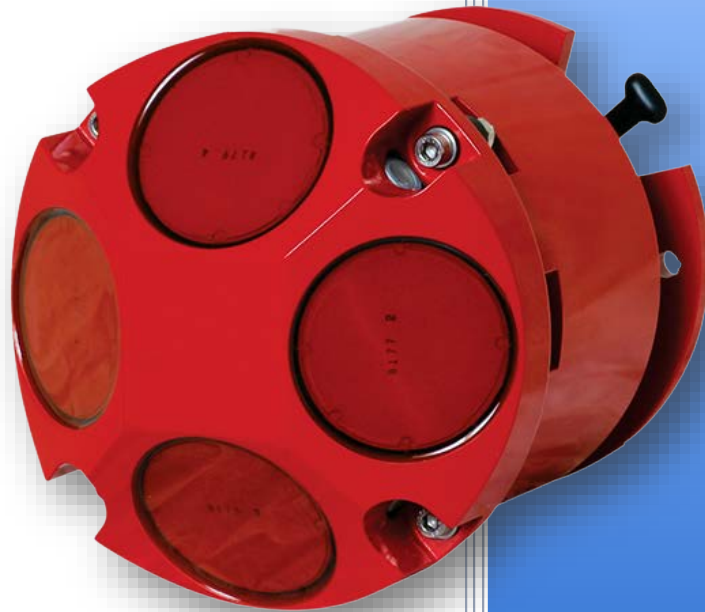


NAVIGATOR

INTEGRATION GUIDE



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Self-Service Customer Portal

Use our online customer portal at <http://www.teledynemarine.com/rdi> and click on the **Support** link to download manuals, firmware updates, software, or other Teledyne RDI documentation.

Getting Started with the Navigator

Identifying what's in the Box

Navigator Inventory

Part Number	Name	Description
WHN300 WHN600 WHN1200	Navigator DVL	The Navigator system includes the transducer and connector dummy plug. When unpacking, use care to prevent physical damage to the transducer face and connectors. Use a soft pad to protect the transducer.
717-7000-00 717-7007-00	Shipping Case	Shipping case with foam inserts.
737-3009-005	I/O Pigtail Cable	The DVL I/O pigtail cable allows you to build a custom cable to connect the Navigator to your vehicle/platform. It provides all the leads for serial COM, Trigger, and Power.
737-3030-005	I/O Cable	The DVL I/O pigtail cable allows you to connect the Navigator to your computer for testing.
717-3014-00	AC Power Adapter	The adapter is a 75-Watt power supply, with 48 VDC, 1.5 amp output.
90Z-8002-00	Navigation CD	This CD has PDF versions of all of the Navigator DVL documentation including the Navigator DVL Guide. Please read the manual! The CD also includes the <i>TRDI Toolz</i> Software. <i>TRDI Toolz</i> is a utility and testing software package that can be used to test the DVL.
957-6281-00	Navigator Getting Started Guide	A printed quick start card showing test setup is included. A PDF version is included on the documentation CD.
957-6280-00	Navigator Integration Guide	A printed guide showing how to integrate the Navigator DVL onto a ROV. Refer to Chapter 2 of the Navigator DVL guide for detailed instructions.
757K6088-00 757K6089-00	See table below for description	Anodes and closing hardware



This list only shows the part included with the standard Navigator DVL. See the packing slip for additional options. If you are missing parts, contact TRDI support rdifs@teledyne.com or call +1 (858) 842-2700.

Navigator Spare Parts*

Part Number	Part Description	Quantity Per Assembly
206062-1	AMP CPC CLAMP, SHELL SIZE 11	1
206430-2	RECEPTACLE, 4 PIN, FREE HANG	1
5020	SILICONE LUBRICANT, 4-PACK	1
66101-4	TYCO SOCKET AWG18-16,LP,MULTIMATE,SELECT	2
717-3008-00	JUMPER, GND, MAIN	1
7289A16	KEY, HEX, 5M	1
75ZK6001-00	KIT, CLIP, CABLE	1
75ZK6001-01	KIT, CLIP, DUMMY, PLUG	1
810-4006-00	ANODE, HOUSING FLANGE, 3000/6000M	4
817-1067-00	SCREW, PRESSURE SENSOR	1
817-3003-00	WASHER, FELT WH	4
84Z-6000-00	TOOL BAG, CANVAS	1
97Z-6050-00	O-RING, 2-258, 70 DURO, EPDM SCD	4
97Z-6053-00	O-RING, 2-261 DURO 70, EDPM SCD	4
97Z-6068-00	SOCOD, O-RING, BACK-UP RING BORE SEAL, DURO 90	2
DES3	DESICCANT, SEALED BAG,2 UN MIL PAK	1
GMA-3A	FUSE, 5MM X 20MM 3R 250V	2

