

EXPLORERDVL

OPERATION MANUAL



TELEDYNE
MARINE
Everywhereyoulook™



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REVISION HISTORY

February 2024

- Updated Returning Systems to the TRDI Factory, page 87 Brokerage address.

July 2023

- Updated website address.

February 2023

- Removed RTV from anodes. Applying RTV to the anodes reduces their effectiveness which can lead to corrosion of the housing.
- Updated EAR statement.
- Fixed leader IDs on page 174.

June 2022

- Fixed Leader Binary Byte 37,38 was WL command. Changed to Spare.

April 2022

- 95Z-6007-00 replaces the 90Z-8000-00 CD.

February 2022

- Corrected the format for GPS Latitude/Longitude on Table 71, page 241. "Latitude Dec Minutes" field should be renamed to "Latitude Dec Degrees". "Longitude Dec Minutes" field should be renamed to "Longitude Dec Degrees". Added an example.
- New cover photo.

May 2021

- Added the PDDecoder link in the Output Data Format chapter. Use the Teledyne Marine library to decode Teledyne RD Instruments (TRDI) PD data types, such as PDO and waves packets.

October 2018

- Replaced setup cards with new Deployment Guide.
- Added Getting Started sheet to documentation.
- Added using cable clips.
- Corrected signal names on 737-3055 cable drawing.
- Corrected page 60; step 5a tells you to set up the communications using the command SP 2 9. The correct command should be SP 4 9.
- Added note to temperature sensor specification.
- Updated Outline Installation drawings 96B-1004 and 96B-1015
- Updated Table 31: Summary of Output Data Formats with PDO Distance Made Good information.
- Updated Figure 42. PDO Standard Output Data Buffer Format with missing bottom track output formats and IDs.
- Added figures for Environmental Command Parameters Output Format, Bottom Track Command Output Data Format, Bottom Track High Resolution Velocity Output Format, Bottom

Track Range Output Data Format, Navigation Parameters Data Format, and Sensor Source for Doppler Processing Output Format

- Added Export Administration Regulations (EAR) footers

December 2016

- Updated CX command.
- Updated #EY command.
- Added #B1 command.

September 2015

- Updated outline installation drawing 96B-6006.
- Added missing outline installation drawing 96B-1002.
- Added Self-Contained Test Cable P/N 737-3114
- Updated specifications.
- Added note about dynamic commands to Table 12, page 114.
- Updated the OL command example printout.
- Updated the PA command.
- Updated WD command default.
- Updated Table 68, page 232.

April 2014

- TCM3/5 commands replaced by PNi TRAX sensor.
- Changed WV command default from WV175 to WV500.
- Updated the specifications.
- Updated the Outline Installation Drawings.
- Removed the Reserved for TRDI description that was just before the PDO checksum. These two bytes were not in the ExplorerDVL output data.
- Added BIT Decoding Method to variable leader data format.
- Corrected binary bytes 23-30 (Hex 45-60) on PD4/PD5 description.
- Corrected PD5 DMG fields scale from dm (decimeters) to mm (millimeters).
- Added caution about using dry silicone lubricant to Self-Contained I/O connectors – ICN 145
- Added sensor set up example to chapter 3.
- Updated fonts and styles.

November 2010

- Added Self-Contained model.
- ICN074, 084, 097, 099, and ICN104 incorporated into manual.

July 2007

- Firmware version 34.08 added PD6 Output Data Format and two commands used by PD6 – #BN and #BO.
- Other minor corrections and updates

HOW TO CONTACT TELEDYNE RD INSTRUMENTS

If you have technical issues or questions involving a specific application or deployment with your instrument, contact our Field Service group:

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For all your customer service needs including our emergency 24/7 technical support, call +1 (858) 842-2700

Self-Service Customer Portal

Use our online customer portal at <https://www.teledynemarine.com/support/RDI/technical-manuals> to download manuals or other Teledyne RDI documentation.

Teledyne Marine Software Portal

Teledyne RD Instruments Firmware, software, and Field Service Bulletins can be accessed only via our Teledyne Marine software portal.

To register, please go to <https://tm-portal.force.com/TMsoftwareportal> to set up your customer support account. After your account is approved, you will receive an e-mail with a link to set up your log in credentials to access the portal (this can take up to 24 hours).

Once you have secured an account, use the Teledyne Marine software portal to access this data with your unique username and password.

If you have an urgent need, please call our Technical Support hotline at +1-858-842-2700.

CONVENTIONS USED IN THIS MANUAL

Thank you for purchasing a Teledyne RD Instruments ExplorerDVL. This Operation Manual is designed to help ExplorerDVL users to get familiar with the system.

Conventions used in the ExplorerDVL Operation Manual have been established to help learn how to use the system quickly and easily.

Menu items are printed in bold: click **Collect Data**. Items that need to be typed by the user or keys to press will be shown as <**F1**>. If a key combination were joined with a plus sign (<**ALT+F**>), press and hold the first key while pressing the second key. Words printed in italics include program names (*TRDI Toolz*) and file names (*TestWH.rds*).

Code or sample files are printed using a fixed font. Here is an example:

```
ExplorerDVL
Teledyne RD Instruments (c) 2013
All rights reserved.
Firmware Version: 34.xx
```

>

There are four other visual aids to help: Notes, Cautions, Recommended Settings and References.



This paragraph format indicates additional information that may help avoid problems or that should be considered in using the described features.



This paragraph format warns the reader of hazardous procedures (for example, activities that may cause loss of data or damage to the ExplorerDVL).



This paragraph format indicates additional information that may help set command parameters.



This paragraph format tells the reader where they may find additional information.

NOTES

Chapter 1

AT A GLANCE




In this chapter:

- System Overview
- Models and Options
- Computer Considerations
- Power Overview
- Setting up the ExplorerDVL System
- Caring for the ExplorerDVL System

System Overview

The transducer assembly contains the transducer ceramics. The standard acoustic frequency is 614.4 kHz. See the outline drawing for dimensions and weights ([Outline Installation Drawings](#)).

Picture	Description
	<p>The standard piston transducer housing allows deployment depths to 300 meters (see Figure 1) and the Phased Array transducer (see Figure 2) allows deployment depths to 1000 meters.</p> <hr/> <p>The transducer ceramics are mounted to the transducer housing. The urethane faces cover the transducer ceramics.</p> <p>Never set the transducer on a hard surface. The urethane faces may be damaged.</p>
	<p>The Transmit and Receive cables connect the ExplorerDVL transducer to the Electronics Chassis.</p>
	<p>The Electronic Chassis contains all the interfaces to and from the transducer, computer, vessel, and power.</p>
	<p>The Self-Contained ExplorerDVL electronics and transducer are contained in a waterproof housing (see Figure 4 and Figure 5).</p>

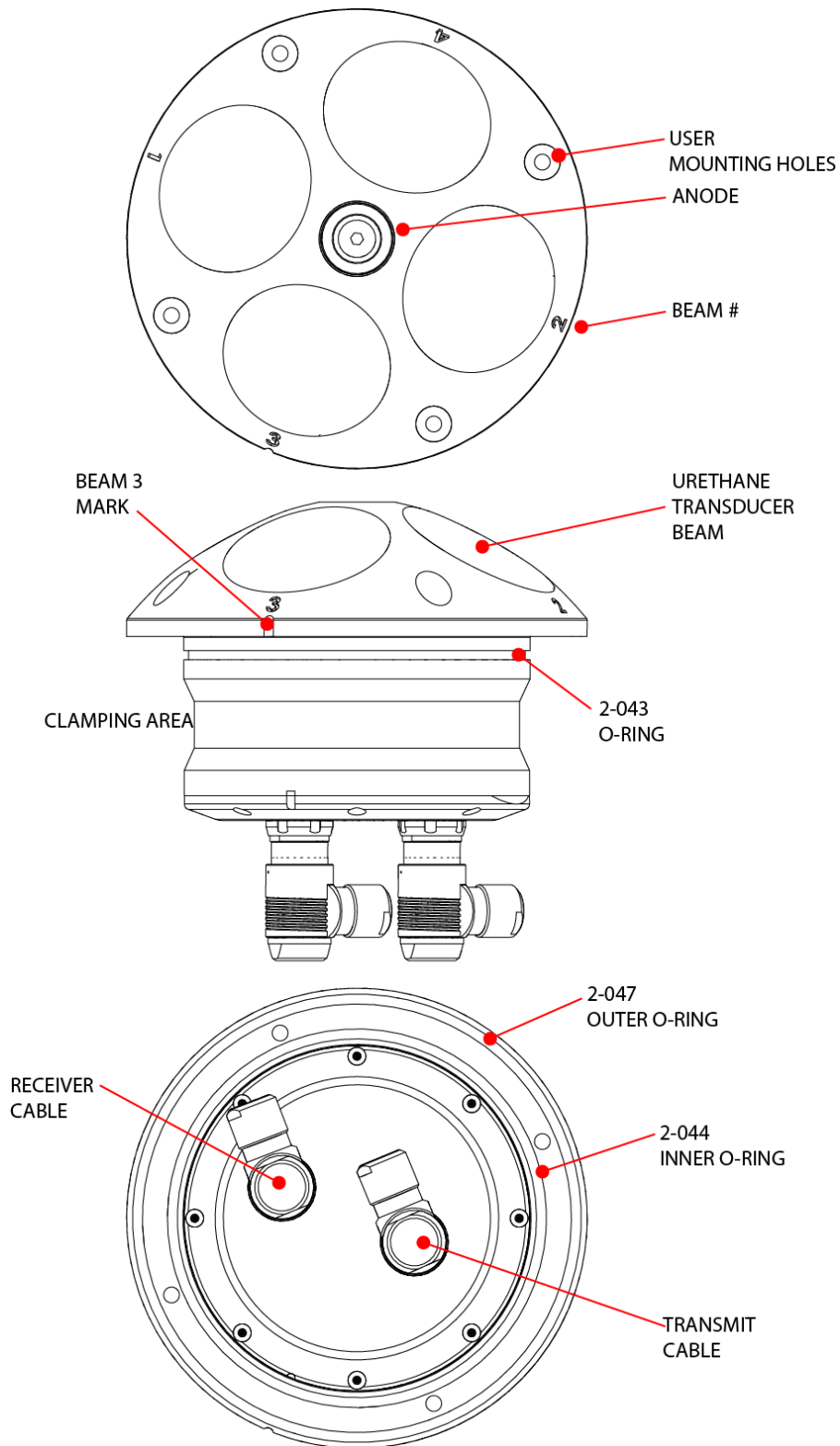


Figure 1. ExplorerDVL Piston Transducer

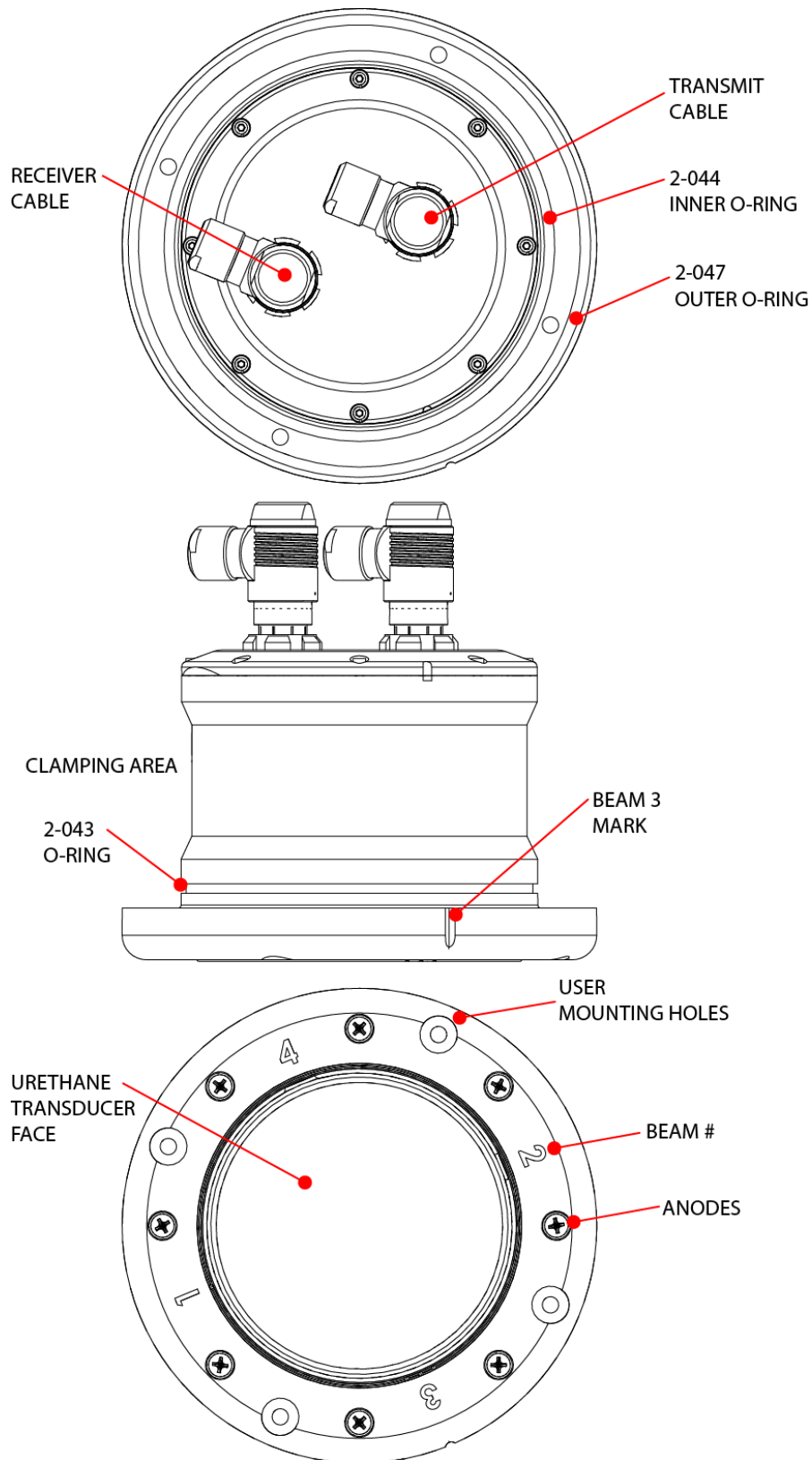


Figure 2. ExplorerDVL Phased Array Transducer

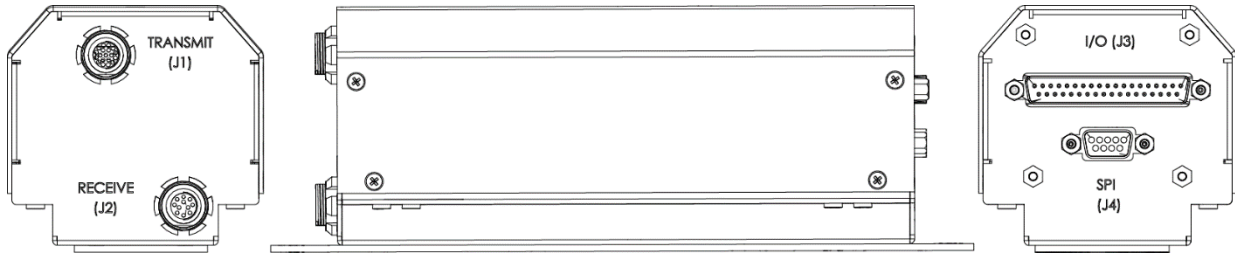


Figure 3. ExplorerDVL Electronics Chassis



The ExplorerDVL Electronics Chassis contains Electro Static Sensitive Devices. Take accepted ESD prevention measures **before** removing the cover.

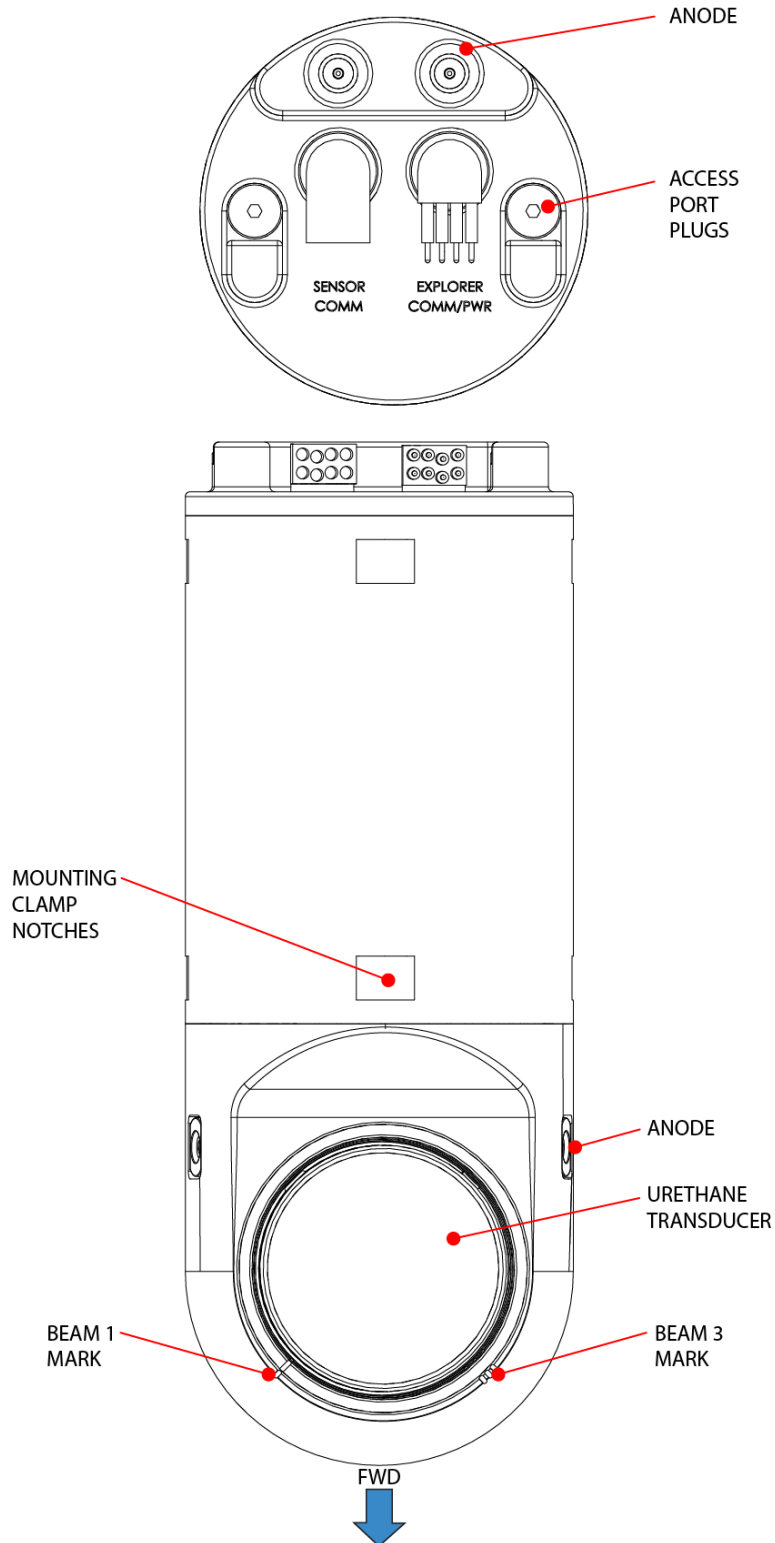


Figure 4. Self-Contained Phased Array ExplorerDVL



The Self-Contained ExplorerDVL housing contains Electro Static Sensitive Devices. Take accepted ESD prevention measures **before** removing the end-cap and housing.

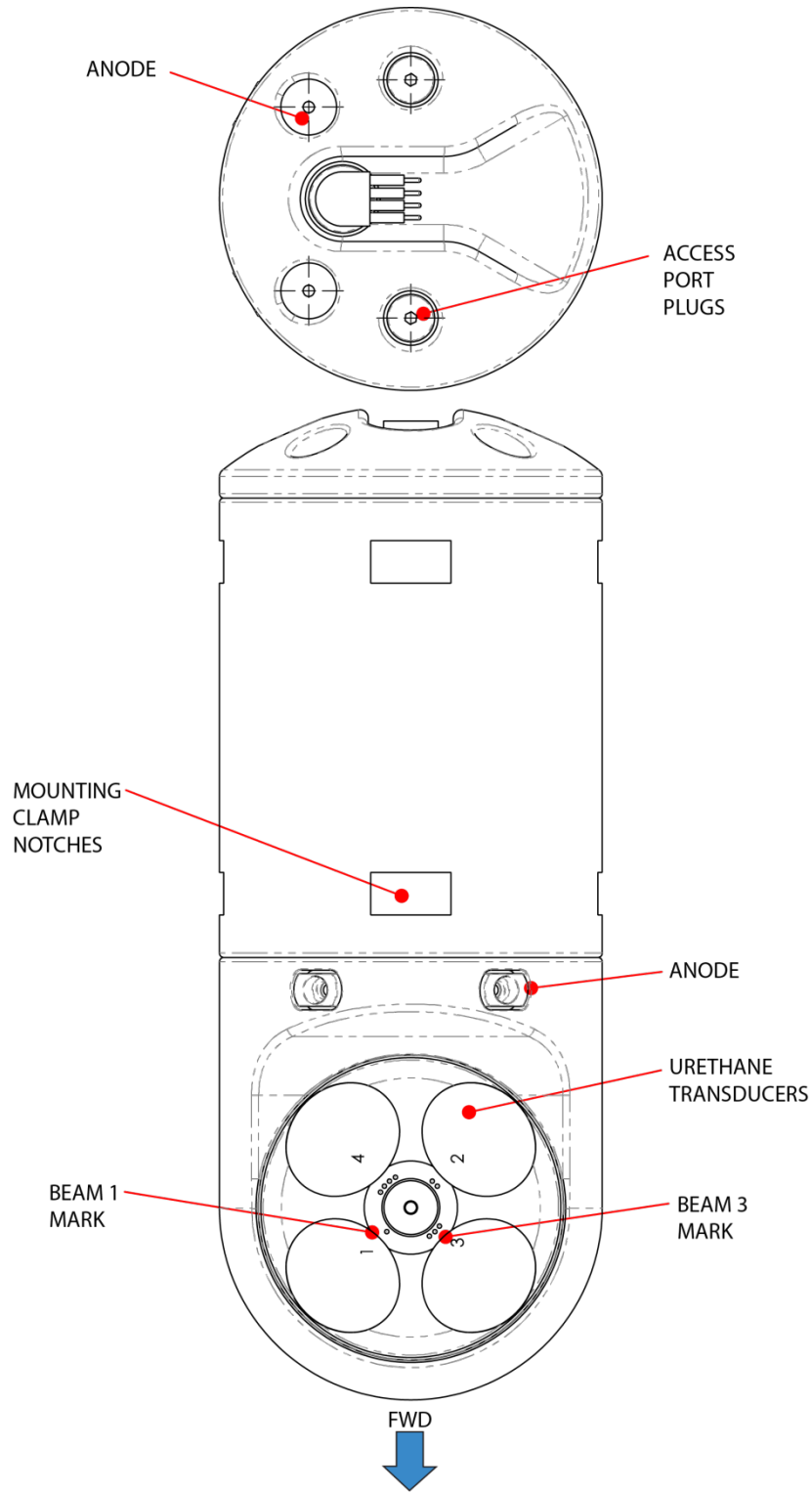


Figure 5. Self-Contained Piston Array ExplorerDVL



The Self-Contained ExplorerDVL housing contains Electrostatic Sensitive Devices. Take accepted ESD prevention measures **before** removing the end-cap and housing.

Models and Options

Transducer Type and Depth Rating – The ExplorerDVL can utilize one of two transducer technologies depending on the required depth rating. The Phased Array transducer and the Janus piston transducer provide a standard 300 meters depth rating. High-pressure systems are available with a depth rating up to 4000 meters.

Self-Contained ExplorerDVL - The Self-Contained Phased Array ExplorerDVL contains the electronics and transducer in a waterproof housing.

Transducer material – Transducers are available in aluminum (standard), and optionally in titanium and bronze.

Communication configurations – The ExplorerDVL has four communication channels available. The personality module (hardware dependent) can be one of the following combinations of electrical protocols:

- Four RS-232 channels,
- One RS-422 channel and three RS-232 channels,
- Two RS-422 channels and two RS-232 channels.

Cable lengths – The maximum length of the transmit and receive cables is 2.0 meters.

Angled / straight cable connectors – The Transmit and Receive cable connectors on the transducer end-cap are available in both right angled and straight connectors.

Feature upgrades – Contact a local TRDI sales representative if interested in upgrading the system.

- The Low Altitude Bottom Capability feature upgrade extends the minimum altitude for Bottom Tracking from 0.5 meters to 0.25 meters for piston and phased array at 0.31 meters.
- Water Profiling Real-time current profiling option

Setting up the ExplorerDVL System

Use this section to connect the ExplorerDVL to a computer and establish communications. Install the *RDI Tools* software in order to communicate with the ExplorerDVL.

Computer and Software Considerations

The ExplorerDVL system includes the utility program *TRDI Toolz* to help set up, use, test, and troubleshoot the ExplorerDVL. Use this program to “talk” to the ExplorerDVL and to run script files (see [Creating or Modifying Command Files](#) and [Use TRDI Toolz to Send the Commands to the ExplorerDVL](#)). *TRDI Toolz* is included on the Navigation CD. For detailed information on how to use *TRDI Toolz*, see the help file included with the software.

TRDI designed the Pinnacle to use a Windows® compatible computer with the minimum computer requirements:

- Windows 10®, Windows 8®, Windows 7® Desktop, Laptop, or Netbook computer
- Screen resolution above 1024x768
- One Serial Port (two or more High Speed UART Serial Port recommended)



TRDI highly recommends downloading and installing all of the critical updates, recommended updates, and the service releases for the version of Windows® being used prior to installing any TRDI software.

Power Overview

The ExplorerDVL requires a DC supply between 12 and 28 VDC with a minimum inrush capability of 3A. Either an external DC power supply or battery can provide this power. 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 12 to 28 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 . Many customers have successfully operated the ExplorerDVL using 24 volts. It may be worth the cost of providing a higher supply voltage to achieve the maximum bottom-tracking range.

The self-contained Explorer can accept custom power input with the inclusion of a custom power conversion board. Please contact a TRDI sales representative for further details on this capability.

Power on Cycle

The power supply must be able to handle the inrush current as well. Inrush current is the current required to fully charge up the capacitors when power is applied to the ExplorerDVL. The capacitors provide a store of energy for use during transmit. The inrush current is as high as three Amps rms. The ExplorerDVL will draw this amperage until its capacitors are fully charged.

If the power supply limits the current or the power drop on the cable is significant, then the power on cycle will take longer. It can take up to one minute. If the power shuts down during the inrush current draw, this may not allow the ExplorerDVL electronics to start.

Connecting the ExplorerDVL Cables

Figure 6 illustrates how to connect the ExplorerDVL cable to a computer and power. Make sure the ExplorerDVL is resting on a soft pad to protect the I/O cable connectors and the transducer urethane face(s).

To set up the ExplorerDVL:

1. Connect the Transmit and Receive cables to the electronics housing and transducer.



Match the red dots to connect the Transmit and Receive cables. See [Connecting the Transmit/Receive Cables](#) for details.

2. Wire the I/O cable to the computer's communication port (see [Input Power and Communications Cable Wiring](#)).
3. Connect +12 to 28 VDC power.

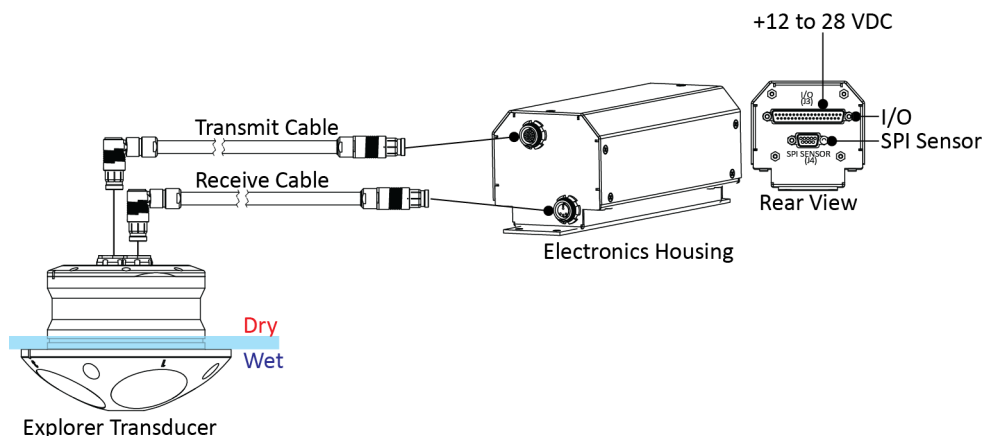


Figure 6. ExplorerDVL Connections

Connecting the Self-Contained ExplorerDVL

Figure 7 illustrates how to connect the Self-Contained ExplorerDVL cable to your computer and power. Make sure the Self-Contained ExplorerDVL is resting on a soft pad to protect the I/O cable connectors and the transducer urethane face.

To set up the Self-Contained ExplorerDVL:

1. Connect the I/O cable to the ExplorerDVL.



Place a light amount of dry silicone lubricant spray on the connector pins (rubber portion only). This will make it easier to connect or remove the I/O cable and dummy plug. See [Self-Contained I/O Cable and Dummy Plug](#) for details.

2. Wire the I/O cable to the computer's communication port (see [Self-Contained Communications / Power Cable](#)).
3. Connect +12 to 28 VDC power.

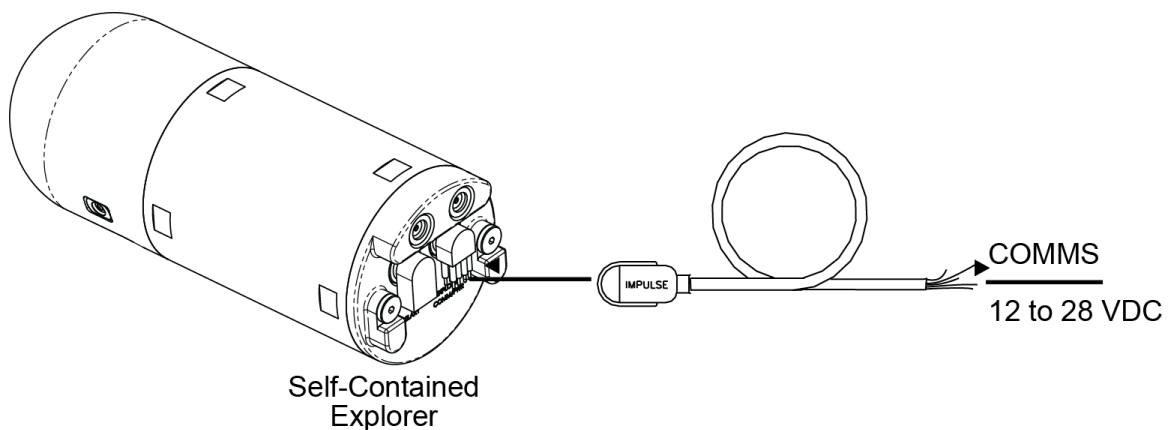


Figure 7. Self-Contained ExplorerDVL Connections (RS-232)



The dummy plugs should be installed any time the cables are removed. Use the dummy plug when the ExplorerDVL is in storage or is being handled.

Connecting to the ExplorerDVL

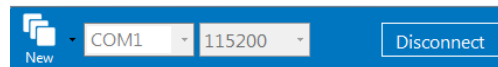
ExplorerDVL units are configured to use 4xRS232, or 3xRS232 and 1xRS422, or 2xRS232 and 2xRS422 communications protocols. The computer's communication port must match the ExplorerDVL communication lines on its port. To change the communication protocol, return the unit to TRDI or contact field service.

To establish communications with the ExplorerDVL:

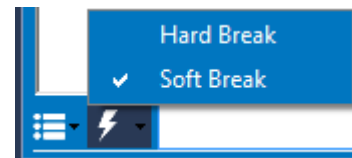
1. Connect the system and apply power.
2. Start the *TRDI Toolz* software.
3. Select **New Serial Connection**.
4. Enter the Pathfinder's communication settings.

Serial Communications:

Select the **COM Port** the serial cable is connected to and set the **Baud Rate** from the drop down list to 115200



5. Click the **Connect** button. Once connected, the button will change to **Disconnect**.
6. Click the **Break** (⚡) button. From the **Break** button drop down menu, select **Soft Break** (= = =). The wakeup banner will display in the terminal window.



```
ExplorerDVL
Teledyne RD Instruments (c) 2014
All rights reserved.
Firmware Version: 34.xx
```

>



It may be necessary to click inside the terminal window and then click the **Break** button to wake up the system.

Testing the ExplorerDVL System

To test the ExplorerDVL:

1. Connect the system as described in [Setting Up the ExplorerDVL System](#).
2. Apply power to the system.
3. Start the *TRDI Toolz* program (for help on using *TRDI Toolz*, see the TRDI Toolz Help file).
4. Click the **Break** button. The wakeup banner appears on the log file window.

```
ExplorerDVL
Teledyne RD Instruments (c) 2010
All rights reserved.
Firmware Version: 34.xx
```

>

5. At the ">" prompt in the communication window, enter the command **CR1** then press the **Enter** key. This will set the ExplorerDVL to the factory default settings.

6. At the “>” prompt in the communication window, enter the direct command **CK** then press the **Enter** key. This will save the factory default setting.
7. At the “>” prompt in the communication window, enter the direct command **PS0** then press the **Enter** key. This will display the ExplorerDVL system configuration data.

```
>ps0
Serial Number: 0
Frequency: 614400 Hz
Configuration: ExplorerDVL : 4-beam velocity.
Transducer Type: PISTON
Beam Angle: 30 Degrees
Beam Pattern: CONVEX
Sensors: TEMP PRESS TILTS

CPU Firmware: 34.xx
FPGA Version: 3.00.005
Sensor Firmware: 33.03
```

```
Board Serial Number Data:
53 00 00 00 15 5A 04 28
4F 00 00 00 34 A7 60 23 BFP72B-1102-03X
DC 00 00 00 41 51 C4 23 DSP72B-2102-00X
E6 00 00 00 41 7E A6 23 PER72B-2104-00X
F0 00 00 00 34 A7 89 23 BFT72B-1101-03X
8F 00 00 00 3D 07 1B 23 RCV72B-2103-03X
A1 00 00 00 32 00 67 23 SNS72B-1000-00A
4B 00 00 00 34 A6 5F 23 PIO72B-2101-00X
```

```
>
```

8. At the “>” prompt in the communication window, enter the command **PA** then press the **Enter** key. This will run the ExplorerDVL Pre-Deployment test.

```
>PA
RAM test.....PASS
ROM test.....PASS

Receive Path Test (Hard Limited):
H-Gain W-BW L-Gain W-BW H-Gain N-BW L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4
0 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
1 81 79 81 82 82 83 83 81 81 83 80 81 81 83 82 81
2 45 45 47 48 46 51 54 49 49 50 45 40 46 49 47 43
3 20 21 25 24 17 28 30 26 22 19 21 10 17 16 21 13
4 3 15 10 7 5 17 16 14 4 5 11 8 5 8 8 7
5 5 8 3 1 8 11 7 8 3 8 5 13 8 12 3 14
6 9 8 4 3 15 8 4 6 2 8 8 7 7 10 2 13
7 9 10 5 6 17 4 10 9 4 8 7 2 4 11 3 12
P P P P
Sin Duty Cycle (percent)
50 47 52 46 47 50 48 48 52 50 48 47 49 49 46 47
P P P P
Cos Duty Cycle (percent)
51 53 48 51 50 48 49 50 53 52 47 55 44 53 46 50
P P P P
RSSI Noise Floor (counts)
54 60 70 58 38 43 53 42 65 70 80 68 44 49 58 47
P P P P
RESULT...PASSED

Transmit/Receive Continuity Check:
(Transducer Must be in Air)
Test Beam
1 2 3 4
Noise (Amp/Rslt): 58/ PASSED 64/ PASSED 73/ PASSED 58/ PASSED
Elect (Amp/Rslt): 168/CONNECTED 172/CONNECTED 180/CONNECTED 169/CONNECTED
Ceramics (Amp/Rslt): 146/CONNECTED 152/CONNECTED 156/CONNECTED 145/CONNECTED

RESULT...PASSED

Composite Result:
GO for Deployment
```



This test may fail if the ExplorerDVL 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.). The test may also fail if the ExplorerDVL or its cable is exposed or installed near potential sources of EMI's such as high voltage lines like main engine cables, galley equipment, winches, engine room equipment, cranes, high voltage lighting circuit, etc. Interference from the mentioned sources may contaminate the ExplorerDVL's data as well. Oftentimes, a noisy (i.e. non-UPS) power supply may cause failures in this test as well.

9. If the wakeup displays, PSO displays, and PA message displays with a result of "GO for Deployment", the ExplorerDVL is functioning normally.
10. To test communication to external sensors in the system, assign the sensors to the ports using the SP command and then send the SR command to verify the sensors initialize.

Caring for the ExplorerDVL System

This section contains a list of items to be aware of every time handling, using, or deploying the ExplorerDVL. *Please refer to this list often.*

General Handling Guidelines

- Never set the ExplorerDVL transducer on a hard or rough surface. **The urethane face or anodized finish may be damaged.**
- Do not expose the transducer face to prolonged sunlight (24 hours or more). **The urethane face may develop cracks.** Cover the transducer face on the ExplorerDVL if it will be exposed to sunlight.
- Do not store the ExplorerDVL in temperatures over 60 degrees C or under -25 degrees C. **The internal components and/or urethane face may be damaged.**
- Do not scratch or damage the O-ring surface or grooves on the transducer and end-cap. **If scratches or damage exists, they may provide a leakage path and cause the ExplorerDVL to flood.** Do not risk a deployment with damaged O-ring surface.
- Do not lift or support an ExplorerDVL transducer by the external cables. **The connector or cable will break.**
- Do not connect or disconnect any cable with power applied. When the cable is connected with power applied, it may cause a small spark. **The connector pins may become pitted and worn.**
- Use light amounts of silicone lubricant (such as 3M™ Silicone Lubricant (Dry Type) ID No: 62-4678-4930-3) on both the male pins and female socket to help seat the Self-Contained cable connectors. Wipe off excessive silicone spray from the metal portions of the pins. **Regular lubrication is required: Apply dry type silicone lubricant prior to each connection.**
- The Self-Contained ExplorerDVL I/O cable may be connected while slightly wet; do not connect under water.

Installation Guidelines

- Make sure the O-rings stay in their groove when installing the ExplorerDVL in the vessel. **Loose, missing, stripped hardware, or damaged O-rings can lead to water ingress and damage the ExplorerDVL and/or vessel.**
- **The electronics housing and transmit and receive cables are not waterproof** and are intended for installation within a pressure vessel.
- The Phased Array and piston transducers are intended for installation onto a pressure vessel from the outside, **where the transducer face is subjected to the water and the end-cap (where the connectors are located) is dry.**

Chapter 2

INSTALLATION



In this chapter:

- How to mount the transducer
- How to connect/disconnect the cables
- Cable wiring diagrams

This section is a guide for installing the ExplorerDVL on ROVs, AUVs, ASVs, Towfish, or vessels. Use this section to plan the installation layout. Also use this information to see what requirements must be considered before purchasing an ExplorerDVL. TRDI recommends distributing this information to your organization's decision-makers and installation engineers.

TRDI are not experts in installing the ExplorerDVL aboard a ship. There are too many installation methods. We suggest seeking expert advice in this area because of its importance in ExplorerDVL performance. However, we can give guidelines based on theory and on how others have installed their systems. In return, we do appreciate receiving information about your installation and the results.



Always use caution when mounting the ExplorerDVL. Never rest the transducer head on a rough surface. Use foam padding to protect the transducer during handling.

Mounting the ExplorerDVL Transducer

Internal Clamp

The preferred method of mounting the transducer is using a clamp that grips the beveled edge on the circumference of the housing near the end-cap (see Figure 1 and Figure 2). This feature is provided so that when a mating beveled feature is clamped to it, the transducer is forced up and into the housing. This, in turn, loads up the face O-ring seal on the transducer flange and provides a water tight seal.

The advantage of this method is that no threaded connection outside the vehicle is needed, which should improve corrosion resistance and eliminates the need for the outer face O-ring on the flange. The disadvantages are slightly greater mechanical complexity and possible ringing depending on shape and material of the clamp (see [General Mounting Considerations](#)).

Bolted Connection

The fallback method of mounting the transducer is to use the clearance holes in the flange of the transducer. Cap screws that thread into the vehicle should have their heads sealed with urethane (manufacturer BJB, part number 753). The anodized area of the counter bore should be primed (manufacturer Chemglaze, part number 9944A/B) prior to application of the urethane (see Figure 1 and Figure 2).

The advantage of this method is simplicity. The disadvantage is that it is more difficult to repair/replace and possibly poses an increased risk of flooding if the urethane fails and the threads in the vehicle corrode.



Whatever mounting solution chosen, particular attention should be paid to acoustic coupling that would increase the ringing of the transducer head and corrupt the collected data. The PA test should result in a No-Go for deployment in this case.

Connecting the Transmit/Receive Cables

The Transmit and Receive cables connect the electronics housing and transducer using keyed connectors. To make the connection:

1. Pull the outer barrel back to release the locking mechanism.
2. Insert the cable connector into the receptacle, matching the red dots until the keyed portions are properly aligned.
3. Push straight onto the receptacle to complete the connection and then push the barrel down to lock the connector.
4. Test the cable is properly locked by pulling up lightly on the right angle portion of the connector; if the cable does not disconnect, than it is locked.

To disconnect the cable:

1. Pull the barrel back to release the locking mechanism
2. Grasp the cable connector and pull straight out away from the connector.



Figure 8. Transmit / Receive Cable Connectors

Mounting the Self-Contained ExplorerDVL

The preferred method of mounting the Self-Contained ExplorerDVL is using two clamps that grip the notches on the circumference of the housing (see Figure 4).

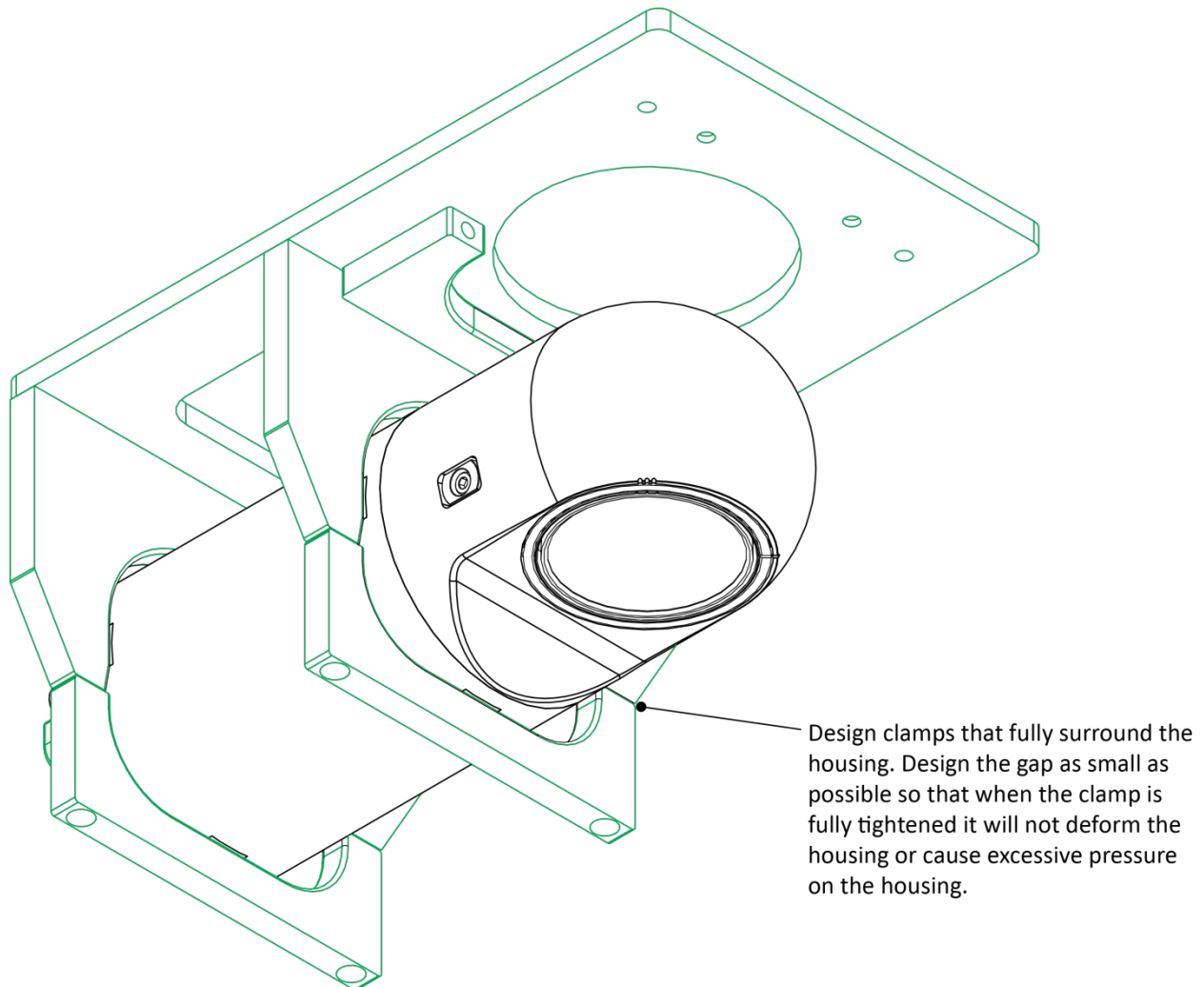


Figure 9. Mounting the Instrument with a Clamp Design



Do not connect other metal to the ExplorerDVL. Other metals may cause corrosion damage. Isolating bushings may be used when mounting the ExplorerDVL to a metal structure if the transducer is bolted to the vehicle.

Self-Contained I/O Cable and Dummy Plug

The underwater connector (on the Self-Contained housing) and the I/O cable and dummy plug are molded wet-mate connectors.



The dummy plugs should be installed any time the cable is removed. Use the dummy plug when the ExplorerDVL is in storage or is being handled.



When disconnecting or connecting the ExplorerDVL I/O cable, do not apply any upward force on the connector. Applying an upward angle as the cable is disconnected or connected puts stress on the connector. This may cause several serious problems:

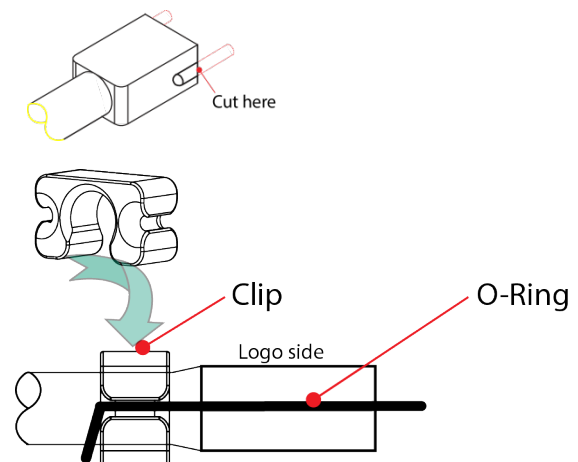
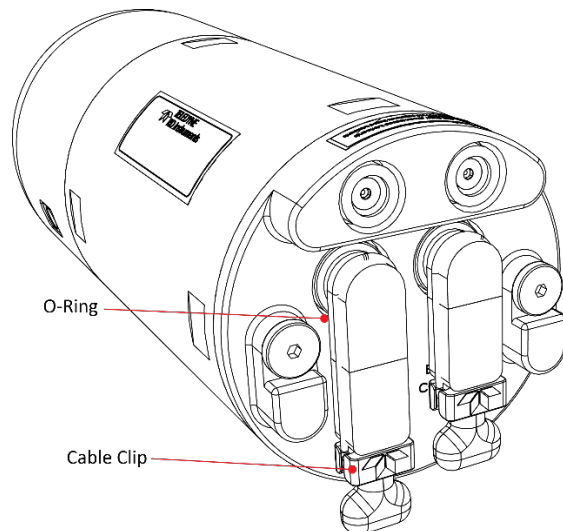
- 1) The connector or connector pins can crack.
- 2) The O-ring on the bottom of the connector can be damaged.
- 3) The molded urethane on the connector may separate from the brass insert.

If the connector is damaged in any of these ways, the ExplorerDVL system will flood.

Using the Cable Clips

New dummy plugs and cables no longer use a molded retaining strap. **To use the cable clips:**

1. Remove the broken retaining strap if needed.
2. Snap the clip onto the cable or dummy plug.
 - Black clip & 2-137 O-ring = cables
 - White clip & 2-130 O-ring = dummy plugs
3. Route the O-ring through the clip. Connect the cable/dummy plug and then stretch O-ring over connector.



To disconnect the cable:

1. Release the retaining strap/Cable Clip with O-Ring by pulling it over the connector.
2. Grasp the cable close to the connector. *Do not try to fit your hand under the cable as it passes over the housing.* This is what causes the upward force!
3. Pull the cable straight out away from the housing with a gentle rocking motion. Do not apply any upward force on the connector as it is being disconnected.

To connect the cable:

1. Check all pins for signs of corrosion (greenish oxidation, black deposits, or pitting).
2. Use light amounts of silicone lubricant (such as 3M™ Silicone Lubricant (Dry Type) ID No: 62-4678-4930-3) on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone spray from the metal portions of the pins. **Regular lubrication is required:** Apply dry type silicone lubricant prior to each connection.



When the cable is connected without any lubricant, excessive force is needed to fully seat or remove the connector. This can cause several serious problems:

- The neoprene rubber portion of the contact pin may tear from the metal pin.
- Wiggling the cable side-to-side to overcome the friction as it is connected or disconnected may cause the neoprene rubber to tear or create pin-holes on the side of the connector.

Any damage to the neoprene rubber may cause corrosion on current carrying pins or leakage into the DVL.

3. Gently push the cable straight in toward the connector. Do not apply any upward force on the connector as it is being connected.
4. Roll the retaining strap/Cable Clip with O-Ring over the connector.

Routing Cables

Use care when routing cables through bulkheads, deck plates, cable runs, and watertight spaces. Make allowances in cable length and engineering design plans for cable routing. When necessary, use strain reliefs on the cables.

Route cables so:

- Cable does not have kinks or sharp bends.
- Protect the cables with hose if zip-ties are used to secure them to structures.
- Cable can easily be replaced if it fails.



Figure 10. Do not use Zip-Ties Directly on Cables



When attaching the ExplorerDVL cables to a mount, do not zip-tie the cables directly to the structure. Zip-ties slowly cut through the cable's outer jacket and cause leaks.

Cable Wiring Diagrams

This section has information on ExplorerDVL cabling. Special user-requests may cause changes to the basic wiring system and may not be shown here. If there is a conflict, contact TRDI for specific information about the system. The following figures show various ExplorerDVL cable locations, connectors, and pin-outs.

Input Power and Communications Cable Wiring

The Input Power / Communications Interface Connector (J3) uses a DB37M (Amp 747375-2) connector.



COM 1 is reserved for communicating to and controlling the ExplorerDVL ONLY. This port will not support sensors. Ports 2, 3, 4 and the SPI bus port are for sensors.

Trigger In and Out lines must each be referenced to pin 5 COMM 1_2.



This cable is provided by the user.

To change the communication protocol, see [Personality Module Replacement](#)



TRDI defines the RS422 signal state (0 or 1) as the difference in voltage between the “A” and “B” line. The ExplorerDVL system uses 1 when the 422A line is greater than the 422B line, thus the “A” line is non-inverting with respect to the board level logic convention and the “B” line is inverting.

- 422A = 422+
- 422B = 422-

Table 1: Input Power and Communications Interface Connector (J3) Wiring

DB37 Pin #	Available Signal	Serial Communication Modules		
		2 RS232 and 2 RS422	3 RS232 and 1 RS422	4 RS232 no RS422
1	RX1A	RX1A	RX1A	RX1
2	RX1B	RX1B	RX1B	Unused
3	TX1A	TX1A	TX1A	TX1
4	TX1B	TX1B	TX1B	Unused
5	COMM 1_2	COM1_2	COM1_2	COM1_2
6	RX2A	RX2A	RX2	RX2
7	RX2B	RX2B	Unused	Unused
8	TX2A	TX2A	TX2	TX2
9	TX2B	TX2B	Unused	Unused
10	Unused	Unused	Unused	Unused
11	RX3A	RX3	RX3	RX3
12	RX3B	Unused	Unused	Unused
13	TX3A	TX3	TX3	TX3
14	TX3B	Unused	Unused	Unused
15	COMM 3_4	COM3_4	COM3_4	COM3_4
16	RX4A	RX4	RX4	RX4
17	RX4B	Unused	Unused	Unused
18	TX4A	TX4	TX4	TX4
19	TX4B	Unused	Unused	Unused
20	Unused	Unused	Unused	Unused
21	TRIG_IN Voltage	TRIG_IN Voltage	TRIG_IN Voltage	TRIG_IN Voltage

Table 1: Input Power and Communications Interface Connector (J3) Wiring

DB37 Pin #	Available Signal	Serial Communication Modules		
		2 RS232 and 2 RS422	3 RS232 and 1 RS422	4 RS232 no RS422
22	Unused	Unused	Unused	Unused
23	TRIG_OUT Voltage	TRIG_OUT Voltage	TRIG_OUT Voltage	TRIG_OUT Voltage
24	Unused	Unused	Unused	Unused
25	Unused	Unused	Unused	Unused
26	Unused	Unused	Unused	Unused
27	Unused	Unused	Unused	Unused
28	Unused	Unused	Unused	Unused
29	Unused	Unused	Unused	Unused
30	Unused	Unused	Unused	Unused
31	Unused	Unused	Unused	Unused
32	Unused	Unused	Unused	Unused
33	CHAS_GRND	CHAS_GRND	CHAS_GRND	CHAS_GRND
34	VDC +	VDC +	VDC +	VDC +
35	VDC +	VDC +	VDC +	VDC +
36	VDC -	VDC -	VDC -	VDC -
37	VDC -	VDC -	VDC -	VDC -

Sensor Interface Cable Wiring

The Sensor Interface Connector (J4) uses a DB9F (Amp 747150-2) connector.



