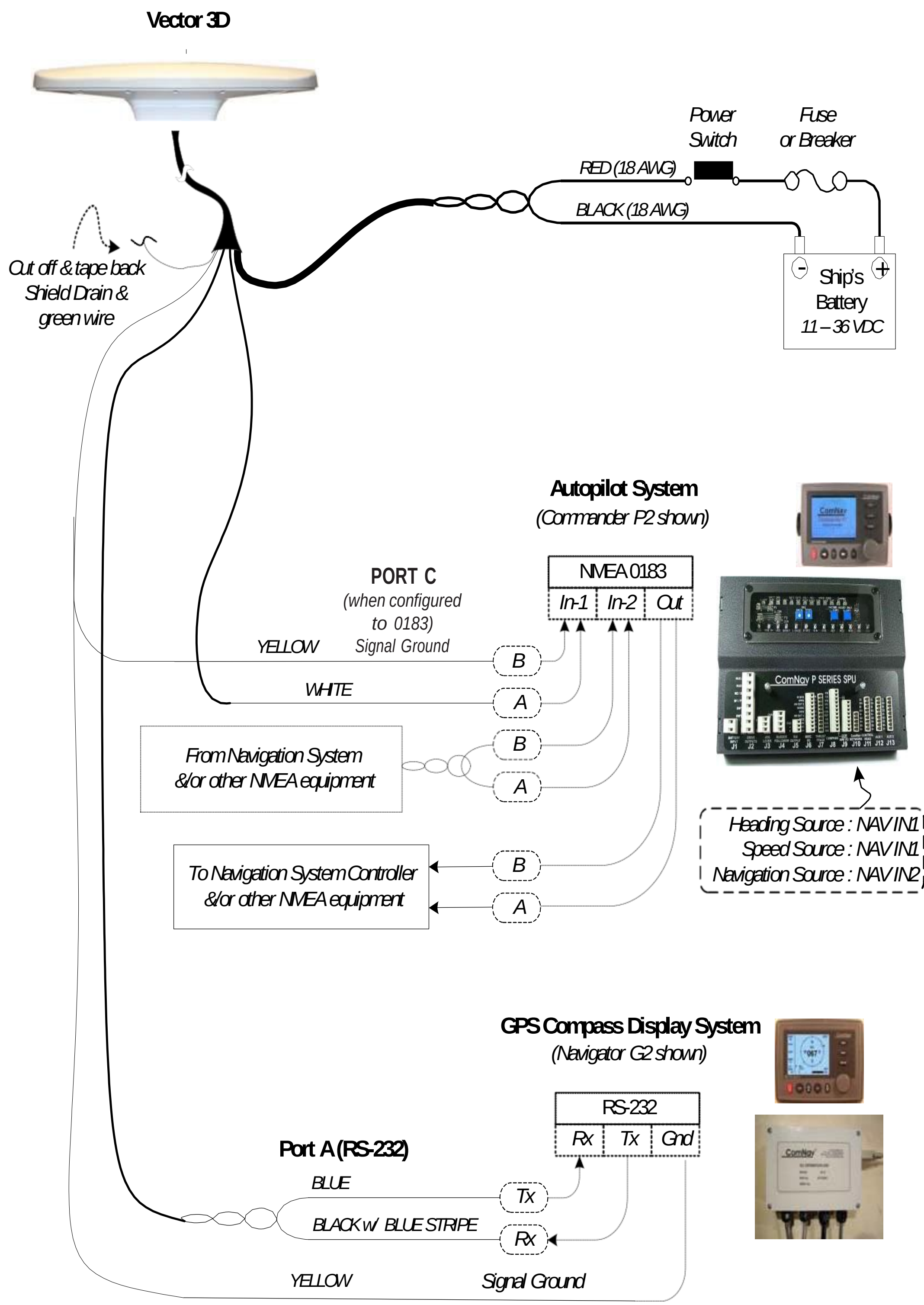


Figure 1 - Typical Wiring Diagram of a Vector 3D System with Autopilot & Compass Display

Interfacing to a PC

Figure 2 shows the typical connections when using a PC to perform "Navigation display &/or control" functions or to use the SI-TEX Toolkit to configure the 3D.

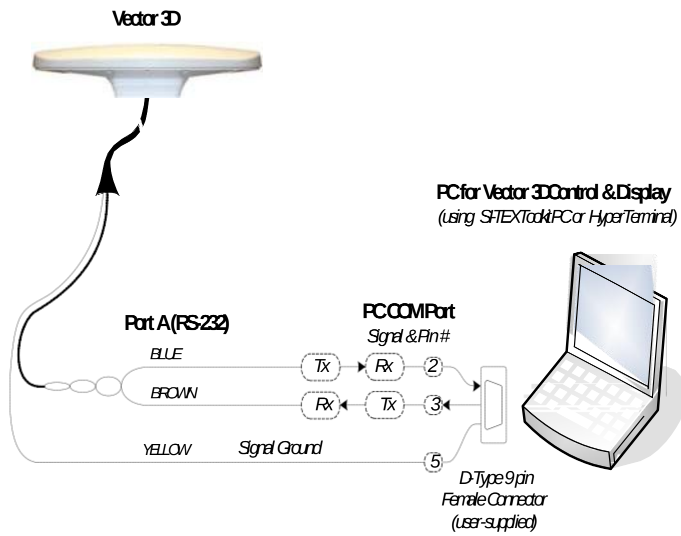


Figure 2 - Typical Wiring with a PC for Vector 3D Control & Display

Interfacing to other NMEA 0183 devices

Many NMEA 0183 devices can accept RS 232 input signal. For these devices, you can connect the 3D RS 232 Rx of Port A or Port C to NMEA 0183 "A" and the 3D signal ground to NMEA 0183 "B". However, there are devices that only accept RS 422 signal. In such situation, a standard RS 232   RS 422 Convertor can be used to interface the 3D to an NMEA 0183 devices.

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(The closest service station may be found by contacting your dealer of purchase)
OR
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(c) You must present a copy of your Purchase Sales Slip at the time you request warranty service.

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: :

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The contact numbers and e-mail address for Sitex Customer Service are:

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Sitex Fax..……………………..…..+1-631-996-2693

Sitex Service E-mail address: service@si-tex.com

Sitex Customer Support E-mail address: customerservice@si-tex.com

Sitex Main Office Address:

25 Enterprise Zone Drive, Ste 2

Riverhead, NY 11901

Technical Support is available from 9:00 AM to 5:00 PM Eastern Standard Time, Monday through Friday.

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