Part Number	Part Description	Quantity Per Assembly
M8WASHSPL	WASHER, SPLIT LOCK,SST316	2
M8WASHSTD	WASHER, FLAT16MMOD,SST316	4
M8X1.25NUT	NUT, HEX,SST316	2
M8X1.25X45SH	SCREW, SKT HD.SST 316	2
M13COMBINATION	WRENCH, 13MM COMB.	1
M6WASHNYLON	WASHER, FLAT, 6.4 ID 12.5 OD, NYLON	4
M6WASHSMOD	WASHER, FLAT, 11MM OD,SST 316	4
M6WASHSPL	WASHER, SPLIT LOCK SST316	4
M6X1.0NUT	NUT, HEX, SST 316	2
M6X1.0X35SH	SCREW, SKT HD, SST 316	2
M10COMBINATION	WRENCH, 10MM COMB.	1
SPR84-1LB	RUBBER BAND 50 / BAG CORPORATE EXPRESS	2

Blue = 757K6088-00 Spare Parts for 300/600 kHz Navigator

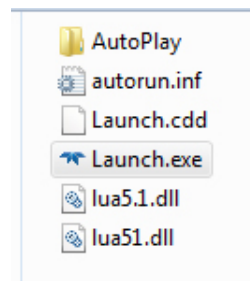
Gray = 757K6089-00 Spare Parts for 1200 kHz Navigator

Installing Documentation and Software

The Navigator system includes a CD with the documentation and software needed for the Navigator.

To install the Navigator Documentation and Software CD:

1. Insert the CD into the drive and follow the browser instructions on the screen. If the browser does not start automatically, complete steps 2 through 3.
2. Use Windows Explorer® to open the CD drive folder.
3. Double-click on the *launch.exe* file. Follow the browser to install the software and documentation to your computer.



Many companies require that Autorun is disabled. Double-click on *Launch.exe* to start the browser on all TRDI software and documentation CDs.

4. Click **Start, All Programs, Teledyne RD Instruments** to locate the installed documentation and software.

Connecting to the Navigator

Power Overview

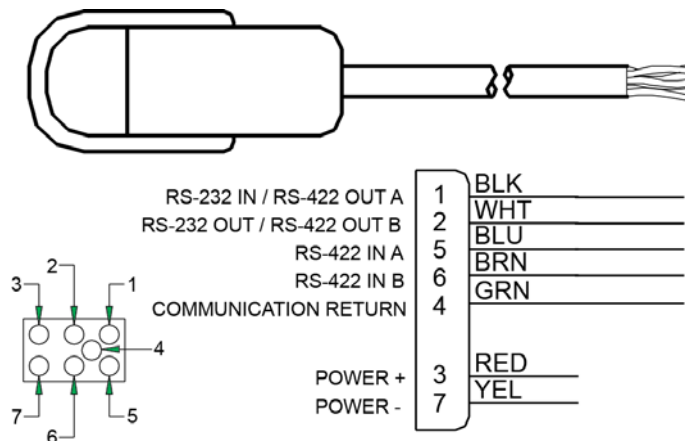
For deployments, the Navigator requires a power supply designed to supply between 20 to 50 VDC, 25 watts. Sonar performance depends on supply voltage, but not very strongly. The processing electronics use a DC/DC converter, so their function is independent of the supply voltage over the 20 to 50 volt range. However, the raw supply voltage is provided directly to the transmitter so that the transmitted acoustic power is proportional to V_{in}^2 . Table 1 shows the bottom-track range (assuming a salinity of 35 ppt and temperature of 5° C) versus supply voltage:

Table 1: Input Voltage vs. Bottom-Track Range for a DVL

Power Supply Voltage (VDC)	Bottom-Track Range (meters)		
	1200kHz	600kHz	300kHz
20	22	83	212
24	23	86	220
30	24	89	228
40	25	92	239
50	26	94	246