Only connect the Teledyne RDI sensor module, if used, to the 9-pin connector (J4) of the electronics enclosure.



This cable is provided by the user.

Table 2: SPI Sensor Interface Cable (J4) Wiring

Pin	Signal
1	CSS1
2	CSS0
3	SCLK
4	MISO
5	MOSI
6	GND
7	VDD1
8	ROMDAT
9	CSS2

Transmit and Receive Cables

The Transmit and Receive cables are custom-made in lengths specified by the user (maximum length 2.0 meters).

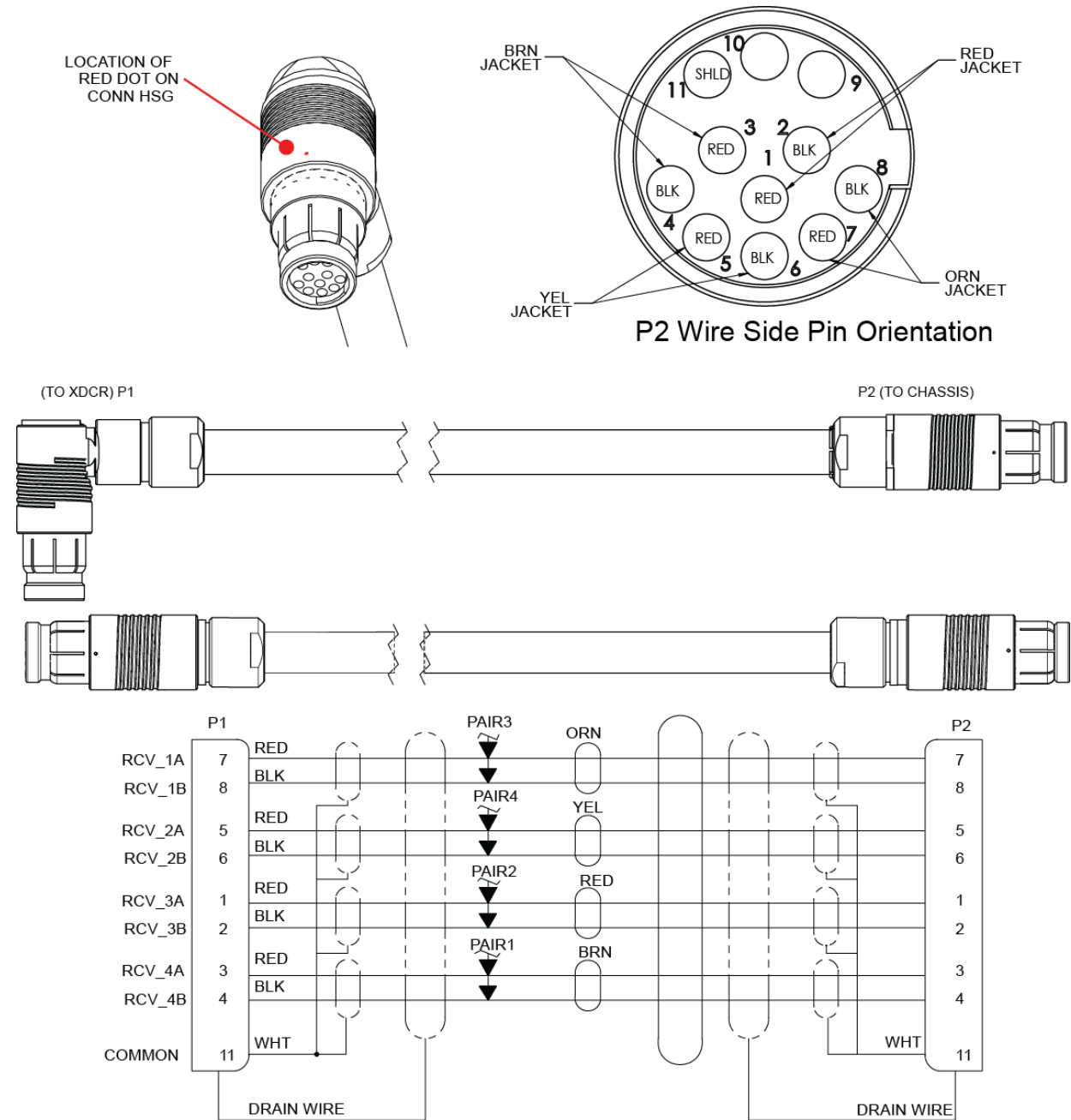


Figure 11. Receive Cable

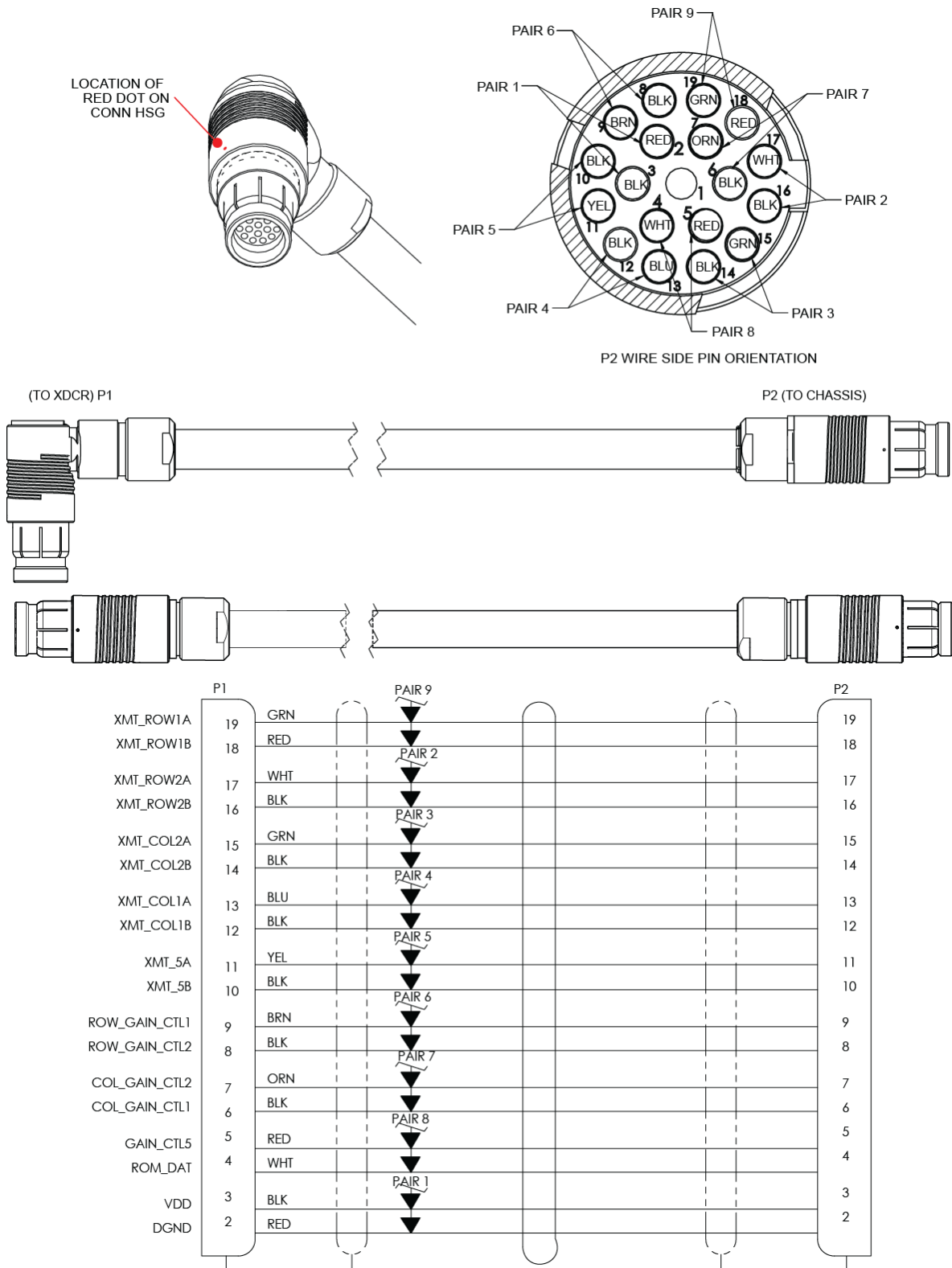


Figure 12. Transmit Cable

Self-Contained Test Cable

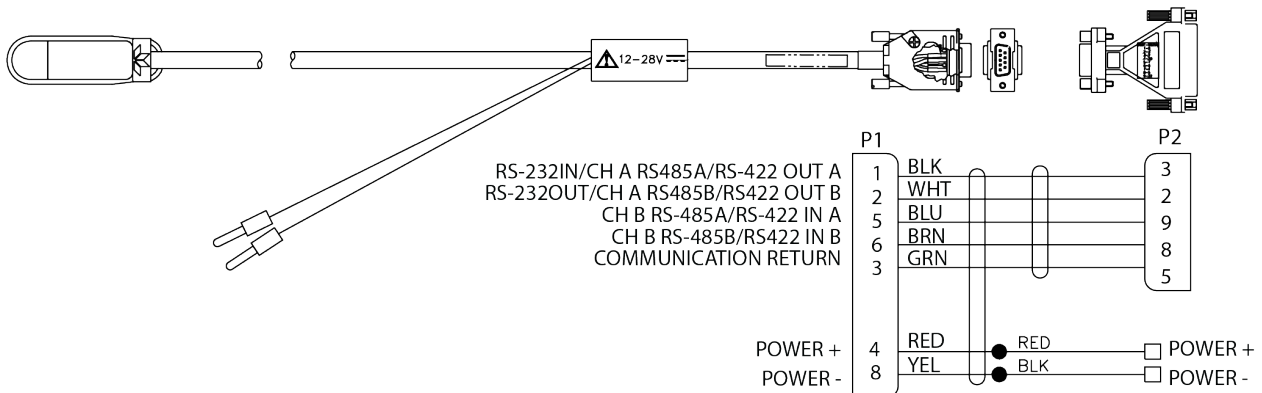


Figure 13. Self-Contained Test Cable P/N 737-3114



This cable is included with Self-Contained systems.

The dummy plug should be installed any time the Communications /Power cable is removed. Use the dummy plug when the ExplorerDVL is in storage or is being handled.

Self-Contained Communications / Power Cable

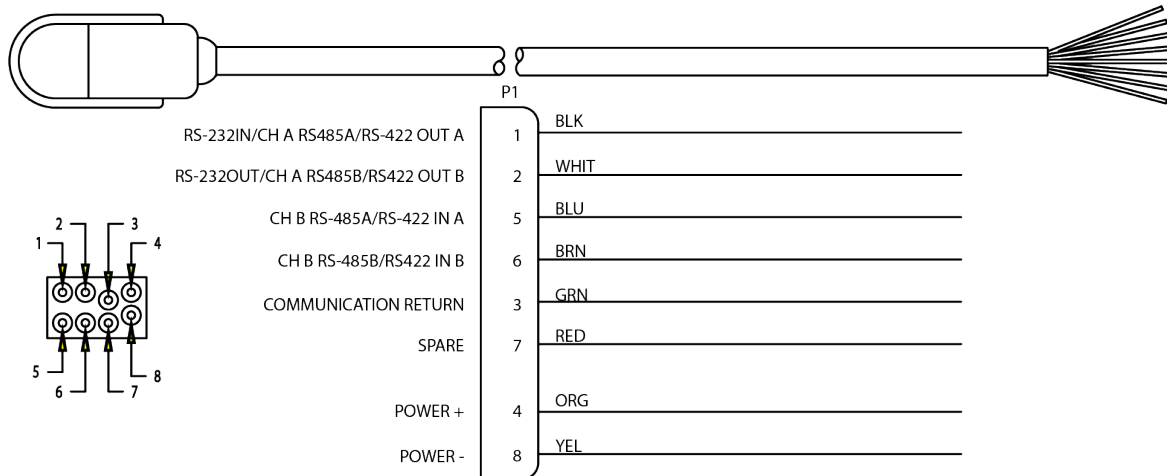


Figure 14. Self-Contained ExplorerDVL Comm/Power Cable P/N 737-3055



See Table 3, page 27 for other wiring configurations.

The dummy plug should be installed any time the Communications /Power cable is removed. Use the dummy plug when the ExplorerDVL is in storage or is being handled.

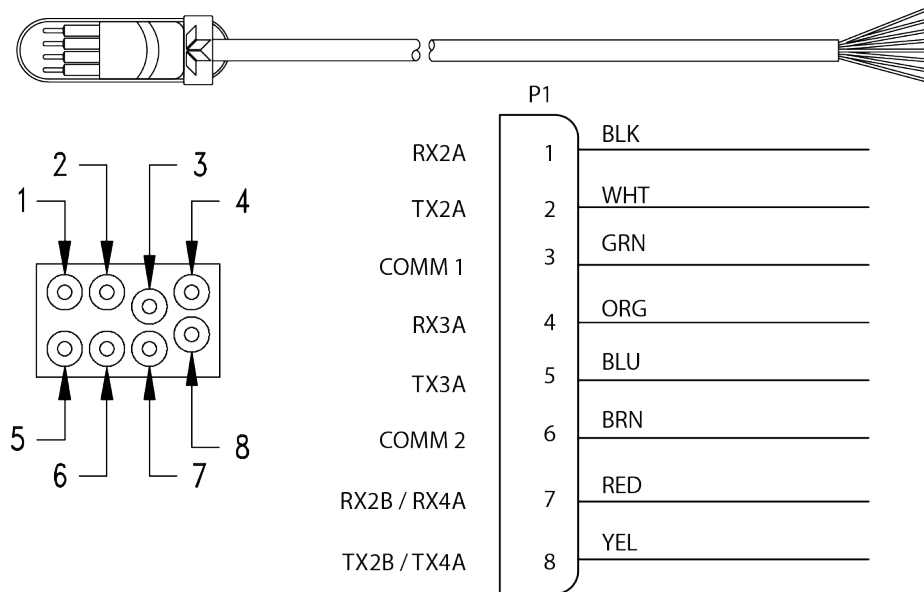


Figure 15. Self-Contained ExplorerDVL Sensor/COMMS P/N 73B-6037



See Table 3, page 27 for other wiring configurations.

The dummy plug should be installed any time the Sensor/COMMS cable is removed. Use the dummy plug when the ExplorerDVL is in storage or is being handled.

Self-Contained Sensor Comms Port

Table 3. Self-Contained Connector Wiring

External Connector	Pin Number	NO RS422 4 RS232	1 RS422 3 RS232	2 RS422 2 RS232
COMM/POWER (Male, 8-pin Impulse connector) See Figure 14, page 25	1	RX1	RX1A	RX1A
	2	TX1	TX1A	TX1A
	3	COMM1_2	COMM1_2	COMM1_2
	4	PWR+	PWR+	PWR+
	5	TRIG_IN	RX1B	RX1B
	6	TRIG_OUT	TX1B	TX1B
	7	NC	NC	NC
	8	PWR-	PWR-	PWR-
SENSOR COMMS (Female, 8-pin Impulse connector) See Figure 15, page 26	1	RX2	RX2	RX2A
	2	TX2	TX2	TX2A
	3	COMM1_2	COMM1_2	COMM1_2
	4	RX3	RX3**	RX3**
	5	TX3	TX3**	TX3**
	6	COMM3_4	COMM3_4	COMM3_4
	7	RX4*	RX4*	RX2B
	8	TX4*	TX4*	TX2B
Optional Internal Compass	-	* RX4 AND TX4 USED FOR COMPASS	* RX4 AND TX4 USED FOR COMPASS	RX4 TX4
Optional Trigger	-	-	** RX3 AND TX3 USED FOR TRIGGER	** RX3 AND TX3 USED FOR TRIGGER

Explorer	Note: When using RS422 to communicate with the Explorer, the trigger can be implemented through the SENSOR COMMS port at the customer's request. It will occupy one of the sensor communication lines.
Sensor 1	
Sensor 2	Note: With the 2 RS422/ 2 RS232 personality module, the Self-contained explorer can only communicate with two external sensors.
Sensor 3	Note: The Explorer must be returned to the factory to change the configuration.



This cable is provided by the user.

The dummy plug should be installed any time the Sensor Comms Cable is removed. Use the dummy plug when the ExplorerDVL is in storage or is being handled.

General Mounting Considerations

This section includes several mounting considerations that may cause reduction in range, biased data, fouling, and other performance related considerations if not followed.

Beam Coordinate Systems

The ExplorerDVL can produce velocity measurements in any of the following four sets of coordinate axes by setting the [EX command](#). Except for the first, they are all right-handed orthogonal systems. The user operational requirements dictate the best coordinate system to be used.

Earth Axis, also known as Geographic or Geodetic Coordinates. (E, N, U) Earth Axis are selected (default setting) with command EX11xxx. These axes are named east, north, and up. Strictly speaking, these terms refer to true orientations, although magnetic orientations are often used instead. This is the most commonly used coordinate system because it provides a stable reference frame for ensemble averaging.

Radial Beam Coordinates. (BM1, BM2, BM3, BM4) Radial Beam Coordinates are selected by the EX00xxx command. These are the “raw” velocity measurements measured independently by each transducer, in units of millimeters per second. The sense is positive when the motion is towards the transducer. These axes are not orthogonal.

Instrument Coordinates. (X, Y, Z) Instrument Coordinates are selected by the EX01xxx command. This set of axes is always oriented the same relative to the transducer head. Looking at the end view of the housing, the transducers are labeled clockwise in the order 3-2-4-1 (Figure 16). When you look at the face of the transducer head, the transducers are labeled clockwise in the order 3-1-4-2 (see Figure 17, page 29). The X-axis lies in the direction from transducer Beam 1 towards transducer Beam 2 and the Y-axis lies in the direction from transducer Beam 4 towards transducer Beam 3. The Z-axis lies along the axes of symmetry of the four beams, pointing away from the water towards the housing. The internal compass is mounted so that when the X-Y plane is level, the compass measures the orientation of the Y-axis relative to magnetic north.

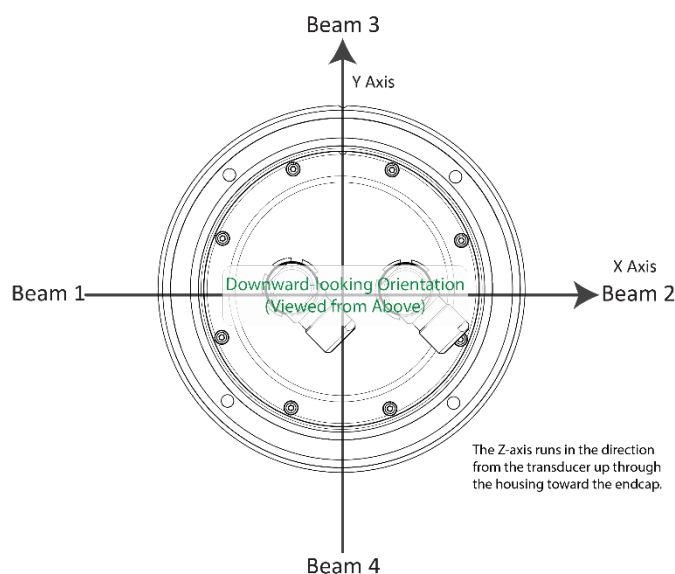


Figure 16. X, Y, and Z Velocities

The PD0 Bottom Track output data format assumes that the instrument is stationary and the bottom is moving.

- If Beam 3 is going forward, then the Y velocity is negative.
- If Beam 2 is going forward, then X velocity is negative.
- If the bottom is going towards the face of a down facing DVL, then Z is positive.

The PD0 High Resolution Bottom Track and PD3 through PD6 data formats assume that the bottom is stationary and that the DVL or vessel is moving.

- If Beam 3 is going forward, then the Y velocity is positive.
- If Beam 2 is going forward, then X velocity is positive.
- If the bottom is going towards the face of a down facing DVL, then Z is negative.

Ship Coordinates (or Righted Instrument Coordinates). (S, F, M) Ship Coordinates are selected by the EX10xxx command. TRDI uses the names Starboard, Forward, and Mast, although these axes are more commonly called the pitch, roll, and yaw-axes, respectively. Assuming that Beam 3 is aligned with the keel on the forward side of the DVL, for the downward-looking orientation, these axes are identical to the instrument axes:

$$S = X, F = Y, M = Z$$

For the upward-looking orientation, these axes are rotated 180° about the Y-axis:

$$S = -X, F = Y, M = -Z$$

The M (mast) axis points in a direction that is closer to upward than downward (mast is always in the same direction no matter if looking down or up).

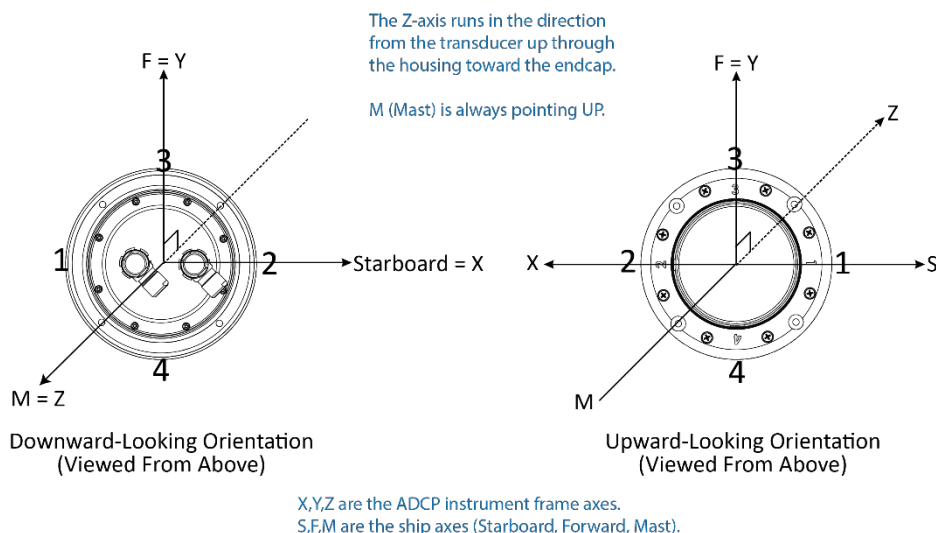


Figure 17. ExplorerDVL Ship Coordinates

The importance of the ship axis is that the attitude angles (pitch, roll, and heading) measure the orientation of the ship axes relative to the earth axes, regardless of up/down orientation. The sense of internal sensors Tilt 1 (pitch) and Tilt 2 (roll) is positive for counterclockwise tilts respectively about the S and F axes, using the right-hand rule (see Figure 18).

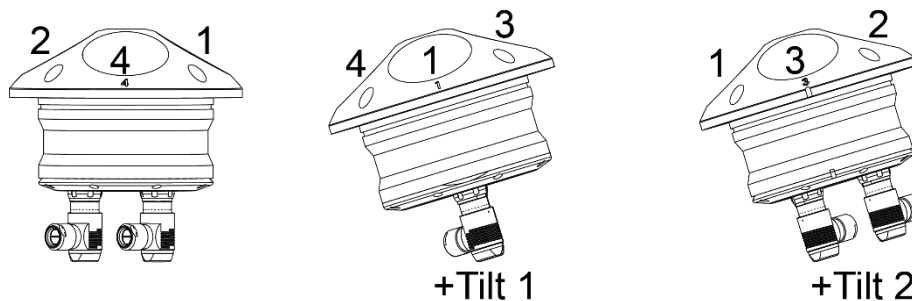


Figure 18. ExplorerDVL Tilts

Sign of Angle for a Unit Facing	Up	Down
Tilt 1 (Pitch) Beam 3 higher than Beam 4	+	+
Tilt 2 (Roll) Beam 2 higher than Beam 1	+	-

Orientation

TRDI recommends mounting the transducer head with Beam 3 (instrument y-axis) rotated 45° relative to the ship forward axis. This causes the magnitude of the signal in each beam to be about the same. This improves error rejection, reduces the effect of ringing (see [Acoustic Isolation](#)), and increases the ExplorerDVL'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 (see [EA - Heading Alignment](#)).

Use the ship's roll and pitch reference to mount the transducer head aligned with the ship axis as closely as possible. If the instrument x and y axis are not in the same plane as the ship forward and starboard axis, then use the #EI (see [EI - Roll Misalignment Angle](#)) and #EJ (see [EJ - Pitch Misalignment Angle](#)) commands to align them.



If the head is not level, Water Profile bin-mapping will be incorrect. Large misalignments can cause large velocity measurement errors.

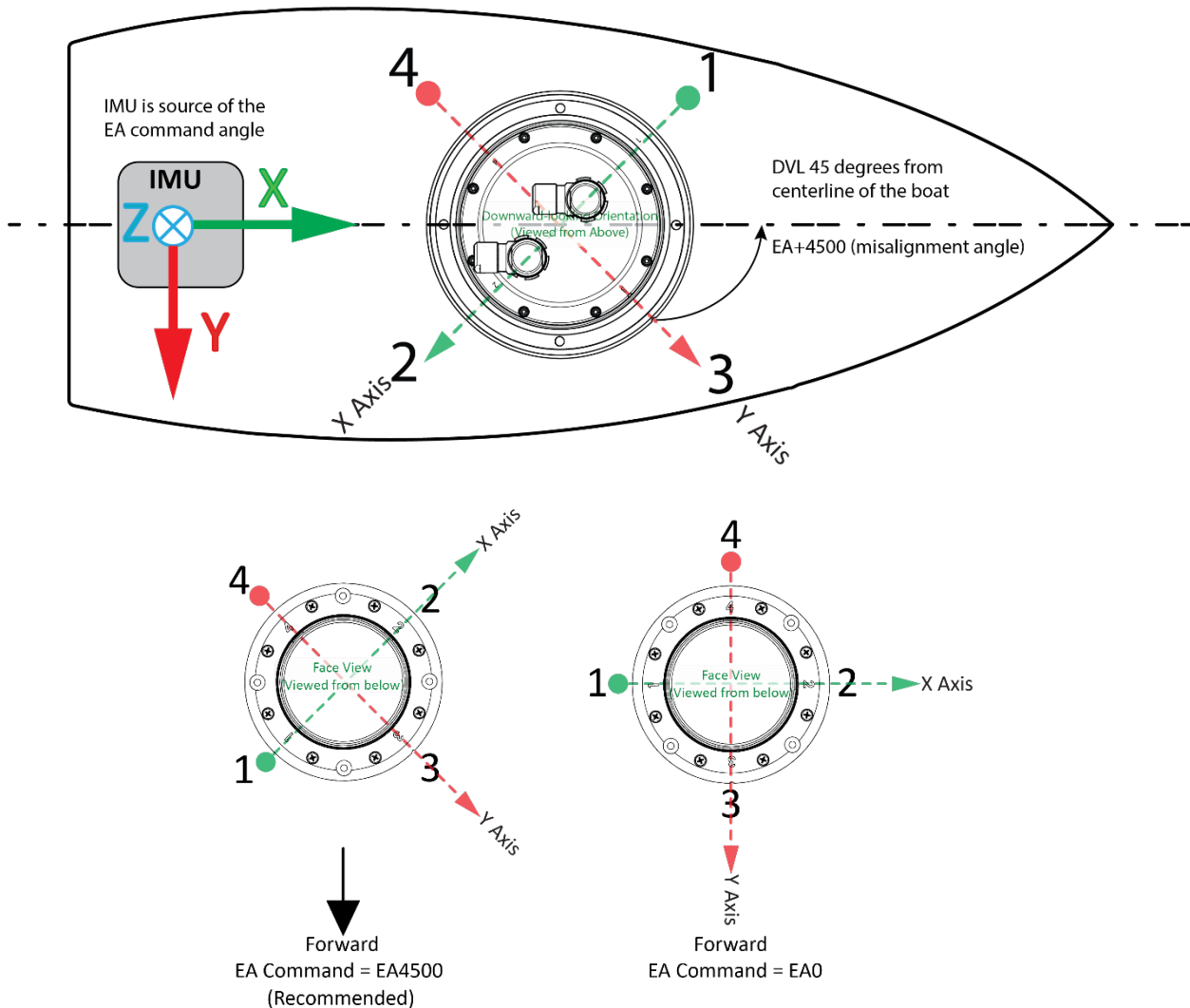


Figure 19. Transducer Alignment Reference Points

Air Bubbles

Design the installation to minimize the volume of air bubbles in the path of the acoustic beams. Air bubbles attenuate (weaken) the signal strength and reduce the ExplorerDVL profiling range. Vehicles with a deep draft or a non-flat bottom have fewer problems with bubbles. Ways to reduce bubble flow vary with vehicle characteristics, but two options are available. Mount the transducers below or away from the bubble layer.

- The flow layer is usually within the first two feet below the hull. Bubbles can be trapped in this layer. Mounting the transducer head amid vehicle on the fore-to-aft centerline may help. For vehicles with propulsion systems that make large amounts of bubbles, use a mounting technique that lets you lower the transducer head below the hull while underway.



If an adapter plate is needed to connect hardware to the transducer head and/or to the electronic chassis, please refer to Outline Installation Drawings for the exact dimensions and layout of the transducer head and/or electronic chassis bolt holes for the installation.

- Divert the bubble layer so it flows around the transducers - use fairings to alter the bubble flow. An acoustic window may help reduce the bubble problem, but can cause ringing (see [Acoustic Isolation](#)) and attenuation problems.

Fairing/Hull/Acoustic Window

If the vehicle operates where there is danger of barnacle damage or a high density of ice or other floating objects, then using the ExplorerDVL behind an acoustic protective layer is an option to be considered.

A fairing is a structure that produces a smooth outline and reduces drag or water resistance. The fairing also diverts floating objects away from the transducer. A fairing that is shaped like a teardrop, sloped such that the leading edge (closer to the bow) is higher than the back edge, and extends below the hull will divert the air bubbles away from the transducer faces.

If the ExplorerDVL transducer head is mounted behind a fairing or a hull or an acoustic window, it will have to transmit through this layer in front of its beams. Although a fairing may be considered acoustically transparent, consider that not all the energy will go through as there are 3 types of waves that will be created out of the transmit signal:

- 1- A reflected wave. This wave could be trapped in the fairing and might interfere with the ExplorerDVL or even make the ExplorerDVL bottom lock on this trapped wave. It is advised if such condition is suspected to install an absorbing material inside the fairing or hull to cancel these reflections.
- 2- A shear wave. This wave will propagate in the fairing. If the ExplorerDVL is acoustically coupled to the fairing, a shear wave might increase the ringing time of the transducer. It is advised to add an absorbing material at the connection between the ExplorerDVL and the vehicle to reduce/cancel acoustic coupling.
- 3- A refracted wave. This wave will propagate through the layer and travel through the water. If the layer is not ideally acoustically transparent, only part of the wave sent by the ExplorerDVL will go into the water.

The same waves and issues will be reproduced at lower amplitudes when the wave returned from the bottom travels back to the layer in front of the ExplorerDVL. Acoustic material specifications should include the insertion loss (which should be as small as possible) and the refractive index (which should be as close as possible to that of water) with respect to frequency.

There are two acoustic refractive indices: one for shear waves and one for plane waves. The acoustic refractive indices are simply the ratios of speed of sound in water to speed of sounds in the material. Insertion loss combines absorption and reflection of sound, and it depends on both the thickness and the material properties of the window. In particular, avoid using an acoustic layer thickness equal to odd multiples

of shear mode quarter-waves (Dubbelday and Rittenmeyer, 1987; Dubbleday, 1986). Refer to Selfridge (1985) and Thompson (1990) for more information. Note that the speeds of sound in plastics decrease with increasing temperature and that causes the resonant frequencies to shift. This can be a large effect. Neither Selfridge nor Thompson has much information on the temperature coefficients of sound speeds.

It is theoretically possible to use ExplorerDVL behind a fairing or a hull or an acoustic window successfully. Please consider the following advantages and disadvantages to before using ExplorerDVL behind an acoustic layer:

Advantages

- Depending on the design of your vehicle, it is possible to avoid the well from filling with air bubbles caused by the vehicle moving through the surface water.
- Flow noise can be reduced, see [Flow Noise](#).
- The well can be filled with fresh water to limit corrosion and barnacle growth 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 ExplorerDVL will be reduced because the window can and will absorb some transmit and receive energy.
- The transmit signal could be reflected into the well, causing the well to “ring” like a bell. This will cause the data being collected during the ringing to be biased. 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), see [Ringing](#).
- The transmit signal could be reflected off the acoustic layer and back into the other beams.
- If the acoustic layer is not parallel to the bottom edge of the ExplorerDVL transducer head, the wave will impact the acoustic interface at an angle and absorption could be increased.

Listed below are a few things to consider when integrating ExplorerDVL in an acoustic enclosure:

Window Thickness: The thickness of the materials depends on the frequency you intend to use. As an example, Table 4 shows the maximum thickness to use when using Polycarbonate material as it was proven to work great with TRDI systems:

Table 4: Maximum Window Thickness

Frequency	Thickness
600	0.25 inches

Sound Absorption in the Acoustic enclosure: A sound absorbing material should be used inside the acoustic enclosure to minimize the effects of sound ringing. The material should be a minimum of one wavelength thick (include the sound speed of the absorbing material when calculating the size of a wavelength).

For reference: $\lambda_m = C_m / F_{DVL}$, Where C_m = Speed of Sound in the material
 F_{DVL} = Center Frequency of your ExplorerDVL unit
 λ_m = wavelength of the signal in the material

Approximate one-way wavelengths of sound in seawater are given below in Table 5. Using standard neoprene wet suit material has been found to work well with 600KHz ExplorerDVLs.

Table 5: One-way Wavelength of sound in seawater (1500 m/s sound speed)

FREQUENCY (kHz)	WAVELENGTH (mm)
600	2.5

Fluid in the Acoustic enclosure: The acoustic enclosure should be filled with fresh water. Seawater can be used, but at the cost of increased corrosion. Seawater should not be circulated through the enclosure unless it has been painted with anti-fouling paint. The pressure within the enclosure should be controlled so that neither the transducer depth rating nor the acoustic enclosure window pressure capabilities are exceeded.

If using a special fluid inside the window, the ExplorerDVL needs to know what the speed of sound is in this specific fluid (see [EC - Speed of Sound](#)). If the speed of sound is unknown for this fluid, enable the computation of the speed of sound based on the ExplorerDVL temperature and salinity sensor (see [EZ - Sensor Source](#) and [ES - Salinity](#) (if no salinity sensor is present) commands).



Set the profile blank ([WF - Blank after Transmit](#)) and bottom blanking interval (See [BB - Bottom Blanking Interval](#)) considerably longer than the distance from the transducer to the acoustic window to avoid corrupted profile data and bottom tracking locking on to the acoustic layer/water interface rather than on the actual bottom.

Flow Noise

Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the ExplorerDVL. Reduce the flow across the transducer faces with a fairing, or an acoustic window (see [Fairing/Hull/Acoustic Window](#)).

Corrosion and Cathodic Disbondment

The ExplorerDVL is made of naval bronze, aluminum, or other materials. Standard anode protection used for the vehicle is installed outside of the well of the transducer head. Mounting of the vehicle's standard anode protection outside of the transducer well will typically protect the parts that may corrode. However, plan regular inspections of the mounting hardware for signs of corrosion. TRDI disposes many corroded hardware sets during inspections.

By returning the system for a Refurbishment Service at signs of important corrosion, TRDI can inspect it and replace questionable parts. At the same time, we will inspect the urethane and make any necessary upgrades to boards, assemblies, and firmware. If the Refurbishment Service is not needed, we can upgrade your system as part of one of our Inspection Services. With proper care, general maintenance, and this refurbishment service, you will ensure that the ExplorerDVL will have a long service life.



Corrosion can be further reduced if the well is covered with a window and then filled with fresh water (although a loss in range will result).

Mounting the transducer so it is electrically isolated will also reduce corrosion. This can be accomplished by using polymer shoulder washers under the mounting screws.

Ringing

The ExplorerDVL transmits an acoustic pulse into the water. The main lobe of this pulse bounces off the sea bottom or off particles in the water. The signals returned from the bottom are used to calculate speed over seabed and from the particles are used to calculate the velocity of the water.

The transmitted pulse will excite the metal of the transducer and anything bolted or clamped to the transducer. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. TRDI refers to this as "ringing."

If the ExplorerDVL is in receive mode while the transducer is ringing, then it will receive both the return signals from the water and the "ringing." Whichever signal is strongest will be processed by the ExplorerDVL. The ringing may cause bias to the velocity data.

All ExplorerDVL transducers "ring" for some amount of time. Therefore, each ExplorerDVL transducer requires a blanking period (time of no data processing) to keep from processing the ringing energy.

The typical ringing period for an ExplorerDVL is 15cm for an un-mounted transducer. Ringing will be greater when installed in a vehicle, which accounts for the higher default profile blank (see [WF – Blank after Transmit](#)) or minimum water mass layer (see [BL - Water-Mass Layer Parameters](#)). This blank is recommended as the minimum setting for ExplorerDVLs unless additional testing is performed to ensure a shorter blank is satisfactory.

It should be noted, on some installations the effects of ringing will last longer than the recommended setting above. For example, the effects of ringing will last longer if the transmit signal becomes trapped inside the transducer well. This can occur because the well itself is ringing with the transducer or when windows covering the opening of the well reflect the signal back inside the well.

The window causes the transmit signal to reflect back into the well due to the difference in impedance between the window and the water. When the transmit signal is reflected in the well it becomes trapped and this results in longer ringing periods. To keep from processing this signal, the blanking period must be increased (contact TRDI for more information).

Line the inside walls of the well with a sound absorbing material to dampen the ringing effect. Use a sound absorbing material to mate with a mounting plate or a clamp to reduce acoustic coupling increasing the ringing period. Using standard neoprene wet suit material has been found to work well.

Acoustic Isolation

Try to minimize the acoustic coupling between the transducer head and the vehicle. Without adequate acoustic isolation, the transducer output will "ring" throughout the vehicle feeding back into the ExplorerDVL receive circuits. Ringing causes bias errors in profile and water-track velocities (See [WF – Blank after Transmit](#) and [BL - Water-Mass Layer Parameters](#) for setting-up water-track/water layer reference on your ExplorerDVL) and results in the loss of data when water-tracking the closest to the ExplorerDVL or water profiling in the closest depth cells (bins). Reflections inside an acoustic enclosure with an acoustic window also can cause ringing.

To attain acoustic isolation, design the installation for:

- A minimum number of contact points between the transducer head and the ship.
- Minimal contact area.
- Single points of contact for positioning and support (when possible).
- Try to separate the transducer head from the vehicle using intermediate connections. This is because direct connections transfer the most acoustic energy.

Acoustic isolation from other acoustic devices on the vehicle is also necessary. Do this using the following techniques:

- Mount the other acoustic devices as far apart as possible.
- Make sure neither the main lobes nor the side lobes of the acoustic devices point at the transducers, including acoustic reflections.
- Try not to operate devices that use the same frequency or a harmonic of the ExplorerDVL's frequency.

Interference

Interference from other acoustic devices can cause velocity and direction bias. In extreme cases it can prevent the ExplorerDVL from operating. However, it is possible to avoid this circumstance. From our experience, if the other device operating frequency is within 25% of the operating frequency of the ExplorerDVL or is an odd multiple of the ExplorerDVL frequency, prevent both devices from transmitting at the same time.

The ExplorerDVL transmits a pulse or series of pulses that contain four carrier cycles, i.e. $4T$ on Figure 20.

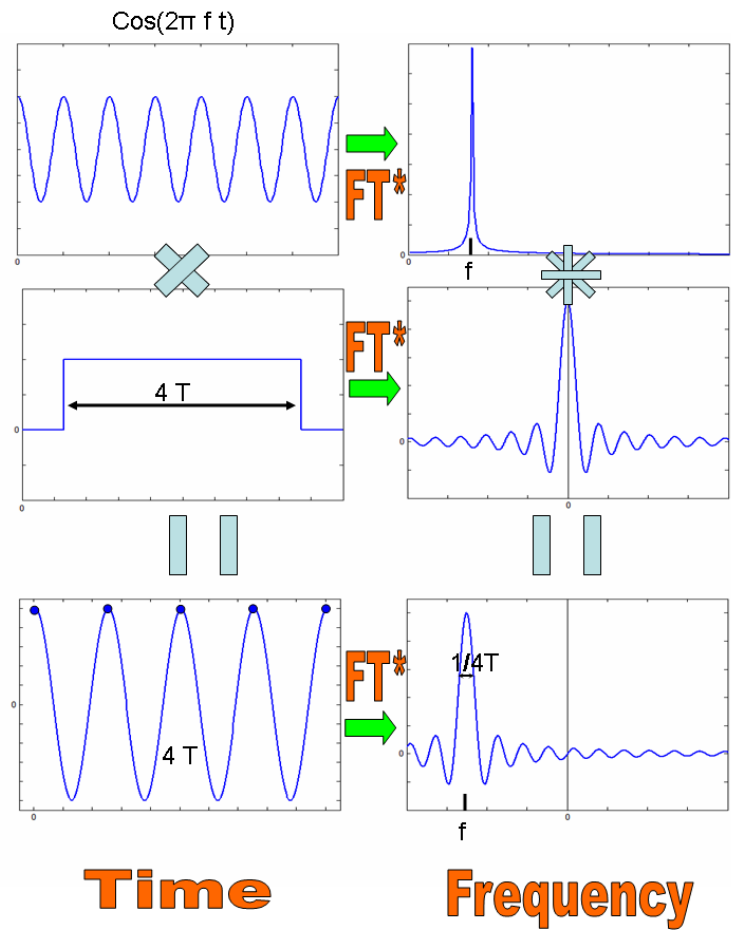



Figure 20. ExplorerDVL Carrier Cycles

 * FT = Fourier Transform – used to look at the frequency content of a signal.

As depicted in Figure 20, a narrow band acoustic wave is sent into the water by exciting the transducers with an electric sinusoidal signal, $\cos(2\pi ft)$ – (Figure 20 - top left corner). Its Fourier Transform is approximately Dirac function centered on f the frequency of the sinusoidal signal (Figure 20 - top right corner). Since four carrier cycles constitute the acoustic pulse sent into the water, the sinusoidal signal will have to be truncated. In fact this truncation is equivalent to multiplying the sinusoidal signal by a standard rectangular window four carrier cycles wide (cf - middle row left). Its Fourier Transform is a sinus cardinal, i.e. $\text{sinc}(\chi) = \sin(\chi) / \chi$ (Figure 20 - middle row right). The result of this multiplication in the time domain is a sinusoidal signal containing four carrier cycles, in other words one pulse (Figure 20 - bottom left corner). Multiplying in time means convolution in the frequency domain. In this case, the sinus cardinal will simply be shifted to be centered on f , the frequency of the sinusoidal signal which is the carrier

wave (Figure 20 - bottom right corner). The resulting transmit frequency bandwidth is 25% of the carrier frequency, i.e. $4T = f/4 = 25\%f$ (or $.25f$). Finally, the front end receive bandwidth is determined by the transducer and receiver filters, and approximately matches the transmitted bandwidth.

The following table summarizes transmit and receive bandwidth for ExplorerDVL systems:

Table 6: Transmit and Receive Bandwidth

System	Carrier frequency	Xmit/Receive BW (25%)
600kHz	614400Hz	154kHz

Special care should be taken when routing the transmit and receive cables in the vehicle. These cables could pick-up signals from devices in the vicinity, which could cause biases on the velocity measurement. Avoid routing these cables close to magnetic sources such as transducers, batteries, electric motors, etc.

A FFT program, available upon request to TRDI sales, is at your convenience for visualizing the effect of nearby devices on the receive signal.



Avoid the use of multiple or lengthy ground connections to the Chassis and the ExplorerDVL transducer. Ideally, only the chassis will be grounded, or the XDCR will be grounded to other grounds within the vessel. If the system must be grounded, use only one, short connection to ground.

Biofouling

Objects deployed within about 100 meters (328 feet) of the surface are subject to the buildup of organic sea life (biofouling). Soft-bodied organisms usually cause no problems, but hard barnacle shells can cut through the urethane transducer face causing transducer failure and leakage into the ExplorerDVL transducer (see Figure 21).



Figure 21. Barnacle Damage to a Urethane Face

The best-known way to control biofouling is cleaning the ExplorerDVL transducer faces often. However, in many cases this is not possible. The other alternatives include the use of a window or some sort of anti-foulant protection.

Some of our users have had success applying a thin coat (≈ 4 mm; ≈ 0.16 in.) of either a 50:50 mix of chili powder and Vaseline or chili powder and silicone grease to the transducer faces. The chili powder should be the hottest that can be found. Water flowing across the transducers will wash this mix away over time. The silicone mixture tends to last longer.

Some organizations may decide to use antifouling grease. However, most antifouling greases are toxic and may cause problems. Recent tests suggest antifouling grease may cause the urethane on the transducer faces to develop cracks. Warmer temperatures accelerate this effect.

The other method is to use antifoulant paint. Almost any EPA approved anti-fouling paint on the housing or the urethane transducer faces. Contact the antifouling paint manufacturer for preparation and application procedures for this and other antifoulant paints. Interlux is one source of antifouling paint. Contacting this company is done with the knowledge that Teledyne RD Instruments is not recommending them, but only offering this as a source for the anti-fouling paint.

Manufacturer	Contact
Courtalds Finishes	Telephone: +1 (800) 468-7589
Interlux brand paints	Web Page : http://www.yachtpaint.com/usa/



1. Read the Material Safety Data Sheet before using any of the listed solvents and paints.
2. Some antifouling coatings may not be legal for use in all areas. Check with your local environmental agency before using the antifouling paint.
3. Do not arbitrarily use antifouling paints. Be aware that antifouling paints can accelerate the dezincification corrosion of brass. Once initiated, dezincification will rapidly destroy the brass.
4. TRDI no longer recommends the use of Nopocide for the prevention of biofouling. If using antifouling grease, remove it immediately after recovering the ExplorerDVL.
5. Antifouling grease is toxic. Read the product safety data sheet before using the grease. Wear gloves and a face shield when applying the grease. If the skin comes in contact with the grease, immediately wash the affected area with warm, soapy water.
6. When possible, do not coat the transducer faces with cuprous oxide or related paints that contain chemicals such as copper, chrome, or arsenic. These paints advance the corrosion of the transducer assembly and will cause the urethane to separate from the transducer cups.
7. All US Coastal States prohibit the use of tributyl-tins on boat hulls. The European Economic Commission prohibits the use of many organo-tins. We strongly recommend you obey your local laws.

NOTES

Chapter 3

COLLECTING DATA

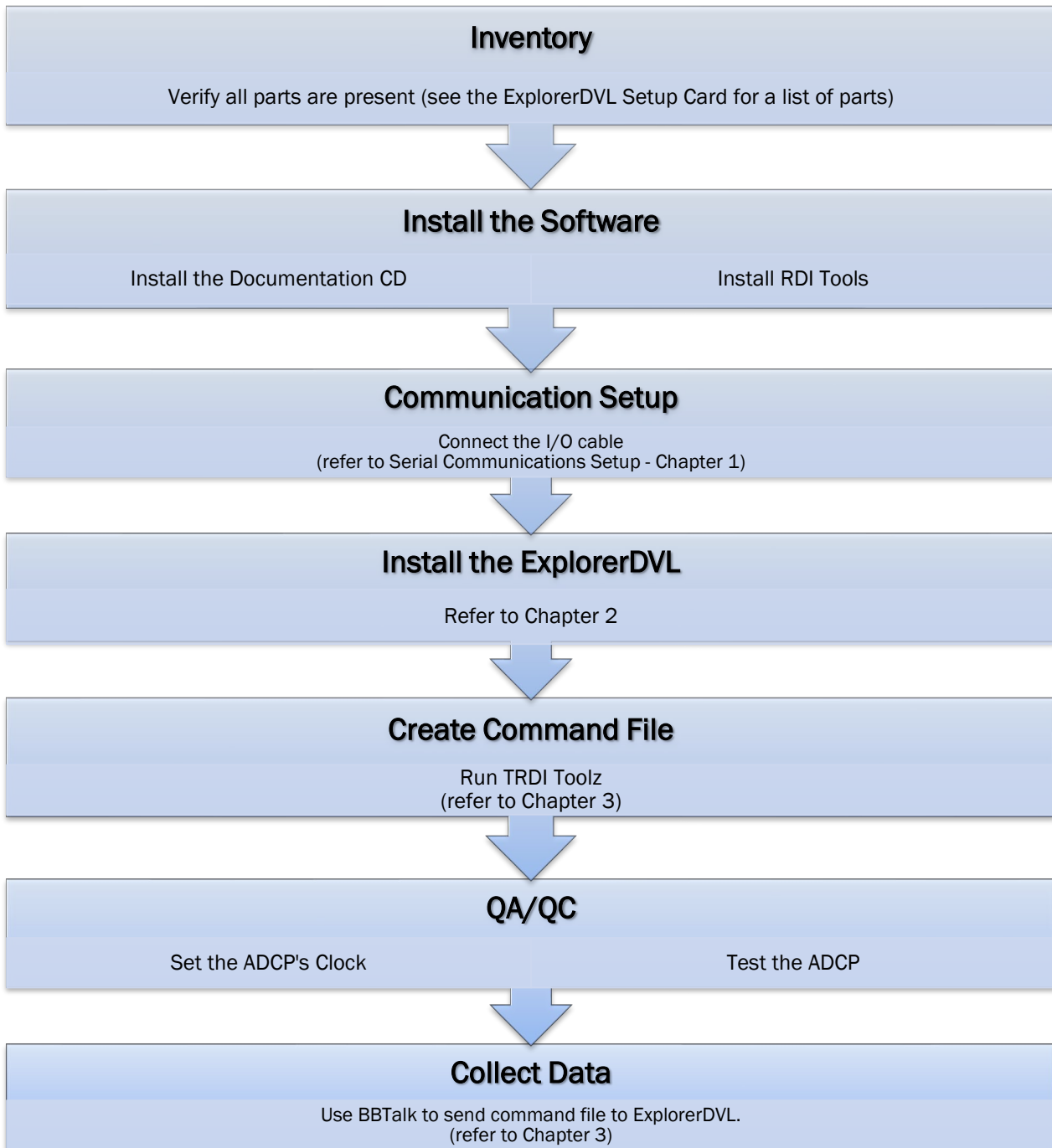


In this chapter:

- [Creating or Modifying Command Files](#)
- [Sending Commands to the Pioneer](#)
- [External Sensor Setup](#)

Operation Overview

Use the following list to collect data with the ExplorerDVL:



Creating or Modifying Command Files

Command files are simply ASCII files produced by ASCII editors such as *NotePad* that set ExplorerDVL command parameters. In general, they contain ASCII characters that are sent out through the serial port.

To create a command file:

- Copy the example command file into *NotePad* and edit the commands as needed. Refer to the [Command Descriptions](#) for detailed information on each command.
- If the first character of a line is a semi-colon, then all characters after the semi-colon (including the semi-colon) are ignored. This feature is to provide file comments that the user may insert for clarity.
- Use one command per line.

The following shows an example printout of a command file.

```

;-----
; ExplorerDVL type:      600 kHz ExplorerDVL
; Setup name:           ExplorerDVL.txt
; Setup type:           Bottom Track only
;
; NOTE: Any line beginning with a semicolon in the first column is
;       treated as a comment and is ignored by the software.
; Modified Last: 21 March 2013
;-----
; *****
; ExplorerDVL Basic Setup Commands
; *****
; Restore factory default settings in the ExplorerDVL
CR1
; set the data collection baud rate to 9600 bps,
; no parity, one stop bit, 8 data bits
CB411
; Flow Control - set to default
CF11110
; *****
; ExplorerDVL Bottom Track Setup Commands
; *****
; Enable single-ping bottom track,
BP001
; Set maximum bottom search depth to 100 meters
BX01000
; *****
; ExplorerDVL Environment Setup Commands
; *****
; Set Heading Alignment to 0 degrees
; NOTE. If the ExplorerDVL is rotated +45 degrees starboard
; (recommended alignment), set EA to EA+45000
EA00000
; Set manual transducer depth in case depth sensor fails
ED0000
; Set Salinity to saltwater
ES35
; Output earth coordinates, use tilts, allow 3 beam
; solutions and bin mapping
EX11111
; Set to use external sensors
EZ2222220
; *****
; ExplorerDVL Timing Setup Commands
; *****
; Set Time between Ensembles to zero (ExplorerDVL will ping as fast as possible)
TE00000000
; Set Time between Pings to zero (ExplorerDVL will ping as fast as possible)
TP00:00.00
; *****
; ExplorerDVL Water Profiling Setup Commands
; *****
; Note: By default, water profiling is turned off.
;       To use water profiling, set the WP command >0
WP0
; Bin size set to 200 cm
WS0200

```

```

; Number of bins set to 30
WN030
;
; *****
; ExplorerDVL Expert Command Section
; *****
;
; CAUTION - Editing or adding expert commands to the command file will allow
;           items to be set that if set incorrectly can cause data to
;           be the wrong format, bad, and/or uncorrectable even in post
;           processing.
;
; Disable Water-Mass Layer Mode (default)
#BK0
; Set Water-Mass Layer parameters to minimum 20 meters,
; near 80 meters, far 160 meters (600kHz default).
#BL20,80,160
; Turnkey mode on (default) - ExplorerDVL will ping when power turned on.
#CT1
; Environmental Data Output - sets specialized attitude data types
; Piston transducer default, for Phased Array transducer use #EE0000111
#EE0000101
; Set Heading Bias to 0 degrees
; NOTE. Set #EV = [(local magnetic declaration)*100] + (-4500)
; to compensate for the transducer misalignment (if used).
#EV000000
; Select type of external sensor to use
#EY 0 0 0 0 0 0 0 0
; Set output data format to #PD0
#PD0
; *****
; ExplorerDVL Sensor Setup Commands
; *****
; See the ExplorerDVL Operation Manual for details on the sensor commands.
; If needed, add the commands here.
;
;-----
; Save this setup to non-volatile memory in the ExplorerDVL
CK
; Start pinging
CS

```

The commands shown in Table 7 explain each command set by the example command file. These commands directly affect the range of the ExplorerDVL, standard deviation (accuracy) of the data, ping time, and power usage.

Teledyne RD Instruments ***strongly recommends*** that the commands shown in Table 7 be the ***minimum*** commands that should be sent to the ExplorerDVL.



Although these are TRDI's recommended minimum commands, they may not be the only commands needed for the deployment to be successful!

Editing or adding expert commands (#xx) to the command file will allow items that if set incorrectly can cause the data to be the wrong format, bad, and/or uncorrectable even in post processing.



The deployment may require additional commands and these commands can be sent any time after the CR1 command but must be placed before the CK command.

Table 7: Recommended Commands

Command	Choices	Description
CR1	Sets factory defaults	This is the first command sent to the ADCP to place it in a “known” state.
CBxxx	CB011 to CB811	Sets the baud rate from 300 to 115200 baud. Recommended to leave at default setting of 9600 baud (CB411) (see CB - Serial Port Control).
CF11110	See manual for description	Flow control - Recommended to leave at default setting of CF11110 (see CF - Flow Control).
BP1	BP0 (off) to BP999	Sets the Bottom Track Pings Ping to once per ensemble. Recommended to leave at default setting of BP1 (see BP – Bottom-Track Pings per Ensemble).
BX01000	BX80 to BX9999	Sets the Maximum Tracking Depth to 100 meters (1000 decimeters) (see BX – Maximum Tracking Depth)
EA00000	EA-17999 to EA18000	Heading alignment uses beam-3 as the heading alignment. If the ExplorerDVL is rotated +45 degrees starboard (recommended alignment), set EA to EA+45000 (see EA - Heading Alignment)
ED0000	ED0 to ED65535	Manually set depth of the transducer in decimeters. If a pressure sensor is available, the ED-command will be used only if the depth sensor fails (see ED - Depth of Transducer).
ES35	ES0 to ES40	Salinity of water is set to 35 (saltwater) (see ES – Salinity).
EX11111	Coordinates, Use Tilts, 3-beam solution, bin mapping	Sets coordinates, use tilts, allow 3-beam solutions, and allow depth cell (bin) mapping (see EX – Coordinate Transformation).
EZ2222220	Sensor source	Calculate speed of sound from external sensor readings (Speed of Sound, Depth, Heading, Pitch, Roll, Salinity, and Temperature). See the #EY command to override automatic selection of which sensor to use (see EZ - Sensor Source).
TE00:00:00.00	Time per ensemble	Ping as fast as possible (see TE – Time Per Ensemble).
TP00:00.00	Time per ping	Ping as fast as possible (see TP – Time Between Pings).
WPO	WPO to WP16384	Water Profiling – The default setting WPO will turn off water profiling (see WP – Pings Per Ensemble).
WS0200	WS10 to WS800	Sets the depth cell size in cm. Recommended to leave at default setting of WS0200 (see WS – Depth Cell Size).
WN030	WN1 to WN255	Sets the number of depth cells. Recommended to leave at default setting of WN030 (see WN – Number of Depth Cells).
#BKx	#BK0, BK1, BK3	This command selects the when the Water-Mass Layer ping will be used. Recommended to send the #BK0 (default) command to disable the Water-Mass Layer (this also disables the #BL command) (see BK - Water-Mass Layer Mode). If you need to enable the Water-Mass Layer pings, see the ExplorerDVL Operation Manual command section for detailed information on the #BK and #BL commands.
#BLmmmm,nnnn,ffff	Min, Near, Far layer boundary	This command sets the Water-Mass Layer boundaries. Recommended to leave at the default settings: #BL20,80,160 (see BL - Water-Mass Layer Parameters).
#BJtc*hr****	Bottom Data Types	This command sets the Bottom Data Types that will be output. Recommended to leave at the default setting #BJ110 000 000 (see BJ – Data Type Output Control).
#CTx	CT0 or CT1 (default)	Setting the #CT command to #CT1 (default) turns the Turnkey mode on. The ExplorerDVL will ping 10 seconds after power is turned on (see CT - Turnkey Operation).
#EE0000101	Environmental data output	Selects specialized Environmental data. Recommended to leave at the default settings: Piston transducer default#EE0000101, #EE0000111 for Phased Array transducers (see EE - Environmental Data Output).

Table 7: Recommended Commands

Command	Choices	Description
#EV00000	#EV-17999 to #EV18000	Sets the Heading Variation in degrees. Set #EV = [(local magnetic declination)*100] + (-4500) to compensate for the transducer misalignment (if used) (see EV - Heading Bias).
#PDx	PD0 (default), PD4, PD5, PD6	Sets the output data format (see PD0 Output Data Format).
#EY 0 0 0 0 0 0 0	Select external sensors	Overrides the automatic sensor selection logic. Use this command to specify a sensor to use for a parameter needed in the Doppler velocity calculation (see EY – Sensor Source Override for Doppler Parameters).
CK	Keep parameters as user defaults	If power is lost and then restored, all commands will be restored as last sent (see CK - Keep Parameters). Sent right before the CS-command.
CS	Start ping	Last command sent to begin collecting data (see CS – Start Pinging (Go)).



The CR1 command must be the first command sent to the ExplorerDVL. The CK command must be sent just before the CS command. Other commands may be sent in any order.

Sending Commands to the ExplorerDVL

To send the commands to the ExplorerDVL:

1. Place the ExplorerDVL system in water.
2. Start *TRDI Toolz*.
3. Send a BREAK to the ExplorerDVL. When the ExplorerDVL receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The ExplorerDVL is now ready to accept commands at the “>” prompt.

```
ExplorerDVL
Teledyne RD Instruments (c) 2013
All rights reserved.
Firmware Version: 34.xx
```

>

4. To send the command file, on the **Tools** menu, select **Script Editor**.
5. Click the **Open** icon and select the file to run from the scroll-down list. If no extension is given for the script file, an extension of *.txt is assumed.
6. Click the **Send** icon.



Teledyne RD Instruments does not recommend the use of direct commands as your primary way of deploying ExplorerDVLs as **any incorrect command setting can have severe consequences to your data collection**. **Always use a script file to send the commands.**

See the [Command Descriptions](#) and [Introduction to Output Data Format](#) sections for information on each command setting.



Script files can have any extension as long as they are ASCII text files.

External Sensor Setup Example

The ExplorerDVL can connect to external sensors using any of the following comports:

2 RS232 and 2 RS422	3 RS232 and 1 RS422	4 RS232 no RS422
COM2 RS422	COM2 RS232	COM2 RS232
COM3 RS232	COM3 RS232	COM4 RS232
COM4 RS232	COM3 RS232	COM4 RS232

A full description of the External Sensor is provided in [Detailed Discussion of Individual Sensors](#). In order to understand how the external sensors are connected to the ExplorerDVL, one first needs to understand that in order to take full advantage of external sensors connected to the ExplorerDVL, specific sensors drivers have been coded in the ExplorerDVL to fully take control of them. This ultimately guarantees optimum performance. Each sensor has a specific interface (either ASCII or binary) with a specific set of commands that will be sent by the ExplorerDVL in order to adequately set it up to meet the operation requirements. A table of compatible sensors is provided in Table 20, page 144.

This section provides an example of the steps necessary to connect the ExplorerDVL to an attitude sensor providing Heading, Pitch and Roll (Honeywell HMR3000) and to a GPS for Latitude, Longitude, Speed over Ground, and Course over Ground (Garmin 15H-W).

Honeywell HMR3000

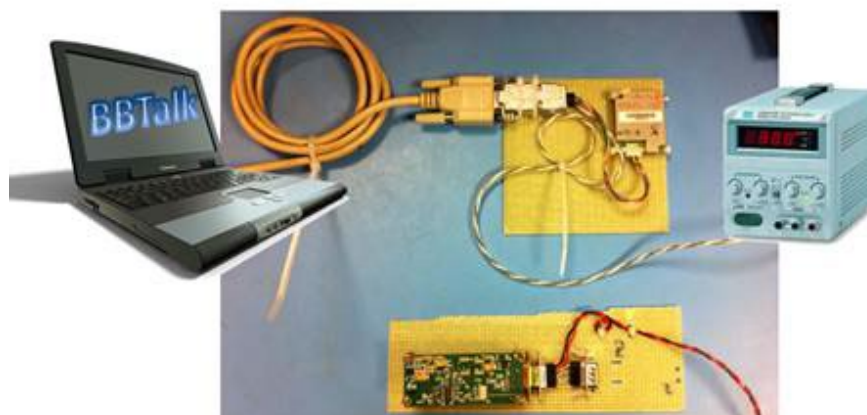
1. Identify Power and Com for External Sensor

Each sensor has a specific input voltage range, default communication baudrate, and serial pin-out. Make sure to respect input power limits before applying power.

In our example the power and default baud rates are as follow:

	Input Voltage	Default Baud Rate
GPS Garmin 15H-W	8 to 40VDC	4800
Honeywell HMR3000	6 to 15VDC	19200
PNI TRAX	3.6 to 5 VDC	38499
SBG IG500	3.3 to 30V	115200

2. Apply power and verify communication baudrate with *TRDI Toolz*.



4. Setup the ExplorerDVL to take control of the sensor.
Setup communication with the Honeywell HMR3000:

- a. Set sensor comport:

SP Port# Sensor_ID

In this example, the Honeywell HMR3000 is connecting to comport 2.

Find the Honeywell HMR300 sensor ID in the table below:

External Sensor Source Range (1-10)

Sensor	ID	Manufacturer	Model
Streaming HPR Device	1	SBG/GPS/TRDI	Strings: \$SBG01/\$xxHDT/\$PRDID
GPS1	2	Garmin	15H-W
Pressure (Press1)	3	Paroscientific	8000 Series
Speed of Sound (SoS1)	4	Applied MicroSystems	MicroSVT&P
Mag Compass #1	5	Honeywell	HMR3000
CTD1	6	Seabird	Fast Cat (SBE 49)
Echo Sounder	7	Benthos	PSA916
Temperature	8	TRDI Internal in Transducer	Dallas 18B20 One Wire
Mag Compass #2	9	PNI	TCM5/TRAX
Pitch, Roll, Temp, Press	10	TRDI Sensor Package	72B-1000-00

Based on the table above the sensor ID for the Honeywell HMR3000 is '5'.

Send the following command to the ExplorerDVL: SP 2 5

- b. Verify good communication with the Sensor:

Send 'SM' then send '5' to access the Honeywell HMR3000 sensor menu.

Verify that the comport baudrate is correct. Here it is correctly set at 511 which is the default 19200bds. See the [CB command](#) for more information on the baudrate 3 digits code.

Then send 'T' to open a terminal session with the Honeywell HMR3000.

```

>SP 3 5
>SP?
SP 0 99;0 99;5 200;0 99 ---- Sensor-port Assign [sp p sid [to]]
>SM
Sensor Auxilliary Menu
0 ----- Exit Menu                6----- SeaBird SBE-49 Fast Cat
1 ----- Not Used                  7----- Benthos PSA-916 Echo Sounder
2 ----- Garmin G-15H GPS          8----- One Wire Temp - No Menu
3 ----- Paros. 8CDF Pressure      9----- FNI TCM3/5 Compass
4 ----- AMS SVP&T                 10----- RDI Sensor Module
5 ----- Honeywell HMR3k Cmp
5

Make sure sensors are initialized with SR command
once after a break before entering this menu.
HMR3000 Auxiliary Menu
0 ----- Help
R ----- Reset to Factory Cal
C ----- Calibrate Compass
S 511----- Change Port Serial Params
T ----- Terminal Mode
X ----- Exit
T

Entering compass terminal mode. Enter Honeywell HMR3000 compass commands
up to but not including "**". All commands must begin with "#" or "$".
The "*" and a NEMA checksum will be automatically calculated and
appended to the command. '+' displays compass messages, '-' turns off
display. Hit Esc to exit this mode.
# HMR3000 Rev 4.10 - TNT 1250 Rev A - 10/08/04 !0000*4A

```

Then request one measurement by sending '\$PTNT,HPR' <ENTER> '+' <Enter>:

```

Entering compass terminal mode. Enter Honeywell HMR3000 compass commands
up to but not including "**". All commands must begin with "#" or "$".
The "*" and a NEMA checksum will be automatically calculated and
appended to the command. '+' displays compass messages, '-' turns off
display. Hit Esc to exit this mode.
# HMR3000 Rev 4.10 - TNT 1250 Rev A - 10/08/04 !0000*4A

$PTNT,HPR
$PTNTHPR,169.5,N,-1.9,N,27.2,O*2C

```

A measurement from the Honeywell HPR sensor is received, thus confirming proper port setting. Press the 'Esc' key to exit the terminal mode.

Now send the following command to properly configure the ExplorerDVL to use the newly connected sensor:

EZ10022020 -> Forces the ExplorerDVL to use the HMR300 for Heading, Pitch, and Roll.

#EY 3 5 -> Forces use of the HMR300 (sensor ID#5) to be used for heading (heading is field ID#3 in the #EY command as seen in the table below)

#EY 4 5

#EY 5 5

Doppler Data Input	Source when EY bit not 0	Primary Sensor Source when EY bit 0	Alternate Source					
			#1	#2	#3	#4	#5	#6
Speed of Sound	ID of EY, entry 1	CTD1	SoS1	RDI calc ¹	---	---	---	EC Cmd
Depth (from surface) and Pressure	ID of EY, entry 2	Press1	CTD1	SoS1	TRDI Sensor Package	Vert Beam ²	---	ED Cmd
Heading	ID of EY, entry 3	Gyro Cmp	Mag Cmp 1	Mag Cmp 2	---	---	---	#EH Cmd
Pitch	ID of EY, entry 4	Gyro Cmp	Mag Cmp 1 or 2	---	TRDI Sensor Package	---	---	#EP Cmd
Roll	ID of EY, entry 5	Gyro Cmp	Mag Cmp 1 or 2	Mag Cmp 2	TRDI Sensor Package	---	---	#ER Cmd
Salinity	ID of EY, entry 6	CTD1	---	---	---	---	---	ES Cmd
Temperature	ID of EY, entry 7	CTD1	SoS 1	Press1	TRDI Sensor Package	Transducer One Wire	Mag Cmp 2	ET Cmd

c. Verify the setup:

Now send PC2 to verify the Heading, Pitch, and Roll from the HMR300:

```
>PC2
Sensor data is sampled and displayed in a loop.
The number to the right of each backslash indicates the ID of the
sensor used for that data.
Press any key to exit the loop.

Temp(degC)  Press(kPa)  Depth(m)  Hdq(deg)  Pitch(deg)  Roll(deg)  Win
  21.00/ 0    0.000/ 0    0.000/ 0  169.10/ 5  -1.90 / 5   27.10/ 5   23.18
```

The '/5' at the right of Heading, Pitch, and Roll indicates that the sensor used for these values is Sensor ID#5 Honeywell HMR300.

The HMR300 as the Heading, Pitch, and Roll source for the ExplorerDVL is successfully setup.

Garmin GPS 15H-W

1. Setup the GPS Garmin 15H-W:

Do the same as above steps 1-3, i.e. apply power and verify communication through *TRDI Toolz* then connect the sensor to the ExplorerDVL sensor comport.

2. Setup communication between the GPS Garmin 15H-W and the ExplorerDVL:

Send the following commands:

SP 2 2

SM2 – Verify baudrate is adequately set at 311.

T to access terminal then send '+' to see the GPS data coming from the GPS, then press 'Esc' key to exit the terminal mode.

```

>sm2

Make sure sensors are initialized with SR command
once after a break before entering this menu.
Garmin G-15 GPS Auxiliary Menu
0 ----- Help
Q ----- Quiet - Stop Broadcasts
S 311----- Change Port Params
T ----- Terminal Mode
X ----- Exit
T

Entering GPS terminal mode. Enter Garmin G-15 GPS commands
up to but not including "$". All commands must begin with "$" or "$".
The "$" and a NEMA checksum will be automatically calculated and
appended to the command. '+' displays gps messages, '-' turns off
display. Hit Esc to exit this mode.
E,N*17
$GPGGA,001214,3254.1852,N,11706.6495,W,0,00,,,M,,M,,*48
$GPRMC,001206,3254.1852,N,11706.6495,W,0,00,,,M,,M,,*4B
$GPRMC,001207,V,3254.1852,N,11706.6495,W,,110506,013.0,E,N*15
$GPGGA,001207,3254.1852,N,11706.6495,W,0,00,,,M,,M,,*4A
$GPRMC,001208,V,3254.1852,N,11706.6495,W,,110506,013.0,E,N*1A
$GPGGA,001208,3254.1852,N,11706.6495,W,0,00,,,M,,M,,*45
$GPRMC,001209,V,3254.1852,N,11706.6495,W,,110506,013.0,E,N*1B
$GPGGA,001209,3254.1852,N,11706.6495,W,0,00,,,M,,M,,*44
$GPRMC,001210,V,3254.1852,N,11706.6495,W,,110506,013.0,E,N*13
$GPGGA,001210,3254.1852,N,11706.6495,W,0,00,,,M,,M,,*4C

```

SD 02 1111 -> to enable the GPS data to be output in each of the PDO ensembles. The full description of the GPS Garmin data output can be found in Table 69: Garmin G-15 GPS PGRMT NMEA Sentence Output Format through Table 72: Garmin G-15 GPS GPVTG NMEA Sentence Output Format.

3. Verify the setup.

It is strongly advised to collect some data with the instrument and verify that the output data contains the external sensor data.

PNi TRAX – External

In this example we consider the PNi TRAX sensor to be external to the DVL, which in other words means that you can access it directly and connect it to a computer to run the TRAX studio software.



PNi TRAX sensors are only available when using firmware version 34.14 and higher.

1. Identify Power and Com for External Sensor.

Each sensor has a specific input voltage range, default communication baudrate, and serial pin-out. Make sure to respect input power limits before applying power.

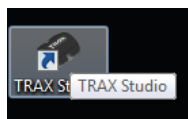
In our example the power and default baud rates are as follow:

	Input Voltage	Default Baud Rate
GPS Garmin 15H-W	8 to 40VDC	4800
Honeywell HMR3000	6 to 15VDC	19200
PNi TRAX	3.6 to 5 VDC	38499
SBG IG500	3.3 to 30V	115200

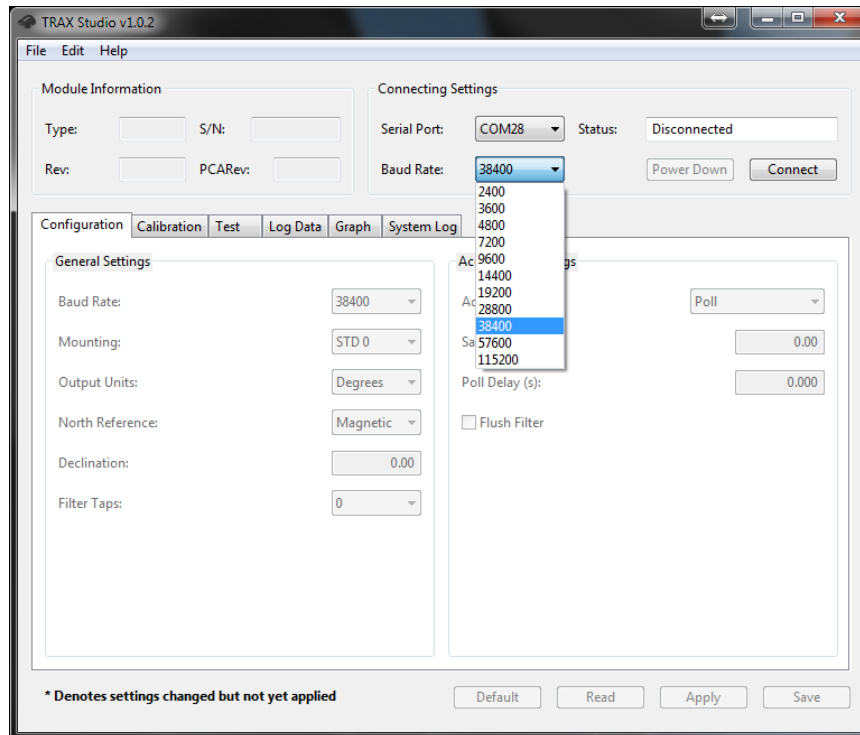
2. Apply power and connect the sensor to your computer



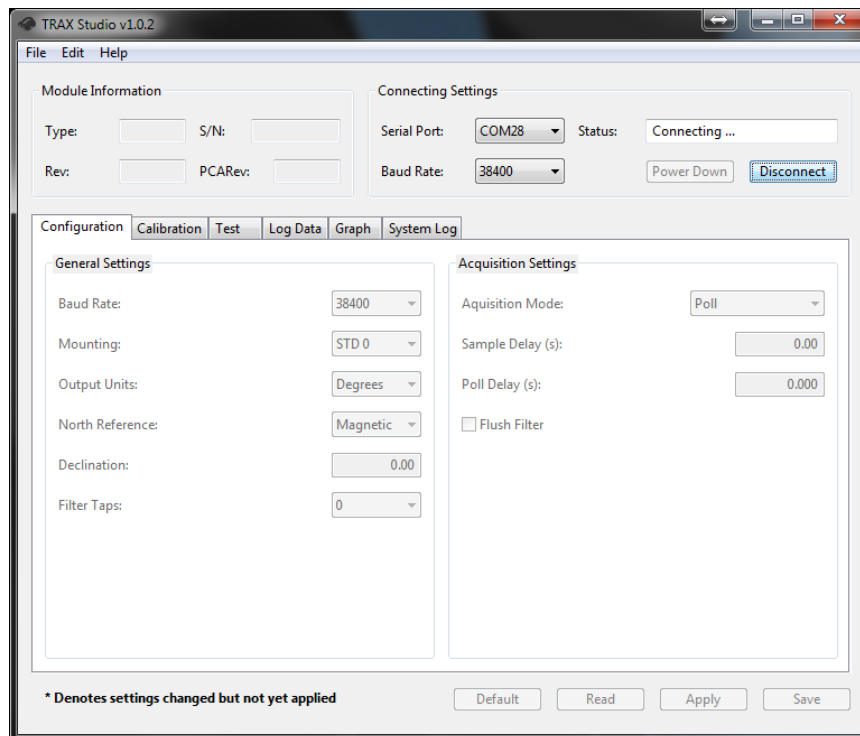
3. Run the PNi Trax Studio software.



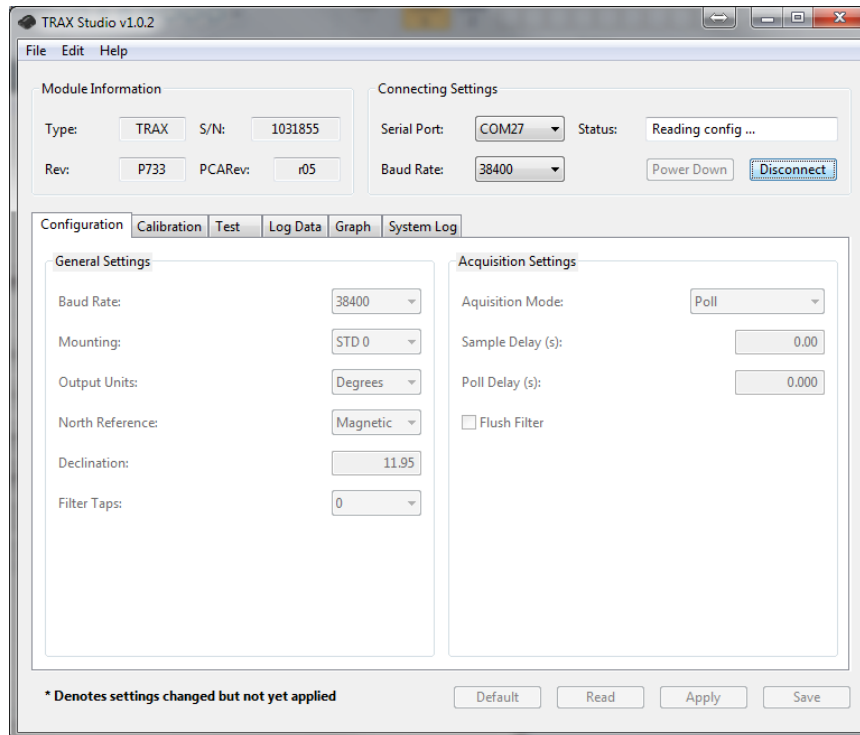
4. Select the proper comport and baudrate:



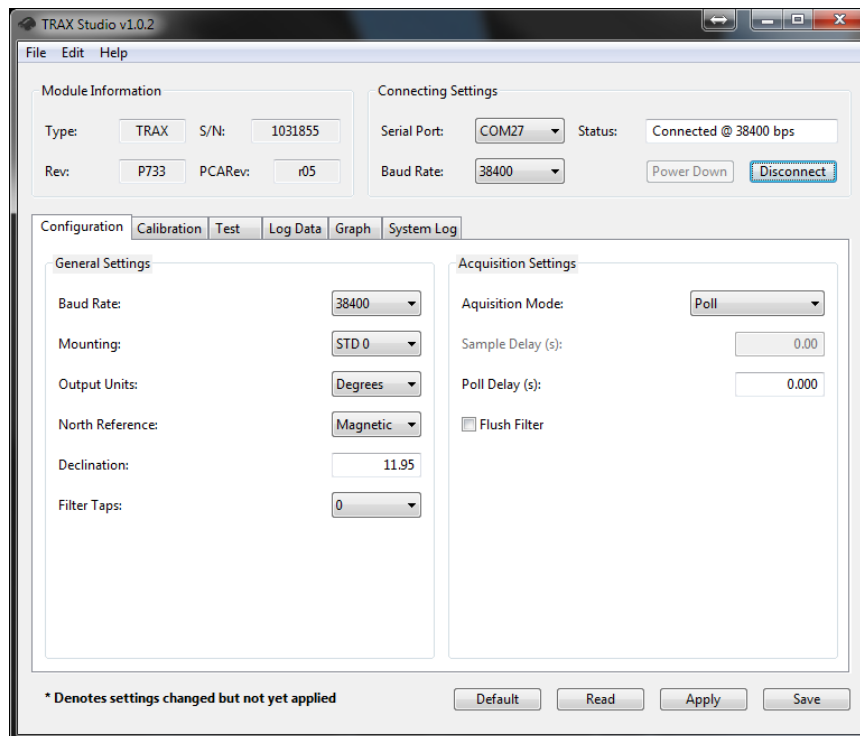
5. Click **Connect**:



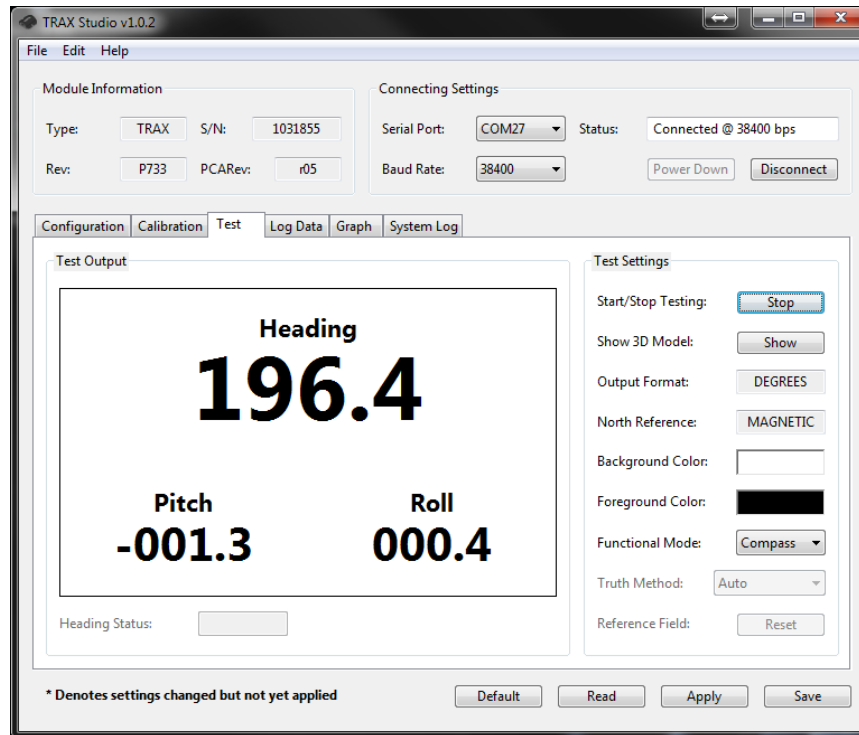
6. The PNi Trax is detected and the TRAX Studio reads its configuration:



7. The PNi TRAX has been successfully connected:

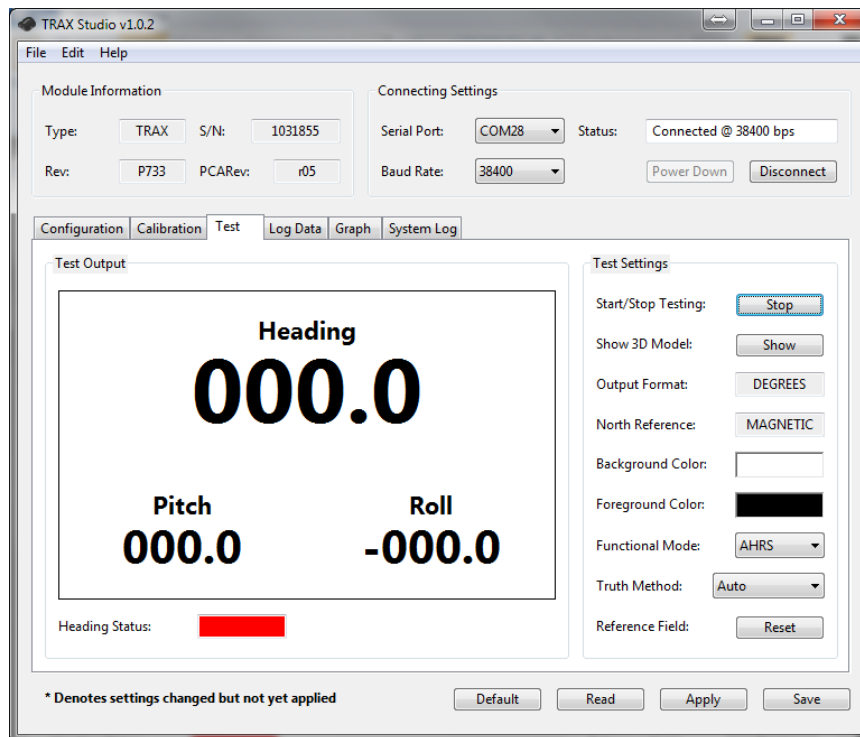


8. Click on the **Test** tab then select either **COMPASS** –similar to TCM5- or AHRS –Kalman filtered gyros, magnetometers and accelerometers will be used to obtain Heading, Pitch and Roll.
9. Click **SAVE** for this setting to be saved internally and kept despite power cycling the TRAX sensor.
10. If you selected:
 - **COMPASS** mode: In compass mode it is advised to run a calibration; Jump to step 13.

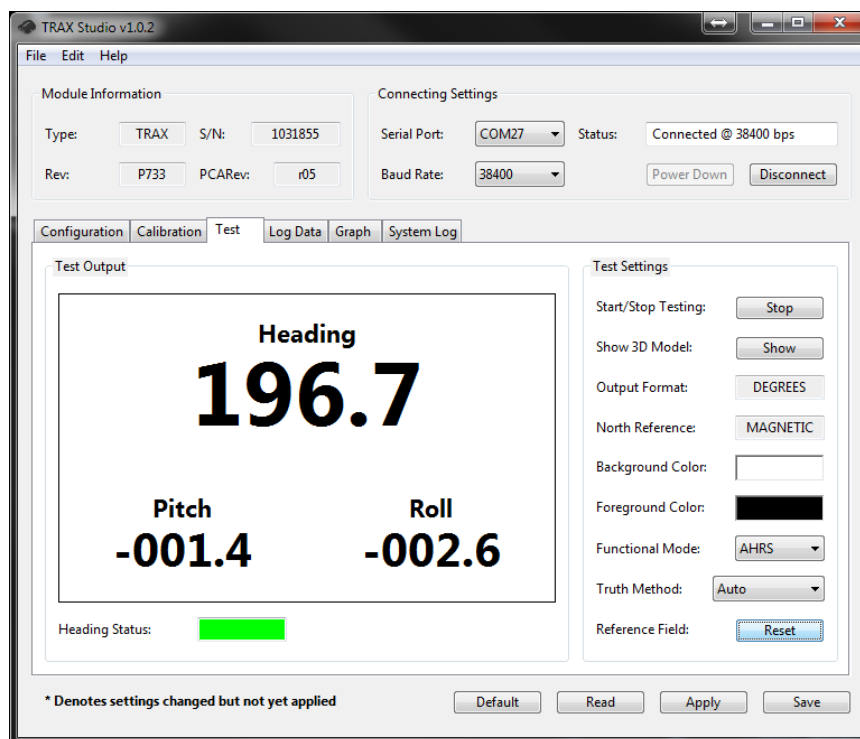


- **AHRS** mode: continue to the next step below.

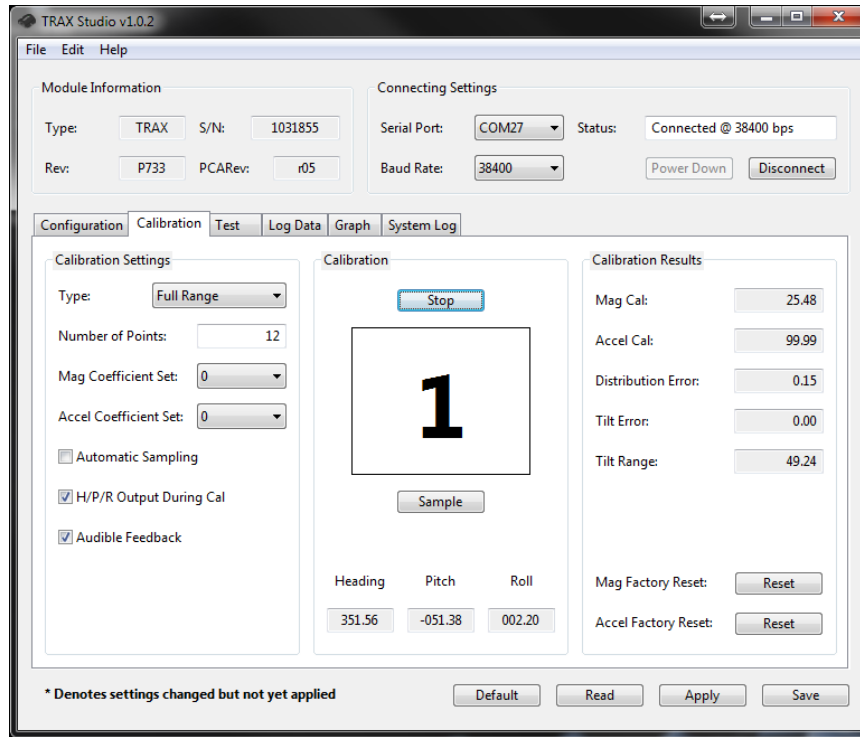
- In AHRS mode, should the field around the TRAX sensor have a strong magnetic signature not calibrated for, then you could get a RED color for the heading status and worst case the Heading, Pitch and Roll might report zero:



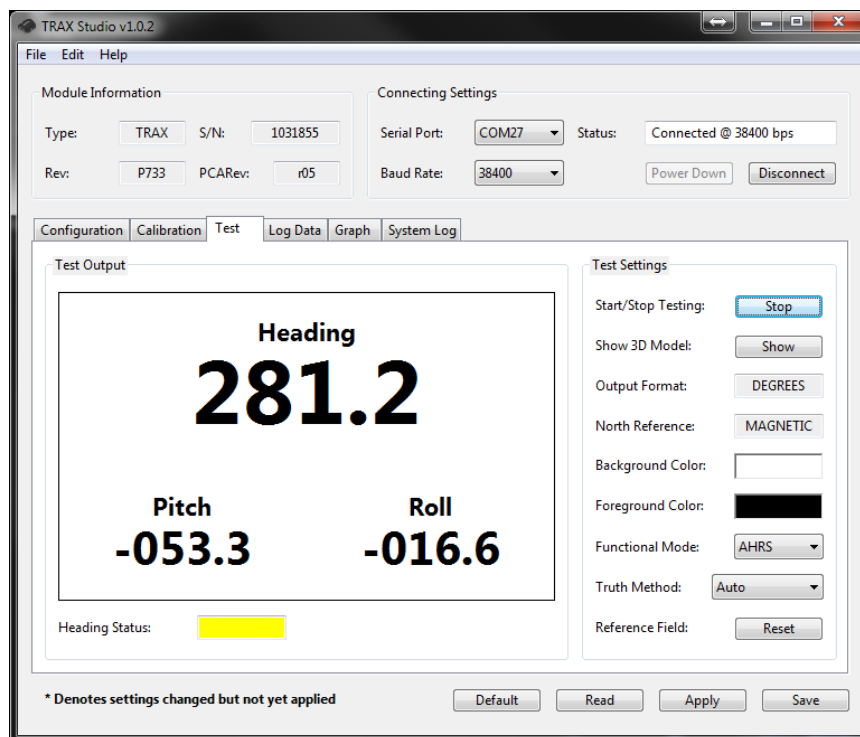
- In that case, it is worth trying to go to a cleaner magnetic spot and see if the Heading status changes – as depicted below when moving away from power lines and power supplies in our lab:



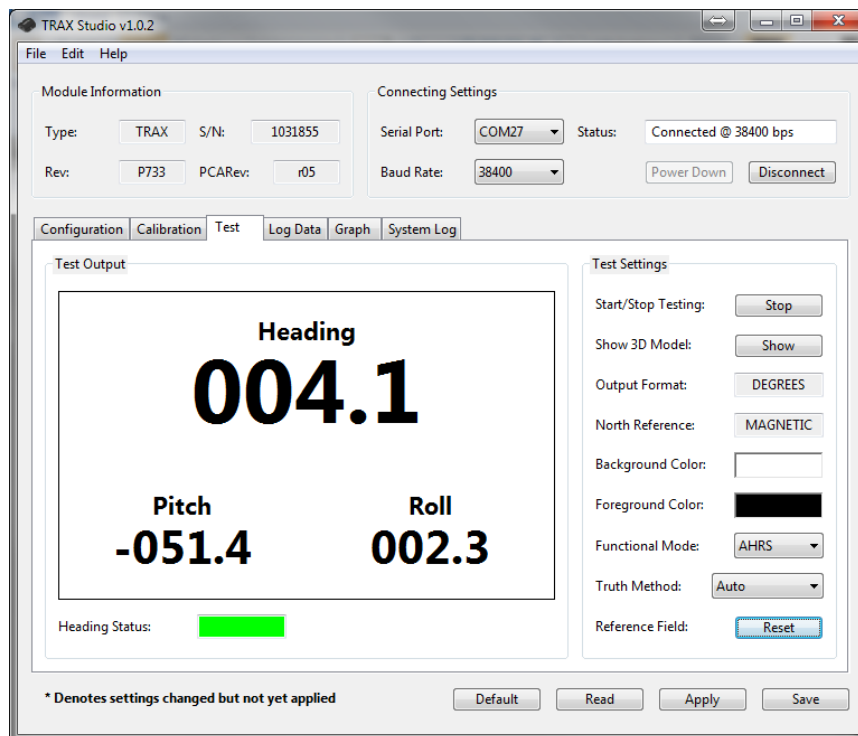
- If the heading status cannot be cleared due to your vehicle signature, it is strongly advised to run a Full Range calibration:



- In AHRS mode, after the full range calibration, should you still get a non-green Heading status then, make sure to reset the reference field by clicking the **Reset** button at the bottom right corner:



15. This should get the heading status to report GREEN:



16. Click on **Configuration** tab to setup the orientation in which the TRAX will be integrated to the vehicle with respect to the vehicle FWD, STBD and UP axis. Here are the different orientations:

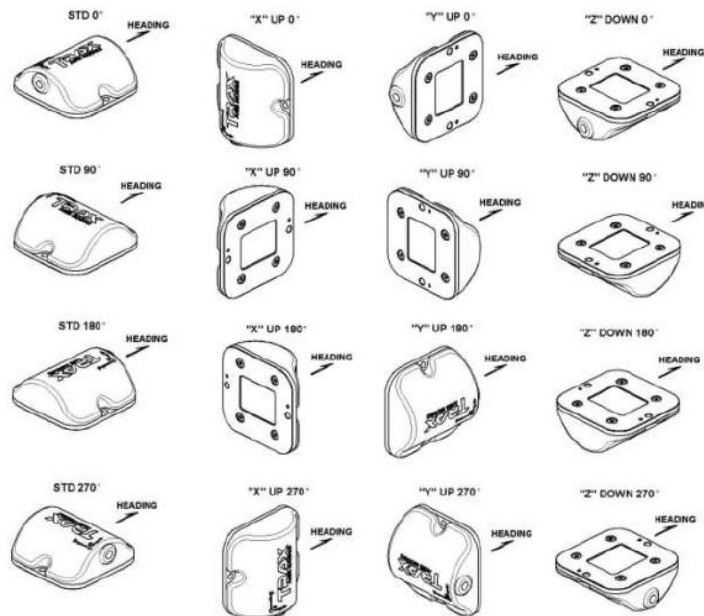
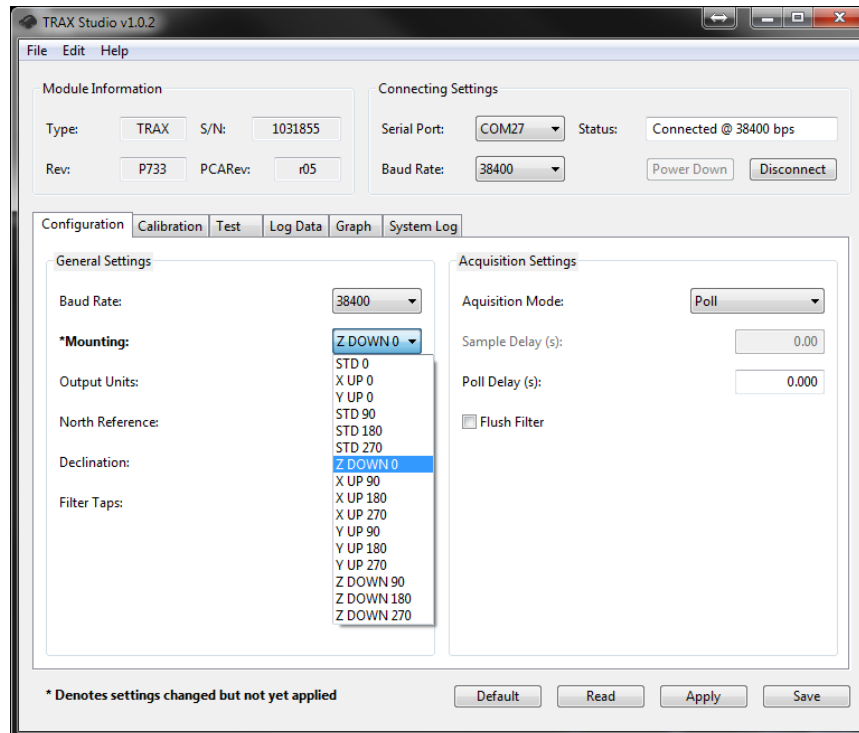


Figure 4-2: Trax Enclosed Mounting Orientations

17. Select the adequate orientation and click **SAVE**.



18. Close *TRAX Studio* and connect the PNi Trax to the ExplorerDVL. Note that if you are using the OEM RS232 cable with female DB9 you may need a NULL MODEM. For this example we will use comport 2.
19. Setup the ExplorerDVL Setup communication between the PNi TRAX and the ExplorerDVL:
20. Send the following commands:
- SP 2 9
 - SM9 – This will access the PNi TRAX menu
 - Verify baudrate is adequately set at 611.
 - Press V which should return the Module Name and Rev of the PNi TRAX connected to the ExplorerDVL comport 2:


```

BBTalk - Teledyne RD Instruments - [COM2:]
File Edit View Transfer Tools Window Help
[Icons]
>SP?
SP 0 99;0 99;1 100;0 99 ---- Sensor-port Assign [sp p sid [to]]
>SP 3 0 99

>SP?
SP 0 99;0 99;0 99;0 99 ---- Sensor-port Assign [sp p sid [to]]
>SP 2 9

>sp?
SP 0 99;9 110;0 99;0 99 ---- Sensor-port Assign [sp p sid [to]]
>SM9

Make sure sensors are initialized with SR command
once after a break before entering this menu.

TCM Auxiliary Menu
O ----- Help
R ----- Reset to factory Cal.
C ----- Cal. compass (sampling method, mode, points)
S 611----- Change port serial params
M ----- Save current config./cal.
N ----- Set reference magnetic field
V ----- Show compass version
F ----- Show/set mounting ref.
B ----- Show heading status
Z ----- Compass/AHRS mode (0/1) (TRAX only)
X ----- Exit
V

Module = TRAX
Rev = 50373334
>SM 9 V

Make sure sensors are initialized with SR command
once after a break before entering this menu.

Module = TRAX
Rev = 50373334
>
    
```

Note that you can either send ‘SM9’ then ‘V’ or ‘SM9 V’.

21. Verify the setup:

Now send PC2 to verify the Heading, Pitch, and Roll from the HMR300:

```

>PC2
Sensor data is sampled and displayed in a loop.
The number to the right of each backslash indicates the ID of the
sensor used for that data.
Press any key to exit the loop.

Temp (degC)   Press (kPa)   Depth (m)   Hdg (deg)   Pitch (deg)   Roll (deg)   Vin
V 31.75/ 9    0.000/ 0     0.000/ 0    30.83/ 9    -10.53 / 9    -157.69/ 9    14.27
    
```

- The ‘/9’ at the right of Heading, Pitch, and Roll indicates that the sensor used for these values is Sensor ID#9, i.e. the PNi TRAX AHRS sensor.
- The PNi TRAX AHRS sensor as the Heading, Pitch, and Roll source for the ExplorerDVL is successfully setup.

PNi TRAX – Internal



PNi TRAX sensors are only available when using firmware version 34.14 and higher.

In this example we consider that the PNi TRAX is integrated internally to the ExplorerDVL, which in other words means the user cannot access it directly and connect the sensor to a computer to run calibration as previously explained.

1. Identify Power and Com for External Sensor
2. Each sensor has a specific input voltage range, default communication baudrate, and serial pin-out. Make sure to respect input power limits before applying power.

In our example the power and default baud rates are as follow:

	Input Voltage	Default Baud Rate
GPS Garmin 15H-W	8 to 40VDC	4800
Honeywell HMR3000	6 to 15VDC	19200
PNi TRAX	3.6 to 5 VDC	38499
SBG IG500	3.3 to 30V	115200

3. Apply power and connect the sensor to your ExplorerDVL.
4. Setup the ExplorerDVL Setup communication between the PNi TRAX and the ExplorerDVL:
5. Send the following commands:
 - a. SP 4 9
 - b. SM9 – This will access the PNi TRAX menu
 - c. Verify baudrate is adequately set at 611.
 - d. Press V which should return the Module Name and Rev of the PNi TRAX connected to the ExplorerDVL comport 2:

```
>sp 4 9
```

```
>sr
```

```
Initializing sensor 9 on port 4.
```

```
>sm 9v
```

```
Make sure sensors are initialized with SR command  
once after a break before entering this menu.
```

```
Module = TRAX  
Rev = 50373334  
>
```



Note that you can either send 'SM9' then 'V' or 'SM9 V'.

- e. Set the sensor to either COMPASS –similar to TCM5- or AHRS –Kalman filtered gyros, magnetometers and accelerometers will be used to obtain Heading, Pitch and Roll.
- f. IF you selected:
 - COMPASS mode: In compass mode it advised to run a calibration. Jump straight to step 11.

```

>SM9

Make sure sensors are initialized with SR command
once after a break before entering this menu.

TCM Auxiliary Menu
0 ----- Help
R ----- Reset to factory Cal.
C ----- Cal. compass (sampling method, mode, points)
S 611----- Change port serial params
M ----- Save current config./cal.
N ----- Set reference magnetic field
V ----- Show compass version
F ----- Show/set mounting ref.
B ----- Show heading status
Z ----- Compass/AHRS mode (0/1) (TRAX only)
X ----- Exit
Z 0

Cal./config. saved
The functional mode is: 0

>

```

- AHRS mode: continue to the next step below.

```

>SM 9

Make sure sensors are initialized with SR command
once after a break before entering this menu.

TCM Auxiliary Menu
0 ----- Help
R ----- Reset to factory Cal.
C ----- Cal. compass (sampling method, mode, points)
S 611----- Change port serial params
M ----- Save current config./cal.
N ----- Set reference magnetic field
V ----- Show compass version
F ----- Show/set mounting ref.
B ----- Show heading status
Z ----- Compass/AHRS mode (0/1) (TRAX only)
X ----- Exit
Z 1

Cal./config. saved
The functional mode is: 1

>|

```

6. In AHRS mode, the sensor needs a few seconds to stabilize, during that time it is sensitive to EMI. As most vehicles create EMI most often during power-up sequence it is advised to verify the Heading Status upon powering up.
7. Send the SM9 B command. Here is the return in an EMI-Free environment:

```

>sm9 b

Make sure sensors are initialized with SR command
once after a break before entering this menu.

Heading status: <2deg uncertainty

```

Here is the return with the sensor close to a large power supply:

```

>sm9 b

Make sure sensors are initialized with SR command
once after a break before entering this menu.

Heading status: 2-10deg uncertainty

```

8. The Heading Status provides an indication of the accuracy of the heading. Good Status is represented by a heading accuracy of $<2^\circ$, a marginal status means the heading uncertainty is approximately 2° to 10° , and a bad status means the uncertainty is $>10^\circ$.