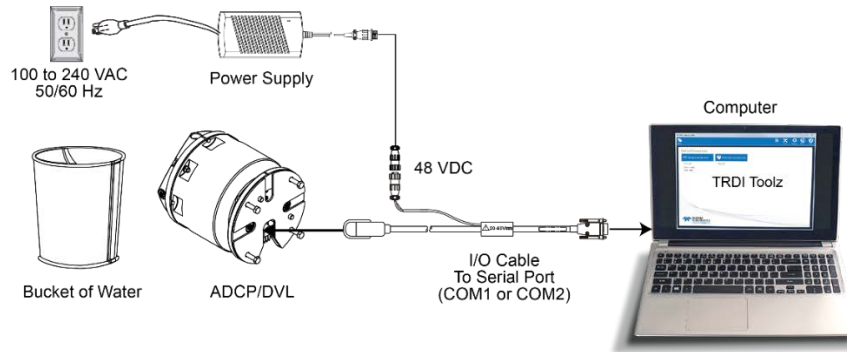
Many customers have successfully operated the Navigator using 24 volts. It may be worth the cost of providing a higher supply voltage to achieve the maximum bottom-tracking range.

Wiring Diagrams



Navigator Pigtail Cable Wiring

Using the Test Cable



Navigator Connections for Bench Test

Using TRDI Toolz

To establish communications with the Navigator:

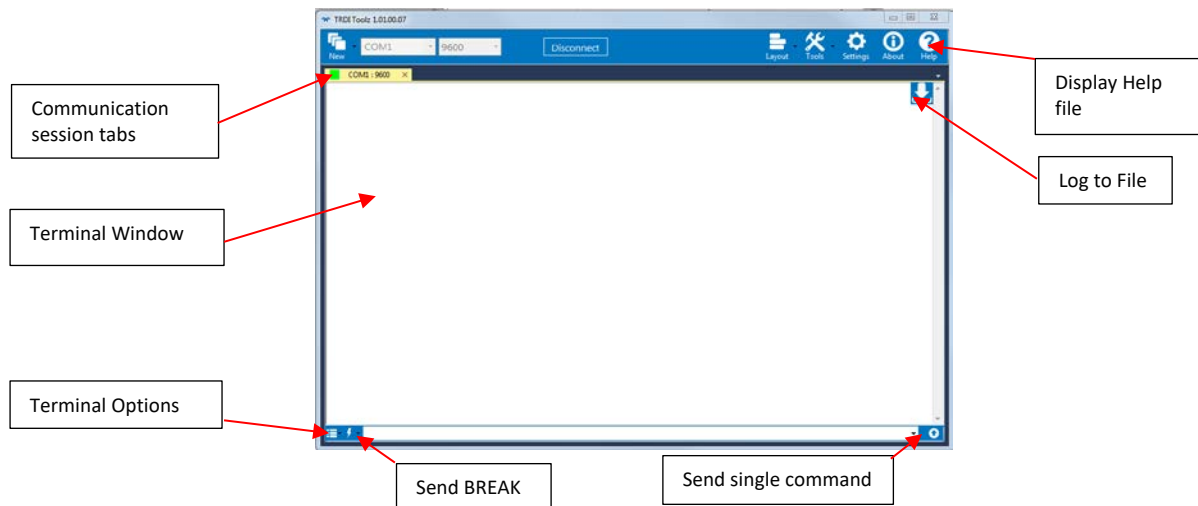
1. Connect the system and apply power.
2. Start *TRDI Toolz*.
3. Select **New Serial Connection**.
4. Enter the Navigator's communication settings.

Serial Communications:

Select the **COM Port** the serial cable is connected to and set the **Baud Rate** from the drop down list to **9600**




5. Click the **Connect** button. Once connected, the button will change to **Disconnect** and the tab will show a green box.
6. Click the **Break** (⚡) button. The wakeup banner will be displayed in the Terminal window.



For more information on *TRDI Toolz*, click the Help icon (ⓘ) to open the TRDI Toolz Software help file.




Testing the Navigator DVL

To test the Navigator:

1. Interconnect the system and apply power.
2. Place the Navigator transducer in water (at least a few inches to cover the transducer face).
3. Start the *TRDI Toolz* program and connect.
4. Click the **Break** () button. The wakeup banner appears on the Terminal window.

```
Navigator DVL
Teledyne RD Instruments (c) 2012
All rights reserved.
Firmware Version: 9.xx
```

>5. Enter the following commands in the command box:

- Enter **CR1** then press the  icon. This will set the Navigator to the factory default.
- Enter **CK** then press the  icon. This will save the factory default setting.
- Enter **PA** then press the  icon. This will run the Navigator Pre-Deployment test.



Submerge the transducer face in a few inches of water. **The PA test may fail in air.** Only a failure with the transducer in water is a relevant test.



This test may fail if the Navigator is exposed to electrical interference such as that from other acoustic devices or SONARS or other electronic devices (i.e. cellphones, radios, computers, TV's, etc.).

```
>pa
```

```
PRE-DEPLOYMENT TESTS
```


```
CPU TESTS:
RTC.....PASS
RAM.....PASS
ROM.....PASS
RECORDER TESTS:
PC Card #0.....DETECTED
Card Detect.....PASS
Communication.....PASS
DOS Structure.....PASS
Sector Test (short).....PASS
PC Card #1.....NOT DETECTED
DSP TESTS:
Timing RAM.....PASS
Demod RAM.....PASS
Demod REG.....PASS
FIFOs.....PASS
SYSTEM TESTS:
XILINX Interrupts... IRQ3 IRQ3 IRQ3 ...PASS
Wide Bandwidth.....PASS
Narrow Bandwidth.....PASS
RSSI Filter.....PASS
Transmit.....PASS
SENSOR TESTS:
H/W Operation.....PASS
>
```

6. If the wakeup banner displays and PA message displays with a result of "PASS", the Navigator is functioning normally.

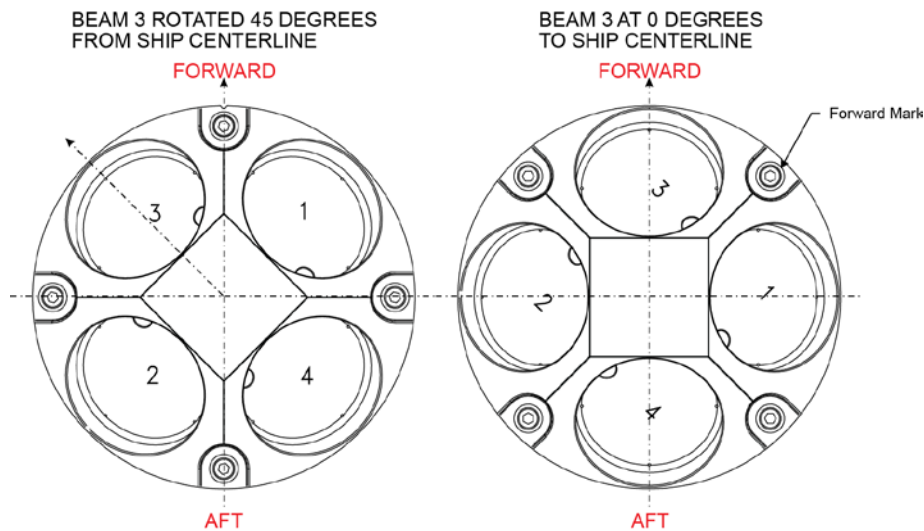
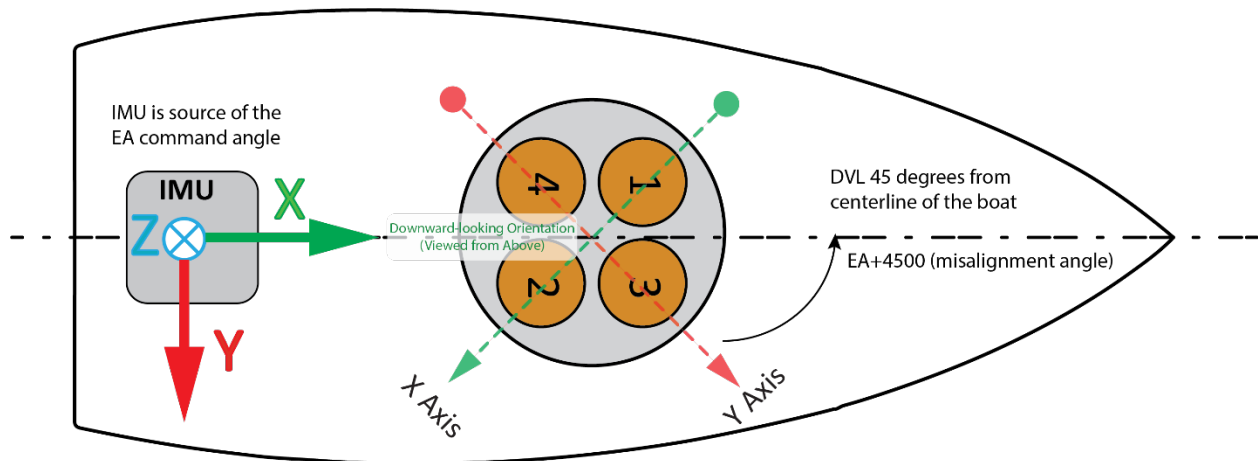
Mechanical Integration