9. In case you do not obtain a Good Status, you should try to reset the reference field by sending the SM9 N command as post power-up the EMI field in your vehicle might now be acceptable to the TRAX in AHRS mode:

```
>sm9 b
Make sure sensors are initialized with SR command
once after a break before entering this menu.
Heading status: 2-10deg uncertainty
>sm9 n
Make sure sensors are initialized with SR command
once after a break before entering this menu.
Reset reference magnetic field.
>sm9 b
Make sure sensors are initialized with SR command
once after a break before entering this menu.
Heading status: <2deg uncertainty
>|
```

10. In case you still do not get a better heading status, it might not be your vehicle but the environment, thus it is worth trying to go to a cleaner magnetic spot and see if the Heading status changes.
11. If the heading status cannot be cleared due to your vehicle's strong EMI signature, it is strongly advised to run a Full Range calibration by Sending SM9 C:

```

BBTalk - Teledyne RD Instruments - [COM2:]
File Edit View Transfer Tools Window Help
[Icons]
R ----- Reset to factory Cal.
C ----- Cal. compass (sampling method, mode, points)
S 611----- Change port serial params
M ----- Save current config./cal.
N ----- Set reference magnetic field
V ----- Show compass version
F ----- Show/set mounting ref.
B ----- Show heading status
Z ----- Compass/AHRS mode (0/1) (TRAX only)
X ----- Exit
C
Enter cal. sampling method [Auto=a, Manual=m]?
m
Choose cal. mode:
1 - Full range: 12, 10-18.
2 - 2D cal.: 12, 10-18.
3 - Limited tilt range: 12, 10-18
4 - Hard iron only: 6, 4-18
Enter cal. mode?
1
Enter number of cal. points?
12
Sample (out of 12 required)
Hit any key to take sample (01)
Hit any key to take sample (02)
Hit any key to take sample (03)
Hit any key to take sample (04)
Hit any key to take sample (05)
Hit any key to take sample (06)
Hit any key to take sample (07)
Hit any key to take sample (08)
Hit any key to take sample (09)
Hit any key to take sample (10)
Hit any key to take sample (11)
Hit any key to take sample (12)

Wait.....
Mag cal.: 5.42
Distribution error: 0.04
Tilt error: 0.00
Tilt range: 38.46
Cal. successful.

Done.

Do you want to save the cal. [y/n]?
    
```

12. Make sure to look at the calibration scores and refer to PNi documentation for their meaning before saving the calibration.
13. Note that if you do not like the results and do not want to keep this calibration, then the ExplorerDVL will request that you power cycle as the PNi TRAX keeps the current calibration active until power is cycled.

```
>SM9 C m 1 12

Make sure sensors are initialized with SR command
once after a break before entering this menu.

Sample (out of 12 required)
Hit any key to take sample (01)
Hit any key to take sample (02)
Hit any key to take sample (03)
Hit any key to take sample (04)
Hit any key to take sample (05)
Hit any key to take sample (06)
Hit any key to take sample (07)
Hit any key to take sample (08)
Hit any key to take sample (09)
Hit any key to take sample (10)
Hit any key to take sample (11)
Hit any key to take sample (12)

Wait.....
.....
Mag cal.: 180.00
Distribution error: 32.21
Tilt error: 25.11
Tilt range: 0.08
Cal. successful.

Done.

Do you want to save the cal. [y/n]?
n
Power cycle DVL to return to last cal.

>|
```

Note that you could have sent ‘SM9 C m 1 12’ to start the same manual Full Range 12 points calibration:

```
>SM9 C m 1 12

Make sure sensors are initialized with SR command
once after a break before entering this menu.

Sample (out of 12 required)
Hit any key to take sample (01)
Hit any key to take sample |
```

14. The main objective of a magnetic user calibration is to compensate for hard iron and soft iron distortions to the magnetic field caused by components within the user’s host system. To that end, the Trax needs to be mounted within the host system and the entire host system needs to be moved as a single unit during a user calibration. The Trax allows the user to perform a calibration only in a 2D plane or with limited tilt, but provides the greatest accuracy if the user can rotate through a full sphere. Here are the different types of calibrations supported:

Table 5-1: Magnetic Calibration Mode Summary

Calibration Mode	Static Accuracy in Compass Mode	Tilt Range during Cal	# of Samples in Recommended Cal Pattern	Allowable Range of # of Samples
Full Range	0.3° rms	>±45°	12	10 – 18
2D Calibration	<2°	<±5°	12	10 – 18
Limited Tilt Range	<2° over 2x tilt range	±5° to ±45°	12	10 – 18
Hard Iron Only	Restores prior accuracy	>±3°	6	4 - 18

15. Note that we recommend the Full Range Calibration. A Full Range Calibration is appropriate when the Trax can be tilted ±45° or more. This method compensates for hard and soft iron effects in three dimensions, and allows for the highest accuracy readings. The recommended 12 point calibration pattern is a series of 3 circles of evenly spaced points, as illustrated in Figure 5-1 and listed in Table 5-2. The pitch used in the second and third circles of the calibration should at least match the maximum and minimum pitch the device is expected to encounter in use.

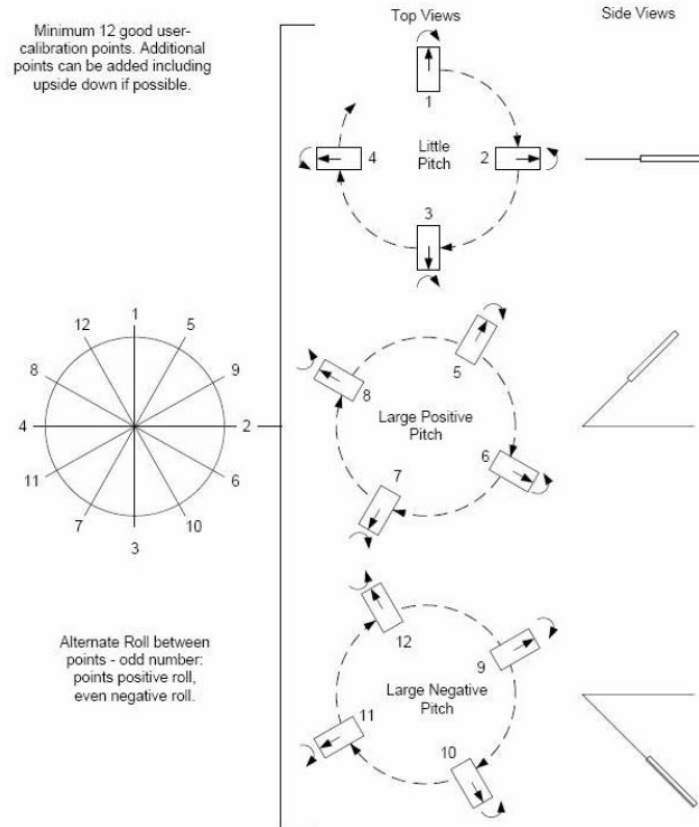


Figure 5-1: 12 Point Full Range Calibration

Table 5-2: 12 Point Full Range Calibration Pattern

Sample #	Yaw ¹	Pitch	Roll
First Circle			
1	0°	±5°	30° to 40°
2	90°	±5°	-30° to -40°
3	180°	±5°	30° to 40°
4	270°	±5°	-30° to -40°
Second Circle			
5	30°	> +45°	30° to 40°
6	120°	> +45°	-30° to -40°
7	210°	> +45°	30° to 40°
8	300°	> +45°	-30° to -40°
Third Circle			
9	60°	< -45°	30° to 40°
10	150°	< -45°	-30° to -40°
11	240°	< -45°	30° to 40°
12	330°	< -45°	-30° to -40°

Footnote:

1. Yaw listings are not absolute heading directions but rather relative heading referenced to the first sample.

16. If a full range calibration is not possible we advise to run a 2D calibration. A 2D Calibration is intended for very low tilt operation (<5°) where calibrating the Trax with greater tilt is not practical. This procedure calibrates for hard and soft iron effects in only two dimensions, and in general is effective for operation and calibration in the tilt range of -5° to +5°. The recommended 12 point calibration pattern is a circle of evenly spaced points, as given in this Table below:

Table 5-3: 12 Point 2D Calibration Pattern

Sample #	Yaw	Pitch ¹	Roll ¹
1	0°	0°	0°
2	30°	max. negative	max. negative
3	60°	0°	0°
4	90°	max. positive	max. positive
5	120°	0°	0°
6	150°	max. negative	max. negative
7	180°	0°	0°
8	210°	max. positive	max. positive
9	240°	0°	0°
10	270°	max. negative	max. negative
11	300°	0°	0°
12	330°	max. positive	max. positive

Footnote:

1. For best results, the tilt experienced during calibration should match that experienced in service. For example, if the Trax is restrained to a level plane in service, then calibration should be in a plane, where “max. positive” and “max. negative” are 0°.

17. Post calibration it is strongly advised to check the heading status again and reset if necessary.
18. Setup the orientation in which the TRAX will be integrated to the vehicle with respect to the vehicle FWD, STBD and UP axis. Here are the different orientations:

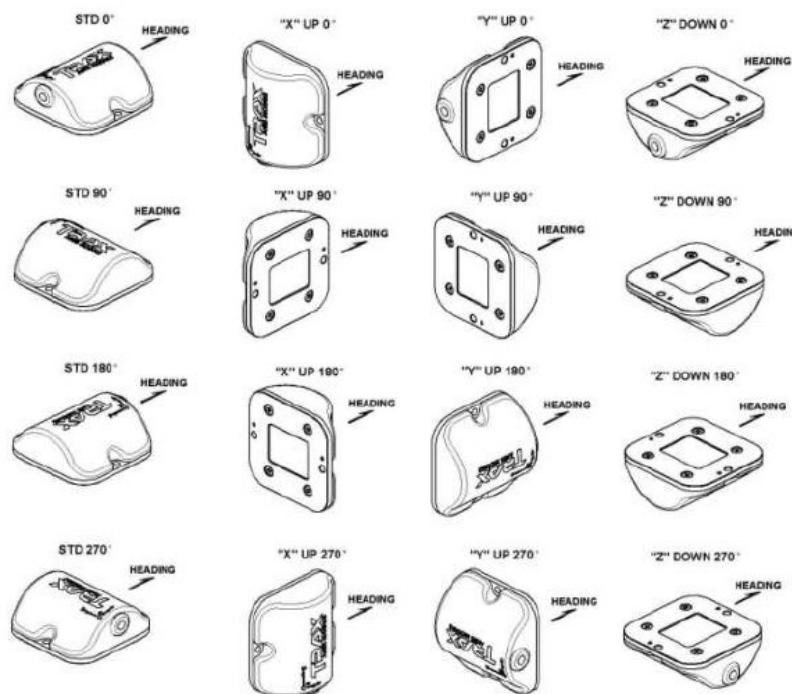


Figure 4-2: Trax Enclosed Mounting Orientations

19. Send the SM9 F command and select the orientation based on this table below:

- 1 = STD 0°
- 2 = X UP 0°
- 3 = Y UP 0°
- 4 = STD 90°
- 5 = STD 180°
- 6 = STD 270°
- 7 = Z DOWN 0°
- 8 = X UP 90°
- 9 = X UP 180°
- 10 = X UP 270°
- 11 = Y UP 90°
- 12 = Y UP 180°
- 13 = Y UP 270°
- 14 = Z DOWN 90°
- 15 = Z DOWN 180°
- 16 = Z DOWN 270°

```

Explorer DVL
Teledyne RD Instruments (c) 2014
All rights reserved.
Firmware Version: 34.14

>SM9

Make sure sensors are initialized with SR command
once after a break before entering this menu.

TCM Auxiliary Menu
0 ----- Help
R ----- Reset to factory Cal.
C ----- Cal. compass (sampling method, mode, points)
S 611----- Change port serial params
M ----- Save current config./cal.
N ----- Set reference magnetic field
V ----- Show compass version
F ----- Show/set mounting ref.
B ----- Show heading status
Z ----- Compass/AHRS mode (0/1) (TRAX only)
X ----- Exit
F

Mounting ref is: 7

>SM9 F 3

Make sure sensors are initialized with SR command
once after a break before entering this menu.

Mounting ref is: 3

>|
    
```

20. Save the setup:

```

>SM9

Make sure sensors are initialized with SR command
once after a break before entering this menu.

TCM Auxiliary Menu
0 ----- Help
R ----- Reset to factory Cal.
C ----- Cal. compass (sampling method, mode, points)
S 611----- Change port serial params
M ----- Save current config./cal.
N ----- Set reference magnetic field
V ----- Show compass version
F ----- Show/set mounting ref.
B ----- Show heading status
Z ----- Compass/AHRS mode (0/1) (TRAX only)
X ----- Exit
M

Cal./config. saved

>|
    
```

21. Verify the setup:

Send PC2 to verify the Heading, Pitch, and Roll from the PNi TRAX AHRS sensor:

```
>PC2
Sensor data is sampled and displayed in a loop.
The number to the right of each backslash indicates the ID of the
  sensor used for that data.
Press any key to exit the loop.

Temp(degC)  Press(kPa)  Depth(m)  Hdg(deg)  Pitch(deg)  Roll(deg)  Vin
/ 28.03/ 9   0.000/ 0   0.000/ 0  258.85/ 9  -18.68 / 9  -177.63/ 9  14.27
```

- The ‘/9’ at the right of Heading, Pitch, and Roll indicates that the sensor used for these values is Sensor ID#9, the PNi TRAX AHRS sensor.
- The PNi TRAX AHRS sensor as the Heading, Pitch, and Roll source for the ExplorerDVL is successfully setup.

SBG IG-500 (or Ekinox)



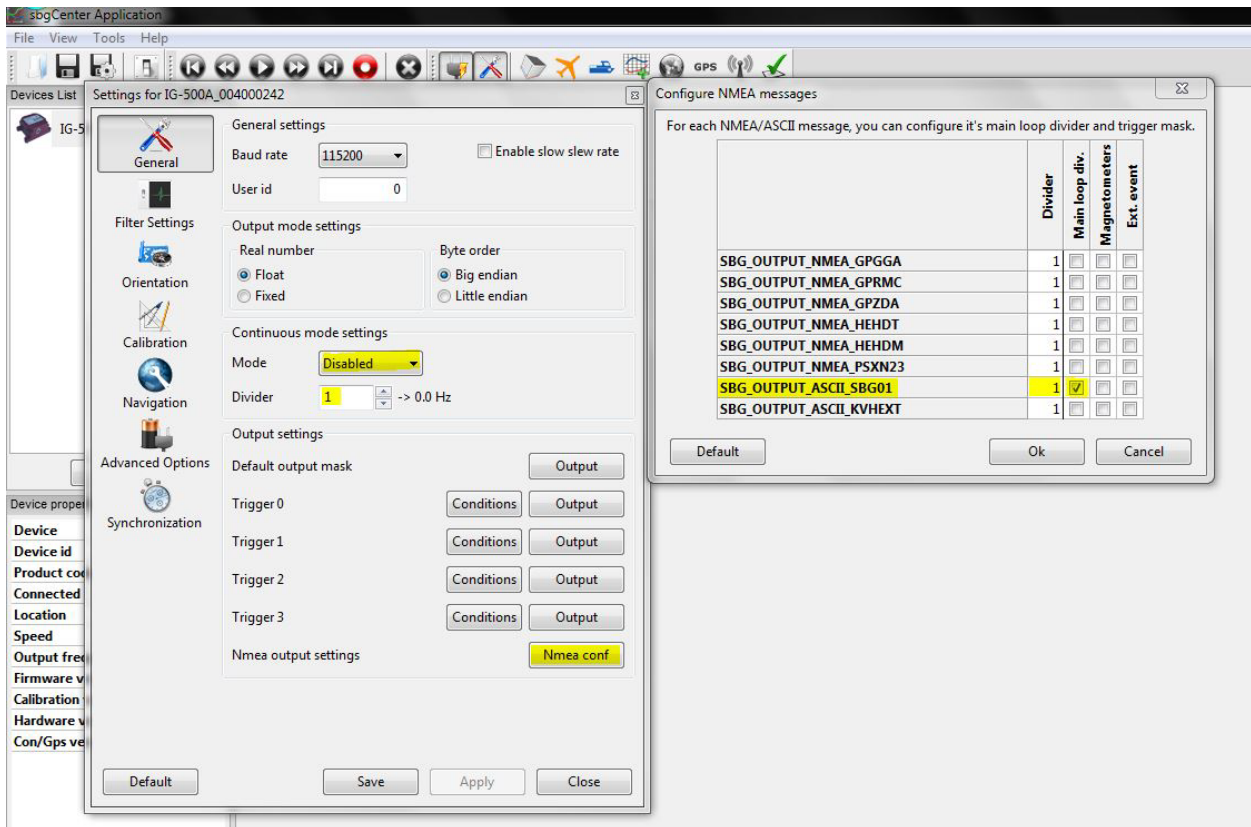
SBG sensors are only available when using firmware version 34.14 and higher.

1. Identify Power and Com for External Sensor
2. Each sensor has a specific input voltage range, default communication baudrate, and serial pin-out. Make sure to respect input power limits before applying power.

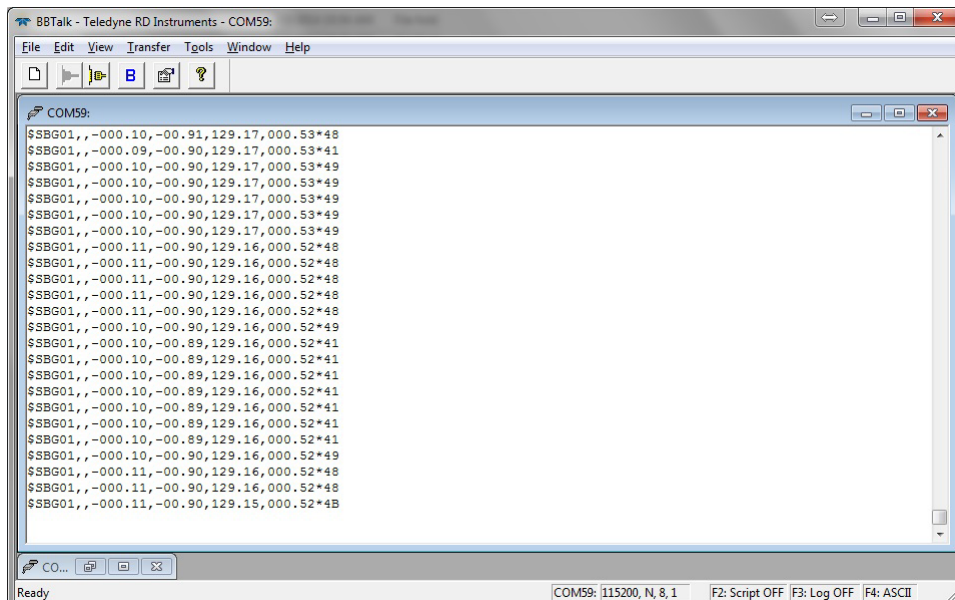
In our example the power and default baud rates are as follow:

	Input Voltage	Default Baud Rate
GPS Garmin 15H-W	8 to 40VDC	4800
Honeywell HMR3000	6 to 15VDC	19200
PNi TRAX	3.6 to 5 VDC	38499
SBG IG500	3.3 to 30V	115200

3. Apply power and connect the sensor to your computer
4. Run the *SBGCenter* software and setup the device to output the SBG proprietary \$SBG01 NMEA string by going to general settings and setting:
 - a. Mode to Disabled
 - b. Divider to ‘1’
 - c. Then going to Nmea conf and setting SBG_OUTPUT_ASCII_SBG01 Divider to ‘1’ and check only the box for ‘Main loop div.’



5. Run the necessary calibration using the *SBGCenter*.
6. Close *SBGCenter* and connect the SBG IG-500 to a hyperterminal software and verify that you are getting the \$SBG01 NMEA string for the set baudrate as depicted below:



7. Connect the SBG IG-500 to the desired comport. For this example we'll use comport 3.



8. Setup the ExplorerDVL Setup communication between the SBG IG-500 and the ExplorerDVL:
9. Send the following commands:
 - a. SP 3 1
 - b. SM1 – Verify baudrate is adequately set at 811.

```

BBTalk - Teledyne RD Instruments - [COM2]
File Edit View Transfer Tools Window Help
[Icons]
>SP?
SP 0 99;0 99;0 99;0 99 ---- Sensor-port Assign [sp p sid [to]]
>SP 3 1

>SP?
SP 0 99;0 99;1 100;0 99 ---- Sensor-port Assign [sp p sid [to]]
>SM
Sensor Auxilliary Menu
0 ----- Exit Menu                6----- SeaBird SBE-49 Fast Cat
1 ----- Streaming HPR device      7----- Benthos PSA-916 Echo Sounder
2 ----- Garmin G-15H GPS          8----- One Wire Temp - No Menu
3 ----- Paros, 8CDP Pressure      9----- ENI TRAX Compass
4 ----- AMS SVP&T                10----- RDI Sensor Module
5 ----- Honeywell HMR3k Cmp
1

Make sure sensors are initialized with SR command
once after a break before entering this menu.
Streaming HPR Device Auxilliary Menu
0 ----- Help
S 411----- Change Port Serial Params
T ----- Terminal Mode
X ----- Exit
S811

Exiting menu.

>SM1

Make sure sensors are initialized with SR command
once after a break before entering this menu.
Streaming HPR Device Auxilliary Menu
0 ----- Help
S 811----- Change Port Serial Params
T ----- Terminal Mode
X ----- Exit

```

- c. T to access terminal then send '+' to see the SBG \$SBG01 NMEA string streaming in from the IG-500 AHRS sensor, then press 'Esc' key to exit the terminal mode.



Pressing '+' 3 times will be received by the ExplorerDVL as a software Break and thus will return the TRDI ExplorerDVL welcome banner.

```

BBTalk - Teledyne RD Instruments - [COM2:]
File Edit View Transfer Tools Window Help
[Icons]
>SM1
Make sure sensors are initialized with SR command
once after a break before entering this menu.
Streaming HPR Device Auxiliary Menu
O ----- Help
S 811----- Change Port Serial Params
T ----- Terminal Mode
X ----- Exit
T

Entering compass terminal mode. Enter compass commands
up to but not including "**". All commands must begin with "#" or "$".
The "*" and a NEMA checksum will be automatically calculated and
appended to the command. '+' displays compass messages, '-' turns off
display. Hit Esc to exit this mode.
$SBG01,,000.16,-00.79,117.84,000.34*63
$SBG01,,000.16,-00.79,117.84,000.34*63
$SBG01,,000.16,-00.79,117.84,000.34*63
$SBG01,,000.15,-00.79,117.84,000.34*60
$SBG01,,000.15,-00.79,117.84,000.34*60
$SBG01,,000.15,-00.79,117.84,000.34*60
$SBG01,,000.16,-00.78,117.84,000.34*62
$SBG01,,000.16,-00.78,117.84,000.34*62
$SBG01,,000.16,-00.78,117.84,000.34*62

```

10. Verify the setup:

Send PC2 to verify the Heading, Pitch, and Roll from the SBG IG-500:

```

>PC2
Sensor data is sampled and displayed in a loop.
The number to the right of each backslash indicates the ID of the
sensor used for that data.
Press any key to exit the loop.

/ Temp(degC)  Press(kPa)  Depth(m)  Hdq(deg)  Pitch(deg)  Roll(deg)  vin
/ 21.00/0    0.000/0    0.000/0   121.49/1   -0.89/1     0.32/1     14.29

```

- The '/' at the right of Heading, Pitch, and Roll indicates that the sensor used for these values is Sensor ID#1, the Attitude sensor streaming input.
- The SBG IG-500 as the Heading, Pitch, and Roll streaming source for the ExplorerDVL is successfully setup.



Only one type of string should be sent at a time on this comport when set to the Streaming HPR device.

NOTES

Chapter 4

MAINTENANCE



In this chapter:

- How to spot problems
- How to do periodic maintenance items on the PAVS

Replaceable Parts

Spare anodes are included with the system. Use the following table to order additional replacement parts:

Table 8: ExplorerDVL Spare Parts

Description	Used On	Part number
O-ring, bore, 2-043	Piston and Phased Array transducer	97Z-6064-00
O-ring, face, inner, 2-044	Piston and Phased Array transducer	97Z-6065-00
O-ring, face, outer, 2-047	Piston and Phased Array transducer	97Z-6066-00
O-ring, 2-013	Self-Contained housing access port plug	97Z-6008-00
O-ring, AS568A-042	Self-Contained housing	9557K133
O-ring, AS568A-045	Self-Contained housing	9557K136
O-ring, AS568A-157	Self-Contained housing	9557K193
O-ring, 2-043	Self-Contained housing	97Z-6064-00
Lubricant, silicone, 4-pack	All O-rings	5020
Desiccant, sealed bag, 1/3 unit	Inside Self-Contained housing	DES2
Anode, round	Piston transducer, Self-Contained end-cap	810-4006-00
Anode, housing	Self-Contained housing	810-4005-00
Anode, round, small OD	Phased Array transducer, Self-Contained Phased Array housing	810-4106-00
Screw, Flat/Socket Head	Round anodes	M5X0.8X12FH
Screw, M5X8MMSHCS	Housing anodes	92290A222
Screw, Flat/Socket Head	Small round OD anode	M3X0.5X10FHS

Long Term Maintenance

To ensure continued optimal results from the ExplorerDVL, TRDI recommends that every system be returned to our factory for an inspection every two to three years. We'll provide the unit with a thorough multi-point inspection, and notify if any refurbishment services are required to properly maintain the unit. To learn more about this service, please [contact field service](#).

Maintenance Schedule

TRDI recommends the following regular maintenance to be performed before every deployment:

Table 9: Visual Inspection Criteria

Item	Inspection Criteria
Transducer	<p>The urethane coating on the transducer face is important to ExplorerDVL watertight integrity. Mishandling, chemicals, abrasive cleaners, and excessive depth pressures can damage the transducer ceramics or urethane coating. Inspect the transducer face for dents, chipping, peeling, urethane shrinkage, hairline cracks, and damage that may affect watertight integrity or transducer operation.</p> <p>Before each deployment, check the urethane coating on the transducer faces for dents, chipping, peeling, urethane shrinkage, hairline cracks and damage that may affect watertight integrity or transducer operation.</p> <p>Based on experience, TRDI knows that most systems need to have the urethane inspected after three to five years of field use; shorter periods may be required depending on marine growth. Repair of the transducer face should only be done by TRDI.</p>
Connectors/ Cables	<p>Check the connectors for cracks or bent pins. Repair of the connectors should only be done by TRDI.</p> <p>Check the cable connectors for cracks or bent pins. Inspect the full length of the cable for cuts, nicks in the insulation, and exposed conductors.</p> <p>TRDI recommends that the connectors be replaced every five years or whenever visible signs of wear or corrosion appear.</p>
Housing paint / anodize coating	<p>Inspect the end-cap, housing, and transducer assembly for corrosion, scratches, cracks, abrasions, or exposed metal (silver-colored aluminum). Be critical in judgment; the useful life of the ExplorerDVL depends on it. Thoroughly clean the exterior of the system after retrieval. See Removing Biofouling for details.</p>
Anodes	<p>Inspect the anodes on the transducer assembly and housing for corrosion and pitting. Cover bolts with silicone sealant prior to deployment. Replace anodes whenever the mounting bolt is in less than 75% in contact with the bolt. Replace all anodes every one to two years maximum.</p>
Hardware	<p>Check all bolts, washers, housing plugs, and split washers for signs of corrosion. TRDI recommends replacement after every deployment or every year whichever is longer. Damaged hardware should never be used.</p>
O-rings	<p>O-rings should be replaced whenever the system is opened and BEFORE they are showing any signs of wear and tear.</p> <p>All O-rings should be replaced every one to two years maximum.</p>

Transducer Inspection



Never set the transducer face on a rough surface; always use foam padding to protect the transducer.

Based on experience, TRDI knows that **most** DVLs need to have the urethane inspected after 2 to 3 years of field use. Many users are not familiar with the early signs of urethane failure. The primary damage to the urethane is from bio-fouling and long exposure to the water and sun. Damage occurs on the surface of the urethane and at the edge where the urethane bonds to the cup. By returning the system every 2 to 3 years, TRDI can inspect it for early signs of urethane failure and repair it through our Refurbishment Service. At the same time, TRDI will make any necessary upgrades to boards, assemblies, and firmware. If the Refurbishment Service is not needed, TRDI can upgrade the system as part of one of our Inspection

Services. Proper care, general maintenance, and this routine service period ensures that the ExplorerDVL system lasts for a minimum of 10 years with no loss in performance.

Removing Biofouling

To remove foreign matter and biofouling:

1. Remove soft-bodied marine growth or foreign matter with soapy water. Waterless hand cleaners remove most petroleum-based fouling.



Do not use power scrubbers, abrasive cleansers, scouring pads, high-pressure marine cleaning systems or brushes stiffer than hand cleaning brushes on the transducer faces. The urethane coating on the transducer face could be damaged.

If there is heavy fouling or marine growth, the transducer faces may need a thorough cleaning to restore acoustic performance. Barnacles do not usually affect ExplorerDVL operation, but TRDI does recommend removal of the barnacles to prevent water leakage through the transducer face. Lime dissolving liquids such as Lime-Away® break down the shell-like parts. Scrubbing with a medium stiffness brush usually removes the soft-bodied parts. Do NOT use a brush stiffer than a hand cleaning brush. Scrubbing, alternated with soaking in Lime-Away®, effectively removes large barnacles.



If barnacles have entered more than 1.0 to 1.5 mm (0.06 in.) into the transducer face urethane, send the ExplorerDVL to TRDI for repair. If the barnacles can not be removed without damaging the transducer faces, contact TRDI.

2. Rinse with fresh water to remove soap or Lime-Away® residue.
3. Dry the transducer faces with low-pressure compressed air or soft lint-free towels.



Always dry the ExplorerDVL before placing it in the storage case to avoid fungus or mold growth. Do not store the ExplorerDVL in wet or damp locations.

Inspecting and Replacing O-Rings

This section explains how to inspect/replace the O-rings. A successful deployment depends on the condition of the O-rings and their retaining grooves.

TRDI strongly recommend replacing O-rings whenever the transducer is removed from the vessel. Inspecting and replacing the O-rings should be the last maintenance task done before installation.



The O-rings should be replaced on a yearly basis or whenever the system is removed from the vessel.

To inspect/replace the O-rings:

1. Inspect the O-rings. When viewed with an unaided eye, the O-rings must be free of cuts, indentations, abrasions, foreign matter, and flow marks. The O-ring must be smooth and uniform in appearance. Defects must be less than 0.1 mm (0.004 in.).



If the O-rings appear compressed from prior use, replace them. Weak or damaged O-rings will cause the system to flood.

2. Clean and inspect the O-ring grooves. Be sure the grooves are free of foreign matter, scratches, indentations, corrosion, and pitting. Run your fingernail across damaged areas. If you cannot feel the defect, the damage may be minor; otherwise, the damage may need repair.



Check the O-ring groove thoroughly. Any foreign matter in the O-ring groove will cause the system to flood.

3. Lubricate the O-ring with a thin coat of silicone lubricant. Apply the lubricant using latex gloves. Do not let loose fibers or lint stick to the O-ring. Fibers can provide a leakage path.



TRDI uses Dow Corning's silicone lube model number 111 but any type of silicone O-ring lube can be used.



Apply a very thin coat of silicone lube on the O-ring. Using too much silicone lube on the O-ring can be more harmful than using no O-ring lube at all.

4. Place the O-rings in the O-ring grooves. When installing the ExplorerDVL unit, make sure the O-rings stay in their grooves.

Zinc Anode Inspection and Replacement

The ExplorerDVL piston transducer has one zinc anode (see Figure 22) and the Phased Array has eight zinc anodes (see Figure 23). The Self-Contained ExplorerDVL has two zinc anodes located on the forward housing and two on the end-cap (see Figure 24). If the ExplorerDVL does not have exposed bare metal, a properly installed anode helps protect the ExplorerDVL from corrosion while deployed.

Zinc Anode Inspection

The life of a zinc anode is not predictable. An anode may last as long as one year, but dynamic sea conditions may reduce its life. Use a six-month period as a guide. If the total deployment time for the anodes has been six months or more, replace the anodes. If the next deployment is expected to last six months or more, replace the anodes.

To inspect the anodes:

1. Inspect the anodes on the transducer assembly, housing and end-cap for corrosion and pitting. If most of an anode still exists, it may not need to be replaced.
2. If there are doubts about the condition of the anodes, remove and replace the anode.

Zinc Anode Electrical Continuity Check

Check the electrical continuity using a digital multi-meter (DMM). Measure the resistance between any two anodes attached to the same part of the instrument (end-cap, housing, etc.). The resistance should be less than two ohms. If not, reinstall the affected anode.

Zinc Anode Replacement

To remove and replace the zinc anode/s:

1. Remove the screws.
2. The anode may stick to the ExplorerDVL. To break this bond, first place a block of wood on the edge of the anode to protect the housing anodizing and paint. Carefully strike the block to loosen the anode.
3. Clean the bonding area under the anode. Remove all foreign matter and corrosion. Look for signs of corrosion such as white deposits. If corrosion caused part of the housing to be visibly damaged, do not redeploy the system. Send it back to TRDI for inspection (see [Returning ADCPs to TRDI for](#)

[Service](#)). Clean the mounting hole with a thin brush and lime based product. Flush the hole with the lime based product if there is no brush available. Be sure to clean and remove any signs of corrosion.



TRDI knows from our experience that it is difficult to anodize sharp edges on threaded holes such as these. In marine and fresh water environments, poor anodizing on aluminum will lead to corrosion problems. Although TRDI has rarely seen corrosion around the anode mounting holes, **we would like to remind our customers that it is good practice to always inspect for corrosion in this (and all) areas between deployments.**

4. Set the new anode in place. Brush the anode screw threads with marine environment grease such as Aqua Shield grease and tighten the screw to 35 inch/LB. Use gloves as it tends to stick to skin. Note that the grease is incompressible and therefore apply a thin layer to the screw to avoid binding or difficulty in the installation of the screw in the mounting hole.
5. Check the electrical continuity. If any measurement is greater than one ohm, reinstall the affected anode.



Do not connect other metal to the ExplorerDVL. Other metals may cause corrosion damage. Use isolating bushings when mounting the ExplorerDVL to a metal structure.



Do not use zinc anodes with an iron content of more than 0.0015%. The major factor controlling the electrical current output characteristics of zinc in seawater is the corrosion film that forms on the surface of the zinc. Corrosion product films containing iron have a high electrical resistance. As little as 0.002% iron in zinc anodes degrades the performance of the anode.

Do not use magnesium anodes. Magnesium rapidly corrodes aluminum housings.

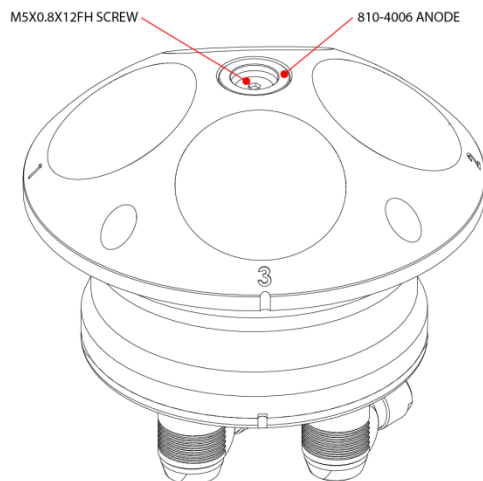


Figure 22. Piston Transducer Anode

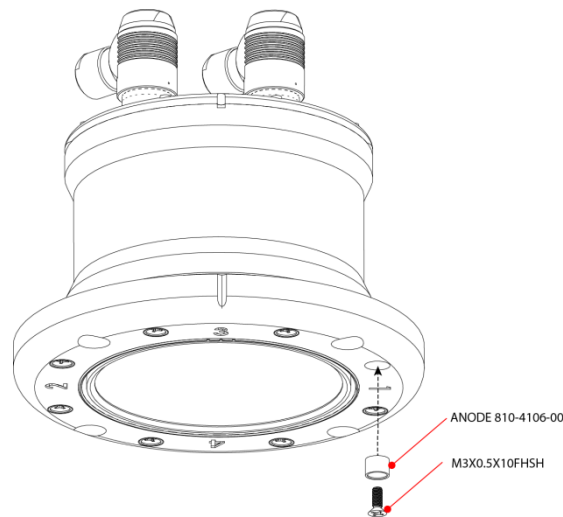


Figure 23. Phased Array Transducer Anodes

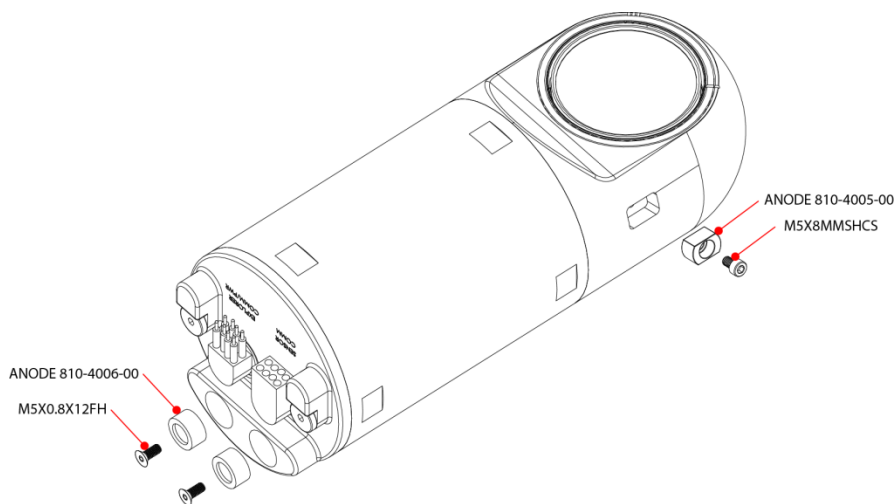


Figure 24. Self-Contained ExplorerDVL Anodes

Self-Contained ExplorerDVL Assembly

This section explains how to remove and replace the end-cap/housing to gain access to the ExplorerDVL's electronics.



Normal maintenance does not require opening the Self-Contained ExplorerDVL housing. Only use the following procedures if directed to do so by TRDI Field Service personnel.

End-Cap and Housing Removal Procedures



Caution label on ExplorerDVL



Wear safety glasses and keep head and body clear of the end-cap while opening. Any system that was deployed may have pressure inside the housing.

To remove the end-cap and housing:

1. Dry the outside of the ExplorerDVL.
2. Disconnect the Power/Communications and Auxiliary cables and install the dummy plugs.
3. Place the ExplorerDVL on a soft pad.
4. Inspect the housing, end-cap, and access port plugs for any signs of damage such as bending, stretched, crushed or deformed, etc. These signs may indicate that there is internal pressure inside the system.
5. To avoid any possible injury it is ALWAYS recommended loosening but not removing the two access port plugs to allow any internal pressure to be vented from the system. The access plug ports require a 5/32 hex wrench to remove. **Loosen the access port plugs two turns each Repeat until the access port plug O-ring is not compressed and the system has the opportunity to vent.** Be sure to only loosen the plugs far enough to allow the system to vent.
6. Once both access port plugs have been loosened and there is no internal pressure, remove the plugs from the end-cap.



Save all hardware removed during this procedure for re-assembly.

7. Using a 7/64 Hex wrench, remove the two vented screws.
8. Carefully pull the housing and end-cap away from the transducer assembly until access to the connector jack on the electronics is gained. Do not damage the mating surfaces of the housing.



The end-cap is connected to the housing with a ground strap. When the end-cap needs to be removed to replace the O-rings, remove one of the screws holding the ground strap in place.

9. There is an inline connector between the end-cap and main electronics. This connector and the ground strap should be disconnected. Then the end-cap is removed, followed by the housing. Set the end-cap/housing assembly aside.
10. Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see [O-ring Inspection and Replacement](#)). Even small scratches can cause leakage around the O-ring seal.

Self-Contained ExplorerDVL Re-assembly

To replace the end-cap and housing:

1. Place the ExplorerDVL on a soft pad.
2. Make sure all printed circuit boards, spacers, cables, and screws have been installed.
3. Install a fresh bag of desiccant just before closing the ExplorerDVL.



A desiccant bag is used to dehumidify the housing interior. The factory-supplied desiccant lasts a year at specified ExplorerDVL deployment depths and temperatures. Remember that desiccant rapidly absorbs moisture from normal room air.

Desiccant bags are shipped in an airtight aluminum bag to ensure maximum effectiveness. There is a moisture indicator inside the bag. If the moisture indicator is pink, do not use the desiccant bag until it has been dried. TRDI recommends replacing the desiccant bag just before the deployment.

4. Inspect, clean, and lubricate the O-ring on the housing (see [O-ring Inspection and Replacement](#)). Apply a very thin coat of silicone lube on the O-ring.



TRDI recommends using new O-rings when preparing for a deployment.



Apply a **very thin** coat of silicone lube on the O-ring. Using too much silicone lube on the O-ring can be more harmful than using no O-ring lube at all.

5. Connect the internal connector to the plug on the electronics.
6. Slide the housing onto the transducer assembly, aligning to the pin on the transducer assembly. When mating the housing with the transducer assembly, apply equal pressure to all parts of the O-rings. Make sure the O-rings remain in its retaining groove.
7. Connect the ground strap to the end-cap. Connect the inline connector between the end-cap and main electronics. Slide the end-cap onto the housing, aligning to the pin on the end-cap assembly with the housing. When mating the end-cap with the housing, apply equal pressure to all parts of the O-rings. Make sure the O-rings remain in its retaining groove.



Check that no wires or any other object is pinched between the transducer assembly, end-cap, and the housing. If the O-rings are not in the groove or if a wire or other object is pinched, the ExplorerDVL will flood.

Make sure the ground strap between the end-cap and housing is connected.

8. Examine the vented screws and washers for corrosion; replace if necessary. [Figure 25](#) shows the assembly order of the end-cap/housing mounting hardware. All the hardware items are needed to seal the ExplorerDVL properly.
9. Install both vented screws of hardware until “finger-tight.”
10. Tighten the bolts in small increments.



Apply equal pressure to the O-rings as you tighten the vented bolts. If one bolt is tightened more than the other, the O-rings can become pinched or torn. **A damaged O-ring will cause the system to flood.**

Install the vented screws until “finger-tight”: over-tightening can strip the tension rods.

11. Install the access port plugs and O-rings. Tighten the access port plugs in small increments to compress the O-rings evenly.

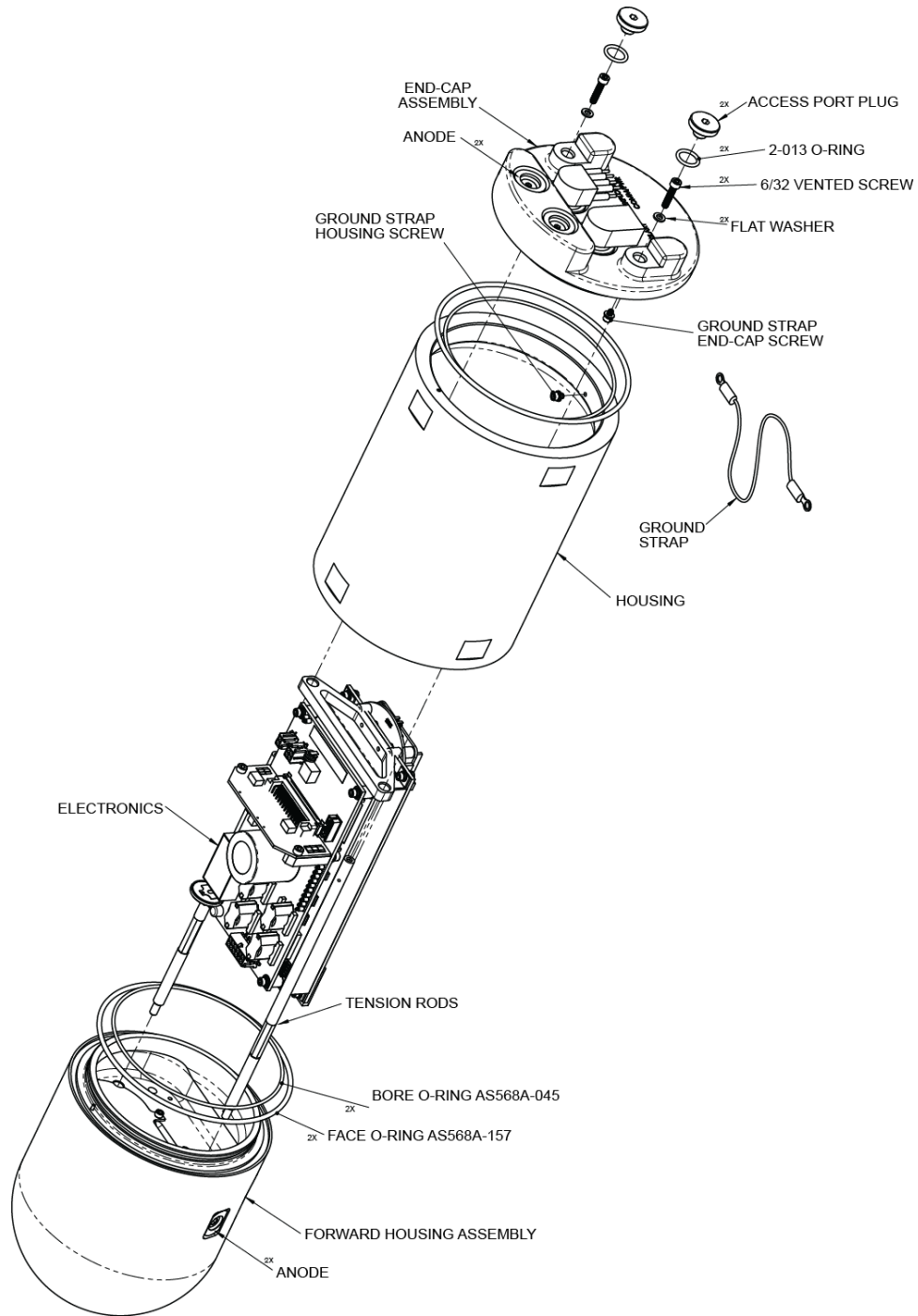


Figure 25. Self-Contained ExplorerDVL Assembly

Replacing the Personality Module

Personality modules on the piston and phased array ExplorerDVLs electronics chassis can be replaced to change the communications protocols (i.e. switch from RS-232 to RS-422).



Return the unit to TRDI or contact field service to replace the personality module on the Self-Contained ExplorerDVLs.

COM 1 is the only port for communicating to the ExplorerDVL. The standard configuration uses RS-232 on COM 1 to communicate with the ExplorerDVL. If you want to use RS-422 to communicate with the ExplorerDVL, then use the 72B-2105-00 or 72B-2106-00 personality modules.

Table 10: Personality Module Part Numbers

Part Number	Type	Com 1 Communications
72B-2104-00	4CH RS-232	COM 1 is 232 (standard configuration)
72B-2105-00	3CH RS-232	COM 1 is 422
72B-2106-00	2CH RS-232	COM 1 is 422



COM 1 is reserved for communicating to and controlling the ExplorerDVL. This port will not support sensors. Ports 2, 3, 4 and the SPI bus port are for sensors.

To replace the Personality Module:

1. Remove all power to the ExplorerDVL.
2. Remove the cover on the Electronics Chassis by removing the 10 screws.



Before handling any ExplorerDVL boards, always wear an earth-grounding static protection strap. The electronics in the ExplorerDVL are very sensitive to static discharge. Static discharge can cause damage that will not be seen immediately and will result in early failure of electronic components.

TRDI assume that a qualified technician or equivalent will perform all of the following work.

3. With an earth-ground static protection strap on, remove the two screws holding the personality module to the black plastic board supports so the Personality Module can be removed (see Figure 26). Pull out the Personality Module and replace it with the new module. Replace the screws to hold the new Personality Module in place.
4. Replace the cover.
5. Test the ExplorerDVL (see [Testing Your ExplorerDVL](#)).

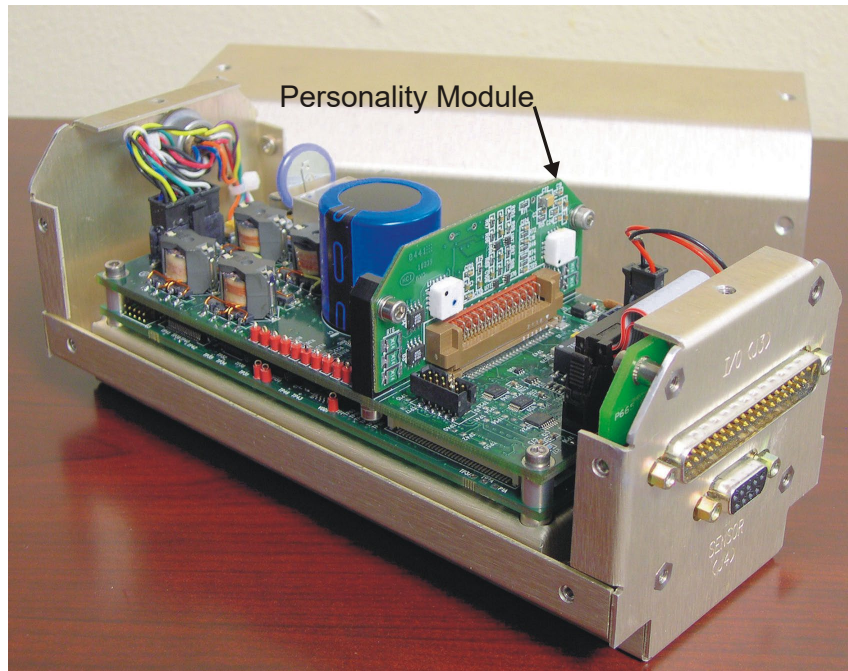


Figure 26. Personality Module Location

Chapter 5

RETURNING SYSTEMS TO TRDI FOR SERVICE



In this chapter:

- How to pack and ship the Pioneer
- How to get a RMA number
- Where to send the Pioneer for repair

Shipping the ExplorerDVL

This section explains how to ship the ExplorerDVL.



Remove all customer-applied coatings or provide certification that the coating is nontoxic if shipping a ExplorerDVL to TRDI for repair or upgrade. This certification must include the name of a contact person who is knowledgeable about the coating, the name, manufacturer of the coating and the appropriate telephone numbers. If the equipment is returned without meeting these conditions, TRDI has instructed our employees not to handle the equipment and to leave it in the original shipping container pending certification. If certification is not provided, TRDI will return the equipment or send it to a customer-specified cleaning facility. All costs associated with customer-applied coatings will be at the customer's expense.

When shipping the ExplorerDVL through a Customs facility, be sure to place the unit so identifying labels are not covered and can be seen easily by the Customs Inspector. Failure to do so could delay transit time.



TRDI strongly recommends using the original shipping crate whenever transporting the ExplorerDVL.

Use the original shipping crate whenever possible. If the original packaging material is unavailable or un-serviceable, additional material is available through TRDI.

For repackaging with commercially available materials:

1. Use a strong shipping container made out of wood or plastic.
2. Install a layer of shock-absorbing static-shielding material, 70-mm to 100-mm thick, around all sides of the instrument to firmly cushion and prevent movement inside the container.
3. Seal the shipping container securely.
4. Mark the container FRAGILE to ensure careful handling.
5. In any correspondence, refer to the ExplorerDVL by model and serial number.

Returning Systems to the TRDI Factory

When shipping the system to TRDI from either inside or outside the United States, the following instructions will help ensure the ExplorerDVL arrives with the minimum possible delay. Any deviation from these instructions increases the potential for delay.

Step 1 - Request a Return Material Authorization

To obtain a Return Material Authorization (RMA) number and shipping instructions for the return of the instrument, do one of the following:

- Contact Customer Service Administration at rdicsadmin@teledyne.com
- Call +1 (858) 842-2700

When requesting a RMA number, please give us the following information:

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What issue(s) need to be corrected
- Name of the Field Service Engineer that knows about the issue
- When you need the instrument returned

TRDI's Customer Service will then respond with the RMA number for the shipment. Please include this number on all packages and correspondence.

Step 2 – Provide a MSDS as necessary

Please provide a Material Safety Data Sheet (MSDS) if the system/transducer is painted with antifouling paint.

Step 3 - Ship via air freight, prepaid

Urgent Shipments should be shipped direct to TRDI via overnight or priority air services. Do not send urgent airfreight as part of a consolidated shipment. Consolidated shipping will cost less, but may lose up to three days in transit time.

Non-urgent shipments may be shipped as part of a consolidated cargo shipment to save money. In addition, some truck lines may offer equivalent delivery service at a lower cost, depending on the distance to San Diego.

Mark the Package(s)

To: Teledyne RD Instruments, Inc. (RMA Number)
14020 Stowe Drive
Poway, California 92064

Airport of Destination = San Diego
UPS Supply Chain Solutions Brokerage
15 E Oregon avenue
Philadelphia PA 19148
USA
Email: phldocreceipt@ups.com
Tel: + 1 (215) 952-1745

Step 4 - Urgent shipments

Send the following information by telephone to TRDI.

Attention: Customer Service Administration

Phone: +1 (858) 842-2700

- Detailed descriptions of what you are shipping (number of packages, sizes, weights and contents).
- The name of the freight carrier
- Master Air bill number
- Carrier route and flight numbers for all flights the package will take

Returning Systems to TRDI Europe Factory

When shipping the system to TRDI Europe, the following instructions will help ensure the ExplorerDVL arrives with the minimum possible delay. Any deviation from these instructions increases the potential for delay.

Step 1 - Request a Return Material Authorization

To obtain a Return Material Authorization (RMA) number and shipping instructions for the return of the instrument, do one of the following:

- Contact Customer Service Administration at rdiefs@teledyne.com
- Call +33(0) 492-110-930

When requesting a RMA number, please give us the following information:

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What issue(s) need to be corrected
- Name of the Field Service Engineer that knows about the issue
- When you need the instrument returned

TRDI's Customer Service will then respond with the RMA number for the shipment. Please include this number on all packages and correspondence.

Step 2 – Provide a MSDS as necessary

Please provide a Material Safety Data Sheet (MSDS) if the system/transducer is painted with antifouling paint.

Step 3 - Ship Via Air Freight, Prepaid

Urgent Shipments should be shipped direct to TRDI via overnight or priority air services. Do not send urgent airfreight as part of a consolidated shipment. Consolidated shipping will cost less, but may lose up to three days in transit time.

Non-urgent shipments may be shipped as part of a consolidated cargo shipment to save money.

Mark the package(s) as follows:

To: Teledyne RD Instruments, Inc. (RMA Number)
2A Les Nertieres
5 Avenue Hector Pintus
06610 La Gaude, France

Step 4 - Include Proper Customs Documentation

The Customs statement must be completed. It should be accurate and truthfully contain the following information.

- Contents of the shipment
- Value
- Purpose of shipment (example: “American made goods returned for repair”)
- Any discrepancy or inaccuracy in the Customs statement could cause the shipment to be delayed in Customs.