Alignment

The mechanical alignment of the transducer head is important to DVL data accuracy. Mechanically mount the head as close as possible to your reference point. You also must mount the transducer head as level as possible using the ship's roll and pitch references.

 TRDI recommends mounting the transducer head with Beam 3 (instrument Y-axis) rotated 45° relative to the ship forward axis, and thus, the Forward mark is facing forward.

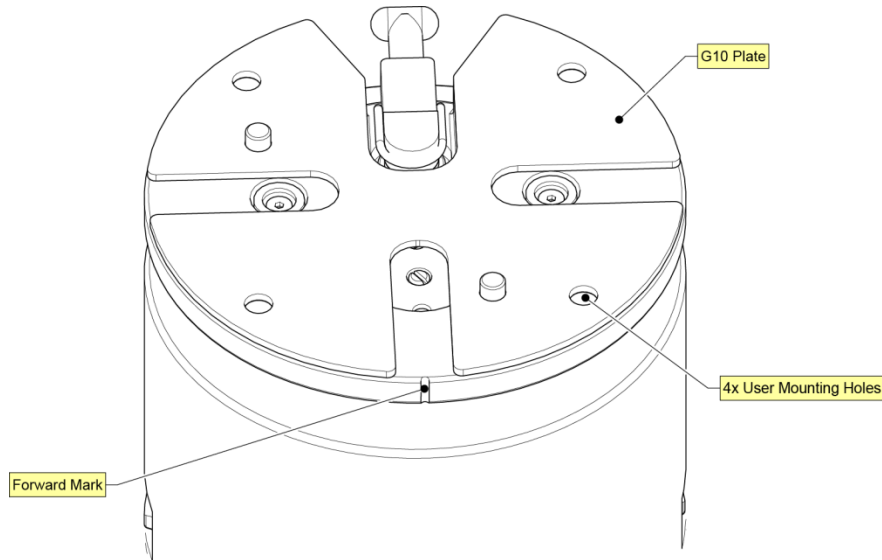
Mounting the transducer head with Beam 3 (instrument Y-axis) rotated 45° relative to the ship forward axis causes the magnitude of the signal in each beam to be about the same. This improves error rejection, reduces the effect of ringing, and increases the Navigator's effective velocity range by a factor of 1.4. If Beam 3 is aligned at an angle other than zero, use the EA command to describe the rotation between instrument Y-axis (beam 3) and ship forward axis.



Transducer Alignment Reference Points

Installing the DVL

There are many options for mounting the Navigator systems and they depend on the application. The preferred method of mounting the DVL is using the holes on the end-cap flange.



End-Cap view of the transducer showing mounting holes



Your Navigator DVL transducer housing is made of aluminum that is protected by sacrificial anodes and a hard anodize coat. **Do not connect other metal to the DVL.** Other metals may cause corrosion damage.

Use M6 isolating bushings and washers when mounting the DVL to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the vehicle.

Electrical Integration

Grounding Issues

Multiple grounds connected to a vehicle hull or to a vehicle chassis can have undesirable consequences. Grounding problems can be avoided by implementing prudent grounding schemes.

The DVL has three isolated grounds in order to achieve the desired performance levels of the instrument. The grounding systems are as follows:

- Communication ground
- Power ground
- Chassis ground

Bypassing or shorting the DVL isolation / ground noise filter circuit will increase the sensitivity of the DVL to vehicle noise, which will increase noise floor in the instrument and in the data, thereby resulting in a reduced operational range and data contamination from interference. Additionally, bypassing of the DVL isolation/ground filter can lead to accelerated corrosion.



Your Navigator DVL transducer housing is made of aluminum that is protected by sacrificial anodes and a hard anodize coat and paint. **Do not connect other metal to the DVL.** Other metals may cause corrosion damage.

Use M6 isolating bushings and washers when mounting the DVL to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the vehicle.

Electro-Magnetic Interference (EMI)

The main sources of EMI are induced voltages from signal and power lines that are located in proximity to the effected component or signal. These problems are avoided or minimized by the proper routing of wires, proper shielding of wires and proper location of individual systems components. EMI is also caused by unwanted differences in potential on signal or ground electronic lines.



For more information, see the Navigator Guide, Chapter 2 – System Integration, Identifying EMI.

Acoustic Integration

The following items must be taken into consideration when using the Navigator DVL.

Flow Noise – Water flowing over the transducer faces increases the acoustic noise level, which in turn decreases the operational range of the DVL. Flow noise can be reduced across the transducer faces by mounting the DVL behind a sea chest, fairing, or acoustic window. Flow noise can also be reduced by optimizing the transducer head type and design to conform to the platform hull form being used.

Cavitation – Cavitation is the formation of air bubbles due to the reduction of ambient pressure because of hydrodynamic flow conditions. Cavitation at the edges of the transducer or surrounding area near the transducer often results in increased acoustic noise, and a corresponding reduction in operating range. As with flow noise, cavitation can also be reduced by optimizing the transducer head type and design to the platform hull form being used.

Ringling – Ringing occurs in DVLs when the energy from the side lobes of the transmitted signal excites the metal portion of the DVL transducer such that a resonant condition occurs. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. While some ringing is normal in DVLs, its magnitude must be minimized.

Windows Use Considerations – Windows can be used to produce overall performance improvements in vessel-mounted DVLs. There are several advantages and disadvantages to consider before using an acoustic window.

Advantages

- Well will not fill with air bubbles caused by the ship moving through the surface water.
- Flow noise is reduced.
- The well can be filled with fresh water to limit corrosion.
- Barnacles cannot grow on the transducer faces. Barnacle growth is the number one cause of failure of the transducer beams.
- The transducer is protected from debris floating in the water.

Disadvantages

- The range of the DVL may be reduced because the window can and will absorb some of the transmit and receive energy.
- The transmit signal could be reflected into the well, causing the well to “ring”. This will cause the data being collected during the ringing to be biased. Some vessels have reported a loss in range as great as 50 meters. As noted, the ringing may be damped by applying sound absorbing material on the well walls (standard neoprene wet suit material has been found to work well).
- The transmit signal could be reflected off the window and back into the other beams.

SONAR Interference Considerations – Interference from other acoustic and electromagnetic devices can cause velocity and direction bias. In extreme cases, interference may prevent the DVL from operating.



For more information, see the Navigator Guide, Chapter 2 – Installation and Deployments.

Operational & Setup Integration

The following items must be taken into consideration when using the Navigator DVL.

Unfavorable Environments – There are certain environmental conditions where the DVL's errors may be large or where the instrument does not function at all.

- In the surf zone where waves are actively breaking, the acoustic beams may not be able to penetrate the bubble clouds, and even if they do, the sound speed may be significantly affected by the high concentration of bubbles. This changes the Doppler scale factor.
- The dense growth of weeds or kelp on the bottom may prevent the DVL from detecting the true bottom. If the DVL locks onto the top of the weeds by mistake, they may have motion relative to the bottom due to wave action, which would give inaccurate velocity measurements.
- In areas of high salinity (>35ppt), the absorption of the sound by the water column will reduce the altitude capability of the DVL. Absorption (maximum range) can also be affected by water temperature.
- In areas where the salinity varies as a function of location and/or time, the Doppler scale factor will be varying and it may be necessary to integrate a speed-of-sound sensor into the navigation system to keep the velocity measurement errors to an acceptable value. Temperature gradients can cause similar issues. This is only for the Z-axis velocity, as Speed of Sound does not impact 2D velocities on a Phased Array Transducer.