Step 5 - Send the Following Information by Telephone to TRDI

Attention: Sales Administration

Phone: +33(0) 492-110-930

- Detailed descriptions of what you are shipping (number of packages, sizes, weights and contents).
- The name of the freight carrier
- Master Air bill number
- Carrier route and flight numbers for all flights the package will take

NOTES

Chapter 6

SPECIFICATIONS



In this chapter:

- [Operational Specifications](#)
- [Outline Installation Drawings](#)

A brief review of ExplorerDVL operation may help explain the specifications listed in this section. The discussion below regarding water profiling is generally applicable to bottom track as well.



The specifications and dimensions listed in this section are subject to change without notice.

The ExplorerDVL emits an acoustic pulse called a PING. The seabed and scatterers that float ambiently with the water currents reflect some of the energy from the ping back to the ExplorerDVL transducer. The ExplorerDVL uses the return signal to calculate a velocity.

The energy in this signal is the *echo intensity*. The echo intensity returned from the seabed is used to detect the bottom. The echo intensity returned by floating scatterers is sometimes used to determine information about the scatterers.

The velocity calculated from each ping has a *statistical uncertainty*; however, each ping is an independent sample. The ExplorerDVL reduces this statistical uncertainty by averaging a collection of pings. A collection of pings averaged together is an *ensemble*. The ExplorerDVL's maximum *ping rate* limits the time required to reduce the statistical uncertainty to acceptable levels.

The ExplorerDVL does not measure velocity at a single point; it measures its speed over the seabed, i.e. Bottom Track, its speed through the water current, i.e. Water Track and current velocities throughout the water column, i.e. Water Profile.

When bottom tracking, the ExplorerDVL calculates velocity data relative to itself. The velocity data has both speed and direction information. If the ExplorerDVL is moving, and is within range of the bottom, it can obtain a velocity from returns off the bottom. The bottom track information can be used to calculate the absolute velocity of the water. The ExplorerDVL can get absolute direction information from a heading sensor.

When water profiling the ExplorerDVL measures velocities from its transducer head to a specified range and divides this range into uniform segments called *depth cells* (or *bins*). The collection of depth cells yields a *profile*. The ExplorerDVL produces two profiles, one for velocity, and one for echo intensity.

The following tables list the specifications for the ExplorerDVL. About the specifications:

1. Except where noted, these specification tables applies to typical setups and conditions. Typical setups use the default input values for each parameter (exceptions include Pings per Ensemble and Number of Depth Cells). Typical conditions assume uniform seawater velocities at a given depth, moderate shear, moderate ExplorerDVL motion, and typical echo intensity levels.
2. The total measurement error of the ExplorerDVL is the sum of:
 - Long-term instrument error (as limited by instrument accuracy),
 - The remaining statistical uncertainty after averaging,
 - Errors introduced by measurement of ExplorerDVL heading and motion.
3. Because individual pings are independent, the statistical uncertainty of the measurement can be reduced according to the equation:

$$\frac{\text{Statistical Uncertainty for One Ping}}{\sqrt{\text{Number of Pings}}}$$

Operational Specifications

	Phased Array	Piston Array
Bottom Tracking		
Maximum Altitude ^{(1) (3)}	81m	66m
Minimum Altitude	0.5m (0.31m optionally)	0.5m (0.25m optionally)
Velocity Range ⁽²⁾	±9.5m/s	±17.0 m/s
High Accuracy Bottom Track Long Term Accuracy ⁽⁶⁾	±0.3% ± 0.2cm/s	±0.5% ± 0.2cm/s
Basic Bottom Track Long Term Accuracy ⁽⁷⁾	±1.15% ± 0.2cm/s	
Precision @ 1 m/s ⁽⁴⁾	±1.0cm/s	±1.0cm/s
Precision @ 3 m/s ⁽⁴⁾	±1.8 m/s	±1.9cm/s
Precision @ 5 m/s ⁽⁴⁾	±2.6 cm/s	±2.8 cm/s
Resolution	0.1cm/s (default), 0.001cm/s (selectable)	0.1cm/s (default), 0.001cm/s (selectable)
Ping Rate	12Hz max	12Hz max
Water Profiling		
Maximum Range ^{(1) (3)}	35m	25m
Minimum Range	1.33m	1.33m
Velocity Range ⁽²⁾	±12 m/s	±12 m/s
Long Term Accuracy	±0.3% ± 0.2 cm/s	±0.5% ± 0.2 cm/s
Precision @ 1m/s and 2m bin size ⁽⁴⁾	±4.7cm/s	±2.3cm/s
Precision @ 3m/s and 2m bin size ⁽⁴⁾	±4.8 cm/s	±2.5 cm/s
Precision @ 5m/s and 2m bin size ⁽⁴⁾	±5.0cm/s	±2.6cm/s
Resolution	0.1cm/s	0.1cm/s
Cell Sizes	10 to 800cm	10 to 800cm
Acoustic		
Center Frequency	614.4kHz	614.4kHz
Source Level (re 1µPa)	207dB	204dB
1-Way Beam Width	2.2°	3.8°
Number of Beams	4 (phased array)	4
Beam Angle	30°	30°
Bandwidth (nominal)	6.25% of center frequency	25% of center frequency
Depth Rating		
	1000m	1000m/4000m (based on configuration)

¹ @ 5°C and 35 ppt salinity, 24V input.

² When mounted with beam 3 at 45°. Also, for platforms with forward velocity higher than reverse (or vice versa) the maximum velocity can be increased 4.75 m/s for bottom track via a firmware command.

³ Maximum range may be reduced due to flow noise.

⁴ Standard deviation refers to single-ping horizontal velocity, specified at half the maximum altitude.

⁵ Electronics platform designed to interface with stated 3rd party sensors.

⁶ ECCN 6A001 export license required outside US.

⁷ ECCN 6A991 export license-free option.

Environmental Specifications

Parameter	Value
Operating Temperature	-5 to 40 Degrees C
Storage Temperature	-25 to 60 Degrees C
Vibration (Operation)	IEC 60945, 4th ED, 2002-08
Vibration (Transport)	IEC 60721-3-2, 2Nd Ed, 1997-3
Shock (Transport)	IEC 60721-3-2, 2Nd Ed, 1997-3
Shock (Operation)	IEC 1010-1



Applies to both piston and phased array transducers.

Electrical Specifications

Parameter	Value
DC Input	12 to 24VDC (24VDC typical)
Current	0.4A minimum supply capability
Peak Power @ 24V	21W
Average Power while transmitting (typical)	3W
Average Quiescent Power	1.1W



Applies to both piston and phased array transducers.

Temperature Sensor Specifications

Parameter	Value
Range	-5°C to 45°C
Accuracy	±0.4°C
Resolution	0.01°C



The temperature sensor is embedded in the transducer head. Model number DS18B20.

Communications Specifications

Parameter	Value
Number of Channels	4
Channel Protocol (Hardware Dependent)	4 x RS-232 or 1 x RS-422 & 3 x RS-232 or 2 x RS-422 & 2 x RS-232
Isolation Channels 1 & 2	500 VAC
Isolation Channels 3 & 4	50 VAC
Transmit Trigger Level	3V CMOS- Level, 1ms Latency from Trigger to Transmit Start, referenced to pin 5 of J3 (DB37).
Trigger Output	3V CMOS-Level, Trigger Active During Transmit & Receive, referenced to pin 5 of J3 (DB37).
Master Channel Baud Rate	1200 – 115,200 bps
Ensemble Types	PD0, PD4, PD5, PD6



Applies to both piston and phased array transducers.



Channel 1 is the Master Port and is the only channel available for command input and ensemble output.

Cable Specifications

Parameter	Value
Transmit/Receive Cable Maximum Length	2.0 m
Bend Radius	0.1 m



Applies to both piston and phased array transducers.

Available Sensor Interfaces

Sensor	ID	Manufacturer	Model	Sample Interval
Gyro Compass	1	TBD	TBD	Ping
GPS	2	Garmin	15H-W (010-00240-01)	Ping
Pressure	3	Paroscientific	8000 Series	Ensemble
Speed of Sound	4	Applied MicroSystems	MicroSVT&P	Ensemble
Mag Compass	5	Honeywell	HMR3000	Ping
CTD	6	Seabird	FastCat SBE-49	Ensemble
Echo Sounder	7	Benthos	PSA916	Ensemble
Temperature	8	TRDI Internal in Transducer	One Wire	Ensemble
Mag Compass#2	9	PNi	TCM5/TRAX	Ping
Pitch, Roll, Temp, Press	10	TRDI Sensor Package	72B-1000-00	P/R: Ping T/P: Ensemble



Applies to both piston and phased array transducers.

Outline Installation Drawings

Drawing #	Description	Depth Rating
96B-1000	Piston Explorer Transducer	300m
96B-1001	Phased Array Explorer Transducer	300m
96B-1002	Piston Explorer Transducer	1000m
96B-1003	Phased Array Explorer Transducer	1000m
96B-1004	Right-Angle Self-Contained Explorer	1000m
96B-1015	Inline Self-Contained Explorer	1000m
96B-6006	Explorer Electronics	N/A
96B-6031	Right-Angle Self-Contained Explorer	4000m
96B-6047	Inline Self-Contained Explorer	4000m

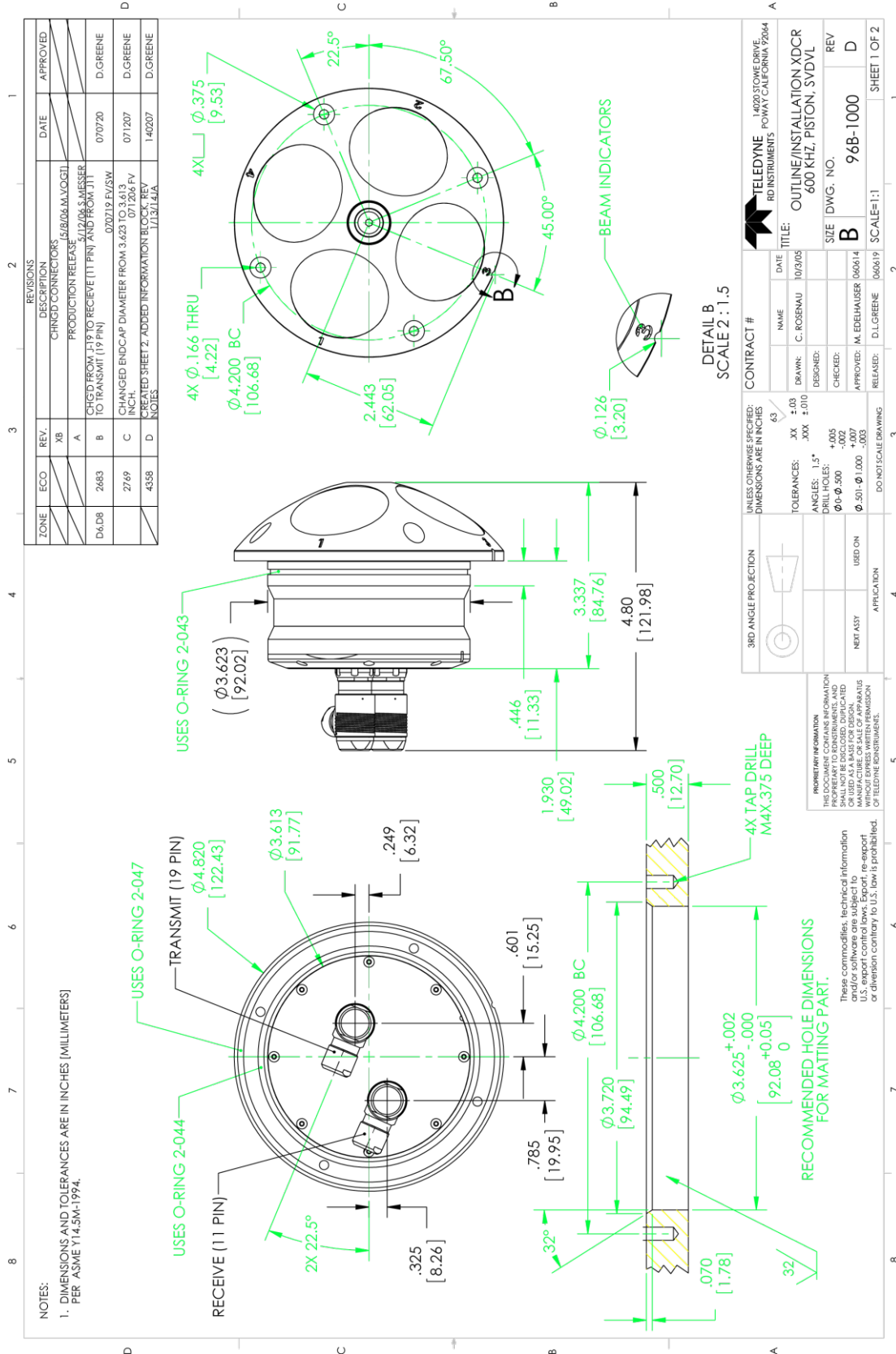


Figure 27. Outline Installation Drawing – 600 kHz Piston ExplorerDVL – Sheet 1

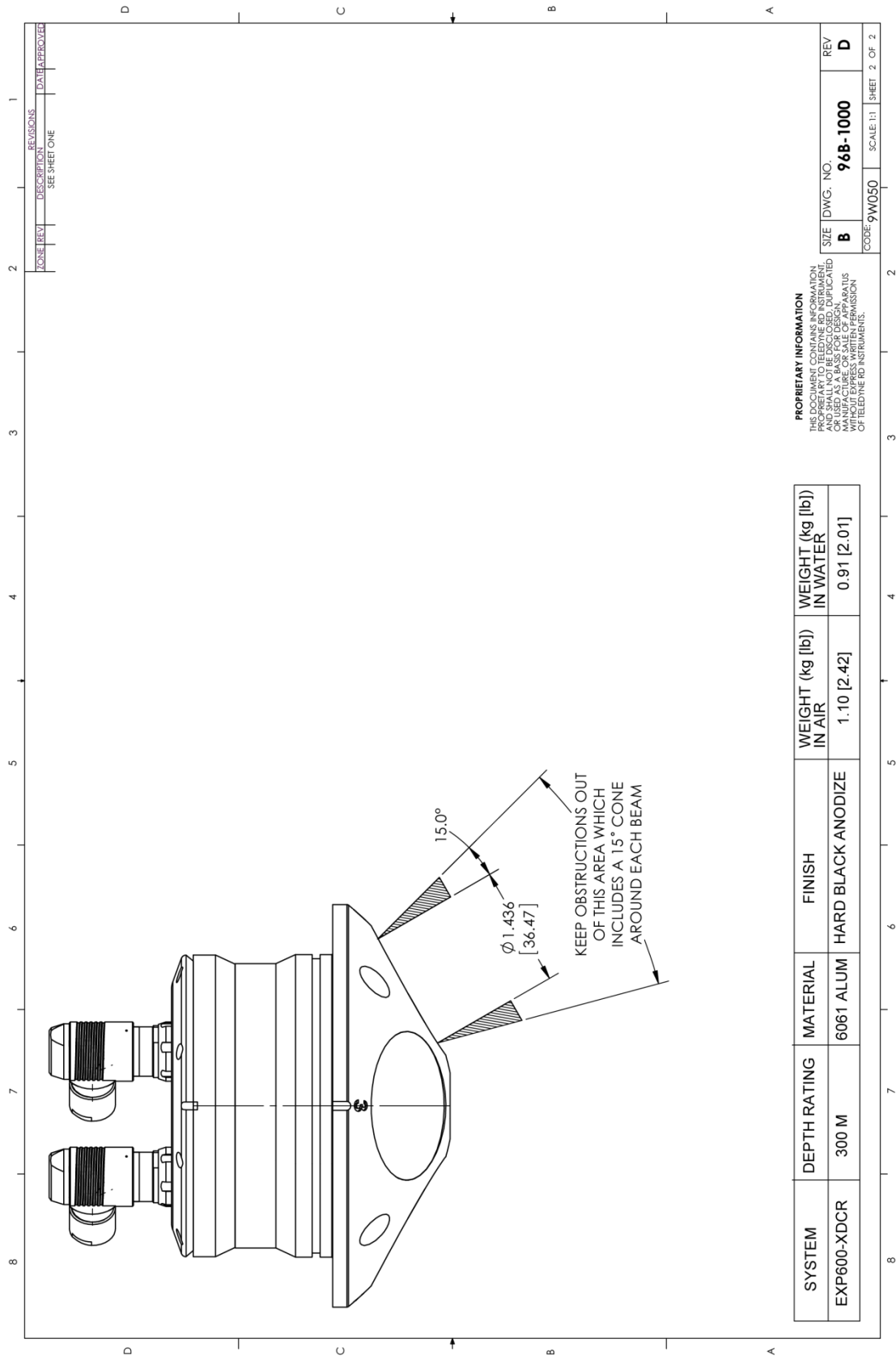


Figure 28. Outline Installation Drawing – 600 kHz Piston ExplorerDVL – Sheet 2

ZONE REV	DESCRIPTION	DATE/APPROVER
	SEC SHEET ONE	

PROPRIETARY INFORMATION
 THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO TELEDYNE RD INSTRUMENTS. IT IS NOT TO BE REPRODUCED, COPIED, OR USED AS A BASIS FOR DESIGN, MANUFACTURE, OR SALE OF APPARATUS OF TELEDYNE RD INSTRUMENTS.

SYSTEM	DEPTH RATING	MATERIAL	FINISH	WEIGHT (kg [lb]) IN AIR	WEIGHT (kg [lb]) IN WATER
EXP600-XDCR	300 M	6061 ALUM	HARD BLACK ANODIZE	1.10 [2.42]	0.91 [2.01]

SIZE	DWG. NO.	REV
B	96B-1000	D

CODE	SCALE	SHEET	2 OF 2
9W050	1:1	1	

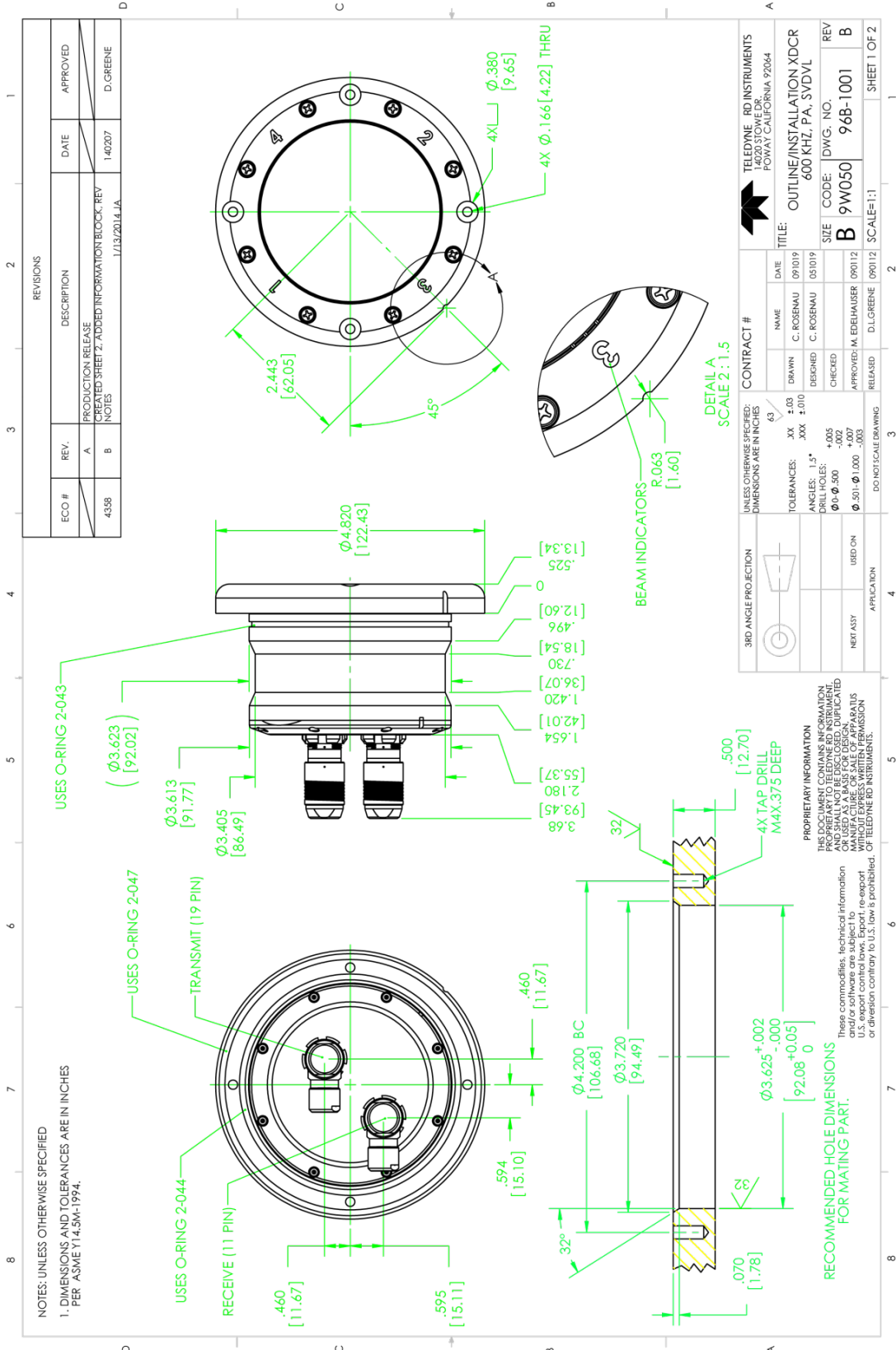


Figure 29. Outline Installation Drawing – 600 kHz Phased Array ExplorerDVL – Sheet 1

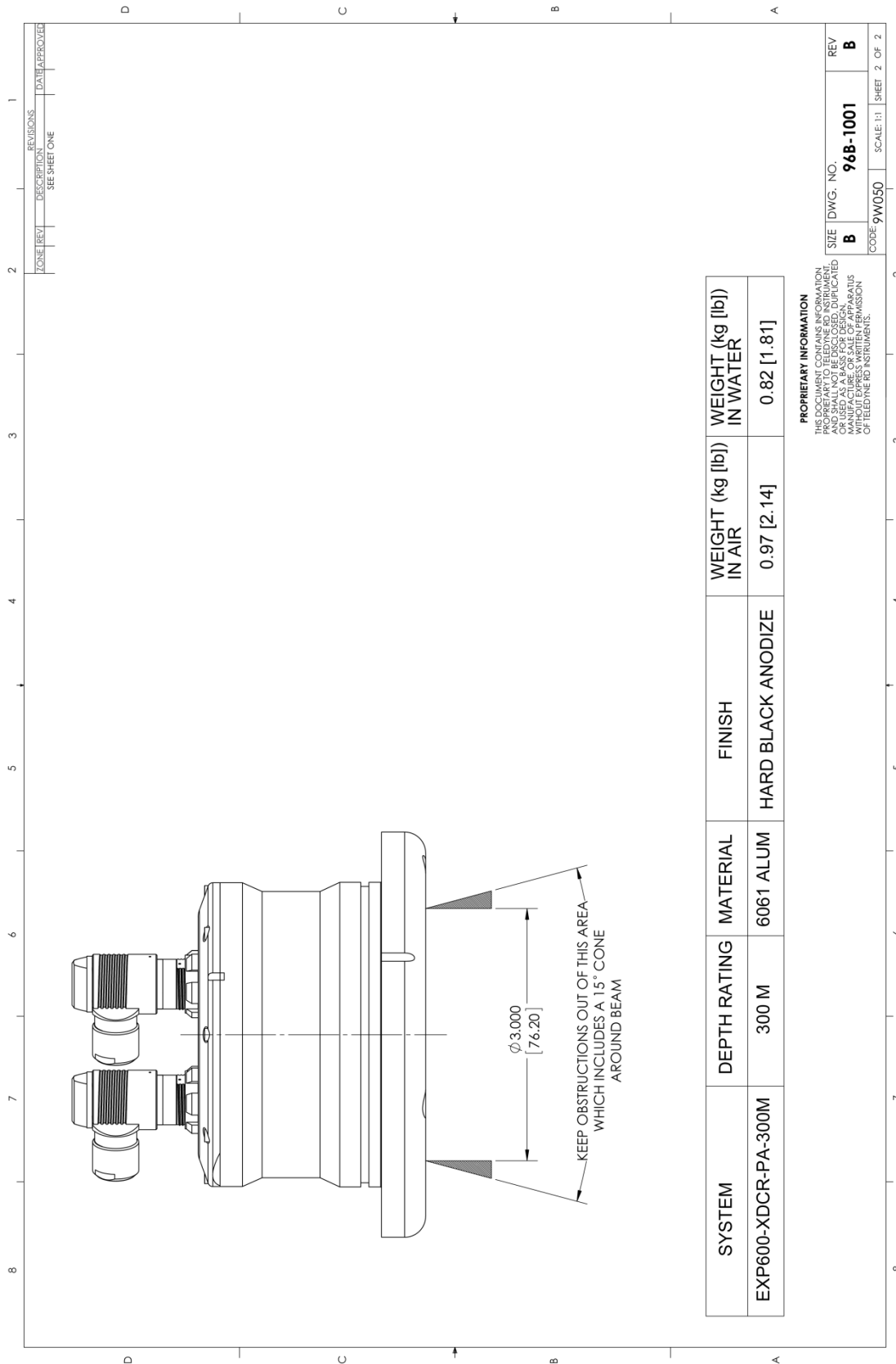


Figure 30. Outline Installation Drawing – 600 kHz Phased Array ExplorerDVL – Sheet 2

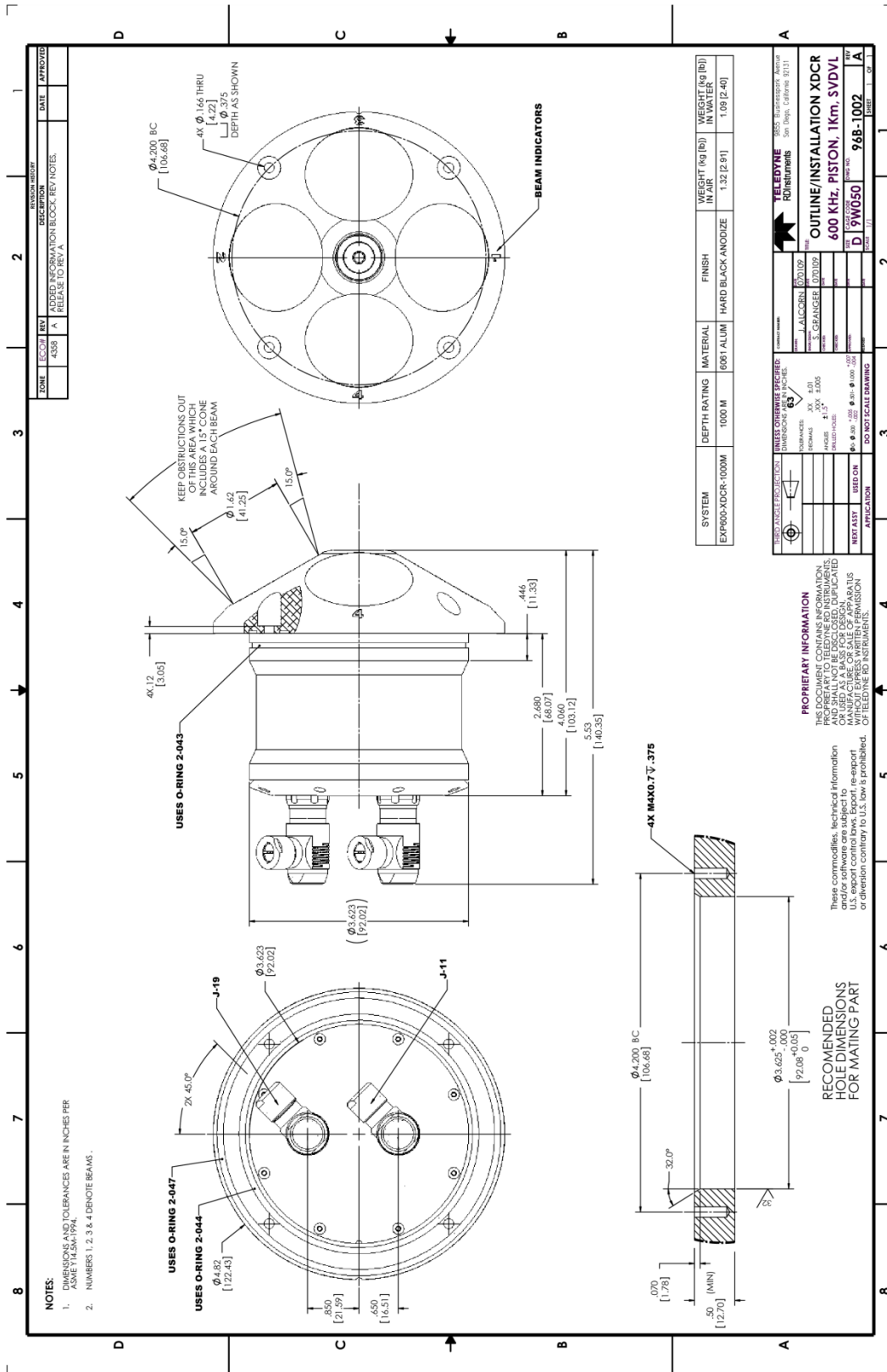


Figure 31. Outline Installation Drawing – 600 kHz Phased Array ExplorerDVL

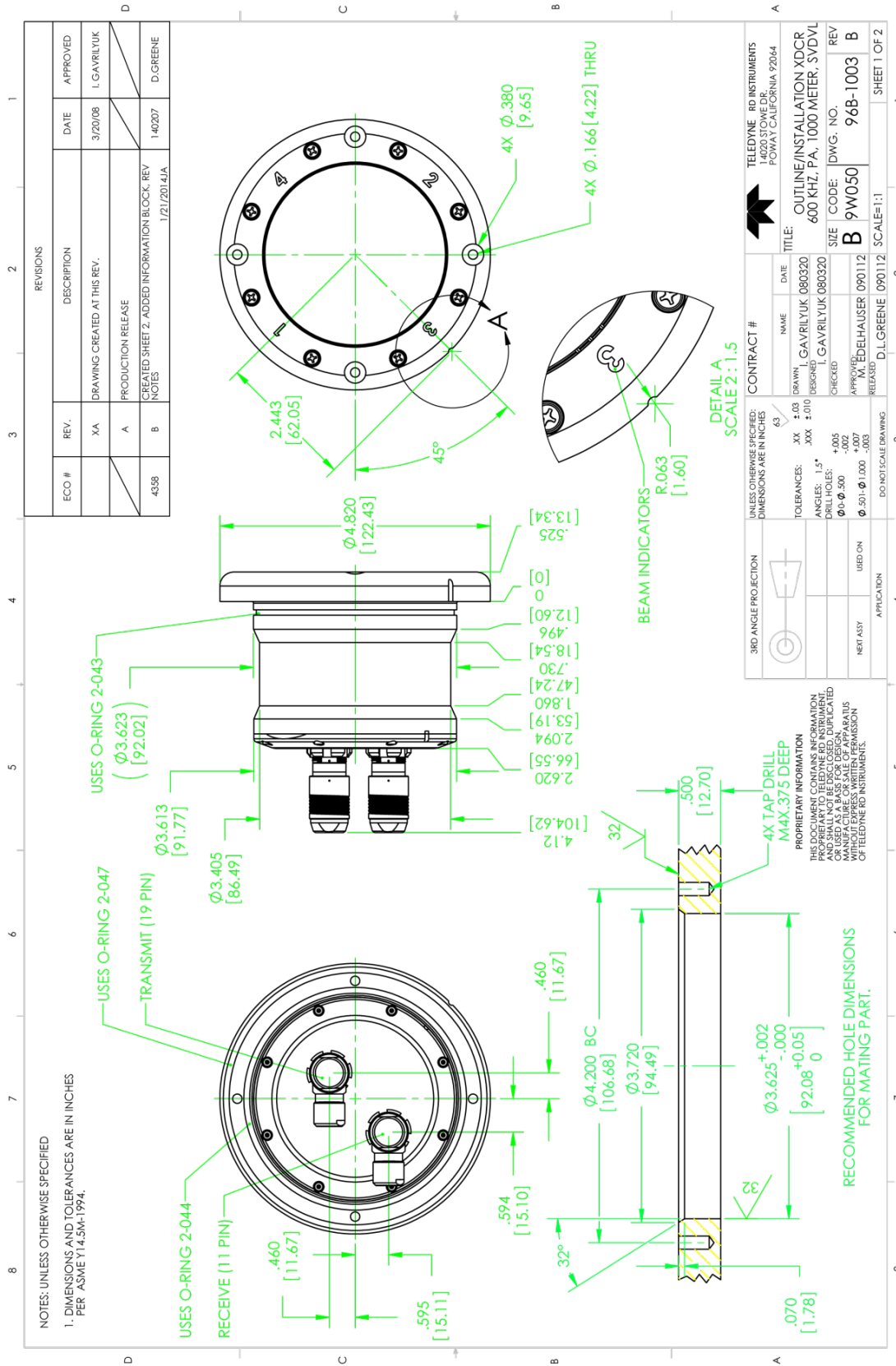


Figure 32. Outline Installation Drawing – 600 kHz Phased Array ExplorerDVL – Sheet 1

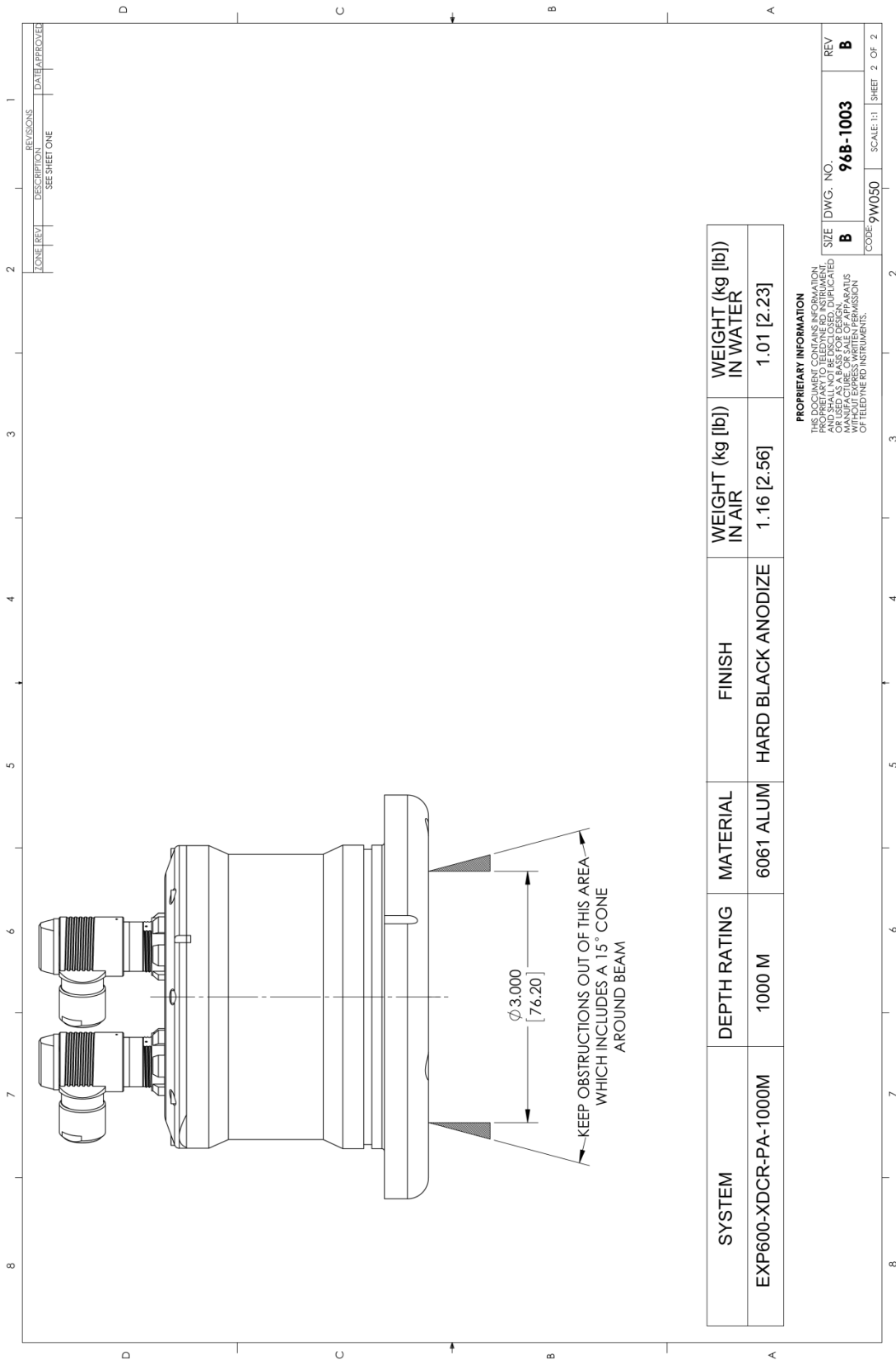


Figure 33. Outline Installation Drawing – 600 kHz Phased Array ExplorerDVL – Sheet 2

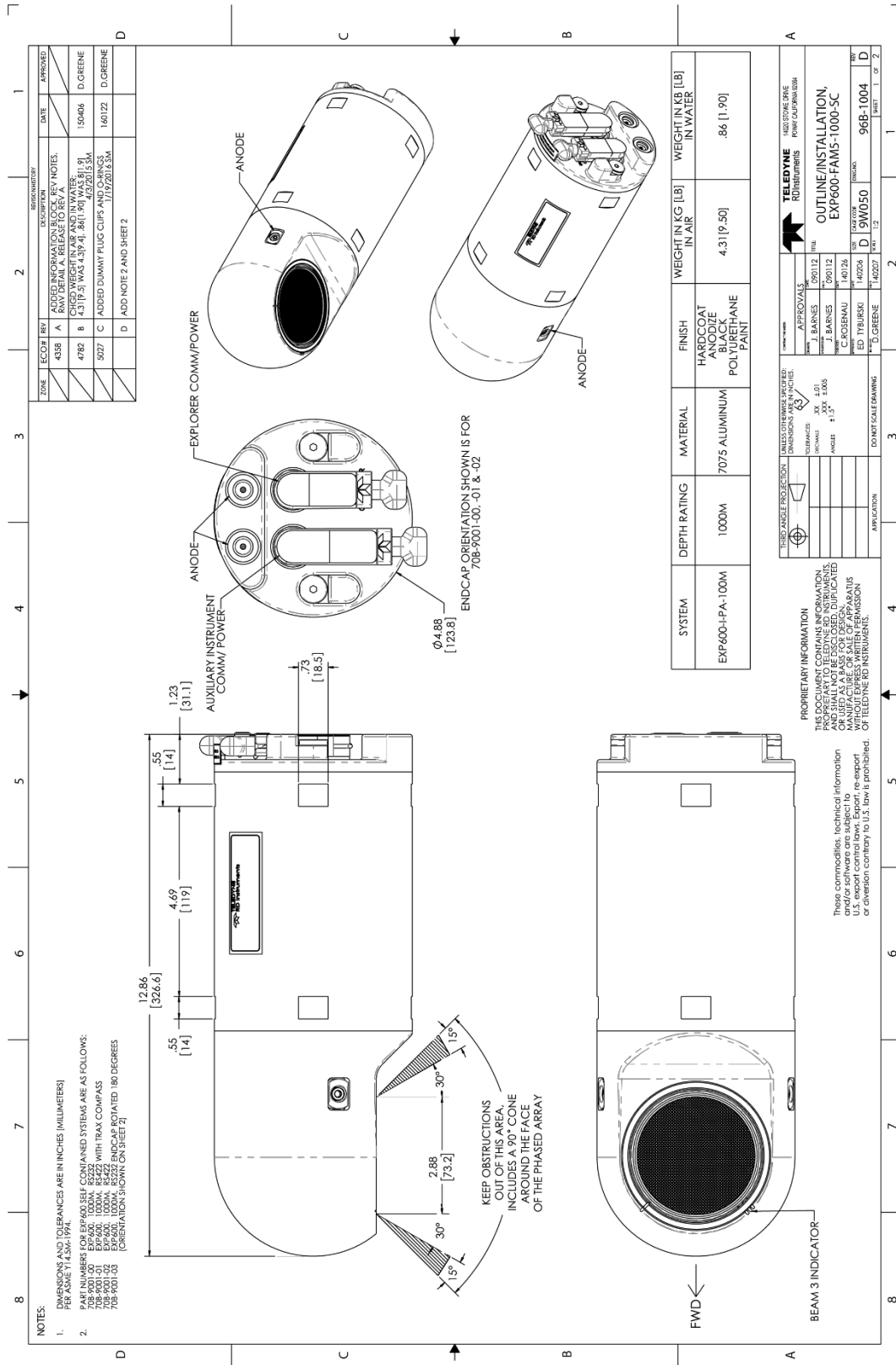


Figure 34. Outline Installation Drawing – Self-Contained Phased Array ExplorerDVL

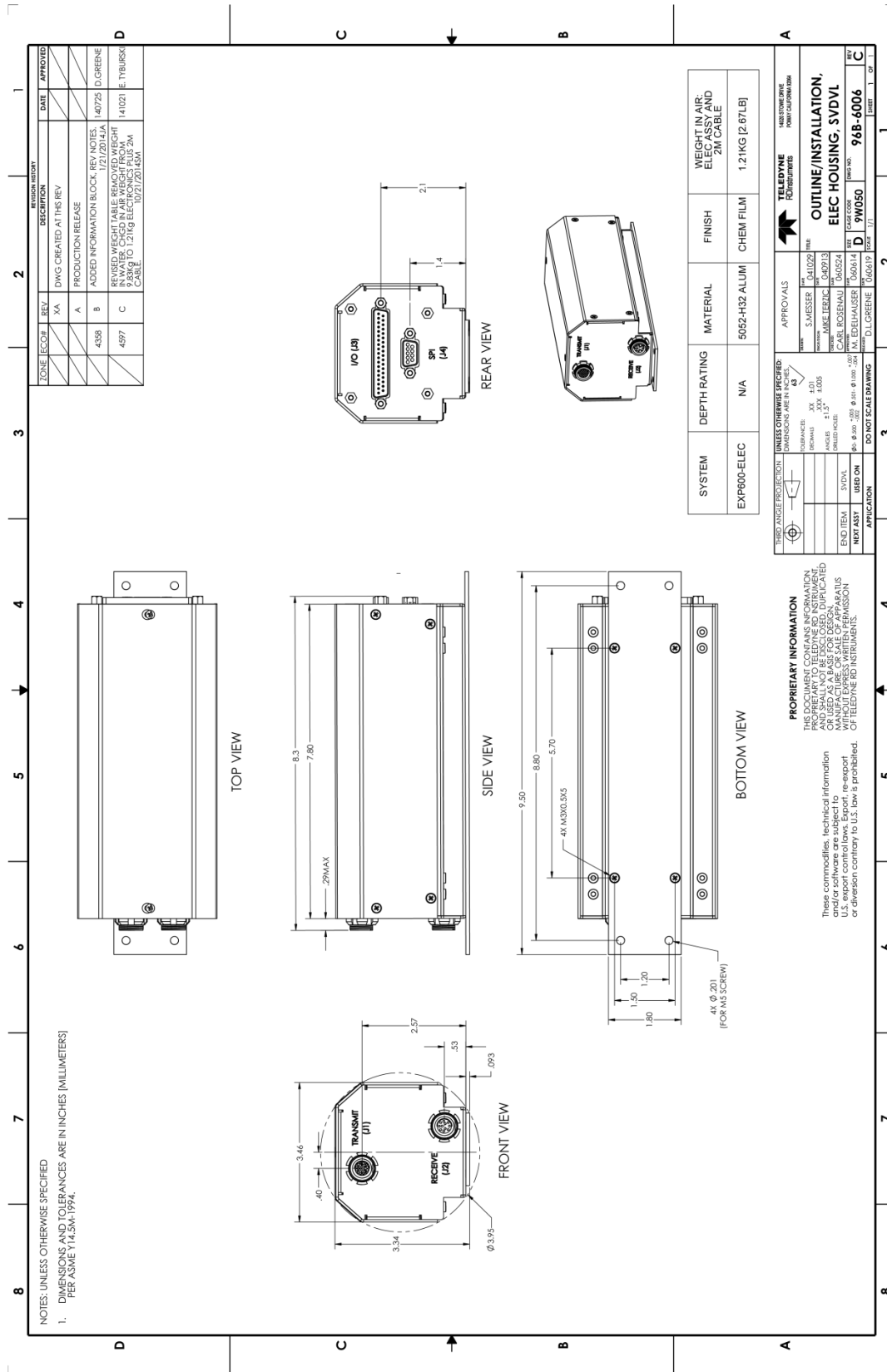


Figure 36. Outline Installation Drawing – ExplorerDVL Electronic Housing

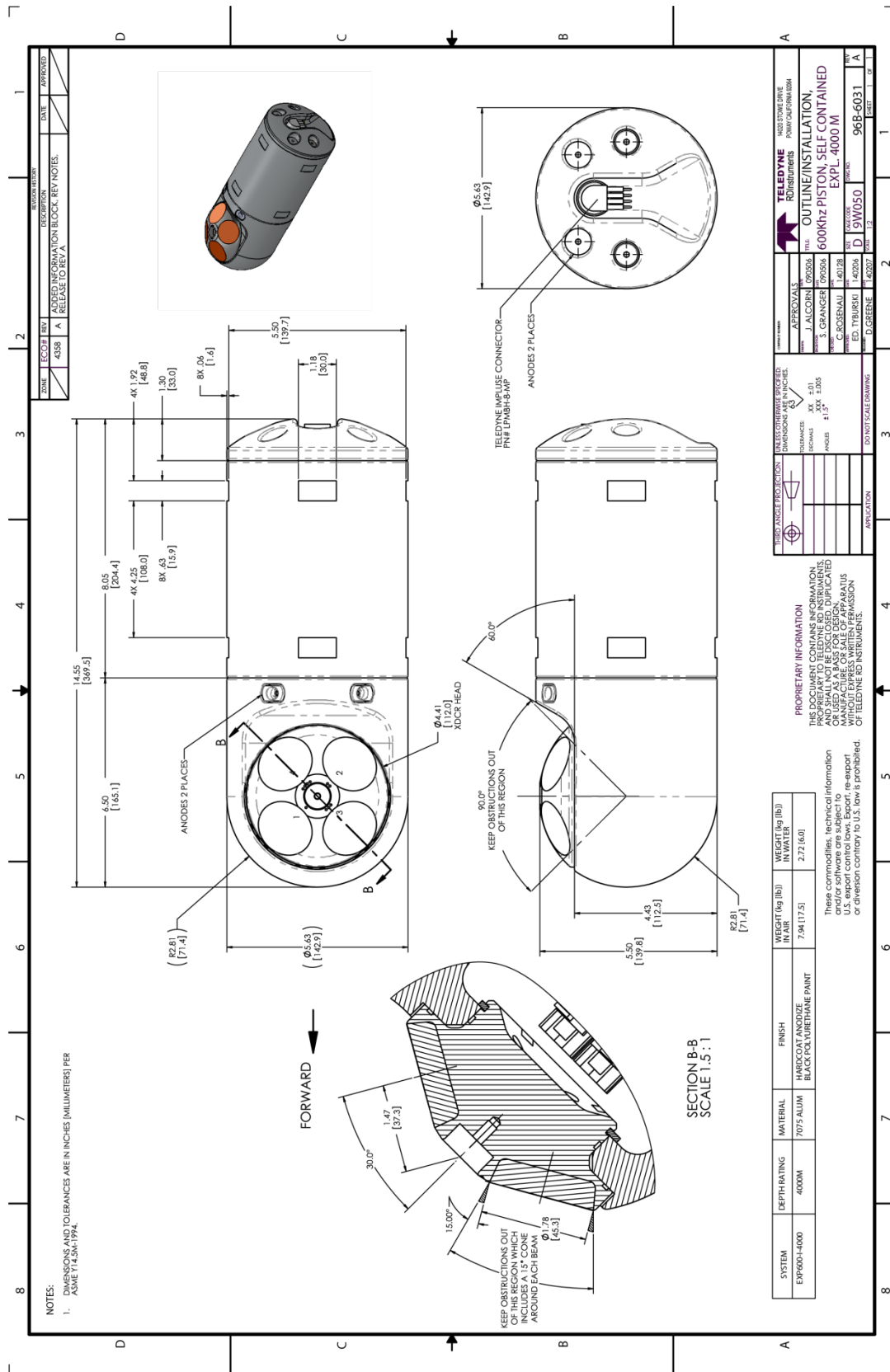


Figure 38. Outline Installation Drawing – Self-Contained Piston Array ExplorerDVL

NOTES

Chapter 7

COMMANDS



In this chapter:

- Data Communication and Command Format
- Command descriptions

This section defines the commands to set up and control the ExplorerDVL. Teledyne RD Instruments recommend using a *TRDI Toolz* script file to control the ExplorerDVL because entering commands directly from a terminal can be difficult. *Make sure to read and understand [Creating or Modifying Command Files](#) before deploying the ExplorerDVL.* Most ExplorerDVL command settings use factory-set values (Table 11). If these values are changed without thought, the deployment may be ruined. *Be sure to know what effect each command has before using it.* Call Teledyne RD Instruments for help in understanding the function of any command.

Data Communication and Command Format

Enter commands with a Windows®-compatible computer running TRDI's *TRDI Toolz*. The ExplorerDVL communicates with the computer through an RS-232 (or RS-422) serial interface. TRDI initially sets the ExplorerDVL at the factory to communicate at 9600 baud, no parity, and one stop bit.

Immediately after power is applied to the ExplorerDVL, it enters the STANDBY mode. Send a BREAK signal using *TRDI Toolz* by pressing the **End** key. Alternately, a software break may be sent by sending either “+++” or “===”. When the ExplorerDVL first powers up or receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The ExplorerDVL is now ready to accept commands at the “>” prompt from either a terminal or computer program.

```
ExplorerDVL
Teledyne RD Instruments (c) 2005
All rights reserved.
Firmware Version: 34.xx
>
```



If using a terminal/program other than *TRDI Toolz*, the BREAK length (up to down transition) must last at least 300 ms. The ExplorerDVL may respond to breaks shorter than this, so care must be taken to avoid transients on the communication lines.



By default, the Turnkey mode is on and the ExplorerDVL will ping within 10 seconds if a command is not received (see [CT - Turnkey Operation](#)).

Command Input Processing

Input commands set ExplorerDVL operating parameters, start data collection, run built-in tests (BIT), and asks for output data. All commands are ASCII character(s) and must end with a carriage return <CR>. For example,

```
>BP0001<CR> [input]
```

If the entered command is valid, the ExplorerDVL executes the command. If the command is one that does not provide output data, the ExplorerDVL sends a carriage return line feed <CR> <LF> and displays a new “>” prompt. Continuing the example,

```
>BP00001<CR> [the original input]
> [ExplorerDVL response to a valid, no-output command]
```

If a valid command is entered that produces output data, the ExplorerDVL executes the command, displays the output data, and then redisplay the “>” prompt. Some examples of commands that produce output data are ? (help menus), CS (start pinging), PS (system configuration data), and PA (run built-in tests).

If the command is not valid, the ExplorerDVL responds with an error message similar to the following.

```
>BPA<CR> [input]
>BPA ERR: Bad command parameters!<CR><LF> [ExplorerDVL response]
>
```

After correctly entering all the commands for the application, send the CK to save the setup and then a CS command to begin the data collection cycle.

Data Output Processing

After the ExplorerDVL completes a data collection cycle, it sends a block of data called a *data ensemble* through the serial communication lines. A data ensemble consists of the data collected, processed, and averaged during the ensemble interval (see [TE – Time Per Ensemble](#)). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, and status data.

ExplorerDVL output data can be in either hexadecimal-ASCII (Hex-ASCII) or binary format (set by [CF - Flow Control](#)). The Hex-ASCII mode is useful when using a terminal to communicate with, and view data from the ExplorerDVL. The binary mode is useful for high-speed communication with a computer program. Do not use the binary mode to view data on a terminal because the terminal could interpret some binary data as control codes.



Most of Teledyne RD Instruments' software supports binary PDO Output Data Format.

When data collection begins, the ExplorerDVL uses the settings last entered (user settings) or the factory-default settings. The same settings are used for the entire deployment. If the user settings are saved (see [CK - Keep Parameters](#)) then the ExplorerDVL will always use the user settings until a factory default is recalled, or use the last entered settings, if any, or until power is turned off. The following three rules apply for setting-up the ExplorerDVL:

1. The last entered command of a particular command takes precedence,
2. The last entered commands will be kept in volatile memory until power is shutdown (only CK will keep these in non-volatile memory, see [CK - Keep Parameters](#)).
3. The user can recall the factory default-settings at any time (see [CR – Retrieve Parameters](#)).

The ExplorerDVL will continue to be configured from volatile memory until it receives a CR-command or until the volatile memory loses its backup power. If the ExplorerDVL receives a CRO it will load into volatile memory the command set last stored in non-volatile memory (semi-permanent user settings) through the CK-command. If the ExplorerDVL receives a CR1, it will load into volatile memory the factory default command set stored in ROM (permanent or factory settings).

Command Summary

Table 11 gives a summary of the ExplorerDVL input commands, their format, default setting, whether the ExplorerDVL will follow the command change if sent while pinging, and a brief description of the parameters they control. Commands that start with the # sign are considered “expert” commands. Commands sent while ping will be used on the next ensemble after the one during which they are received.



When newer firmware versions are released, some commands may be modified or added. Read the README file on the upgrade disk or check TRDI’s web site for the latest changes.



When an addition or correction to the manual is needed, an updated manual will be posted to our web site on <https://www.teledynemarine.com/support/RDI/technical-manuals>. Please check our web site often.



The ExplorerDVL accepts command changes during operation without the need to stop the ping cycle (by sending a <BREAK>). This allows for dynamic setup configuration without stopping the operation of the ExplorerDVL. These dynamic setup commands are defined in the column **Dynamic Commands** in the table below.

Table 11: ExplorerDVL Input Command Summary

Command	Default	Dynamic Command	Description
?	N/A	N/A	Shows command menu
<BREAK> End	N/A	N/A	Interrupts or wakes up ExplorerDVL and loads last settings used
#B1n	0	Yes	Blank range with bad velocity (0 to 1)
#BA nnn	024	Yes	Evaluation amplitude minimum (1 to 255 counts)
#BB $nnnn$	0005	Yes	Bottom Blanking Interval (0 to 9999 cm)
#BC nnn	220	Yes	Bottom Correlation Magnitude minimum (0 to 255 counts)
#BE $nnnn$	1000	Yes	Bottom Error velocity maximum (0 to 9999 mm/s)
#BF $nnnnn$	00000	Yes	Bottom Depth guess (1 to 65535 dm, 0 = automatic)
#Bl nnn	003	Yes	Bottom Gain switch depth (0 to 999 meters)
#BJ $nnnnnnnn$	110000000	No	Bottom Data Out {t;c;*;h;r;*;*;*}
#BK n	0	Yes	WMass Mode [0=off 1=WB 2=LostB 3=W]
#BL $mmm,nnnn,ffff$	20, 80,160	Yes	Water mass layer parameters: Min Size (dm), Near (dm), Far (dm)
#BN x,y	0, 999	Yes	Speed log hold/drop control (x = hold (1), clear (0), y = 0 to 999 seconds)
#BOK	25	Yes	Distance measure filter constant (0 to 100 1/100 th s)
BP nnn	1	Yes	Bottom Track Pings per Ensemble
#BS	N/A	Yes	Clear distance traveled
BX $nnnn$	01000	Yes	Maximum Tracking Depth (0 to 65535 dm)
CB nnn	411	No	Serial port control (baud rate/parity/stop bits)
CF $nnnn$	11110	No	Flow control
CK	N/A	No	Keep parameters as user defaults
CR n	N/A	No	Retrieve parameters (0 = User, 1 = Factory)
CS or Tab	N/A	No	Start pinging
#CT n	1	No	Turnkey operation (0 = Off, 1 = On)
#CO $n p$	0 1	Yes	Set Out Trig ([0-3]=[off r/x x r], pol)
CX n	0 0 65535 0	Yes	Set Input Trigger [mode, dly, timeout, ping-once]
EA $\pm nnnn$	+00000	Yes	Heading Alignment [.01 deg cw]
#EC $nnnn$	1500	Yes	Speed of Sound (1400 to 1600 m/s)
ED $nnnn$	00000	Yes	Transducer Depth (0 to 65535 dm)
#EE	0000101	No	Output Coordinate Frame (Att[2]; Intrap[2]; Cmd[1]; Rw/Nm[1]; Snsr Out[1])
#EH $nnnn,n$	00000,1	Yes	Heading {heading; frame}
#EI $nnnn$	+00000	Yes	Roll Misalignment Angle [.01 deg cw]
#EJ	+00000	Yes	Pitch Misalignment Angle [.01 deg cw]
#EP $\pm nnnn$	+00000, +00000,1	Yes	Tilts {pitch; roll; frame}
#ER $\pm nnnn$	+00000	Yes	Roll [.01 deg cw]
ES nn	35	Yes	Salinity (0 to 40 parts per thousand)
#ET $\pm nnnn$	2100	Yes	Temperature (-5.00 to +40.00 degrees C) [.01 deg cw]
#EU	0	Yes	Orientation [0=Switch,1=Up,2=Down]
#EV	+00000	Yes	Heading Variation [.01 deg cw]
EX $nnnn$	11111	Yes	Coordinate Transformation (Xform:Type; Tilts; 3Bm; Map)
#EY	0 0 0 0 0 0 0	No	Doppler Param Source {c;d;h;p;r;s;t;u}
EZ $nnnnnn$	22222220	Yes	Sensor Source (C;D;H;P;R;S;T; U)
ME	N/A	No	ErAsE recorder

Table 11: ExplorerDVL Input Command Summary

Command	Default	Dynamic Command	Description
MM	N/A	No	Show memory usage
MN XYZ	MN EXP	No	Set file name [1..32 characters]
MR 0	0	No	Set recorder on/off [0=off,1=on]
MY	N/A	No	Y-Modem output
PA	N/A	No	Pre-deployment tests
PC	N/A	No	Display Pressure, Temperature, Heading, Pitch, Roll Built-in test
#PDn	PDO	No	Data stream select (0, 4, 5, 6)
PS0	N/A	No	Display System Configuration
PS1	N/A	No	Display fixed leader (binary).
PT0	N/A	No	Built-In test – Help
PT3	N/A	No	Built-In test - Receive Path
PT5	N/A	No	Built-In test - Transmit/Receive Continuity
SC	N/A	No	Sensor Commands [ID Event "Command"]
SD	N/A	No	Sensor Data Out [ID abcd..., a-d=1/0]
SM	N/A	No	Aux Snr Aux Menu [sid]
#SO	101.325	Yes	Absolute Press Sensor Offset [kPa]
SPn	0 99;0 99;0 99;0 99	No	Sensor-port Assignment [sid0 to0 ...]
SR	N/A	No	Sensor Reset [sid]
TEhh:mm:ss.ff	00:00:00.00	No	Time per ensemble (hours:minutes:seconds.100 th of seconds)
TPmm:ss.ff	00:00.05	No	Time between pings (minutes:seconds.100 th of seconds)
TSyy/mm/dd, hh:mm:ss	N/A	Yes	Set real-time clock (year/month/day, hours:minutes:seconds)
TTccyy/mm/dd, hh:mm:ss	N/A	Yes	Set real-time clock (Y2k compatible) (century year /month/day, hours:minutes:seconds)
#WAnnn	050	Yes	False target threshold maximum (0 to 255 counts)
WBn	0	Yes	Mode 1 Bandwidth Control (0 = Wide, 1 = Narrow)
#WCnnn	064	Yes	Correlation threshold (0 to 255 counts)
WDnnn nnn nnn	111100000	No	Data Out {v;c;a;p;s;*,*,*,*}
#WEnnnn	2000	Yes	Error velocity threshold (0 to 5000 mm/s)
WFnnnn	0088	Yes	Blanking Distance [0 to 999 cm]
#WJn	1	Yes	BroadBand Receiver gain (0 = Low, 1 = High)
WNnnn	030	Yes	Number of Bins (1 to 255)
WPnnnn	000	Yes	Pings per ensemble (0 to 16384)
WSnnnn	0200	Yes	Bin size 10 to 800 cm
#WTnnnn	0000	Yes	Transmit length (0 to 3200 cm)
WVnnn	0175	Yes	Ambiguity velocity (020 to 700 cm/s radial)



Highlighted commands are “expert” commands. Changing these command parameters can have severe consequences to data collection.



Commands queried (e.g., B?) during an ensemble will, in general, cause the ExplorerDVL to respond with the usual description.



Editing or adding expert commands (#xx) to the command file will allow items to be set that if set incorrectly can cause the data to be the wrong format, bad, and/or uncorrectable even in post processing.

Command Descriptions

Each listing includes the command's purpose, format, default setting (if applicable) range, recommended setting, and description. If a numeric value follows the command, the ExplorerDVL uses it to set a processing value (time, range, percentage, processing flags). All measurement values are in metric units (mm, cm, and dm).

? – Help Menus

Purpose	Lists the major help groups.
Format	<i>x?</i> (see description)
Description	Entering ? by itself displays all command groups. To display help for one command group, enter <i>x?</i> , where <i>x</i> is the command group to view. When the ExplorerDVL displays the help for a command group, it also shows the format and present setting of those commands. To see the help or setting for one command, enter the command followed by a question mark. For example, to view the WP command setting, enter <u>WP?</u> .
Examples	See below.

```
ExplorerDVL
Teledyne RD Instruments (c) 2005
All rights reserved.
Firmware Version: 34.xx

>?
Available Commands:

B ----- Bottom Track Commands
C ----- Control Commands
E ----- Environment Commands
M ----- Loop Recorder Commands
P ----- Performance Test Commands
S ----- Sensor Commands
T ----- Time Commands
W ----- Water Profiling Commands
? ----- Display Main Menu

>b?
Available Commands:

BP 1 ----- Number of BT Pings in ensemble [0-999]
BX 01000 ----- Max Depth (dm) [0-65535 dm]
B? ----- Display B-Command Menu
```

Break

Purpose	Interrupts ExplorerDVL without erasing present settings.
Format	<BREAK>
Description	A BREAK signal interrupts ExplorerDVL processing. It is leading-edge triggered and should last at least 300 ms. ExplorerDVL may respond to shorter breaks so care should be taken to avoid spurious signals on the communication lines. A BREAK initializes the system, sends a wake-up (copyright) message, and places the ExplorerDVL in the DATA I/O mode. The BREAK command does not erase any settings or data. Using <i>TRDI Toolz</i> , pressing the End key sends a BREAK.
Example	<BREAK>

```
ExplorerDVL
Teledyne RD Instruments (c) 2005
All rights reserved.
Firmware Version: 34.xx

>?
```

Software Breaks can be used with *TRDI Toolz*. Configure *TRDI Toolz* to use a Software break by using the **Tools, Options** screen. The ExplorerDVL will use the " = = " string instead of a break.

OL – Display Feature List

Purpose	Lists the special firmware upgrades that are installed.
Format	OL
Description	Lists special features that are installed. See the OI command for information on how to install additional capability in the ExplorerDVL.
Examples	See below.

FEATURES	
----- Feature	Installed -----
Base Accuracy Bottom Track	Yes
Water Profile	No
High Accuracy Bottom Track	No
Low Altitude Bottom Capability	No

See your technical manual or contact TRDI for information on how to install additional capability in your unit.



The Low Altitude Bottom Capability feature upgrade extends the minimum altitude for Bottom Tracking from 0.5 meters to 0.25 meters for piston and phased array at 0.31 meters. Contact a local TRDI sales representative if interested in upgrading the system.

Base Accuracy Bottom Track (export complaint) and High Accuracy Bottom Track are mutually exclusive. Only one can be installed.

OI – Install New Feature

Purpose Enables the special firmware upgrades.


Format OI


 Recommended Setting. **Use as needed.**

Description Enter the code provided by TRDI to enable the firmware upgrade.

Examples See below.

```
>oi  
-----1-----2-----  
Enter Code:
```

 The upgrade code is specific to the unit for which it was ordered. **DO NOT** attempt to install this feature for any other unit.

 Many feature upgrades require the latest firmware version to be installed in the ExplorerDVL. Update the firmware **before** installing the feature upgrade.

Bottom Track Commands

The ExplorerDVL system uses these commands for bottom-tracking applications. Bottom track commands tell the ExplorerDVL to collect speed-over-bottom data and detected range-to-bottom data. If the ExplorerDVL were facing UP, all bottom-track information would apply to the surface boundary instead of the bottom boundary. The default state of bottom tracking is ON (BP1) for ExplorerDVLs. To turn OFF the bottom-tracking process, send a BPO command.

Available Bottom Track Commands

This section lists the available Bottom Track commands.

This section lists the available Bottom Track commands.

>B?

Available Commands:

```
BP 1 ----- Number of BT Pings in ensemble [0-999]
BK 0 ----- WMass Mode [0=off 1=WB 2=LostB 3=W]
BX 01000 ----- Max Depth (dm) [0-65535 dm]
B? ----- Display B-Command Menu
```

BP – Bottom-Track Pings per Ensemble

Purpose	Sets the number of bottom-track pings to average together in each data ensemble.
Format	BP nnn
Range	$nnn = 0$ to 999 pings
Default	BP001



The default setting for this command is recommended for most applications.

Description BP sets the number of bottom-track pings to average together in each ensemble before sending/recording bottom-track data.



The ExplorerDVL interleaves Bottom-Track pings with Water-Track pings if water profiling is enabled (see [TP – Time Between Pings](#), [WP – Pings Per Ensemble](#) and [BK - Water-Mass Layer Mode](#)).

If BP = zero, the ExplorerDVL will not collect bottom-track data. This is also true for current profile if WP=0 or the feature is not enabled.

The ExplorerDVL automatically extends the ensemble interval (TE) if $BP \times TP > TE$ (see [TE – Time Per Ensemble](#)).

BK – Water-Mass Layer Mode

Purpose	Selects the ping frequency of the water-mass layer ping
Format	BK n
Range	$n = 0$ to 3
Default	BK0



The default setting for this command is recommended for most applications.



The BK command works with or without the # sign. Using BK or #BK are both valid commands.

Description The BK command selects how often the ExplorerDVL performs a water-mass layer ping while bottom tracking. The number of water-mass layer pings per ensemble is dependent on the BP-command (see [BP – Bottom-Track Pings per Ensemble](#)) and this command setting. Use the #BL-command to set the location of the water-mass layer (see [BL - Water-Mass Layer Parameters](#)).

Table 12: Water-Mass Reference-Layer Modes

Command	Description
#BK0	Disables the water-mass layer ping.
#BK1	Sends a water-mass layer ping after every bottom-track ping
#BK2	Sends a water-mass layer ping after every bottom-track ping that is unable to find the bottom.
#BK3	Disables the bottom-track ping and enables the water-mass ping.

BX – Maximum Tracking Depth

Purpose Sets the maximum tracking depth in bottom-track mode.

Format BXnnnnn

Range nnnnn = 10 to 65535 decimeters (meters x 10)

Default BX01000



Set BX to a depth slightly greater than the expected maximum depth.

Description The BX-command sets the maximum tracking depth used by the ExplorerDVL during bottom tracking. This prevents the ExplorerDVL from searching too long and too deep for the bottom, allowing a faster ping rate when the ExplorerDVL loses track of the bottom.

Example If the maximum depth in the deployment area is 20 meters (200 decimeters), set BX to a value slightly larger than 200 dm, say 210 dm, instead of the default 1000 dm. Now if the ExplorerDVL loses track of the bottom, it will stop searching for the bottom at 210-dm (21 m) rather than spend time searching down to 1000-dm (100 m).



The BX command limits the search range for bottom tracking. If the ExplorerDVL loses lock on the bottom, it goes into search mode, which iteratively searches increasing ranges until either the bottom is found or the maximum range is reached, and then the process starts over at the minimum range. The BX command will prevent the ExplorerDVL from searching to ranges beyond the BX range value, and can result in shorter search cycles if the bottom is known to be within this range.



In addition to limiting the search range, the BX command indirectly limits the bottom track range. While this does not prevent the ExplorerDVL from bottom tracking to ranges beyond the BX range, use caution in setting this command to less than the expected maximum depth as the ExplorerDVL will be less likely to hold a lock on the bottom if there is any slope beyond the BX range.

Expert Bottom Track Commands

This section lists the expert Bottom Track commands. Commands that start with the # sign are considered “expert” commands.

>#B?

Available Commands:

```

B1 0 ----- Blank Range with Bad Velocity [0..1]
BA 024 ----- Amplitude Threshold [0..255]
BB 0005 ----- Blanking distance [0-9999cm]
BC 220 ----- Correlation Threshold [0..255]
BE 1000 ----- Error Velocity Threshold [0-9999mm/s]
BF 00000 ----- Depth Guess [0=Auto, 1-65535dm]
BI 003 ----- Gain Switch Depth [0-999m]
BJ 110000000 ----- Data Out {t;c;*;h;r;*;*;*}
BK 0 ----- WMass Mode [0=off 1=WB 2=LostB 3=W]
BL 80, 160, 240 ----- WMass Params [min, near, far (dm)]
BN 0,999 ----- Speed Log Hold/Drop Control
BO 025 ----- Distance Accum. Filter Tau (1/100ths)
BS ----- Clear Distance Traveled
B? ----- Display #B-Command Menu

```

#B1 – Blank Range with Bad Velocity

Purpose Sets the range output marked bad when the correlation is too low to compute a velocity.

Format #B1 *n*

Range *n* = 0 (Bottom Track range is reported), 1 (Bottom Track range is blanked)

Default #B1 0



Special case use only. Contact TRDI Field Service before using.

Description Setting #B1 1 will enable a mode where the Bottom Track range is blanked (to zero) when velocity correlation is bad.

With #B1 0 (default), the Bottom Track range is reported normally.

#BA – Evaluation Amplitude Minimum

Purpose Sets the minimum value for valid bottom detection.

Format #BA*nnn*

Range *nnn* = 1 to 255 counts

Default #BA24



The default setting for this command is recommended for most applications.

Description #BA sets the minimum amplitude of an internal bottom-track filter that determines bottom detection. Reducing #BA increases the bottom-track detection range, but also may increase the possibility of false bottom detections.

#BB – Bottom Blanking Interval

Purpose	This command sets the near limit of bottom detection beyond the transmit pulse.
Format	#BBnnnn
Range	nnnn = 0 to 9999 cm
Default	#BB5



The default setting for this command is recommended for most applications.

Description The ExplorerDVL will search for the bottom starting at the length of transmit plus this blanking interval.

#BC – Correlation Magnitude Minimum

Purpose	Sets minimum correlation magnitude for valid velocity data.
Format	#BCnnn
Range	nnn = 0 to 255 counts
Default	#BC220



The default setting for this command is recommended for most applications.

Description Sets a minimum threshold for good bottom-track data. Any bottom-track data with a correlation magnitude less than this value will be flagged as bad.



A count value of 255 is a perfect correlation (i.e. solid target)

#BE – Error Velocity Maximum

Purpose	Sets maximum error velocity for good bottom-track data.
Format	#BEnnnn
Range	nnnn = 0 to 9999 mm/s
Default	#BE1000



The default setting for this command is recommended for most applications.



The default setting is set purposely high and as a result effectively disabled. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

Description The ExplorerDVL uses this parameter to determine good bottom-track velocity data. If the error velocity is greater than this value, the ExplorerDVL marks as bad all four beam velocities (or all four coordinate velocities, if transformed). If three beam solutions are allowed (see [EX – Coordinate Transformation](#)) and only three beams are good, then the data is accepted since four good beams are needed for error velocity calculation.

#BF – Depth Guess

Purpose	Sets a “best-guess” of expected bottom range for internal calculations.
Format	#BFnnnnn
Range	nnnnn = 1 to 65535 dm (0 = automatic)
Default	#BF0



The default setting for this command is recommended for most applications.

Description When set to a non-zero value, the ExplorerDVL transmits a fixed pulse based on a given bottom range. This is useful for applications with fixed range bottoms. The command reduces the amount of time the ExplorerDVL uses to search for the bottom if lost.

#BI – Gain Switch Altitude

Purpose	Selects the maximum vertical distance from the transducer to the bottom at which the ExplorerDVL operates at low gain.
Format	#BI nnn
Range	nnn = 0 to 999 meters
Default	#BI003



The default setting for this command is recommended for most applications.

Description When the vertical range to the bottom is less than #BI, the unit operates in low gain. When the vertical range is greater than #BI, internal logic determines which gain (low or high) is optimal. In high backscatter areas, it may be necessary to raise this setting in order to detect bottom throughout the range of the system.

#BJ – Data Type Output Control

Purpose:	Bottom data types that will be output in the ensemble.
Format:	Format #BJ $tc^* hrn$ *** *: not used; reserved for future use (set to zero). t: Standard bottom track output (see Binary Bottom-Track Data Format) c: Commands output (see Bottom Track Command Output Format for a definition of this data type) h: High resolution bottom and water mass velocity and distance (note that this will cause distance to be accumulated). See Bottom Track High Resolution Velocity Format for a data type definition) r: Range (corrected) output. See Bottom Track Range Format for a data type definition. n: Precision Navigation Output. See Navigation Parameters Data Format for data type definition.
Range:	0 or 1 for each digit
Default:	#BJ 100 000 000



The default setting for this command is recommended for most applications.

Description: This command controls the data types that are output in the ensemble.

#BK – Water-Mass Layer Mode

Purpose	Selects the ping frequency of the water-mass layer ping
Format	#BK <i>n</i>
Range	<i>n</i> = 0 to 3
Default	#BK0



The default setting for this command is recommended for most applications.



The BK command works with or without the # sign. Using BK or #BK are both valid commands.

Description See the [BK Command](#) for details.

#BL – Water-Mass Layer Parameters

Purpose	Sets bottom-track water-mass layer boundaries and minimum layer size.
Format	#BL <i>mmm,nnnn,ffff</i>
Range	<i>mmm</i> = Min Layer Size (1 to max profile bin decimeters) [meters x 10] <i>nnnn</i> = Near Layer Boundary (0 - 9999 decimeters) [meters x 10] <i>ffff</i> = Far Layer Boundary (0 - 9999 decimeters) [meters x 10] The far boundary must be greater than the near plus the min layer size. The minimum layer and the difference between the near and the far layers cannot be larger than the maximum profile bin size (800cm for 600 kHz).
Default	#BL20,80,160



The default setting for this command is recommended for most applications.

Description The #BL-command sets a water-mass layer. Use this layer as a reference point when the bottom is out of range or is incorrect. Water-mass layer output data are available when both #BK (see [BK - Water-Mass Layer Mode](#)) and BP (see [BP – Bottom-Track Pings per Ensemble](#)) commands are nonzero values, and the bottom must be at least the Minimum Layer Size + Near Layer Boundary + 20% of the reported depth away from the transducer. The Far Layer Boundary (ffff) must be less than the maximum profiling distance or the ExplorerDVL sends Error Code 011.

The user-defined water-mass layer is used unless the layer comes within 20% of the water boundary (sea floor for down-looking systems; surface for up-looking systems). As the user-defined water-mass layer comes within 20% of the boundary (Figure 40, B), the layer compresses in size until the minimum water-mass layer size is reached. When the boundary moves closer to the transducer (Figure 40, C), no water mass ping will be sent.



The water-mass layer is operational only if BP > zero and #BK > zero.

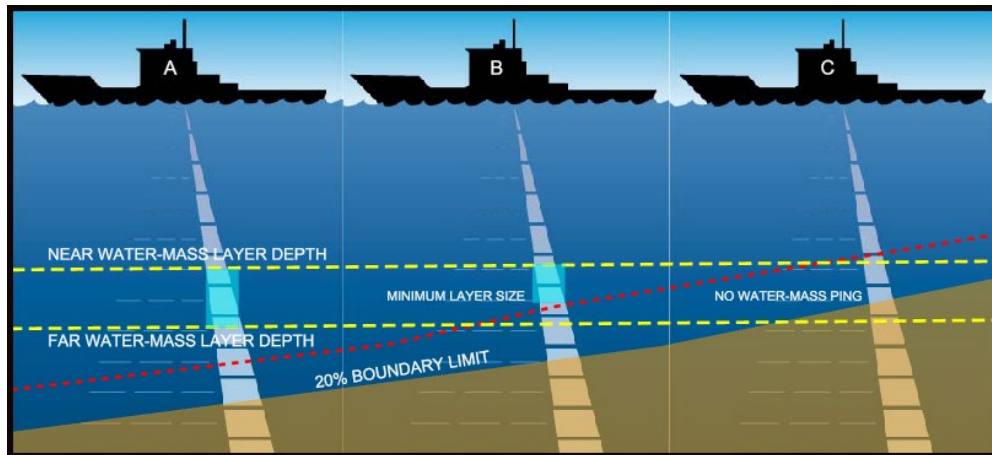


Figure 40. Water-Mass Layer Processing

#BN – Speed Log Hold/Drop Control

Purpose: Controls the behavior of the distance measure calculation when Bottom Track is lost.

Format: #BN x,y

Range: $x = 0$ to 1
 $y = 0$ to 999 seconds

Default: #BNo,999



The default setting for this command is recommended for most applications.

Description: The #BN command governs the behavior of the earth referenced distance measurement calculation in the PD6 data format when the ExplorerDVL can't get a lock on the bottom. The y parameter represents a timeout period during which zero is used for the current velocity measurement in the equation shown in the #BO command. After the expiration of the y timeout, the behavior is governed by the x parameter. If x is zero, then the accumulated distance is set to zero. If x is one, then the accumulated distance is maintained at its current value until the ExplorerDVL achieves bottom lock.

#BO – Distance Measure Filter Constant

Purpose: Sets the value of the filter constant used by the distance measurement calculation in PD6.
 Format: #BO*k*
 Range: $k = 0$ to 100
 Default: #BO25



The default setting for this command is recommended for most applications.

Description: When calculating the earth referenced distance data for output in the PD6 data format, the ExplorerDVL applies a simple exponential filter to the velocity measurements before calculating the distance. The velocity used to calculate the distance is given by the following equation:

$$v = (k \cdot v_{\text{new}} + (k - 100) \cdot v_{\text{old}}) / 100$$

Where v_{new} is the current velocity measurement, v_{old} is the value of v calculated for the previous distance calculation, and k is the value of the #BO command. Setting k to 100 effectively disables the exponential filter.

#BS – Clear Distance Traveled

Purpose: Clears internal distance traveled accumulators.
 Format: #BS



Use as needed.

Description: Distance traveled is calculated and output in the following ExplorerDVL output formats;

- PDO high resolution output (see [BJ – Data Type Output Control](#) and [Bottom Track High Resolution Velocity Format](#))
- PD5 (see [ExplorerDVL Binary Data Format \(PD5\)](#)).
- PD6 (see [ExplorerDVL Output Data Format \(PD6\)](#))

The accumulator is zeroed on <BREAK> or by using this command in the manual ensemble cycling mode (see [CF - Flow Control](#)).

Control System Commands

The ExplorerDVL uses the following commands to control certain system parameters.

Available Control System Commands

This section lists the available Control System commands.

```
>c?
Available Commands:

CB 411 ----- Serial Port Control {baud;parity;stop}
CF 11110 ----- Set Ctrl Flags {e;p;b;s;*}
CK ----- Save Command Parameters to Flash
CR ----- Restore Cmd defaults [0=user,1=factory]
CS ----- Start Pinging
CX 0 0 65535 0 ----- Set Input Trigger [mode, dly, timeout, ping-once]
C? ----- Display C-Command Menu
```


CB – Serial Port Control

- Purpose** Sets the RS-232/422 serial port communications parameters (Baud Rate/Parity/Stop Bits).
- Format** CBnnn
- Range** nnn = baud rate, parity, stop bits (see description)
- Default** CB411



The default setting for this command is recommended for most applications.

Description The ExplorerDVL can be set to communicate at baud rates from 300 to 115200 (see [Changing the ExplorerDVL's Baud Rate](#)). The ExplorerDVL and the external device (dumb terminal, computer software) **MUST** use the same communication parameters to *talk* to each other. After entering a valid CB parameters, the ExplorerDVL responds with a “>” prompt. Then change the external device’s communication parameters to match the ExplorerDVL parameters before sending another command.



If a BREAK is sent before changing the external device’s communication parameters, the ExplorerDVL returns to the communication parameters stored in non-volatile memory (user settings).

Table 13: Serial Port Control

Baud Rate	Parity	Stop Bits
0 = 300		
1 = 1200	1 = None (Default)	1 = 1 Bit (Default)
2 = 2400	2 = Even	2 = 2 Bits
3 = 4800	3 = Odd	
4 = 9600 (Default)	4 = Low (Space, logical 0)	
5 = 19200	5 = High (Mark, logical 1)	
6 = 38400		
7 = 57600		
8 = 115200		

CF – Flow Control

Purpose	Sets various ExplorerDVL data flow-control parameters.
Format	CFnnnnn
Range	Firmware switches (see description)
Default	CF11110



The default setting for this command is recommended for most applications.

Description The CF-command defines whether the ExplorerDVL: generates data ensembles automatically or manually; generates pings immediately or manually; sends serial output data in binary or Hex-ASCII format; sends or does not send output data to the serial interface; sends or does not send data to the recorder (if installed).

Table 14: Flow Control

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF0xxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the > prompt and waits for a new command.
CfX1xxx	Automatic Ping Cycling – Pings immediately when ready.
CfX0xxx	Manual Ping Cycling – Sends a < character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the ExplorerDVL is not echoed. This feature manually controls ping timing within the ensemble. Note the prompt output by the ExplorerDVL when ready to ping is a less-than symbol (<), to distinguish it from the normal command prompt.
Cfxx1xx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled.
Cfxx0xx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled.
Cfxxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/422 serial interface.
Cfxxx0x	Disable Serial Output – No ensemble data are sent out the RS-232/422 interface.
Example	CF01010 selects manual ensemble cycling, automatic ping cycling, Hex-ASCII data output, enables serial output, and disables data recording.

CK – Keep Parameters

Purpose	Stores present parameters to non-volatile memory.
Format	CK



The CR1 command must be the first command sent to the ExplorerDVL. The CK command must be sent just before the CS command. Other commands may be sent in any order.

Description CK saves the present user command parameters to non-volatile memory on the CPU board. The ExplorerDVL maintains data stored in the non-volatile memory (user settings) even if power is lost. It does not need a battery. Use the CR command to recall parameters stored in non-volatile memory (see [CR – Retrieve Parameters](#)).

CR – Retrieve Parameters

Purpose Resets the ExplorerDVL command set to factory settings.
 Format CR*n*
 Range *n* = 0 (User), 1 (Factory)



The CR1 command must be the first command sent to the ExplorerDVL. The CK command must be sent just before the CS command. Other commands may be sent in any order.

Description The ExplorerDVL automatically stores the last set of commands used in volatile memory. The ExplorerDVL will continue to be configured from volatile memory unless it receives a CR-command or until the volatile memory loses its power.

Table 15: Retrieve Parameters

Format	Description
CR0	Loads into volatile memory the command set last stored in non-volatile memory (user settings) using the CK-Command.
CR1	Loads into volatile memory the factory default command set stored in ROM (factory settings).



The CR command keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the ExplorerDVL maintains communications with the terminal/computer.

CS – Start Pinging (Go)

Purpose Starts the data collection cycle (same as the **Tab** key).
 Format CS



The CR1 command must be the first command sent to the ExplorerDVL. The CK command must be sent just before the CS command. The CS command is the last command sent.

Description Use CS (or the **Tab** key) to tell the ExplorerDVL system to start pinging its transducer and collecting data as programmed by the other commands.



After a CS-command is sent to the ExplorerDVL, no changes to the commands can occur until a <BREAK> is sent.

CX – Input Trigger Enable

Purpose Enables or disables the trigger.
 Format CX *n d t [p]*



Use as needed.

Range *n*: *n* = 0 to 5 per Table 16.
d: 0 to 65535 one hundredths of a second delay time.
t: 0 to 65535 one hundredths of a second time-out time. Setting “*t*” to 65535 disables the time-out.
p: (optional) 0 or 1. Setting “*p*” to 1 enables ping-once mode after time-out.
 Default CX 0 0 65535 0


Description The unit will ping once within 1ms after the trigger transitions as indicated in Table 16 for CX = 1 to 3.

For CX 4 to 5, the ExplorerDVL will trigger while the trigger is in the state described in Table 16.

If “p” set to 1, ping only once after time-out, then wait again for another Trigger or time-out. If set to 0 (default), will self-deploy normally after time-out. If not set by CX command, will default to 0.

Table 16: Input Trigger

CX (n)	System Behavior
0	Trigger off
1	Pings after low to high transition
2	Pings after high to low transition
3	Pings after either low to high or high to low transition
4	Ping while trigger is low
5	Pings while trigger is high




The polarity is defined as the electrical level at the connector (J3) on the electronics enclosure (see Table 1).

Note that commanded time between pings (TP) takes higher precedence than this command. That is, the unit will ping on the next trigger after TP has been satisfied.


The trigger delay causes the unit to wait after a trigger is received for ping to start. Delay after trigger is received is valid only for first ping for CX n=4 or 5.

The time-out is effective the first time the time-out occurs. The unit pings without waiting for the trigger after the first time-out.

De-asserting the trigger after it has been asserted and the ping started will not stop the ping for CX n=4 or 5. That is, the trigger condition only delays the ping prior to transmit and will not be checked until the ExplorerDVL unit is ready to transmit again.



Note that commanded time between pings (TP) takes higher precedence than this command. That is, the unit will ping on the next trigger after TP has been satisfied (see [TP – Time Between Pings](#)).



The Trigger In and Out lines must each be referenced to COMM 1_2 (pin 5 of J3 I/O Serial DB37) (see Table 1).

Expert Control System Commands

This section lists the expert Control System commands. Commands that start with the # sign are considered “expert” commands.

```
>#C?
Available Commands:

CO 0 1 ----- Set Out Trig ([0-3]=[off r/x x r], pol)
CT 1 ----- Turnkey [0 = OFF, 1 = ON]
C? ----- Display #C-Command Menu
```


#CO – Output Trigger Enable

Purpose Enable or disable the output trigger. This trigger gives an approximate indication of when transmit and receive occur for the ExplorerDVL. It is not intended to provide exact timing of transmit or receive. This trigger can be used to hold off pinging of other devices that would otherwise interfere with ExplorerDVL operation.

Format #CO *n p*

Range *n*: 0 to 3 trigger event as described below.
p: 0 to 1 polarity as described below.

Default #CO 0 0



The default setting for this command is recommended for most applications.


Description The “*n*” parameter of this command can cause the system to output a trigger through the Input Power and Communications Interface Connector (J3) (see Table 1) on the electronics enclosure during transmit, receive or both transmit and receive as indicated in Table 17.

Table 17: Output Trigger State

#CO (<i>n</i>)	Output Trigger State
#CO 0	Trigger off.
#CO 1	Trigger active during transmit and receive interval.
#CO 2	Trigger active during transmit interval only. Reverts to <i>n</i> =1 for BM8 when shallow due to multi-pulse transmission.
#CO 3	Trigger active during receive interval only. Reverts to <i>n</i> =1 for BM8 when shallow due to multi-pulse transmission.

The “*p*” parameter of this command causes the polarity to be electrically high for *p* = 1 when the trigger is active, otherwise it is electrically low.

To avoid interference between the ExplorerDVL and other devices on the vehicle in general applications, *n* = 1 is recommended.



The Trigger In and Out lines must each be referenced to COMM 1_2 (pin 5 of J3 I/O Serial DB37) (see Table 1).

#CT – Turnkey Operation

Purpose	Allows the ExplorerDVL to initialize to predefined parameters and start pinging within 10 seconds after power is applied, or a break is received, if no command is entered.
Format	#CTn
Range	n = 0 to 1 (0 = Off, 1 = Turnkey)
Default	#CT1



The default setting for this command is recommended for most applications.

Description	<p>Setting the #CT command to #CT1 lets the ExplorerDVL automatically initialize to a predefined command set during any power up or after a break.</p> <p>To place the ExplorerDVL in turnkey mode, first set all other commands to the desired configuration. Then send the #CT1 and CK commands to save this configuration (see CK - Keep Parameters). When power is cycled or a break is sent, the ExplorerDVL will start up with the desired configuration and begin the data collection process unless a valid command is sent within 10 seconds.</p> <p>Turnkey mode can be interrupted by sending a <BREAK>. This will place the ExplorerDVL in the command mode, ready to accept input for another 10 seconds. To turn off the turnkey mode, first send a <BREAK> to the ExplorerDVL. Now send the #CT0 and CK commands to save this configuration. When power is cycled or a break is again sent, the ExplorerDVL will NOT begin the data collection process.</p>
-------------	--

Environmental Commands

The ExplorerDVL uses the following commands to control the environmental and positional information that affects internal data processing.

Available Environmental Commands

This section lists the available Environmental commands.

```
>e?
Available Commands:

EA +00000 ----- Heading Alignment [.01 deg cw]
ED 00000 ----- Xdcr Depth [dm]
ES 35 ----- Salinity [ppt]
EX 11111 ----- Coordinate Transformations
EZ 2222220 ----- Sensor Source {c;d;h;p;r;s;t;u}
E? ----- Display E-Command Menu
```

EA – Heading Alignment

Purpose	Corrects for physical misalignment between Beam 3 and the heading reference.
Format	EA±nnnnn
Range	±nnnnn = -17999 to 18000 (-179.99 to 180.00 degrees)
Default	EA00000



Set as needed.

Description EA is a heading alignment angle (referenced to Beam 3) used as a new zero reference for heading output and for transformation to earth coordinates. Use the [EV - Heading Bias](#) command to correct for heading bias (e.g., magnetic declination).

Example The ExplorerDVL is mounted in place on a moving ship with beam 3 aligned with the forward axis of the ship. Beam 3 has been rotated 45 toward port (-45) from the ship's centerline. Use the EA command to tell the ExplorerDVL where beam 3 is in relation to the ship's centerline. To convert -45 to an EA-command value, multiply the desired alignment angle in degrees by 100:

$$EA = -45.00 \times 100 = -4500 = EA-04500$$

ED – Depth of Transducer

Purpose	Sets the ExplorerDVL transducer depth.
Format	EDnnnnn
Range	nnnnn = 0 to 65535 decimeters (meters x 10)
Default	ED00000



Use the EZ-command (see [EZ - Sensor Source](#)).

Description ED sets the ExplorerDVL transducer depth. This measurement is taken from sea level to the transducer face. The ExplorerDVL uses ED in its speed of sound calculations. The ExplorerDVL assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.



If the EZ *Transducer Depth* field = 1 or 2, the ExplorerDVL overrides the manually set ED value and uses depth from the internal or external pressure sensor, respectively. If a pressure sensor is not available, the ExplorerDVL uses pressure data from the best available sensor or ED command. See Table 20 of the #EY command for more information.

ES – Salinity

Purpose	Sets the water's salinity value.
Format	ESnn
Range	nn = 0 to 40
Default	ES35



The default setting for this command is recommended for most applications.

Description The ES command sets the water's salinity. The ExplorerDVL uses ES in its speed of sound calculations. The ExplorerDVL assumes the speed of sound reading is taken at the transducer head.

EX – Coordinate Transformation

Purpose	Sets the coordinate transformation processing flags.
Format	EXxxptb
Range	xx = Transformation p = Pitch and Roll t = 3 beam solutions b = Bin mapping
Default	EX11111



The default setting for this command is recommended for most applications.

Description EX sets firmware switches that control the coordinate transformation processing for velocity and percent-good data. See [Beam Coordinate Systems](#) for details.

Table 18: Coordinate Transformation Processing Flags

Setting	Description
EX00xxx	No transformation. Radial beam coordinates, I.E., 1, 2, 3, 4. Heading/Pitch/Roll not applied.
EX01xxx	Instrument coordinates. X, Y, Z vectors relative to the ExplorerDVL. Heading/Pitch/Roll not applied.
EX10xxx	Ship coordinates (Note 1) X, Y, Z vectors relative to the ship. Heading not applied. EA-command used, but not the #EV-command. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EX11xxx	Earth coordinates (Note 1) East, North, Vertical vectors relative to Earth. Heading applied. EA and #EV-commands used. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EXxx1xx	Use tilts (pitch and roll) in transformation (Note 2)
EXxxx1x	Allows 3-beam solutions if one beam is below the correlation threshold set by WC
EXxxx1	Allow bin mapping (see Note 4, next page)



1. For ship and earth-coordinate transformations to work properly set the Heading Alignment ([EA - Heading Alignment](#)) and Heading Bias ([EV - Heading Bias](#)) correctly. Ensure that the tilt and heading sensors are active ([EZ - Sensor Source](#)).
2. Setting EX bit 3 (Use Tilts) to 0 collects tilt data without using it in the ship or earth-coordinate transformations.
3. Each ExplorerDVL unit uses its own beam calibration matrix to correct data for beam pointing errors (e.g., if the beams erroneously point toward 21 degrees instead of 20 degrees). Correction is applied when the data are converted from beam coordinates to earth coordinates. If beam-coordinate data is output, apply the beam corrections yourself for the best possible data or use the *VmDas* software.
4. TRDI outputs the water profile bin 1 position for a level system only. We do not adjust the bin 1 position, or the cell sizes, for any tilt. Bin mapping attempts to combine data from sections of the beams that are at the same depth in the water, and does not make any attempt to calculate how that depth that depth might change for a tilted system. The setting of the EX command has no effect on the reported bin 1 distance or the cell size.

EZ – Sensor Source

Purpose	Selects the source of environmental sensor data.
Format	EZcdhprstu
Range	Firmware switches (see description)
Default	EZ22222220



The default setting for this command is recommended for most applications.

Description Setting the EZ-command firmware switches tells the ExplorerDVL to use data from a manual setting or from an associated sensor. When a switch value is nonzero, the ExplorerDVL overrides the manual E-command setting and uses data from the appropriate sensor. If the sensor specified by this command is not available, the best alternate sensor will be used (see the [EY – Sensor Source Override for Doppler Parameters](#) command for more information).

The following table shows how to interpret the sensor source switch settings.

Table 19: Sensor Source Switch Settings

FIELD		VALUE = 0	VALUE = 1	VALUE = 2
C	Speed of sound	Manual #EC (see EC - Speed of Sound)	Calculates using available depth, salinity and temperature.	External Speed of Sound Sensor
D	Depth	Manual #ED (see ED - Depth of Transducer)	TRDI Sensor Package Module	External Depth Sensor
H	Heading	Manual #EH (see EH - Heading)	Not Allowed	External Compass
P	Pitch (tilt 1)	Manual #EP (see EP - Pitch and Roll Angles)	TRDI Sensor Package Module	External Compass
R	Roll (tilt 2)	Manual #ER (see ER - Roll Angle)	Not used (Roll source specified by Pitch field)	Not used (Roll source specified by Pitch field)
S	Salinity	Manual #ES (see ES – Salinity)	Not Allowed	External Salinity Sensor
T	Temp	Manual #ET (see ET - Temperature)	TRDI Sensor Package Module, if available or Internal transducer sensor	External Temp Sensor
U	Up/Down Orientation	Manual #EU (see EU - Up/Down Orientation)	Not Allowed	Not Allowed

Example EZ10022010 means calculate speed of sound from available depth salinity and temperature, use #ED depth, #EH heading, external tilt sensors, #ES salinity, TRDI sensor package module temperature sensor if available or transducer temperature if not, manual up/down orientation.



The TRDI Sensor Package Module and the one wire sensors can also be specified with the appropriate bits set to “2” and the EY command set to 10 or 8, respectively (see [EY – Sensor Source Override for Doppler Parameters](#)).

When a PS1-command is sent, the displayed Fixed Leader data shows the available internal sensors connected to the ExplorerDVL. It does not show external sensors. To interpret this PS1 field, convert the value to binary.

If EZ pitch is one (internal sensor), a pendulum pitch correction will be applied that removes the effect of roll on pitch. This effect is common to most tilt sensors (electrolytic tilt and pendulum).

The pitch field of the EZ command controls the source for roll. The roll field is ignored and has only been retained for legacy purposes.

The heading coordinate frame is determined by the coordinate frame parameter of the #EH command for any heading source (command, internal or external). The pitch and roll coordinate frame is specified by the coordinate frame parameter of the #EP command for any heading source (command, internal or external). See [EH - Heading](#) and [EP - Pitch and Roll Angles](#) for more details.

Expert Environmental Commands

This section lists the expert Environmental commands. Commands that start with the # sign are considered “expert” commands.

>#E?

Available Commands:

```

EC 1500 ----- Speed Of Sound [m/s]
EE 0000010 ----- Rsrvd[4]; Cmd[1]; Rw/Nm[1]; Snsr Out[1]
EH 00000,1 ----- Heading {heading;frame}
EI +00000 ----- Roll Misalignment Angle [.01 deg cw]
EJ +00000 ----- Pitch Misalignment Angle [.01 deg cw]
EP +0000,+0000,1 ----- Tilts {pitch;roll;frame}
ER +0000 ----- Roll [.01 deg cw]
ET 2100 ----- Water Temperature [.01 deg C]
EU 0 ----- Orientation [0=Switch,1=Up,2=Down]
EV +00000 ----- Heading Bias [.01 deg cw]
EY 0 0 0 0 0 0 0 0 ----- Dplr Param Override Src {c;d;h;p;r;s;t;u}
E? ----- Display #B-Command Menu

```

#EC – Speed of Sound

Purpose Sets the speed of sound value used for ExplorerDVL data processing.

Format #ECnnnn

Range nnnn = 1400 to 1600 meters per second

Default #EC1500



The default setting for this command is recommended for most applications.

Description #EC sets the sound speed value used by the ExplorerDVL to scale velocity data, depth cell size, and range to the bottom. The ExplorerDVL assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.



If the EZ Speed of Sound field = 1, the ExplorerDVL overrides the manually-set #EC value and calculates speed of sound using the values determined by ED ([ED - Depth of Transducer](#)), ES ([ES – Salinity](#)), and #ET ([ET - Temperature](#)). EZ also selects the source for ED, ES, and #ET.



The EC command will work with and without the # prefix.

#EE – Environmental Data Output

Purpose	Controls output of specialized data types; controls whether a transform of velocity data to raw or nominal beam is done with associated corrections in the case of the phased array system.
Format	#EE <i>abcdefg</i>
Range	Firmware switches (see description)
Default	#EE 0000000 (Piston) #EE 0000010 (Phased Array)



The default setting for this command is recommended for most applications.

Description Bits “a” and “b” reserved for future use.

Bits *c* and *d* are reserved for future use.

Bit *e* controls the output of Environmental Command Parameters.

Bit *e* = one causes this data type to be output. See [Environmental Command Parameters Output Format](#) for a description of this data type.

Bit *f* signifies the use of the Phased Array transducer. For Phased Array systems, bit *f* controls the type of correction performed on the beam velocity data. For phased arrays, setting bit *f* to one applies the following corrections for all coordinate transforms of all ping types:

- Speed of Sound correction to vertical component
- Phase slope error due to vertical component.

Setting bit *f* to one also results in nominal 30° beam coordinate velocities output in the ensemble, and apply the system Beam correction matrix to correct for Beam pointing errors and hence output velocities in nominal 30° Beam coordinate system.

Setting bit *f* to zero results in raw beam velocities output in the ensemble and no Speed of sound or Phase Slope corrections applied.

Bit *g* controls the output of a data type with sensor source for parameters needed for Doppler calculations. This data indicates what sensors data were used for parameters of the Doppler calculation. This may be different than that specified by the EZ ([EZ - Sensor Source](#)) and EY ([EY – Sensor Source Override for Doppler Parameters](#)) commands depending on whether a sensor failed. Setting bit *g* to one causes this data type to be output. See Table 46 for a definition of this data type.

#EH – Heading

Purpose	Sets the ExplorerDVL heading and the coordinate frame (instrument or ship) to which #EH-command input refers.
Format	#EH <i>xxxx, y</i>
Range	<i>xxxx</i> = 0 to 35999 1/100ths of a degree <i>y</i> = 0 for instrument coordinates <i>y</i> = 1 for ship coordinates
Default	#EHO,0 (Stationary systems), #EHO,1 (Vessel)



The default setting for this command is recommended for most applications.

Description	<p>#EH sets the ExplorerDVL heading and heading coordinate frame if both arguments are entered.</p> <p>#EH sets the ExplorerDVL heading if only one argument is entered. This heading value is assumed to be in instrument coordinates. Figure 18 shows transducer beam axes and tilt signs.</p> <p>#EH may be entered after the unit is commanded to ping (CS command) and will be used in subsequent pings.</p>
Example	<p>Convert heading values of -21.5 degrees to #EH-command values referenced to ship coordinates.</p> <p>Heading in hundredths = $21.50^\circ \times 100 = 2150$ EH 2150, 1 (+ in front of 2150 is optional)</p>



If the EZ Heading field = 1, the ExplorerDVL overrides the manually-set #EH value and uses heading from the transducer's internal sensor. If the EZ Heading field = two the ExplorerDVL takes heading from an external synchro. If EZ Heading field is zero the ExplorerDVL uses the manual EH command settings.

See [EZ - Sensor Source](#) for more details and restrictions for the case of mixed heading sources.

#EI – Roll Misalignment Angle

Purpose	Corrects for a physical roll-like misalignment between the x-axis of the instrument and the ship's starboard axis.
Format	#EI±nnnnn
Range	±nnnnn = -17999 to 18000 1/100ths of a degree
Default	#EI0



Set as needed.

Description	<p>#EI is a rotation about the ship's forward axis. It is defined as the roll of the ship when the instrument is level.</p> <p>For systems that have a roll source referenced to ship coordinates (typical for vehicles), use #EI to set the amount of rotation that the instrument's x-axis is physically offset from the ship's starboard axis. For such systems, the #EI command can also be used to align an upward pointing unit (e.g., mounted on a submarine) to the ship's axis by setting it to 18000.</p> <p>For systems that have attitude referenced to internal coordinates, #EI is typically set to zero since the velocity data is referenced to either beam, instrument or geographic coordinates instead of ship coordinates.</p> <p>For an upward pointing unit with instrument referenced attitude, use EU to align the instrument attitude data with the ship coordinates for use in velocity transformation.</p>
-------------	---

#EJ – Pitch Misalignment Angle

Purpose	Corrects for a physical pitch-like misalignment between the y-axis of the instrument and the ship's forward axis.
Format	#EJ±nnnnn
Range	±nnnnn = -17999 to 18000 1/100ths of a degree
Default	#EJo



Set as needed.

Description	<p>#EJ is a rotation about the ship's starboard axis. It is defined as the pitch of the ship when the instrument is level.</p> <p>For systems that are fixed in place on a moving vessel and that have an external pitch source or an internal pitch source, use #EJ to set the amount of rotation that the instrument's y-axis is physically offset from the ship's forward axis.</p> <p>For systems that are stationary and have an internal compass, #EJ is typically set to zero since the velocity data is referenced to either beam, instrument or geographic coordinates instead of ship coordinates. However, a non-zero value may be used if ship attitude output data is desired for other purposes (see EE - Environmental Data Output).</p>
-------------	---

#EP – Pitch and Roll Angles

Purpose	Sets the ExplorerDVL pitch (tilt 1) and, optionally, the roll (tilt 2) and the coordinate frame (instrument or ship) to which all pitch and roll inputs (including sensors) refer. Alternatively, the #EP commands may be used with single arguments, in which case it is assumed that the pitch and roll inputs represent the pitch and roll of the instrument rather than those of the ship.
Format	#EP±xxxxx, ±yyyyy, z
Range	±xxxxx and ±yyyyy = -17999 to +18000 hundredths of a degree z = 0 for instrument coordinates, z = 1 for ship coordinates
Default	#EP0,0,1



Set as needed.

Description	<p>#EP sets the ExplorerDVL pitch (tilt 1) and roll (tilt 2) and the pitch/roll coordinate frame if all three arguments are entered. #EP sets the ExplorerDVL pitch (tilt 1) if only one argument is entered. This pitch value is assumed to be in instrument coordinates.</p> <p>If only two fields are entered, a command entry error is issued. Figure 18 shows transducer beam axes and tilt signs.</p>
Example	Convert pitch and roll values of +14 degrees and -3.5 degrees to #EP-command values referenced to ship coordinates.

```
Pitch in hundredths = 14.00 × 100 = 1400
Roll in hundredths = -3.50 × 100 = -350
#EP 1400, -350, 1 (+ in front of 1400 is optional)
```

#ER – Roll Angle

Purpose	Sets the ExplorerDVL roll angle that will be used by the system if the corresponding EZ bit is set to 0.
Format	#ER±nnnnn
Range	±nnnnn = -17999 to +18000 hundredths of a degree
Default	#ERO



Set as needed.

Description This command allows the user to input a roll (tilt 2) value that will be used if the roll EZ bit is set to zero. The coordinate frame of this data corresponds to the third parameter of the #ER command. Roll can also be entered with pitch and the pitch/roll coordinate frame in the #EP command (see [EP - Pitch and Roll Angles](#)). See the description of the EZ command ([EZ - Sensor Source](#)) to see how this commands value is used.

Example Convert roll values of +14 and -3.5 to #ER-command values.

```
#ER = 14.00 × 100 = 1400 = #ER01400 (+ is understood)
#ER = -3.50 × 100 = -350 = #ER-00350
```

#ET – Temperature

Purpose	Sets the water's temperature value.
Format	#ET±nnnn
Range	±nnnn = -500 to 4000 (-5.00 C to +40.00 C)
Default	#ET2100



Use the EZ-command (see [EZ - Sensor Source](#)).

Description #ET sets the temperature value of the water. The ExplorerDVL uses #ET in its speed of sound calculations (see the primer). The ExplorerDVL assumes the speed of sound reading is taken at the transducer head.

Example Convert temperatures of +14 C and -3.5 C to #ET-command values.

```
#ET = 14.00 × 100 = 1400 = #ET1400 (+ is understood)
#ET = -3.50 × 100 = -350 = #ET-0350
```



If the EZ Temperature field = one, the ExplorerDVL overrides the manually set #ET value and uses temperature from the transducer's temperature sensor. If the sensor is not available, the ExplorerDVL uses the manual #ET setting.