Triggering – There are two methods for triggering the DVL:

- **Sending ASCII Character through Serial Port.** When the system is interfaced to a serial port (e.g. a navigation computer), the system can be setup to wait for an input before each ping. To setup the DVL in this fashion, clear the Auto Ping Cycle bit in the CF command by sending CFx0xxx, where the x's represent the settings of the other parameters. Start the DVL pinging with the CS command. The DVL will output a '<' before each ping and wait for input. Send any valid ASCII character to trigger the ping. The instrument will not enter sleep mode while it is waiting for the trigger.
- **Using Low-Latency Triggering.** The trigger methods shown above all have latencies ranging from a few milliseconds to a few hundred milliseconds, which may be excessive for high-precision applications. Consequently, TRDI has developed a low-latency trigger method (see CX command). To configure the DVL for low-latency triggering, set the CX command to enable trigger input. Start the DVL pinging with the CS command. The DVL will then wait for a trigger before each ping. Setting the trigger lines to a break state for no less than 10 microseconds sends the trigger. The DVL will then ping within 1 millisecond of the leading edge of the break pulse. Note that it is possible through the CX command settings to set a timeout for the DVL to wait for a Trigger and then shall no Trigger occur during that time it will either Self Deploy and never look for Trigger again or Ping once and then go back to waiting for Trigger.



For more information, see the Navigator Guide, Chapter 2 – Installation and Deployments and Chapter 8 - Commands.

Choosing a Data Format

Deciding on which output data format to use depends on the needs of the deployment. The following describes the basics of the formats available.

- **PD0** is TRDI's standard format. PD0 is a binary output format. It provides the most information possible including a header, fixed and variable leader, bottom track, and water profile information. The fixed and variable leader is a recording of time, DVL setup, orientation, heading, pitch, roll, temperature, pressure, and self-test diagnostic results. Data fields to be output are user selectable.

File Size (if BT Only) is 211 bytes binary

File Size (if water profile included) varies depending on the number of bins selected.

- **PD3** is a binary output format of bottom track speed over the bottom, speed through the water, range to bottom information, and 16 spare bytes with no definition.

File Size is 40 bytes binary.

- **PD4** is a binary output format of bottom track speed over the bottom, speed through the water, and range to bottom information only.

File Size is 28 bytes binary.

- **PD5** is a superset of PD4 and includes information on salinity, depth, pitch, roll, heading, and distance made good.

File Size is 74 bytes binary.

- **PD6** is a text output format. Data is grouped into separate sentences containing system attitude data, timing and scaling, and speed through the water relative to the instrument, vehicle, and earth. Each sentence contains a unique starting delimiter and comma delimited fields

- **PD10** is similar to PD3 but with the addition of pressure and depth fields.

- **PD11** is a text output format. It complies with the NMEA 0183 version 2.30 standard.

- **PD13** is a text output format similar to PD6 with the addition of information about range to bottom and raw pressure sensor data.



For more information, see the Navigator Guide, Chapter 9 – Output Data Formats.

Want to know more?

Congratulations! You have completed the Navigator Integration Guide. Read the following chapters in the Navigator Guide for more detailed information.

- 🔗 **Chapter 1 – Navigator Overview**
This chapter includes an overview of the Navigator features, options, computer and power requirements, and connecting to the Navigator DVL.
- 🔗 **Chapter 2 – Installation and Deployments**
This chapter covers system integration in detail.
- 🔗 **Chapter 3 – Frequently Asked Questions**
Use this chapter covers mechanical installation, electrical installation, and operational questions..
- 🔗 **Chapter 4 – Maintenance**
This chapter covers Navigator DVL maintenance. Use this section to make sure the Navigator is ready for a deployment.
- 🔗 **Chapter 5 – Testing the Navigator**
This chapter covers test procedures and interpreting the test results.
- 🔗 **Chapter 6 – Troubleshooting the Navigator**
This chapter covers troubleshooting procedures.
- 🔗 **Chapter 7 – Returning Systems to TRDI for Service**
Use this information to obtain a Return Material Authorization (RMA) number if the Navigator DVL needs to be returned to TRDI.
- 🔗 **Chapter 8 – Commands**
This chapter defines the commands used by the Navigator.
- 🔗 **Chapter 9 – Output Data Formats**
This chapter defines the output data formats used by the Navigator.
- 🔗 **Chapter 10 – Specifications**
This chapter includes specifications and dimensions for the Navigator DVL (including outline installation drawings).