#EU – Up/Down Orientation

Purpose	Sets the ExplorerDVL up/down orientation.
Format	#EU <i>n</i>
Range	<i>n</i> = 0, 1, or 2 (0 = switch based on tilt, 1 = fix to up orientation, 2 = fix to down)
Default	#EU0



Use the EZ-command (see [EZ - Sensor Source](#)).

Description In conjunction with the EZ command, #EU is used to manually specify the orientation of the ExplorerDVL.



The #EU command can be used to align an upward pointing unit (e.g., mounted on a submarine) if the roll source is in instrument coordinates. In this case, the #EU command will invert instrument coordinate roll. Use the #EI command instead if the roll source is referenced to ship coordinates (see [EI - Roll Misalignment Angle](#)).

#EV – Heading Bias

Purpose	Corrects for electrical/magnetic bias between the ExplorerDVL heading value and the heading reference.
Format	#EV± <i>nnnnn</i>
Range	± <i>nnnnn</i> = -17999 to 18000 1/100ths of a degree
Default	#EV0



Set as needed.

Description #EV is the heading angle that counteracts the local bias or magnetic variation (declination) between the ExplorerDVL and the heading source. #EV is added to heading (either in ship or instrument coordinates) for use in velocity transformation and ensemble output (see Figure 41, page 143).

Use the EA-command to correct for physical heading misalignment between the ExplorerDVL and a vessel's centerline (see [EA - Heading Alignment](#)).

Examples

1. An ExplorerDVL system is receiving heading from a compass. A magnetic variation chart for the deployment area shows a variation of W3.5 (-3.5). To counteract the effects of this magnetic field, enter a heading bias value of -3.5. To convert -3.5 to a #EV-command value, multiply the desired bias angle in degrees by 100: #EV = -3.5 × 100 = -350 = #EV-350.
2. Magnetic maps (such as NOAA) usually provide these types of reading: 10°10'W 1995 (9'E/year). This means the magnetic offset in the year 2001 at this location is (- (10+10/60) + (9/60*6)) = -9.26666 degrees. Set the #EV command value to #EV-926.

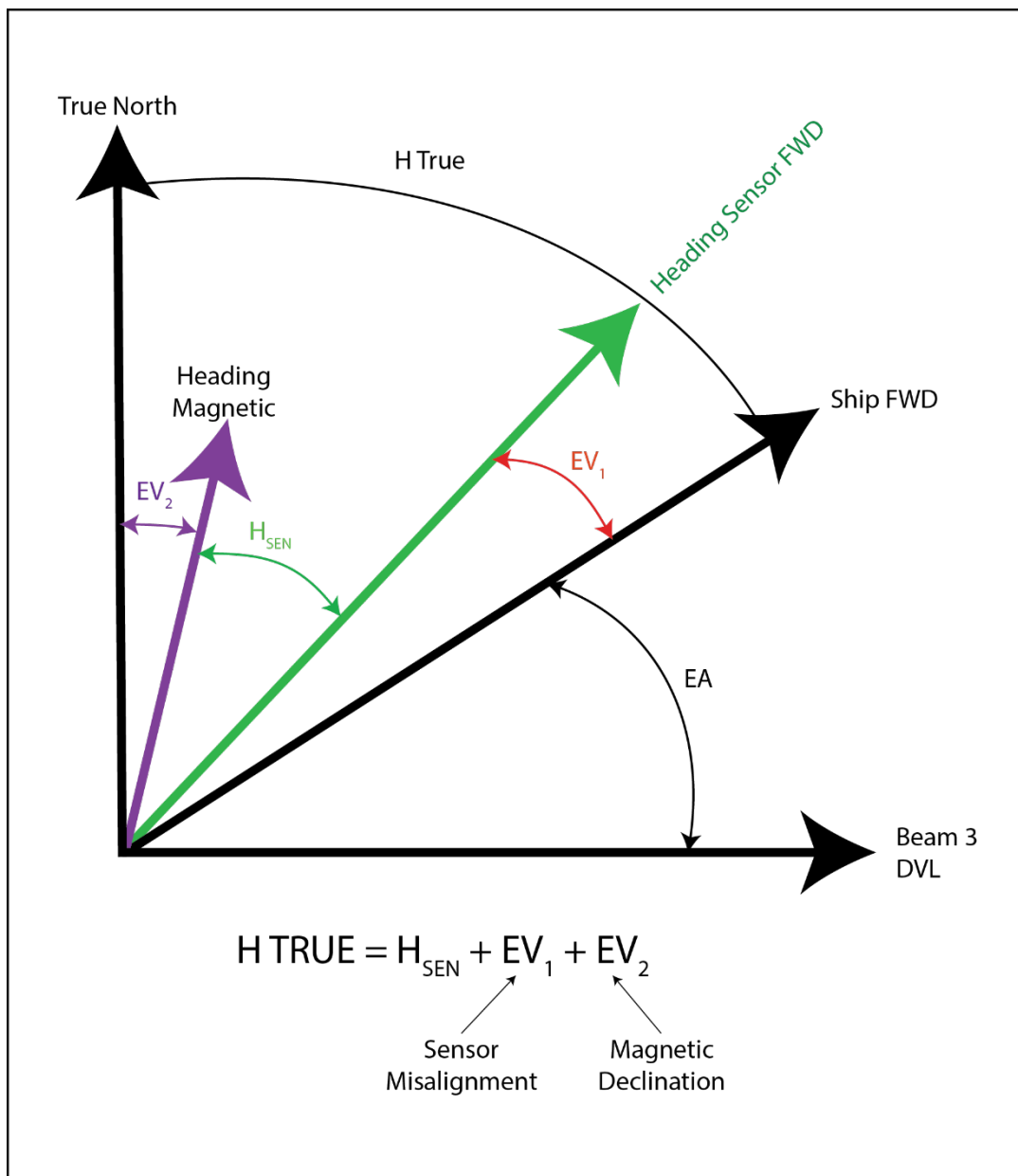


Figure 41. Heading Bias

#EY – Sensor Source Override for Doppler Parameters

Purpose When an external sensor is selected via the EZ command, this command selects a sensor to use for a specific parameter needed for Doppler processing. This overrides the default priority selection table built in the firmware that maps sensors to parameters needed in Doppler processing. This command is only needed if more than one sensor connected to the system can supply a parameter needed for Doppler processing (e.g., many sensors can supply temperature) and the default source in Table 20 is not the desired source.

Format #1 #EY c d h p r s t u

Range Each digit is the sensor ID in the following table that identifies the sensor that is used for the parameter in [EZ - Sensor Source](#). A “2” must be in the corresponding digit of the EZ command for this command to be applied. An id of 0 disables overriding of the firmware priority selection logic: this command then has no affect. 1-10 specifies a sensor corresponding to Table 20:

Table 20: External Sensor Source Range (1-10)

Sensor	ID	Manufacturer	Model
Streaming HPR Device	1	SBG/GPS/TRDI	Strings: \$SBG01/\$xxHDT/\$PRDID (see tables Table 22 to Table 24)
GPS1	2	Garmin	15H-W
Pressure (Press1)	3	Paroscientific	8000 Series
Speed of Sound (SoS1)	4	Applied MicroSystems	MicroSVT&P
Mag Compass #1	5	Honeywell/SBG	HMR3000/IG-500
CTD1	6	Seabird	Fast Cat (SBE 49)
Echo Sounder	7	Benthos	PSA916
Temperature	8	TRDI Internal in Transducer	Dallas 18B20 One Wire
Mag Compass #2	9	PNI	TCM5/TRAX
Pitch, Roll, Temp, Press	10	TRDI Sensor Package	72B-1000-00

Format #2 #EY b id

Range The “id” parameter of this command is the sensor ID in the table above that identifies the sensor that is used for the parameter corresponding to digit “b” of the EZ command. That digit must be “2” for this command to be applied. An “id” of 0 disables overriding of the firmware priority selection logic: this command then has no affect.

Default #EY 0000 0000



Set as needed.

Example Setting the #EY command to #EY 0 0 0 0 0 3 0 would command the unit to use the temperature data from the Paroscientific pressure sensor for temperature data in Doppler calculations. This is equivalent to the command #EY 7 3.

Description Multiple sensors can output the same parameter needed for the Doppler velocity calculation. The firmware has logic that attempts to use the best sensor for each parameter needed in Doppler processing. This logic also defaults to backup sensors’ data, if available, in the case the primary sensor has failed. However, it may be the case that the user wants to override this logic and choose which sensor is used for a particular Doppler parameter.

This command overrides the primary sensor in that firmware logic with one that is selected with this command. The primary sensor and the other alternate sensors are then used as backups in case the sensor selected using this command failed.

Table 21 shows the effect of #EY on the firmware logic for selecting sensor data for a Doppler parameter:

Table 21: Selecting Sensor Data

Doppler Data Input	Source when EY bit not 0	Primary Sensor Source when EY bit 0	Alternate Source					
			#1	#2	#3	#4	#5	#6
Speed of Sound	ID of EY, entry 1	CTD1	SoS1	RDI calc ¹	---	---	---	EC Cmd
Depth (from surface) and Pressure	ID of EY, entry 2	Press1	CTD1	SoS1	TRDI Sensor Package	Vert Beam ²		ED Cmd
Heading	ID of EY, entry 3	Gyro Cmp	Mag Cmp 1	Mag Cmp 2	---	---	---	#EH Cmd
Pitch	ID of EY, entry 4	Gyro Cmp	Mag Cmp 1 or 2		TRDI Sensor Package	---	---	#EP Cmd
Roll	ID of EY, entry 5	Gyro Cmp	Mag Cmp 1 or 2	Mag Cmp 2	TRDI Sensor Package	---	---	#ER Cmd
Salinity	ID of EY, entry 6	CTD1	---	---	---	---	---	ES Cmd
Temperature	ID of EY, entry 7	CTD1	SoS 1	Press1	TRDI Sensor Package	Transducer One Wire	Mag Cmp 2	ET Cmd



1. The calculation for speed of sound depends on temperature, depth, and salinity. These parameters shall be used from sensors as indicated from this table, or from user defined values if the corresponding EZ bit is 0.
2. Feature that may be added later.
3. If the sensor is not assigned to a port or it is not possible to obtain the data from the sensor, then the next available sensor's data in the priority selection logic is used.

Sensor ID#1 is an NMEA External Input Driver – ExplorerDVL sniffs out NMEA strings in the buffer of one of the Ext sensor comports and looks for the latest NMEA string we can accept closest to the ping that is valid and uses its data for the ping.

Strings accepted are:

- \$__HDT
- \$PRDID
- \$SBG01

HDT – Heading – True

Actual vessel heading in degrees True produced by any device or system producing true heading.

\$__HDT,x.x,T *hh<CR><LF>

Table 22: HDT NMEA Format

Field	Description
1* x.x	Heading, degrees True
2 T	HEX 54: T Indicates heading relative to True North



The first two characters match your device. An example of the HDT string from a Trimble device is: **\$GPHDT,123.456,T*00**

\$PRDID

TRDI defines a proprietary NMEA message that contains ship heading, pitch, and roll data.

```
$PRDID,x.x,x.x,x.x,*hh<CR><LF>
```

Table 23: PRDID NMEA Format

Field	Description
1	x.x Vessel Pitch, degrees. Pitch is positive for bow up
2	x.x Vessel Roll, degrees. Roll is positive for starboard down
3	x.x Vessel Heading, degrees True

\$SBG01

SBG01 supports the NMEA string from the SBG IG500 AHRS sensor. This is a higher grade sensor than the PNi Trax as it uses better MEMs sensors and has a more extended Kalman filtering which makes it more versatile in terms of environmental conditions and also a more robust embedded sensor. Time and Euler angles are provided in this frame.

```
$SBG01,hhmmss.ss,roll,pitch,yaw,acc*cs<CR><LF>
```

Table 24: SBG01 NMEA Format

Field	Name	Format	Description
0	\$GPZDA	string	Message ID – SBG01 message
1	Time	hhmmss.ss	UTC time, current time
2	Roll	[-]ddd.dd	Roll angle in degrees [-180 to 180]
3	Pitch	[-]dd.dd	Pitch angle in degrees[-90 to 90]
4	Yaw	[-]ddd.dd	Yaw angle in degrees [-180 to 180]
5	Acc	ddd.dd	Estimated accuracy
7	Checksum	*cs	Checksum: Xor of all previous bytes excluding \$
8	End of frame	<CR><LF>	End of frame: carriage return and line feed

Example frame:

```
$SBG01,010605.18,-000.34,-06.67,007.36,001.49*60<CR><LF>
```


Loop Recorder Commands

The loop recorder contains approximately two megabytes of solid-state nonvolatile memory, which can be used to continuously record data. If more data is collected than fits in the memory, the oldest data will be overwritten with the newest data. The last two megabytes of data is always available for download.

The loop recorder is intended to be used on the ExplorerDVL for troubleshooting purposes during commissioning and integration of the system.

```
>M?
Available Commands:

ME ----- ErAsE recoder
MM ----- Show memory usage
MN EXP - Set file name [1..32 characters]
MR 0 ----- Set recorder on/off [0=off,1=on]
MY ----- Y-Modem output
M? ----- Display M-Command Menu
```

Recorder Command Descriptions

This section lists the Recorder commands.

ME – Erase Recorder

Purpose Erase the contents of the recorder.

Format ME ErAsE



Use as needed.

Description ME ErAsE erases the recorder memory. To make it more difficult to accidentally erase the data, the word “erase” must be typed with exactly one space after the “ME” (which is not case sensitive) and with alternating upper and lower case letters, as shown.

```
>ME ErAsE
[ERASING...]
```



Once erased, data is not recoverable.

MM – Show Memory Usage

Purpose Shows recorder memory usage.

Format MM



Use as needed.

Description Shows memory usage and the number of used and free pages.

```
MM Loop Recorder pages: used = 0, free = 4096, bytes/page = 528
```

```
>
```

MN – Set File Name

Purpose	Sets the file name for the recorder.
Format	MN <i>xxx</i>
Range	<i>xxx</i> = file name up to 32 characters long
Default	MN EXP



Use as needed.

Description The MN command sets the deployment name to be used for any future deployments. The deployment name can be up to 32 characters long, and may contain letters, numbers, or the underscore (i.e. “_”) character. If no deployment name is specified a default of “EXP” is used. The deployment name is used as part of the file name for data files when downloaded to the computer using *TRDI Toolz*.

In order to prevent data files on the computer from being overwritten, a ten-digit time stamp is appended to the file name when **OK** is clicked on the **Download Directory** dialog box.

For example, the file *EXP3281997475.000* would contain data for the deployment named “EXP” (the *3281997475* in the filename is the number of seconds since January 1st, 1900). The file extension is always “.000”. Waiting 25 seconds and downloading the same data again, the file name will change to *EXP3281997500.000*.

MR – Set Recorder On/Off

Purpose	Turns the recorder on or off.
Format	MR <i>n</i>
Range	<i>n</i> = 0, turn recorder off; <i>n</i> = 1, turn recorder on
Default	MRO



Use as needed.

Description Use the MR command to turn the recorder on/off.

MY – Y-Modem Output

Purpose	Uploads recorder data to a host computer using standard YMODEM protocol.
Format	MY



Use *TRDI Toolz* to recover data.

Description Use the MY command to recover data from the recorder only when *TRDI Toolz* is not available to recover the data.

The MY command uploads the entire contents of the recorder via the serial interface to a host computer using the standard YMODEM protocol for binary file transfer. Any communications program that uses the YMODEM protocol may be used to upload the recorder data. The data is transferred to the host and stored as DOS files.

Performance and Testing Commands

The ExplorerDVL uses the following commands for calibration and testing.

Available Performance and Testing Commands

This section lists the available Performance and Testing commands.

```
>P?
Available Commands:


PA ----- Run Go/No-Go Tests
PC ----- Built In Tests [0=help]
PS ----- System Info [0=config,1=fldr]
PT ----- Transmit, Receive and Continuity
P? ----- Display P-Command Menu
```

PA – Pre-deployment Tests

Purpose Sends/displays results of a series of system diagnostic tests.

Format PA

Description These diagnostic tests check the major modules and signal paths. TRDI recommends running this command before a deployment. These tests check non-volatile memory and ROM of the processor board. Also, the transmit and receive circuitry is tested using the PT3 and PT5 tests, respectively. See [PT3 – Receive Test](#) and [PT5 – Transmit/Receive Continuity Check Test](#) for more details.



The transducer should be in water when running the PA test. It is safe to run the PA test in air, but if the test results in FAILED, then it must be ran in water to confirm the validity of any failure.

Example See below

```
>pa
RAM test.....PASS

ROM test.....PASS

Receive Path Test (Hard Limited):
      H-Gain W-BW      L-Gain W-BW      H-Gain N-BW      L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4  Bm1 Bm2 Bm3 Bm4  Bm1 Bm2 Bm3 Bm4  Bm1 Bm2 Bm3 Bm4
0 100 100 100 100  100 100 100 100  100 100 100 100  100 100 100 100
1  81  79  81  82    82  83  83  81    81  83  80  81    81  83  82  81
2  45  45  47  48    46  51  54  49    49  50  45  40    46  49  47  43
3  20  21  25  24    17  28  30  26    22  19  21  10    17  16  21  13
4   3  15  10   7     5  17  16  14     4   5  11   8     5   8   8   7
5   5   8   3   1     8  11   7   8     3   8   5  13     8  12   3  14
6   9   8   4   3    15   8   4   6     2   8   8   7     7  10   2  13
7   9  10   5   6    17   4  10   9     4   8   7   2     4  11   3  12
  P   P   P   P
Sin Duty Cycle (percent)
  50  47  52  46    47  50  48  48    52  50  48  47    49  49  46  47
  P   P   P   P
Cos Duty Cycle (percent)
  51  53  48  51    50  48  49  50    53  52  47  55    44  53  46  50
  P   P   P   P
RSSI Noise Floor (counts)
  54  60  70  58    38  43  53  42    65  70  80  68    44  49  58  47
  P   P   P   P
RESULT...PASSED
```

Transmit/Receive Continuity Check:

```
Test                               Beam
                                     1       2       3       4
Noise (Amp/Rslt):   58/ PASSED   64/ PASSED   73/ PASSED   58/ PASSED
Elect (Amp/Rslt):   168/CONNECTED 172/CONNECTED 180/CONNECTED 169/CONNECTED
Ceramics (Amp/Rslt):146/CONNECTED 152/CONNECTED 156/CONNECTED 145/CONNECTED
```

RESULT...PASSED

Composite Result:
GO for Deployment

Failed example:

↓
RESULT...FAILED

Composite Result:
NO-GO for Deployment



The transducer should be in water when running the PA test. It is safe to run the PA test in air, but if the test results in FAILED, then it **must be ran in water to confirm the validity of any failure.**

PC – User-Interactive Built-In Tests

Purpose	Allow the user to view the values of sensor data used in Doppler processing and to identify the source of the data. IDs.
Format	PC nnn
Range	$nnn = 0, 2$
Description	PC0 displays the help menu. PC1 is reserved for TRDI use. PC2 continuously displays at approximately 1 sec update the current system temperature, pressure, depth, heading, pitch and roll. The sensor ID corresponding to their source is displayed next to each. Refer to the EY command for a list of sensors. The source of the data is assigned by the EZ and the EY commands or internal logic if the primary sensor is not available. See EY – Sensor Source Override for Doppler Parameters for a description of that logic.
Example	See below.

```
>pc2
Sensor data is sampled and displayed in a loop.
The number to the right of each backslash indicates the ID of the
  sensor used for that data.
Press any key to exit the loop.

  Temp (degC)  Press (kPa)  Depth (m)  Hdg (deg)  Pitch (deg)  Roll (deg)  Vin
/ 24.94/10    99.063/10    10.104/10  0.00/0    0.18/10    0.59/10    12.58

>
```



The transducer should be in water when running the PC2 test.

PS – Display System Parameters

Purpose Displays ExplorerDVL system configuration data.

Format PS n

Range $n = 0$ to 4

PS0 – System Configuration Info

```
>ps0
  Serial Number: 0
    Frequency: 614400 Hz
  Configuration: ExplorerDVL : 4-beam velocity.
  Transducer Type: PISTON
    Beam Angle: 30 Degrees
    Beam Pattern: CONVEX
    Sensors: TEMP PRESS TILTS

    CPU Firmware: 34.xx
    FPGA Version: 3.00.005
    Sensor Firmware: 33.03

Board Serial Number Data:
53 00 00 00 15 5A 04 28
4F 00 00 00 34 A7 60 23   BFP72B-1102-03X
DC 00 00 00 41 51 C4 23   DSP72B-2102-00X
E6 00 00 00 41 7E A6 23   PER72B-2104-00X
F0 00 00 00 34 A7 89 23   BFT72B-1101-03X
8F 00 00 00 3D 07 1B 23   RCV72B-2103-03X
A1 00 00 00 32 00 67 23   SNS72B-1000-00A
4B 00 00 00 34 A6 5F 23   PIO72B-2101-00X
```

PS1 – Display Fixed Leader (binary)

PS1 sends the Fixed Leader parameters (i.e., fixed system commands and hardware/firmware information) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see [Fixed Leader Data Format](#)). For example, a Hex-ASCII output may look like this:

```
>PS1
3B00001C0D4C21003502320A001900190001480300E8030000320A941100007D2D3D0023000101FF000C000
000000000000000000000000DC1200001914
>
```



The output format of the PS1 command is determined by the CF command (see [CF - Flow Control](#)).

PS3 – Instrument Transformation Matrix

PS3 sends information about the transducer beams. The ExplorerDVL uses this information in its coordinate-transformation calculations; for example, the output may look like this:

```
>ps3
Instrument Transformation Matrix:
  1.004537   -1.004879   0.005736   -0.006243
  0.007302   -0.005948   -1.000888   0.996154
  0.289602   0.288031   0.286187   0.290252
 -0.707468  -0.707612   0.706830   0.711150

>
```

PS4 – Ping Sequence

This command returns the Bottom Track and Water profile ping sequence (see example below). Send PS4 to the ExplorerDVL anytime to get the ping sequence for one ensemble:

```
Explorer DVL
Teledyne RD Instruments (c) 2007
```

All rights reserved.
Firmware Version: 34.09

>B?

Available Commands:

```
BP 1 ----- Number of BT Pings in ensemble [0-999]
BK 0 ----- WMass Mode [0=off 1=WB 2=LostB 3=W]
BX 01000 ----- Max Depth (dm) [10-65535 dm]
B? ----- Display B-Command Menu
```

>ps4

Ping Sequence: B

>WP1

>ps4

Ping Sequence: WB

>BP2

>ps4

Ping Sequence: B WB

>WP2

>BP1

>ps4

Ping Sequence: W WB

>

‘W’ stands for one single Water Profiling ping and ‘B’ stands for one single Bottom Tracking ping.

PT – Diagnostic Tests

Purpose Displays results of the system diagnostic tests.

Format PT nnn

Range $n = 0$ to 200

Description See below



The transducer should be in water when running the PT3 and PT5 tests. It is safe to run the PT tests in air, but if the test results in FAILED, then it **must be ran in water to confirm the validity of any failure.**

PT0 - Help

The PTO command displays the test menu (shown below). As implied by the NOTE, adding 100 to the test number repeats the test continually until the ExplorerDVL receives a <BREAK>. Sending PT200 runs all tests. PT300 runs all tests continually until the ExplorerDVL receives a <BREAK>.

Example:

```
>pt0
Built In Tests
-----
PT0 = Help
PT3 = Receive Path Test
PT5 = Transmit/Receive Loop Test
PT7 = Transmit/Receive Wiring Check
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT3 – Receive Test

This test displays receive path characteristics.

Example:

```
>pt3
Receive Path Test (Hard Limited):
      H-Gain W-BW      L-Gain W-BW      H-Gain N-BW      L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4      Bm1 Bm2 Bm3 Bm4      Bm1 Bm2 Bm3 Bm4      Bm1 Bm2 Bm3 Bm4
  0 100 100 100 100      100 100 100 100      100 100 100 100      100 100 100 100
  1  80  84  82  81        81  83  80  82        82  82  79  81        83  80  80  82
  2  42  46  49  48        44  49  43  47        47  46  41  46        52  42  45  46
  3  15  18  23  24        25  22  14  24        22  13  13  17        26  15  16  18
  4   6   0  10  10        22  10   6  15         4  12   2   1        10   8   4   4
  5   5   6   9   4        15   4  11   7         7  13   9  11         2   9   7   2
  6   4  11   9   2        11   6  14   6         7  11   8  11         6   6   7   3
  7   5  13   6   6        11   7  13   8         5  13  10  11         7   1   5   5
      P   P   P   P
Sin Duty Cycle (percent)
  50 49 42 43        47 47 47 43        53 49 51 53        49 46 45 50
      P   P   P   P
Cos Duty Cycle (percent)
  49 53 50 43        49 52 48 45        48 54 49 54        51 52 50 51
      P   P   P   P
RSSI Noise Floor (counts)
  54 60 69 58        38 43 53 42        65 72 80 69        43 48 58 47
      P   P   P   P
RESULT...PASSED
```

>
PT3 is considered to have normal values if:

1. Correlation at the last lag is less than 25%.
2. The duty cycle of sine and cosine does not vary from 50% by more than +/-15%.
3. RSSI noise level is less than 90 counts for the high gain, wide bandwidth setting.

PT5 – Transmit/Receive Continuity Check Test

This test checks the entire for signal path continuity (transmitter - transducer – receiver). The test determines if the transducer electronics are connected and, if so, whether the ceramics are connected. The test must be run with the transducer in water. The first line of the test result measures the noise amplitude level of the system in counts; this is used as a reference in the test.

The transducer electronics connection is tested by comparing the amplitude level in the middle of the transmit pulse to the noise level. If it is above a threshold, the transducer electronics are connected to the electronics enclosure.

The test to determine whether the ceramics are connected to the transducer electronics is attempted only if the transducer electronics are connected. The ceramic connection is confirmed by comparing the amplitude level immediately after transmit (the ringing level) to the noise level. If it is greater than the noise level by a threshold, then the ceramic is connected.

Example:

```
>pt5
Transmit/Receive Continuity Check:

Test                               Beam
      1           2           3           4
Noise (Amp/Rslt):  58/ PASSED  63/ PASSED  75/ PASSED  59/ PASSED
Elect (Amp/Rslt):  168/CONNECTED 172/CONNECTED 180/CONNECTED 169/CONNECTED
Ceramics (Amp/Rslt):10/CONNECTED 15/CONNECTED 12/CONNECTED 18/CONNECTED

RESULT...PASSED

>
```

PT5 has the following pass/fail criteria:

1. Noise level is less than 90 counts is passing.
2. The amplitude level at 1/2transmit is at least 120 counts for the transducer electronics to be considered connected.
3. The amplitude level immediately after transmit must be no more than 30 counts below the transmit level for the phased array system to pass. Otherwise, the ceramic(s) will be considered disconnected and the test will report a failure.

PT7 – Transmit/Receive Wiring Check

The test is useful for OEM integrators since its intended purpose is to check the wiring of the phased array. It is able to detect but not isolate wiring faults. If this test fails, a careful check of the transmit and receive cables should be undertaken.



Run this test at the ExplorerDVL nominal voltage of 24VDC. This test was in the PA command, but was removed in firmware version 34.15 since it often fails because of the voltage level.

>PT7

Transmit/Receive Wiring Check:

Running PT5 first to check enclosure and pre-amp electronics are connected...

One or more beams have transducer electronics that are disconnected

From the enclosure electronics. Fix that and retry.

>



If this test fails, make sure to re-run it at 24VDC; a failure on this test is only relevant at the nominal voltage.

Expert Performance and Testing Commands

This section lists the expert Performance and Testing commands. Commands that start with the # sign are considered “expert” commands.

```
>#P?
Available Commands:

PD 0 ----- Data Stream Select
P?  ----- Display P-Command Menu
```

#PD – Data Stream Select

- Purpose** Selects the type of ensemble output data structure.
- Format** #PDn
- Range** n = 0, 4, 5, and 6 (see description)
- Default** #PD0



The default setting for this command is recommended for most applications.


Description #PD selects the normal output data structure, a special application data structure, or a fixed data set for transmission/display as the data ensemble (see Table 25).

Table 25: Data Stream Selections

Format	Description
PD0	PD0 Sends The real water-current data set
PD4	PD4 Sends CSS-ExplorerDVL output data structure (without sensor and made-good data).
PD5	PD5 Sends CSS-ExplorerDVL output data structure (with sensor and made-good data).
PD6	PD6 Sends an ASCII data stream containing bottom track and water layer velocity information for all coordinate transformations.



Most of TRDI’s software supports PD0 formatted data.



The PD command will work with and without the # prefix.

Sensor Commands

The ExplorerDVL uses the following commands for the sensors.

Available Sensor Commands

This section lists the available Sensor commands.

```
>s?
Available Commands:

SC ----- Sensor Commands [ID Event Time-out "Command"]
SD ----- Sensor Data Out [ID abcd..., a-d=1/0]
SM ----- Snsr Auxlliary Menus [sid]
SP 0 99;0 99;0 99;0 99 ---- Sensor-port Assign [sp p sid [to]]
SR ----- Sensor Reset [sid]
S? ----- Display S-Command Menu
```

SC – Sensor Command

Purpose The SC commands stores commands for individual sensors to be sent by the system to the sensor at predefined times (initialization, sampling, etc.).

Format SC *n e t* “*c*”

Range *n*: specifies a sensor ID corresponding to table of the [EY command](#). Note that this id must be entered in a two digit format (zero pad, if needed).

e: 0-1 events corresponding to the following table:

Table 26: Sensor Command Bit “e”

SC (e)	Event
0	Sensor Reset (as a result of the user issuing the SR or CS commands)
1	Sensor Sample Variable Data (before each ping)

t: 0 to 65535 one hundredths of a second time out limit. A time-out value of zero defaults to the time-out limit specified by [SP - Sensor Port Assignment](#).

c: range N/A (command string in quotes that depends on each sensor – see each sensor’s manual)

Default SC 01 0 0 “” (Similar for other sensors (n=>1)).



Set as needed.

Description This command allows user defined commands to be downloaded at various, predefined times during the interaction of the system with each sensor instead of the default commands. For a list of default commands downloaded to the sensor, see [Default Commands Downloaded to the External Sensors](#).

Only one command at a time can be entered in the “c” string of the SC command. Thus, if one of the sensors needs several commands to be sent at events 0 or 1 (see description in Table 26); one SC command will have to be entered for each command. The commands must be stored in non-volatile memory by executing the CK command prior to starting deployment with the CS command. Otherwise, if the commands need to be resent to the sensor to reset a sensor as a result of fault (time-out or buffer overflow), then they will not be available unless they have been saved to non-volatile memory with the CK command.

All events when the system interacts with the sensors can have user commands downloaded except during sampling of setup data. Retrieval of setup or configuration data is controlled by the SD command and either all or none of the default commands for retrieving the setup data will be sent.

In some cases, specific support must be provided by the ExplorerDVL system for a command to work. For example, a command may need to have the sensor's response parsed in a certain way for the sensor's data to be useful. For commands the user sends to the sensor that are not supported, no data will be gathered from the sensor for that command and additional, wasted time will be spent sending such commands to the sensor, so this should be avoided. For a list of these commands for each sensor, see [External Sensor Commands Supported by the ExplorerDVL System](#). Some commands that don't require special parsing or handling, will work even though special provisions have not been made for them. For example, commands that have a response that does not need to be parsed (setting sensor configuration) should work.

Some commands are not allowed to be sent to the sensor because they may alter the sensor sampling or alter the communication setup of the sensor in an unacceptable way. These will be either intercepted by the ExplorerDVL system at command entry and not sent or overwritten after the user's commands are sent. For a list of these commands for each sensor, see [External Sensor Commands Not Allowed by the ExplorerDVL System](#).

It should be noted that those commands not supported may be entered via the dumb terminal mode (see the dumb terminal mode of the SM command).

The TCM3 & 5 have a binary interface. See [Special Output Data Formats](#) regarding special considerations for this sensor when using the SC command.

All prior commands entered for sensor n for all events are cleared by entering "SC n d", where n is the sensor ID. All prior commands entered for sensor n and event e are cleared by entering "SC n e d", where n and e are the sensor ID and event, respectively.


All commands for all events for a given sensor are displayed by the following command:
SC n?

SD – Sensor PDO Data Output

- Purpose** Controls the ensemble data types that are output.
- Format** SD *n abc def ghi*
- Range** *n*: sensor id per Table 27. This must be entered as a two digit number. Sensors with ID<10 should be prefixed with a 0.
a-b: data type per Table 27, which also indicates the tables that describes the format of the data:

Table 27: Sensor PDO Data Output

Sensor	ID	a	b	c	d
Gyro Compass	01	--	--	--	--
GPS	02	PGRMT NMEA Sentence (Table 69)	GPRMC NMEA Sentence (Table 70)	GPGGA NMEA Sentence (Table 71)	GPVTG NMEA Sentence (Table 72)
Pressure	03	Variable (Table 73)	Setup (Table 74)	N/A	N/A
Speed of Sound	04	Variable (Table 75)	N/A	N/A	N/A
Mag Compass #1	05	Variable (Table 76)	Setup (Table 77)	N/A	N/A
CTD	06	Variable (Table 78)	TBD	TBD	TBD
Echo Sounder	07	Variable (Table 79)	N/A	N/A	N/A
Internal Temperature	08	N/A	N/A	N/A	N/A
Mag Compass #2	09	Variable (Table 80)	Setup (Table 81)	N/A	N/A
TRDI Sensor Board (Pitch/Roll, T, Pr)	10	N/A	N/A	N/A	N/A




N/A: no data type
 TBD: to be determined - no sensor selected yet.

Setup data is sampled and output only if the corresponding bit of the SD command is set; Variable data is always sampled (if the sensor is assigned to a port) but only output if the corresponding bit of the SD command is set.

Digits e-i are reserved for future use.

Default SD *n 000 000 000*



Set as needed.

Description This command controls the output of data types in PDO binary ensembles for each sensor. Note that the sensor must be assigned to a communication port for the data to be included in the output ensemble.

Each sensor data type includes at least one 32 bit word whose individual bits show what data in the structure is valid. Also, each data type includes at least one 32 bit word whose bits show sensor errors and errors the ExplorerDVL has encountered trying to communicate with the sensor. One bit of the error word indicates whether the data is fresh (appearing first in this ensemble) or stale (a repeat from a previous ensemble). Stale data may be caused by environmental sensors that are sampled at multiple ensemble intervals or by communication problems with the sensor.

SM – Auxiliary Sensor Menu

Purpose	Allow access to individual sensor auxiliary command menus, such as compass calibration commands.
Format	SM <i>n</i>
Range	1 to 10 corresponding to each of the sensors listed in EY – Sensor Source Override for Doppler Parameters .
Default	There is no default.



Set as needed.

Description	<p>If no argument (<i>n</i>, above) is entered with the command, then a list of sensors with their corresponding numbers is presented for the user to choose from.</p> <p>The user can stack command menu selections. For example “SM 9 P 1” could be entered, which accesses the TCM compass command menu and then selects the power (P) up (1) item of that menu.</p> <p>Note that if the sensor is not connected to the system, the sensor’s menu will still be available, but some items of the menu may not execute.</p>
-------------	---

Example:

```
>sp 3 6
```

```
>sm
Sensor Auxiliary Menus
0 ----- Exit Menu                6----- SeaBird SBE-49 Fast Cat
1 ----- Not Used                 7----- Benthos PSA-916 Echo Sounder
2 ----- Garmin G-15H GPS         8----- One Wire Temp - No Menu
3 ----- Paros. 8CDF Pressure     9----- PNi TCM3/5 Compass
4 ----- AMS SVP&T               10----- Teledyne RDI Sensor Module
5 ----- Honeywell HMR3k Cmp
6
```

```
Make sure sensors are initialized with SR command
once after a break before entering this menu.
SBE-49 CTD Auxiliary Menu
0 ----- Help
S 411----- Change Port Serial Params
T ----- Terminal Mode
X ----- Exit
```

The sub-menu presented here for the Fast Cat SBE-49 CTD sensor, is typical of the sub-menus for each sensor. This menu allows entering a dumb terminal mode with the sensor for troubleshooting purposes and to set the baud rate of the ExplorerDVL port that the sensor is connected to. Some sensors have special commands (e.g., compass calibration) that are supported by their respective menu.

SP – Sensor Port Assignment

Purpose	This command assigns a sensor to a serial port on the system.
Format	SP <i>p sid</i> or SP <i>p sid t</i>
Range	<i>p</i> : port 2 to 4
	<i>sid</i> : 0 for no sensor on the port; Corresponding to the sensor ID in Table 28. This table corresponds directly to the manufacturers and models of sensors listed in EY – Sensor Source Override for Doppler Parameters .

t: time-out 0 to 65535 milli-seconds while waiting for a response for each command that is sent to the sensor. If omitted, a default time-out will be used specific to each sensor. The default time-outs are listed in Table 28.



COM 1 is reserved for communicating to and controlling the ExplorerDVL ONLY. This port will not support sensors. Ports 2, 3, 4 and the SPI bus port are for sensors.

Table 28: Sensor Port Assignment

Sensor	ID	Default Time Out (ms)	Sample Interval*
Gyro Compass	1	--	Ping
GPS	2	300	Ping
Pressure	3	250	Multi-Ensemble
Speed of Sound	4	450	Multi-Ensemble
Mag Compass #1	5	200	Ping
CTD	6	1500	Multi-Ensemble
Echo Sounder	7	300	Multi-Ensemble
Temperature	8	--	Multi-Ensemble
Mag Compass #2	9	110	Ping
Pitch, Roll, Temp, Press	10	--	Ping



The number of ensembles for multi-ensemble sampled sensors depends on the number of commands sent to the sensor. Each command requires approximately two ensembles to transmit to and receive the response from the sensor.

Default SP 1 0 99
 SP 2 0 99
 SP 3 0 99
 SP 4 0 99



Set as needed.

Description The time-out of this command is a general time-out for any sensor command sent to the sensor. However, this value is overridden by the individual time-out entered with the SC command.

Variable data (corresponding to the variable data types in the appendices) for each sensor will be sampled if the sensor is assigned to a port. Setup data will only be sampled if the corresponding bit for setup data is set in the SD command. See [SD - Sensor PDO Data Output](#) for more details.

If the sensor is assigned to more than one port, than the port with the highest port number will be used as the port for that sensor.

SR – Sensor Reset

Purpose	Reset external sensors.
Format	SR [<i>n</i>], where [] indicates an optional parameter.
Range	<i>n</i> : specifies a sensor ID corresponding to table of the EY command (see EY – Sensor Source Override for Doppler Parameters).
Default	N/A


Set as needed.

Description This command resets only one sensor if the optional parameter is entered or resets all sensors assigned by the SP port if no parameter is entered with this command.

Expert Sensor Command Descriptions

This section lists the expert Sensor commands. Commands that start with the # sign are considered “expert” commands.

```
>#S?
Available Commands:
SO 101.325 ----- Abs Press Sensor Offset [kPa]
S? ----- Display #S-Command Menu
```

#SO – Absolute Pressure Sensor Offset for Depth Calculation

Purpose	This command sets an offset used by the system in calculating depth from external sensors that have an absolute pressure output.
Format	#SO <i>f</i>
Range	<i>f</i> = 26.0 to 32.0 inch Hg or 88.0 to 108.4 kPa are valid pressures. A value <0.00001 may also be entered to zero the offset.
Default	SO 101.325


Set as needed.

Description This offset of this command is used with absolute pressure sensors when calculating depth. Currently, this offset is used only with the Paroscientific Pressure sensor to calculate depth. Pressure in units of inch of mercury or kilo Pascals may be entered, but the latter is displayed when this command is queried.

Timing Commands

These commands set the timing of various profiling functions.

Available Timing Commands

This section lists the available Timing commands.

>T?

Available Commands:

```
TE 00:00:00.00 ----- Time Between Ensembles
TP 00:00.05 ----- Time Between Pings
TS 04/01/01,00:02:08.24 --- Set System Date and Time
TT 2004/01/01,00:02:08.24 - Set System Date and Time (4-digit year)
T? ----- Display T-Command Menu
```

TE – Time Per Ensemble

Purpose Sets the minimum interval between data collection cycles (data ensembles).

Format TE $hh:mm:ss.ff$

Range

<i>hh</i>	= 00 to 23 hours
<i>mm</i>	= 00 to 59 minutes
<i>ss</i>	= 00 to 59 seconds
<i>ff</i>	= 00 to 99 hundredths of seconds

Default TE00:00:00.00



Set as needed.

Description During the ensemble interval set by TE, the ExplorerDVL transmits the number of pings set by the WP-command (see [WP – Pings Per Ensemble](#)). If TE = 00:00:00.00, the ExplorerDVL starts collecting the next ensemble immediately after processing the previous ensemble.

Example TE01:15:30.00 tells the ExplorerDVL to collect data ensembles every 1 hour, 15 minutes, 30 seconds.



1. The ExplorerDVL automatically increases TE if (WP x TP > TE).
2. The time tag for each ensemble is the time of the first ping of that ensemble.

TP – Time Between Pings

Purpose	Sets the <i>minimum</i> time between pings.
Format	TPmm:ss:ff
Range	mm = 00 to 59 minutes ss = 00 to 59 seconds ff = 00 to 99 hundredths of seconds
Default	TP00:00.05



Set as needed.

Description The ExplorerDVL interleaves individual pings within a group so they are evenly spread throughout the ensemble.

During the ensemble interval set by TE, the ExplorerDVL transmits the number of pings set by the WP and BP commands (see [WP – Pings Per Ensemble](#) and [BP – Bottom-Track Pings per Ensemble](#)). TP determines the spacing between the pings. If TP = 0, the ExplorerDVL pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs for processing. Several commands determine the actual ping time [WF – Blank after Transmit](#), [WN – Number of Depth Cells](#), [WS – Depth Cell Size](#), and actual water depth).

Example TP00:00.10 sets the time between pings to 0.10 second.



The ExplorerDVL automatically increases TE if $(WP \times TP) > TE$.

TS – Set Real-Time Clock

Purpose	Sets the ExplorerDVL's internal real-time clock.
Format	TSyy/mm/dd, hh:mm:ss
Range	yy = year 00-99 mm = month 01-12 dd = day 01-31 hh = hour 00-23 mm = minute 00-59 ss = second 00-59



Set using *TRDI Toolz*.

Example TS98/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 1998.



1. When the ExplorerDVL receives the carriage return after the TS-command, it enters the new time into the real-time clock and sets hundredths of seconds to zero.
2. If the entry is not valid, the ExplorerDVL sends an error message and does not update the real-time clock.

TT – Set Real-Time Clock (Y2k Compliant)

Purpose	Sets the ExplorerDVL's internal real-time clock.	
Format	TTccyy/mm/dd, hh:mm:ss	
Range	<i>cc</i>	= century 19 - 20
	<i>yy</i>	= year 00 - 99
	<i>mm</i>	= month 01 - 12
	<i>dd</i>	= day 01 - 31
	<i>hh</i>	= hour 00 - 23
	<i>mm</i>	= minute 00 - 59
	<i>ss</i>	= second 00 - 59



Set using *TRDI Toolz*.

Example TT2013/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2013.



1. When the ExplorerDVL receives the carriage return after the TT-command, it enters the new time into the real-time clock and sets hundredths of seconds to zero.
2. If the entry is not valid, the ExplorerDVL sends an error message and does not update the real-time clock.

Water Profiling Commands

These commands define the criteria used to collect the water-profile data.

Available Water Profiling Commands

This section lists the available Water Profiling commands.

This section lists the available Water Profiling commands.

```
>W?
Available Commands:

WB 0 ----- Bandwidth 0=High, 1=low
WD 111110000 ----- Data Out {v;c;a;p;s;*;*;*}
WF 0088 ----- Blanking Distance [0-999cm]
WN 030 ----- Number of Bins [0-255]
WP 000 ----- Number of Pings [0-16384]
WS 0200 ----- Bin Size [cm]
WV 0175 ----- Ambiguity Velocity [2-700cm/s]
W? ----- Display W-Command Menu
```


WB – Mode 1 Bandwidth Control

Purpose The WB command sets the profiling mode 1 and water mass (see [BK - Water-Mass Layer Mode](#)) transmit and receive bandwidths and sample rate. Smaller bandwidths allow the ExplorerDVL to profile farther, but the standard deviation is increased by as much as 2.5 times.

Format WBn

Range n = 0 (Wide), 1 (Narrow)

Default WBo



The default setting for this command is recommended for most applications.

Description The firmware sets the transmit/receive bandwidths and sample rate (see Table 29 and Table 30).

Table 29: Bandwidth Control Effect on Performance

Bandwidth	Sample rate	Data variance	Profiling range
0 = Wide	High	Low	Low
1 = Narrow	Low	High	High

Table 30: Transmit & Receive Bandwidth

Bandwidth	Piston		Phased Array	
	Transmit	Receive	Transmit	Receive
0 = Wide	25%	25%	6%	6%
1 = Narrow	6%	6%	3%	6%

WD – Data Out

Purpose	Selects the data types collected by the ExplorerDVL.
Format	WD <i>abc defghi</i>
Range	Firmware switches (see description)
Default	WD 111 100 000



The default setting for this command is recommended for most applications.

Description WD uses firmware switches to tell the ExplorerDVL the types of data to collect. The ExplorerDVL always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the ExplorerDVL to collect that data type. The bits are described as follows:

<i>a</i> = Velocity	<i>d</i> = Percent good	<i>g</i> = Reserved
<i>b</i> = Correlation	<i>e</i> = Status	<i>h</i> = Reserved
<i>c</i> = Echo Intensity	<i>f</i> = Reserved	<i>i</i> = Reserved

Example WD 111 100 000 (default) tells the ExplorerDVL to collect velocity, correlation magnitude, echo intensity, and percent-good.



1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
2. If WP = zero, the ExplorerDVL does not collect water-profile data.
3. Spaces in the command line are allowed.
4. Status data is not used, as it does not mean anything.

WF – Blank after Transmit

Purpose	Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.
Format	WF <i>nnnn</i>
Range	<i>nnnn</i> = 0 to 9999 cm
Default	WFOo88



The default setting for this command is recommended for most applications.

Description The WF command positions the start of the first depth cell at some vertical distance from the transducer head. This allows the ExplorerDVL transmit circuits time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.



1. The distance to the middle of depth cell #1 is a function of WF, [WS – Depth Cell Size](#), and speed of sound. The fixed leader data contains this distance.
2. Small WF values may show ringing/recovery problems in the first depth cells that cannot be screened by the ExplorerDVL.

WN – Number of Depth Cells

Purpose	Sets the number of depth cells over which the ExplorerDVL collects data.
Format	WNnnn
Range	nnn = 001 to 255 depth cells
Default	WN030



Set as needed.

Description The range of the ExplorerDVL is set by the number of depth cells (WN) times the size of each depth cell [WS – Depth Cell Size](#).



Be careful when setting up long profiles. System memory limitations will limit the amount of data actually collected. Those bins not processed will be marked invalid when output.

WP – Pings per Ensemble

Purpose	Sets the number of pings to average in each data ensemble.
Format	WPnnnnn
Range	nnnnn = 0 to 16384 pings
Default	WP00000



Set as needed.

Description WP sets the number of pings to average in each ensemble before sending/recording the data.



1. If WP = zero the ExplorerDVL does not collect water-profile data.
2. The ExplorerDVL automatically extends the ensemble interval [TE – Time Per Ensemble](#)) if $(WP+BP) \times TP > TE$.

WS – Depth Cell Size

Purpose	Selects the volume of water for one measurement cell.
Format	WSnnnn
Range	10 to 800 cm
Default	WS0200



The default setting for this command is recommended for most applications.

Description The ExplorerDVL collects data over a variable number of depth cells. WS sets the size of each cell in vertical centimeters.

WV – Ambiguity Velocity

Purpose	Sets the radial ambiguity velocity for profile and water mass mode (see BK - Water-Mass Layer Mode).
Format	WVnnn
Range	nnn = 020 to 700 cm/s
Default	WV500



It is strongly recommended that the WV command be left at its' default value of 500.

Description Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur.

The WV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam. WV is used to improve the single-ping standard deviation. The lower the value of the WV command, the lower the single-ping standard deviation.

The WB-command influences profiling range. Narrowing the bandwidth of the system increases the profiling range. An increase in range of approximately 10% is obtained each time the bandwidth is reduced by one-half.

Set the WV command based on the maximum apparent velocity (ExplorerDVL motion plus water speed). The following formula is used to determine the setting of the WV command: $WV = (\text{Max. Apparent Vel. cm/s}) * \sin(\text{beam angle}) * 1.2$

The actual ambiguity velocity that is used will be determined when pinging starts and is dependent on transducer type and bandwidth in addition to WV command input. The reason for this is that the ambiguity velocity is inversely proportional to the transmitted lag and this is a quantized value. Therefore, ambiguity velocity changes in discrete steps as WV is uniformly varied.

To give a sense of this effect, the following table describes the actual ambiguity velocity used vs. the WV input at each end of the allowed WV input range:

Transducer Type	WB Input	WV Input (cm/s)	Actual Ambiguity Velocity re. SoS=1500m/s (cm/s)
Piston	0	20	20.29
Piston	1	20	20.38
Piston	0	700	721.15
Piston	1	700	781.25
Phased Array	0	20	20.38
Phased Array	1	20	20.56
Phased Array	0	700	781.25
Phased Array	1	700	1171.88

Valid data can be collected if the following WV values are not exceeded. The maximum WV values depend on the WB setting. Be aware that the firmware will accept larger values for the WV command; however, WV values that exceed the following values will result in collecting data with ambiguity resolving errors or completely erroneous values.

Example If the maximum expected ExplorerDVL horizontal velocity (vessel velocity) is 250 cm/s (≈ 5 kt) and the maximum expected horizontal water velocity is 100 cm/s, set WV to $([250+100]*0.5*1.2=)$ 210 cm/s.

Expert Water Profiling Command Descriptions

This section lists the expert Water Profiling commands. Commands that start with the # sign are considered “expert” commands.

>#W?

Available Commands:

```
WA 050 ----- False Target Amplitude Threshold [0-255]
WC 064 ----- Correlation Threshold [0-255]
WE 2000 ----- Error Velocity Threshold (mm/s)
WJ 1 ----- BroadBand Rcvr Gain [0=Lo,1=Hi]
WT 0000 ----- Transmit Length (cm)
W? ----- Display #W-Command Menu
```

>

#WA – False Target Threshold Maximum

Purpose Sets a false target (fish) filter.

Format #WA nnn

Range $nnn = 0$ to 255 counts (255 disables this filter)

Default #WA050



The default setting for this command is recommended for most applications.

Description The ExplorerDVL uses the #WA-command to screen water-track data for false targets (usually fish). #WA sets the maximum difference between echo intensity readings among the four profiling beams. If the #WA threshold value is exceeded, the ExplorerDVL rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.



A #WA value of 255 turns off this feature.

#WC – Low Correlation Threshold

Purpose Sets the minimum threshold of water-track data that must meet the correlation criteria for profile and water mass mode (see [BK - Water-Mass Layer Mode](#)).

Format #WC nnn

Range $nnn = 0$ to 255 counts

Default #WC64



The default setting for this command is recommended for most applications.

Description The ExplorerDVL uses #WC to screen water-track data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and depth cell size ([WS – Depth Cell Size](#)). The #WC command sets the threshold of the

correlation below, which the ExplorerDVL flags the data as bad and does not average the data into the ensemble.



The default threshold for all frequencies is 64 counts. A solid target would have a correlation of 255 counts.

#WE – Error Velocity Threshold

Purpose	Sets the maximum error velocity for good water-current data.
Format	WEnnnn
Range	nnnn = 0 to 5000 mm/s
Default	#WE2000



The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

Description	The #WE-command sets a threshold value used to flag water-current data as good or bad. If the ExplorerDVL's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The #WE command screens for error velocities in both beam and transformed-coordinate data. Setting the #WE command to zero (#WE0) disables error velocity screening.
-------------	--

#WJ – Receiver Gain Select

Purpose	Allows the ExplorerDVL to reduce receiver gain by 40 dB for profile and water mass mode (see BK - Water-Mass Layer Mode).
Format	#WJn
Range	n = 0 (low), 1 (high)
Default	#WJ1



The default setting for this command is recommended for most applications.

Description	#WJ0 tells the ExplorerDVL to reduce receiver gain by 40 dB. This may increase data reliability in shallow-water applications where there is a high content of backscatter material. #WJ1 (the default) uses the normal receiver gain.
-------------	--

#WT – Transmit Length

Purpose	Selects a transmit length different from the depth cell length (cell sampling interval) as set by the WS command (see WS – Depth Cell Size).
Format	#WTnnnn
Range	nnnn = 0 to 3200 cm
Default	#WT0000



The default setting for this command is recommended for most applications.

Description	When #WT is set to zero, the transmit signal is set to the depth cell size (WS-command). This is the default setting. Setting #WT allows selection of a transmit length different than the area depth cell size (sampling length).
-------------	--

Chapter 8

OUTPUT DATA FORMAT



In this chapter:

- [Choosing a Data Format](#)
- [PDO Output Data Format](#)
- [Special Output Data Formats PD 4, PD5, and PD6](#)
- [External Sensor Suite Interface Descriptions](#)

Choosing a Data Format

The ExplorerDVL can output data in several user selectable formats using the PD command (see [PD - Data Stream Select](#)). Depending on the output format selected, data will be either binary or ASCII text.

Binary Output Data Format

Use the binary format (CFxx1xx) when recording/processing ExplorerDVL data on an external device. The binary format uses less storage space and has a faster transmission time than the Hex ASCII format. A dumb terminal is of little use in binary format because the terminal interprets some of the data as control characters.



All of TRDI's software supports binary PDO formatted data only.

Hexadecimal-ASCII Output Data

Use the hexadecimal-ASCII (Hex ASCII) format (CFxx2xx) when viewing raw ExplorerDVL data on a computer/dumb terminal. This format uses the standard ASCII codes for 0 through F to represent numeric values as hexadecimal digits. Other standard ASCII characters (text) and control commands (carriage return, line feed, end of file, etc.) are interpreted normally. In the Hex ASCII mode, the ExplorerDVL sends data in one line of ASCII characters. There are no carriage returns and/or line feed sequences (CR/LF) sent from the ExplorerDVL. The CRT provides a CR/LF after 60 characters.



Hex ASCII PDO data is not supported by TRDI's software.

Individual parameters within a data string may be enabled / disabled. All binary output formats have the option of outputting data in HEX-ASCII instead of true binary using the CF command (see [CF - Flow Control](#)). HEX-ASCII is an ASCII representation of the binary data. Binary output formats include PDO, 3, 4, and 5. Text output formats include PD6.

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


- **PDO** – PDO is Teledyne RD Instrument's standard format. PDO 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, ADCP setup, orientation, heading, pitch, roll, temperature, pressure, and self-test diagnostic results. Data fields to be output are user selectable. PDO has distance made good in the output if the Bottom Track High Resolution Velocity Output Format is selected. This format is selected via the #BJ command (see [BJ - Data Type Output Control](#)).
- **PD3** – PD3 is a binary output format of bottom track speed over the bottom, speed through the water, and range to bottom information. If PD3 is selected, there is no data written to the recorder.
- **PD4** – PD4 is a binary output format of bottom track speed over the bottom, speed through the water, and range to bottom information.
- **PD5** – PD5 is a superset of PD4 and includes information on salinity, depth, pitch, roll, heading, and distance made good.
- **PD6** – PD6 is a ASCII 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. If PD6 is selected, there is no data written to the recorder.

The following table is a summary of the type of data outputted by PDO through PD6 data output formats. Note that this is not an exhaustive list and it is advised to check out the full description of a format before choosing it above another.

Table 31: Summary of Output Data Formats

	PD0	PD3	PD4	PD5	PD6
System Info	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Temperature	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Depth	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Tilts (H,P,R)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Time of Ping	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Speed of Sound	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Water Profile Configuration	<input checked="" type="checkbox"/>				
Water Profile Velocities	<input checked="" type="checkbox"/>				
Correlation Magnitude	<input checked="" type="checkbox"/>				
Echo Intensity	<input checked="" type="checkbox"/>				
Percent Good	<input checked="" type="checkbox"/>				
Bottom Range	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Bottom Velocity (SOG*)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Water-Mass Layer Velocity (STW*)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Bottom Track Configuration	<input checked="" type="checkbox"/>				
Distance Over Ground	<input checked="" type="checkbox"/> see note			<input checked="" type="checkbox"/>	
Sea-Bird					
Binary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
ASCII					<input checked="" type="checkbox"/>
NMEA					
Serial Output	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Recorded on loop recorder	PD0	None	PD4	PD5	None

*SOG = Speed Over Ground
 *STW = Speed Through Water



The PD0 [Bottom Track output data format](#) assumes that the instrument is stationary and the bottom is moving. See the [EX – Coordinate Transformation](#) command and [Beam Coordinate Systems](#) for details.

- If Beam 3 is going forward, then the Y velocity is negative.
- If Beam 2 is going forward, then X velocity is negative.

The [PD0 Bottom Track High Resolution Velocity Output](#) (velocity in 0.01mm/s) and PD3 through PD6 data formats assume that the bottom is stationary and that the DVL or vessel is moving.

- If Beam 3 is going forward, then the Y velocity is positive.
- If Beam 2 is going forward, then X velocity is positive.

PD0 has distance made good in the output if the Bottom Track High Resolution Velocity Output Format is selected. This format is selected via the #BJ command (see [BJ – Data Type Output Control](#)).

PDO Output Data Format

The following description is for the standard PDO ExplorerDVL output data format. Figure 43 through Figure 54 shows the ASCII and binary data formats for the ExplorerDVL PDO mode. Table 32 through Table 47 defines each field in the output data structure.

The binary output data formats are composed of at least one data type, i.e. a group of bytes all related by their dynamic or field. For instance in the PDO data format, variables that do not change during the deployment are stored in the [Fixed Leader](#) data type of leader ID 0000h, whereas the dynamic variables, except velocities, which dynamically change during the deployment are stored under the [Variable Leader](#) data type of leader ID 0080h. This distinction is based on the dynamic; other distinctions are present such as velocity types such as data type of leader ID 0100h which groups all the [Water Profile Velocity](#) data and leader ID 0600h stores all [Bottom Track Velocity](#) data. The ExplorerDVL sends all the data for a given type for all depth cells and all beams before the next data type begins.

The advantage of using the leader ID is that one can simply scan for them as the binary data is received in real time on the serial lines and then uses the output data format description table to jump directly to the desired data. The PDO Header ID is 7F7Fh, which makes it easy to detect. In the PDO Header are the number of bytes in the ensemble, the number of data types and the offset respective to each data type location in the binary ensemble. Then choose between jumping down to the data type using the offsets or detecting the data type ID after the header ID is detected.

PDO is the only binary output data format which provides a [Header](#) that describes the data included in the ensemble since some data types presence in the PDO output are dependent on commands parameters. For example, if the number of Bottom Track pings is 0 (BPO), then there will be no Bottom track data type in the ensemble. Figure 42 shows the data types that are always output against command dependable data types.

Output	ID	Description
ALWAYS OUTPUT	7F7Fh	HEADER (6 BYTES + [2 x No. OF DATA TYPES])
	0000h	FIXED LEADER DATA (58 BYTES)
	0080h	VARIABLE LEADER DATA (77 BYTES)
WATER PROFILING DATA WD command WP command	0100h	VELOCITY (2 BYTES + 8 BYTES PER DEPTH CELL)
	0200h	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	0300h	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	0400h	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command #BJ command	0600h	BOTTOM TRACK DATA (81 BYTES)
	5800h	BOTTOM TRACK COMMAND OUTPUT (43 BYTES)
	5803h	BOTTOM TRACK HIGH RESOLUTION VELOCITY (70 BYTES)
	5804h	BOTTOM TRACK RANGE (41 BYTES)
	2013h	NAVIGATION PARAMETERS DATA (85 BYTES)
#EE command	3000h	ENVIRONMENT COMMAND PARAMETERS OUTPUT (47 BYTES)
	3001h	SENSOR SOURCE FOR DOPPLER PROCESSING (62 BYTES)
SD command	541Ch	STATUS (24 BYTES)
	541Dh	IMU DATA (60 BYTES)
	541Eh	EULER Data (34 BYTES)
	541Fh	SHIP MOTION (48 BYTES)
ALWAYS OUTPUT		CHECKSUM (2 BYTES)

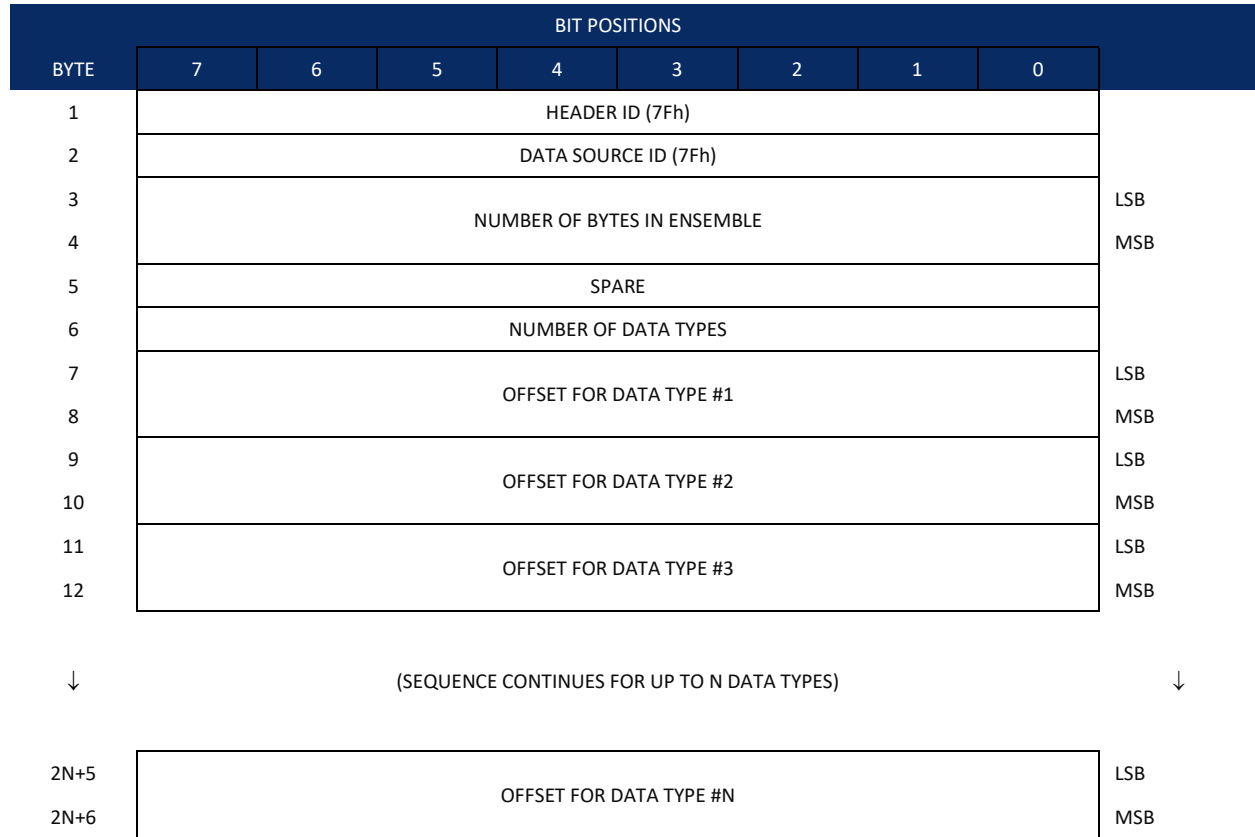
Figure 42. PDO Standard Output Data Buffer Format

Some data outputs are in bytes per depth cell. For example, if the WN-command = 30 (default), WD command = WD 111 110 000 (default), WP command > 0, BP command > 0, the required data buffer storage space is 951 bytes per ensemble.

There are seven data types output for this example: Fixed Leader, Variable Leader, Velocity, Correlation Magnitude, Echo Intensity, Percent Good, and Bottom Track.

20	BYTES OF HEADER DATA (6 + [2 x 7 Data Types])
58	BYTES OF FIXED LEADER DATA (FIXED)
60	BYTES OF VARIABLE LEADER DATA (FIXED)
242	BYTES OF VELOCITY DATA (2 + 8 x 30)
122	BYTES OF CORRELATION MAGNITUDE DATA (2 + 4 x 30)
122	BYTES OF ECHO INTENSITY (2 + 4 x 30)
122	BYTES OF PERCENT-GOOD DATA (2 + 4 x 30)
122	BYTES OF PROFILE STATUS DATA (2 + 4 x 30)
81	BYTES OF BOTTOM TRACK DATA (FIXED)
2	BYTES OF CHECKSUM DATA (FIXED)
951	BYTES OF DATA PER ENSEMBLE

Header Data Format



See Table 32 for a description of the fields.

Figure 43. Binary Header Data Format

Header information is the first item sent by the ExplorerDVL to the output buffer. The ExplorerDVL always sends the Least Significant Byte (LSB) first.

Table 32: Header Data Format

Hex Digit	Binary Byte	Field	Description
1,2	1	HDR ID / Header ID	Stores the header identification byte (7Fh).
3,4	2	HDR ID / Data Source ID	Stores the data source identification byte (7Fh for the ExplorerDVL).
5-8	3,4	Bytes / Number of bytes in ensemble	This field contains the number of bytes from the start of the current ensemble up to, but not including, the 2-byte checksum (Figure 54).
9,10	5	Spare	3-byte checksum offset, which would allow the output of a very large data type in the PDO message, although no data type can start beyond the reach of a 16-bit offset word in the header.
11,12	6	No. DT / Number of Data Types	This field contains the number of data types selected for collection. By default, fixed/variable leader, velocity, correlation magnitude, echo intensity, and percent good are selected for collection. This field will therefore have a value of six (4 data types + 2 for the Fixed/Variable Leader data).
13-16	7,8	Address Offset for Data Type #1 / Offset for Data Type #1	This field contains the internal memory address offset where the ExplorerDVL will store information for data type #1 (with this firmware, always the Fixed Leader). Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #1 begins (the first byte of the ensemble is Binary Byte #1).
17-20	9,10	Address Offset for Data Type #2 / Offset for Data Type #2	This field contains the internal memory address offset where the ExplorerDVL will store information for data type #2 (with this firmware, always the Variable Leader). Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #2 begins (the first byte of the ensemble is Binary Byte #1).
21-24 thru 2n+13 to 2n+16	11,12 thru 2n+5, 2n+6	Address Offsets for Data Types #3-n / Offset for Data Type #3 through #n	These fields contain internal memory address offset where the ExplorerDVL will store information for data type #3 through data type #n. Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Types #3-n begin (first byte of ensemble is Binary Byte) #1).

Fixed Leader Data Format

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
1	FIXED LEADER ID								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	REAL/SIM FLAG								
8	LAG LENGTH								
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS								
11	PINGS PER ENSEMBLE								LSB
12									MSB
13	DEPTH CELL LENGTH								LSB
14									MSB
15	BLANK AFTER TRANSMIT								LSB
16									MSB
17	PROFILING MODE								
18	LOW CORR THRESH								
19	NO. CODE REPS								
20	% GOOD MINIMUM								
21	ERROR VELOCITY MAXIMUM								LSB
22									MSB
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS								
26	COORDINATE TRANSFORM								
27	HEADING ALIGNMENT								LSB
28									MSB
29	HEADING BIAS								LSB
30									MSB
31	SENSOR SOURCE								
32	SENSORS AVAILABLE								
33	BIN 1 DISTANCE								
34									
35	XMIT PULSE LENGTH								LSB
36									MSB

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
37	SPARE								LSB
38									MSB
39	FALSE TARGET THRESH								
40	SPARE								
41	TRANSMIT LAG DISTANCE								LSB
42									MSB
43	SPARE								LSB
↓									↓
50									MSB
51	SYSTEM BANDWIDTH								LSB
52									MSB
53	SPARE								
54	SPARE								
55	System Serial Number								LSB
↓									↓
58									MSB

See Table 33 for a description of the fields

Figure 44. Fixed Leader Data Format

Fixed Leader data refers to the non-dynamic ExplorerDVL data that only changes when certain commands are changed. Fixed Leader data also contains hardware information. The ExplorerDVL always sends Fixed Leader data as output data (LSBs first).

Table 33: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word (00 00h).
5,6	3	fv / CPU F/W Ver.	Contains the version number of the CPU firmware.
7,8	4	fr / CPU F/W Rev.	Contains the revision number of the CPU firmware.
9-12	5,6	Sys Cfg / System Configuration	<p>This field defines the ExplorerDVL hardware configuration. Convert this field (2 bytes, LSB first) to binary (see Decoding Flags and Set Bits) and interpret as follows.</p> <pre> LSB BITS 7 6 5 4 3 2 1 0 - - - - - 0 0 0 75-kHz SYSTEM - - - - - 0 0 1 150-kHz SYSTEM - - - - - 0 1 0 300-kHz SYSTEM - - - - - 0 1 1 600-kHz SYSTEM - - - - - 1 0 0 1200-kHz SYSTEM - - - - - 1 0 1 2400-kHz SYSTEM - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - SENSOR CONFIG #1 - - 0 1 - - - - SENSOR CONFIG #2 - - 1 0 - - - - SENSOR CONFIG #3 - 0 - - - - - - XDCR HD NOT ATT. - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 0 15E BEAM ANGLE - - - - - - 0 1 20E BEAM ANGLE - - - - - - 1 0 30E BEAM ANGLE - - - - - - 1 1 OTHER BEAM ANGLE 0 1 0 0 - - - - 4-BEAM JANUS CONFIG 0 1 0 1 - - - - 5-BM JANUS CFG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFG. (2 DEMD) </pre> <p>Example: Hex 420B identifies a 600 kHz, convex, Sensor Config #1, Transducer head not attached, down facing, 30 degree, 4-beam Janus system.</p> <p>Note: XDCR HD ATTACHED refers to whether the chassis and transducer are delivered as one piece; This is not a sensor detect.</p> <p>Sensor Configuration: #1 = Strap-down; i.e. no gimbals #2 = One axis gimbaled #3 = Two axes gimbaled.</p>
13,14	7	PD / Real/Sim Flag	This field is set by default as real data (0).
15,16	8	Lag Length	Lag Length. The lag is the time period between sound pulses.
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The ExplorerDVL needs only three beams to calculate water-current velocities. The fourth beam provides an error velocity that determines data validity. If only three beams are available, the ExplorerDVL does not make this validity check. Table 38 (Percent-Good Data Format) has more information.
19,20	10	WN / Number of Cells	<p>Contains the number of depth cells over which the ExplorerDVL collects data (WN – Number of Depth Cells).</p> <p>Scaling: LSD = 1 depth cell; Range = 1 to 255 depth cells</p>

Table 33: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP – Pings Per Ensemble). If WP = 0, the ExplorerDVL does not collect the WD water-profile data. Note: The ExplorerDVL automatically extends the ensemble interval (TE) if the product of WP and time per ping (TP) is greater than TE (i.e., if WP x TP > TE). Scaling: LSD = 1 ping; Range = 1 to 16,384 pings
25-28	13,14	WS / Depth Cell Length	Contains the length of one depth cell (WS – Depth Cell Size). Scaling: LSD = 1 centimeter; Range = 1 to 1600 cm (52.5 feet)
29-32	15,16	WF / Blank after Transmit	Contains the blanking distance used by the ExplorerDVL to allow the transmit circuits time to recover before the receive cycle begins (WF – Blank after Transmit). Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Signal Processing Mode	Contains the Signal Processing Mode. This field will always be set to 1.
35,36	18	WC / Low Corr Thresh	Contains the minimum threshold of correlation that water-profile data can have to be considered good data (WC - Low Correlation Threshold). Scaling: LSD = 1 count; Range = 0 to 255 counts
37,38	19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	% Good Minimum	Contains the minimum percentage of water-profiling pings in an ensemble that must be considered good to output velocity data. Scaling: LSD = 1 percent; Range = 1 to 100 percent
41-44	21,22	WE / Error Velocity Threshold	This field, initially set by the WE-command, contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, the ExplorerDVL flags all four beams of the affected bin as bad (see WE - Error Velocity Threshold). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s
45,46 47,48 49,50	23 24 25	Minutes Seconds Hundredths	These fields, set by the TP-command, contain the amount of time between ping groups in the ensemble. NOTE: The ExplorerDVL automatically extends the ensemble interval (set by TE) if (WP x TP > TE). See TP – Time Between Pings .
51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX – Coordinate Transformation). These firmware switches indicate how the ExplorerDVL collected data. <pre> xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES) xxx01xxx = INSTRUMENT COORDINATES xxx10xxx = SHIP COORDINATES xxx11xxx = EARTH COORDINATES xxxxx1xx = TILTS (PITCH AND ROLL) USED IN SHIP OR EARTH TRANSFORMATION xxxxxx1x = 3-BEAM SOLUTION USED IF ONE BEAM IS BELOW THE CORRELATION THRESHOLD SET BY THE WC-COMMAND xxxxxxx1 = BIN MAPPING USED </pre>
53-56	27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (EA - Heading Alignment). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
57-60	29,30	#EV / Heading Bias	Contains a correction factor for electrical/magnetic heading bias (EV - Heading Bias). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees

Table 33: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
61,62	31	EZ / Sensor Source	<p>Contains the selected source of environmental sensor data (EZ - Sensor Source). These firmware switches indicate the following.</p> <pre> FIELD DESCRIPTION 1xxxxxxx = CALCULATES EC (SPEED OF SOUND) FROM ED, ES, AND ET x1xxxxxx = USES ED FROM DEPTH SENSOR xx1xxxxx = USES EH FROM TRANSDUCER HEADING SENSOR xxx1xxxx = USES EP FROM TRANSDUCER PITCH SENSOR xxxx1xxx = USES ER FROM TRANSDUCER ROLL SENSOR xxxxx1xx = USES ES (SALINITY) FROM CONDUCTIVITY SENSOR xxxxxx1x = USES ET FROM TRANSDUCER TEMPERATURE SENSOR xxxxxxx1 = USES EU FROM TRANSDUCER TEMPERATURE SENSOR </pre> <p>NOTE: If the field = 0, or if the sensor is not available, the ExplorerDVL uses the manual command setting. If the field = 1, the ExplorerDVL uses the reading from the internal sensor or an external synchro sensor (only applicable to heading, roll, and pitch). Although a "2" in the EZ-command string can be entered, the ExplorerDVL only displays a 0 (manual) or 1 (int/ext sensor).</p>
63,64	32	Sensor Avail	This field reflects which sensors are available. The bit pattern is the same as listed for the EZ-command (above).
65-68	33,34	dis1 / Bin 1 distance	<p>This field contains the distance to the middle of the first depth cell (bin). This distance is a function of depth cell length (WS), the profiling mode (WM), the blank after transmit distance (WF), and speed of sound.</p> <p>Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)</p>
69-72	35,36	WT Xmit pulse length	<p>This field, set by the WT-command (WT - Transmit Length), contains the length of the transmit pulse. When the ExplorerDVL receives a <BREAK> signal, it sets the transmit pulse length as close as possible to the depth cell length (WS - Depth Cell Size). This means the ExplorerDVL uses a WT <u>command</u> of zero. However, the WT <u>field</u> contains the actual length of the transmit pulse used.</p> <p>Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)</p>
73,74 75,76	37,38	Spare	Spare
77,78	39	#WA / False Target Threshold	<p>Contains the threshold value used to reject data received from a false target, usually fish (WA - False Target Threshold Maximum).</p> <p>Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)</p>
79,80	40	Spare	Contains the CX-command setting. Range = 0 to 5
81-84	41,42	LagD / Transmit lag distance	<p>This field, determined mainly by the setting of the WM-command, contains the distance between pulse repetitions.</p> <p>Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters</p>
85-100	43-50	Spare	Spare
101-105	51-52	WB / System Bandwidth	Contains the WB-command setting (WB - Mode 1 Bandwidth Control). Range = 0 to 1
106-107	53	Spare	Spare
108-109	54	Spare	Spare
110-119	55-58	System Serial Number	System Serial Number

Variable Leader Data Format

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
1	VARIABLE LEADER ID								80h
2									00h
3	ENSEMBLE NUMBER								LSB
4									MSB
5	RTC YEAR								
6	RTC MONTH								
7	RTC DAY								
8	RTC HOUR								
9	RTC MINUTE								
10	RTC SECOND								
11	RTC HUNDREDTHS								
12	ENSEMBLE # MSB								
13	BIT RESULT								LSB
14									MSB
15	SPEED OF SOUND								LSB
16									MSB
17	DEPTH OF TRANSDUCER								LSB
18									MSB
19	HEADING								LSB
20									MSB
21	PITCH (TILT 1)								LSB
22									MSB
23	ROLL (TILT 2)								LSB
24									MSB
25	SALINITY								LSB
26									MSB
27	TEMPERATURE								LSB
28									MSB
29	MPT MINUTES								
30	MPT SECONDS								
31	MPT HUNDREDTHS								
32	HDG STD DEV								
33	PITCH STD DEV								
34	ROLL STD DEV								

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
35	ADC CHANNEL 0								
36	ADC CHANNEL 1								
37	ADC CHANNEL 2								
38	ADC CHANNEL 3								
39	ADC CHANNEL 4								
40	ADC CHANNEL 5								
41	ADC CHANNEL 6								
42	ADC CHANNEL 7								
43	ERROR STATUS WORD (ESW)								LSB
44									
45									
46	SPARE								MSB
47									
48	PRESSURE								LSB
49									
50									
51	PRESSURE SENSOR VARIANCE								MSB
52									
53									
54	SPARE								LSB
55									
56									
57									MSB
58									
59									
60									

See Table 34 for a description of the fields.

Figure 45. Variable Leader Data Format

Variable Leader data refers to the dynamic ExplorerDVL data (from clocks/sensors) that change with each ping. The ExplorerDVL always sends Variable Leader data as output data (LSBs first).

Table 34: Variable Leader Data Format


Hex Digit	Binary Byte	Field	Description																																														
1-4	1,2	VID / Variable Leader ID	Stores the Variable Leader identification word (MSB=00h LSB=80h).																																														
5-8	3,4	Ens / Ensemble Number	<p>This field contains the sequential number of the ensemble to which the data in the output buffer apply.</p> <p>Scaling: LSD = 1 ensemble; Range = 1 to 65,535 ensembles</p> <p>NOTE: The first ensemble collected is #1. At “rollover,” we have the following sequence:</p> <pre> 1 = ENSEMBLE NUMBER 1 ↓ 65535 = ENSEMBLE NUMBER 65,535 ENSEMBLE 0 = ENSEMBLE NUMBER 65,536 #MSB FIELD 1 = ENSEMBLE NUMBER 65,537 (BYTE 12) INCR. </pre>																																														
9,10	5	RTC Year	These fields contain the time from the ExplorerDVL’s real-time clock (RTC) that the current data ensemble began. The TS-command (TS – Set Real-Time Clock) initially sets the clock. The ExplorerDVL <u>does</u> account for leap years.																																														
11,12	6	RTC Month																																															
13,14	7	RTC Day																																															
15,16	8	RTC Hour																																															
17,18	9	RTC Minute																																															
19,22	10	RTC Second																																															
21,22	11	RTC Hundredths																																															
23-24	12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3,4) “rolls over.” This allows ensembles up to 16,777,215. See Ensemble Number field above.																																														
25-28	13,14	BIT / BIT Result	<p>This field contains the results of the ExplorerDVL’s Built-in Test function. A zero code indicates a successful BIT result. See BIT Decoding Method for non-zero values.</p> <p>BIT byte13</p> <table border="1"> <thead> <tr> <th>Error Code</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x01</td> <td>Transmitter Shutdown</td> </tr> <tr> <td>0x02</td> <td>Transmitter Overcurrent</td> </tr> <tr> <td>0x03</td> <td>Transmitter Undercurrent</td> </tr> <tr> <td>0x04</td> <td>Transmitter Undervoltage</td> </tr> <tr> <td>0x10</td> <td>FIFO interrupt missed</td> </tr> <tr> <td>0x11</td> <td>FIFO ISR re-entry</td> </tr> <tr> <td>0x21</td> <td>Sensor start failure</td> </tr> <tr> <td>0x22</td> <td>Temperature sensor failure</td> </tr> <tr> <td>0x23</td> <td>Pressure sensor failure</td> </tr> <tr> <td>0x24</td> <td>Tilt sensor failure</td> </tr> <tr> <td>0x27</td> <td>Bad Comms with sensor</td> </tr> <tr> <td>0x28</td> <td>Bad Comms with sensor</td> </tr> <tr> <td>0x60</td> <td>Sensor Cal Data checksum failure</td> </tr> <tr> <td>0x30</td> <td>Stuck UART</td> </tr> <tr> <td>0x31</td> <td>QUART Transmit timeout</td> </tr> <tr> <td>0x32</td> <td>QUART IRQ Stuck</td> </tr> <tr> <td>0x33</td> <td>QUART Buffer stuck</td> </tr> <tr> <td>0x34</td> <td>QUART IRQ Active</td> </tr> <tr> <td>0x35</td> <td>QUART cannot clear interrupt</td> </tr> <tr> <td>0x50</td> <td>RTC low battery</td> </tr> <tr> <td>0x51</td> <td>RTC time not set</td> </tr> <tr> <td>0xFF</td> <td>Power failure</td> </tr> </tbody> </table> <p>BIT Number of Errors byte 14 Number of BIT errors</p>	Error Code	Description	0x01	Transmitter Shutdown	0x02	Transmitter Overcurrent	0x03	Transmitter Undercurrent	0x04	Transmitter Undervoltage	0x10	FIFO interrupt missed	0x11	FIFO ISR re-entry	0x21	Sensor start failure	0x22	Temperature sensor failure	0x23	Pressure sensor failure	0x24	Tilt sensor failure	0x27	Bad Comms with sensor	0x28	Bad Comms with sensor	0x60	Sensor Cal Data checksum failure	0x30	Stuck UART	0x31	QUART Transmit timeout	0x32	QUART IRQ Stuck	0x33	QUART Buffer stuck	0x34	QUART IRQ Active	0x35	QUART cannot clear interrupt	0x50	RTC low battery	0x51	RTC time not set	0xFF	Power failure
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Table 34: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description																		
29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC - Speed of Sound). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s																		
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED - Depth of Transducer). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters																		
37-40	19,20	EH / Heading	Contains the ExplorerDVL heading angle. This value may be a manual setting (EH - Heading) or a reading from a heading sensor. The variation angle from the EV command is added to heading before output. The coordinate frame this data is referenced to is specified by the EH command. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees																		
41-44	21,22	EP / Pitch (Tilt 1)	Contains the ExplorerDVL pitch angle. This value may be a manual setting (EP - Pitch and Roll Angles) or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. The coordinate frame this data is referenced to is specified by the EP command. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees																		
45-48	23,24	ER / Roll (Tilt 2)	Contains the ExplorerDVL roll angle. This value may be a manual setting (ER - Roll Angle) or a reading from a tilt sensor. For an up-facing ExplorerDVL system, positive values mean that Beam #2 is above the earth's horizontal while than Beam #1 is below the earth's horizontal. For a down-facing ExplorerDVL system, positive values mean that Beam #1 is above the earth's horizontal and then Beam #2 is below the earth's horizontal. The coordinate frame this data is referenced to is specified by the EP command. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees																		
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES - Salinity). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40																		
53-56	27,28	ET / Temperature	Contains the temperature of the water at the transducer head. This value may be a manual setting (ET - Temperature) or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees																		
57,58	29	MPT minutes	This field contains the <u>Minimum Pre-Ping Wait Time</u> between ping groups in the ensemble.																		
59,60	30	MPT seconds																			
61,62	31	MPT hundredths																			
63,64	32	H/Hdg Std Dev	These fields contain the standard deviation (accuracy) of the heading and tilt angles from the gyrocompass/pendulums. Scaling (Heading): LSD = 1°; Range = 0 to 180° Scaling (Tilts): LSD = 0.1°; Range = 0.0 to 20.0°																		
65,66	33	P/Pitch Std Dev																			
67,68	34	R/Roll Std Dev																			
69-70	35	ADC Channel 0	These fields contain the outputs of the Analog-to-Digital Converter (ADC). Here is the description for each channel: <table border="1"> <thead> <tr> <th>CHANNEL</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Not Used</td> </tr> <tr> <td>1</td> <td>XMIT VOLTAGE</td> </tr> <tr> <td>2</td> <td>Not Used</td> </tr> <tr> <td>3</td> <td>Not Used</td> </tr> <tr> <td>4</td> <td>Not Used</td> </tr> <tr> <td>5</td> <td>Not Used</td> </tr> <tr> <td>6</td> <td>Not Used</td> </tr> <tr> <td>7</td> <td>Not Used</td> </tr> </tbody> </table> <p>Note that the ADC values may be “noisy” from sample-to-sample, but are useful for detecting long-term trends.</p>	CHANNEL	DESCRIPTION	0	Not Used	1	XMIT VOLTAGE	2	Not Used	3	Not Used	4	Not Used	5	Not Used	6	Not Used	7	Not Used
CHANNEL	DESCRIPTION																				
0	Not Used																				
1	XMIT VOLTAGE																				
2	Not Used																				
3	Not Used																				
4	Not Used																				
5	Not Used																				
6	Not Used																				
7	Not Used																				
71-72	36	ADC Channel 1																			
73-74	37	ADC Channel 2																			
75-76	38	ADC Channel 3																			
77-78	39	ADC Channel 4																			
79-80	40	ADC Channel 5																			
81-82	41	ADC Channel 6																			
83-84	42	ADC Channel 7																			
85-86	43	Error Status Word	Reserved for TRDI use.																		
87-88	44		Reserved for TRDI use.																		


Table 34: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
89-90	45		Reserved for TRDI use.
91-92	46		Reserved for TRDI use.
93-96	47-48	Reserved	Reserved for TRDI use.
97-104	49-52	Pressure	Contains the pressure of the water at the transducer head relative to one atmosphere (sea level). Output is in deca-pascals. Scaling: LSD=1 deca-pascal; Range=0 to 4,294,967,295 deca-pascals
105-112	53-56	Pressure variance	Contains the variance (deviation about the mean) of the pressure sensor data. Output is in deca-pascals. Scaling: LSD=1 deca-pascal; Range=0 to 4,294,967,295 deca-pascals
113-114	57	Spare	Spare
115-116	58	Spare	Spare
117-118	59	Spare	Spare
119-120	60	Spare	Spare

 If there is more than one BIT error, then it will take several ensembles to output all the BIT errors. For example, if there are 3 BIT errors detected, then the output will be Bytes13, 14 = 03,xx on ensemble n, Bytes13, 14 = 03,yy on ensemble n+1, and Bytes13, 14 = 03,zz on ensemble n+2, where xx, yy, and zz are the three different error messages detected.

BIT Decoding Method

In order to verify if the system has a BIT set for an ensemble, run the file through *BBCheck.exe* or decode it from the PDO binary output using *BBConv.exe*.

 *BBCheck* and *BBConv* are included with RDI Tools.

In any case, one will obtain a decimal value greater than zero if a BIT was set during the ensemble.

To decode it, simply convert the decimal value to Hexadecimal and take the first number to the far left as being the number of BIT failure occurrences during the ensemble and the 2 other numbers on the far right to be the BIT code.

For example:


- BIT obtained from *BBCheck* or *BBConv.exe* is '290'.
- Converted to hexadecimal = '122' (use the Windows® calculator **View** menu, **Programmer** for this).
- Where '1' is the number of occurrences for that BIT and '22' is the BIT failure code which means "Temperature Sensor failure" (see binary bytes 13 and 14).

Velocity Data Format

BYTE	BIT POSITIONS								
	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID								LSB 00h
2									MSB 01h
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
5	DEPTH CELL #1, VELOCITY 2								LSB
6									MSB
7	DEPTH CELL #1, VELOCITY 3								LSB
8									MSB
9	DEPTH CELL #1, VELOCITY 4								LSB
10									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
13	DEPTH CELL #2, VELOCITY 2								LSB
14									MSB
15	DEPTH CELL #2, VELOCITY 3								LSB
16									MSB
17	DEPTH CELL #2, VELOCITY 4								LSB
18									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 128 CELLS)								↓
1019	DEPTH CELL #128, VELOCITY 1								LSB
1020									MSB
1021	DEPTH CELL #128, VELOCITY 2								LSB
1022									MSB
1023	DEPTH CELL #128, VELOCITY 3								LSB
1024									MSB
1025	DEPTH CELL #128, VELOCITY 4								LSB
1026									MSB

See Table 35 for description of fields

Figure 46. Velocity Data Format

 The number of depth cells is set by the WN-command ([WN – Number of Depth Cells](#)).

The ExplorerDVL packs velocity data for each depth cell of each beam into a two-byte, two’s-complement integer [-32768, 32767] with the LSB sent first. The ExplorerDVL scales velocity data in millimeters per second (mm/s). A value of -32768 (8000h) indicates bad velocity values.

All velocities are relative based on a stationary instrument. To obtain absolute velocities, algebraically remove the velocity of the instrument. For example,

```
RELATIVE WATER CURRENT VELOCITY:    EAST 650 mm/s
INSTRUMENT VELOCITY                 : (-) EAST 600 mm/s
ABSOLUTE WATER VELOCITY              :    EAST 50 mm/s
```

The setting of the EX-command (Coordinate Transformation) determines how the ExplorerDVL references the velocity data as shown below.

EX-CMD	COORD SYS	VEL 1	VEL 2	VEL 3	VEL 4
00xxx	BEAM	TO BEAM 1	TO BEAM 2	TO BEAM 3	TO BEAM 4
01xxx	INST	Bm1-Bm2	Bm4-Bm3	TO XDUCER	ERR VEL
10xxx	SHIP	PRT-STBD	AFT-FWD	TO SURFACE	ERR VEL
11xxx	EARTH	TO EAST	TO NORTH	TO SURFACE	ERR VEL

POSITIVE VALUES INDICATE WATER MOVEMENT

Table 35: Velocity Data Format


Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word (MSB=01h LSB=00h).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
9-12	5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2. See above.
13-16	7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3. See above.
17-20	9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4. See above.
21-2052	11-1026	Cells 2 – 128 (if used)	These fields store the velocity data for depth cells 2 through 128 (depending on the setting of WN – Number of Depth Cells). These fields follow the same format as listed above for depth cell 1.

Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

BYTE	BIT POSITIONS								
	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	DEPTH CELL #1, FIELD #4								
7	DEPTH CELL #2, FIELD #1								
8	DEPTH CELL #2, FIELD #2								
9	DEPTH CELL #2, FIELD #3								
10	DEPTH CELL #2, FIELD #4								
↓	(SEQUENCE CONTINUES FOR UP TO 128 BINS)								↓
511	DEPTH CELL #128, FIELD #1								
512	DEPTH CELL #128, FIELD #2								
513	DEPTH CELL #128, FIELD #3								
514	DEPTH CELL #128, FIELD #4								

See Table 36 through Table 39 for a description of the fields.

Figure 47. Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format



The number of depth cells is set by the WN-command ([WN – Number of Depth Cells](#)).

Correlation magnitude data give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The ExplorerDVL represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target). A value of zero indicates bad correlation values.

Table 36: Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word (MSB=20h LSB=00h).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam #4. See above.
13 – 1028	7 – 514	Cells 2 – 128 (if used)	These fields store correlation magnitude data for depth cells 2 through 128 (depending on WN – Number of Depth Cells) for all four beams. These fields follow the same format as listed above for depth cell 1.

The echo intensity scale factor is about 0.61 dB per ExplorerDVL count. The ExplorerDVL does not directly check for the validity of echo intensity data.

Table 37: Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the echo intensity data identification word (MSB=30h LSB=00h).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam #4. See above.
13 – 1028	7 – 514	Cells 2 – 128 (if used)	These fields store echo intensity data for depth cells 2 through 128 (depending on WN – Number of Depth Cells) for all four beams. These fields follow the same format as listed above for depth cell 1.

The percent-good data field is a data-quality indicator that reports the percentage (0 to 100) of good data collected for each depth cell of the velocity profile. The setting of the [EX-command](#) (Coordinate Transformation) determines how the ExplorerDVL references percent-good data as shown below.

EX-Command	Coordinate System	Velocity 1	Velocity 2	Velocity 3	Velocity 4
00xxx	Beam	Percentage Of Good Pings For:			
		Beam 1	BEAM 2	BEAM 3	BEAM 4
EX-Command	Coordinate System	Velocity 1	Velocity 2	Velocity 3	Velocity 4
		Percentage Of:			
01xxx	Instrument	3-Beam Transformations	Transformations Rejected	More Than One Beam Bad In Bin	4-Beam Transformations
10xxx	Ship	(note 1)	(note 2)		
11xxx	Earth				

Note 1. Because profile data did not exceed correlation threshold ([WC command](#)).

Note 2. Because the error velocity threshold was exceeded ([WE command](#)).

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the ADCP uses all four beams to calculate the orthogonal and error velocities. As the echo returns from far away depth cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the ADCP to reject some of its depth cell data. This causes the ADCP to calculate velocities with three beams instead of four beams. When the ADCP does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further depth cell, the ADCP rejects all cell data because of the weak echo. As an example, let us assume depth cell 60 has returned the following percent-good data.

FIELD #1 = 50, FIELD #2 = 5, FIELD #3 = 0, FIELD #4 = 45

If the [EX-command](#) was set to collect velocities in BEAM coordinates, the example values show the percentage of pings having good solutions in cell 60 for each beam based on the Low Correlation Threshold ([WC command](#)). Here, beam 1=50%, beam 2=5%, beam 3=0%, and beam 4=45%. These are neither typical nor desired percentages. Typically, all four beams should be about equal and greater than 25%.

On the other hand, if velocities were collected in Instrument, Ship, or Earth coordinates, the example values show:

Field 1 – Percentage of good 3-beam solutions – Shows percentage of successful velocity calculations (50%) using 3-beam solutions because the correlation threshold ([WC command](#)) was not exceeded.

Field 2 – Percentage of transformations rejected – Shows percent of error velocity (5%) that was less than the [WE command](#) setting. WE has a default of 2000 mm/s. This large WE setting effectively prevents the ADCP from rejecting data based on error velocity.

Field 3 – Percentage of more than one beam bad in bin – 0% of the velocity data were rejected because not enough beams had good data.

Field 4 – Percentage of good 4-beam solutions – 45% of the velocity data collected during the ensemble for depth cell 60 were calculated using four beams.

Table 38: Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word (MSB=04h LSB=00h).
5,6	3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
7,8	4	Depth cell 1, Field 2	Stores percent-good data for depth cell #1, field 2. See above.
9,10	5	Depth cell 1, Field 3	Stores percent-good data for depth cell #1, field 3. See above.
11,12	6	Depth cell 1, Field 4	Stores percent-good data for depth cell #1, field 4. See above.
13-1028	7-514	Depth cell 2 – 128 (if used)	These fields store percent-good data for depth cells 2 through 128 (depending on WN – Number of Depth Cells), following the same format as listed above for depth cell 1.

These fields contain information about the status and quality of ADCP data. A value of 0 means the measurement was good. A value of 1 means the measurement was bad.

Table 39: Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the status data identification word (00 05h).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, beam #1. See above.
7,8	4	Depth cell 1, Field 2	Stores status data for depth cell #1, beam #2. See above.
9,10	5	Depth cell 1, Field 3	Stores status data for depth cell #1, beam #3. See above.
11,12	6	Depth cell 1, Field 4	Stores status data for depth cell #1, beam #4. See above.
13-1028	7-514	Depth cell 2 – 128 (if used)	These fields store status data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

Binary Bottom-Track Data Format

BYTE	BIT POSITIONS								
	7/S	6	5	4	3	2	1	0	
1	BOTTOM-TRACK ID								LSB 00h
2									MSB 06h
3	BT PINGS PER ENSEMBLE								LSB
4									MSB
5	RESERVED								LSB
6									MSB
7	BT CORR MAG MIN								
8	BT EVAL AMP MIN								
9	RESERVED								
10	BT MODE								
11	BT ERR VEL MAX								LSB
12									MSB
13	RESERVED								
14									
15									
16									
17	BEAM#1 BT RANGE								LSB
18									MSB
19	BEAM#2 BT RANGE								LSB
20									MSB
21	BEAM#3 BT RANGE								LSB
22									MSB
23	BEAM#4 BT RANGE								LSB
24									MSB
25	BEAM#1 BT VEL								LSB
26									MSB
27	BEAM#2 BT VEL								LSB
28									MSB
29	BEAM#3 BT VEL								LSB
30									MSB
31	BEAM#4 BT VEL								LSB
32									MSB
33	BEAM#1 BT CORR.								
34	BEAM#2 BT CORR.								
35	BEAM#3 BT CORR.								
36	BEAM#4 BT CORR.								

BIT POSITIONS									
BYTE	7/S	6	5	4	3	2	1	0	
37	BEAM#1 EVAL AMP								
38	BEAM#2 EVAL AMP								
39	BEAM#3 EVAL AMP								
40	BEAM#4 EVAL AMP								
41	BEAM#1 BT %GOOD								
42	BEAM#2 BT %GOOD								
43	BEAM#3 BT %GOOD								
44	BEAM#4 BT %GOOD								
45	REF LAYER MIN								LSB
46									MSB
47	REF LAYER NEAR								LSB
48									MSB
49	REF LAYER FAR								LSB
50									MSB
51	BEAM#1 REF LAYER VEL								LSB
52									MSB
53	BEAM #2 REF LAYER VEL								LSB
54									MSB
55	BEAM #3 REF LAYER VEL								LSB
56									MSB
57	BEAM #4 REF LAYER VEL								LSB
58									MSB
59	BM#1 REF CORR								
60	BM#2 REF CORR								
61	BM#3 REF CORR								
62	BM#4 REF CORR								
63	BM#1 REF INT								
64	BM#2 REF INT								
65	BM#3 REF INT								
66	BM#4 REF INT								
67	BM#1 REF %GOOD								
68	BM#2 REF %GOOD								
69	BM#3 REF %GOOD								
70	BM#4 REF %GOOD								
71	BT MAX. DEPTH								LSB
72									MSB

BYTE	BIT POSITIONS								
	7/S	6	5	4	3	2	1	0	
73	BM#1 RSSI AMP								
74	BM#2 RSSI AMP								
75	BM#3 RSSI AMP								
76	BM#4 RSSI AMP								
77	GAIN								
78	(*SEE BYTE 17)								MSB
79	(*SEE BYTE 19)								MSB
80	(*SEE BYTE 21)								MSB
81	(*SEE BYTE 23)								MSB

Figure 48. Binary Bottom-Track Data Format



This data is output only if the BP-command is > 0 and PD0 is selected. See Table 40 for a description of the fields.



The PD0 Bottom Track output data format assumes that the instrument is stationary and the bottom is moving. See the [EX – Coordinate Transformation](#) command and [Beam Coordinate Systems](#) for details.

- If Beam 3 is going forward, then the Y velocity is negative.
- If Beam 2 is going forward, then X velocity is negative.

The [PD0 Bottom Track High Resolution Velocity Output](#) (velocity in 0.01mm/s) and PD3 through PD6 data formats assume that the bottom is stationary and that the DVL or vessel is moving.

- If Beam 3 is going forward, then the Y velocity is positive.
- If Beam 2 is going forward, then X velocity is positive.

This data is output only if the BP-command is greater than zero and PDO is selected. The LSB is always sent first.

Table 40: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the bottom-track data identification word (MSB=06hLSB=00h).
5-8	3,4	BP/BT Pings per ensemble	Stores the number of bottom-track pings to average together in each ensemble (BP – Bottom-Track Pings per Ensemble). If BP = 0, the ExplorerDVL does not collect bottom-track data. The ExplorerDVL automatically extends the ensemble interval (TE – Time Per Ensemble) if BP x TP > TE. Scaling: LSD = 1 ping; Range = 1 to 999 pings
9-12	5,6	Reserved	Reserved
13,14	7	BC/BT Corr Mag Min	Stores the minimum correlation magnitude value (BC - Correlation Magnitude Minimum). Scaling: LSD = 1 count; Range = 0 to 255 counts
15,16	8	BA/BT Eval Amp Min	Stores the minimum evaluation amplitude value (BA - Evaluation Amplitude Minimum). Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	Reserved	Reserved
19,20	10	BM/BT Mode	Stores the bottom-tracking mode (BM-command).
21-24	11,12	BE/BT Err Vel Max	Stores the error velocity maximum value (BE - Error Velocity Maximum). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
25-32	13–16	Reserved	Reserved
33-48	17-24	BT Range/Beam #1-4 BT Range	Contains the two lower bytes of the vertical range from the ExplorerDVL to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range = 0. See bytes 78 through 81 for MSB description and scaling. Scaling: LSD = 1 cm; Range = 0 to 65535 cm
49-64	25-32	BT Velocity/Beam #1-4 BT Vel	The meaning of the velocity depends on the coordinate system command setting (EX – Coordinate Transformation). The four velocities in mm/s are as follows: a) Beam Coordinates: Beam 1, Beam 2, Beam 3, Beam 4 b) Instrument Coordinates: 1->2, 4->3, toward face, error c) Ship Coordinates: Starboard, Fwd, Upward, Error d) Earth Coordinates: East, North, Upward, Error
65-72	33-36	BTCM/Beam #1-4 BT Corr.	Contains the correlation magnitude in relation to the sea bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
73-80	37-40	BTEA/Beam #1-4 BT Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo. Scaling: LSD = 1 count; Range = 0 to 255 counts
81-88	41-44	BTPG/Beam #1-4 BT %Good	Contains bottom-track percent-good data for each beam, which indicate the reliability of bottom-track data. It is the percentage of bottom-track pings that have passed the ExplorerDVL's bottom-track validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
89-92 93-96 97 – 100	45,46 47,48 49,50	Ref Layer (Min, Near, Far)	Stores the minimum layer size, the near boundary, and the far boundary of the bottom track water-reference layer (BL - Water-Mass Layer Parameters). Scaling (minimum layer size): LSD = 1 dm; Range = 1-999 dm Scaling (near/far boundaries): LSD = 1 dm; Range = 6-9999 dm
101- 116	51-58	Ref Vel/Beam #1-4 Ref Layer Vel	Contains velocity data for the water mass for each beam. Water mass velocities have the same format and scale factor as water-profiling velocities (Table 35). The BL-command explains the water mass.

Table 40: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
117- 124	59-62	RLCM/Bm #1-4 Ref Corr	Contains correlation magnitude data for the water mass for each beam. Water mass correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
125- 132	63-66	RLEI/Bm #1-4 Ref Int	Contains echo intensity data for the Water mass for each beam. Water mass intensities have the same format and scale factor as water-profiling intensities.
133- 140	67-70	RLPG/Bm #1-4 Ref %Good	Contains percent-good data for the water mass for each beam. They indicate the reliability of water mass data. It is the percentage of bottom-track pings that have passed a water mass validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
141- 144	71,72	BX/BT Max. Depth	Stores the maximum tracking depth value (BX – Maximum Tracking Depth). Scaling: LSD = 1 decimeter; Range = 10 to 65535 decimeters
145-152	73-76	RSSI/Bm #1-4 RSSI Amp	Contains the Receiver Signal Strength Indicator (RSSI) value in the center of the bottom echo as determined by each beam. Scaling: LSD ≈ 0.61 dB per count; Range = 0 to 255 counts
153, 154	77	GAIN	Contains the Gain level for shallow water. See WJ - Receiver Gain Select .
155-162	78-81	BT Range MSB/Bm #1-4	Contains the most significant byte of the vertical range from the ExplorerDVL to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range=0. See bytes 17 through 24 for LSB description and scaling. Scaling: LSD = 65,536 cm, Range = 65,536 to 16,777,215 cm

Environmental Command Parameters Output Format

BYTE	BIT POSITIONS								LSB 00h MSB 30h
	7	6	5	4	3	2	1	0	
1	FIXED ATTITUDE ID								↓
2									
3	ATTITUDE OUTPUT COORDINATES and PROCESSING CONTROL USING INTERPOLATED ATTITUDE (#EE)								↓
4									
5									
6									
7									
8									
9									
10									
11	RESERVED								↓
12	FIXED HEADING SCALING (#EH)								
13	FIXED HEADING COORDINATE FRAME (#EH)								↓
14	ROLL MISALIGNMENT (#EI)								
15	PITCH MISALIGNMENT (#EJ)								↓
16	USER INPUT FOR PITCH, ROLL, and COORDINATE FRAME (#EP)								
17	USER INPUT FOR UP/DOWN ORIENTATION (#EU)								↓
18	USER INPUT FOR HEADING BIAS/VARIATION/SYNCHRO OFFSET (#EV)								
19	SENSOR SOURCE (EZ)								↓
20									
21	TRANSDUCER DEPTH (ED)								↓
22									
23									
24									
25									↓
26									
27									
28									
29									↓
30									
31									
32									
33									↓
34									
35									
36									
37									↓
38									

BYTE	BIT POSITIONS							
	7	6	5	4	3	2	1	0
39	SALINITY (ES)							
40	WATER TEMPERATURE (ET)							
41								
42	SPEED OF SOUND (EC)							
43								
44	COORDINATE TRANSFORMATION (EX)							
45	3 BEAM SOLUTION (EX)							
46	BIN MAP (EX)							
47	MSB COORDINATE TRANSFORMATION (EX)							

Figure 49. Environmental Command Parameters Output Format

Environmental Command Parameters correspond to the most useful “E” menu command parameters. The ExplorerDVL will output Fixed Attitude data as output data (LSBs first). See [Command Descriptions](#) for detailed descriptions of commands used to set these values.

Table 41: Environmental Command Parameters Output Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FAID / Fixed Attitude ID	Environmental Command Parameters Output word (MSB=30h, LSB=00h).
5-20	3-10	Attitude Output Coordinates	Stores the setting of the #EE command; a user input for the Variable Attitude data to be output (EE - Environmental Data Output).
21,22	11	Reserved	
23-27	12-13	Fixed Heading Scaling	Stores the setting of the #EH command; a user input for heading (EH - Heading).
28	14	Fixed Heading Coordinate Frame	Stores the setting of the #EH command coordinate frame: 1 is ship, 0 is instrument (EH - Heading).
29-32	15,16	Roll Misalignment	Stores the setting of the #EI command; a user input for the roll misalignment (EI - Roll Misalignment Angle).
33-36	17,18	Pitch Misalignment	Stores the setting of the #EJ command; a user input for the pitch misalignment (EJ - Pitch Misalignment Angle).
37-46	19-23	Pitch, Roll and Coordinate Frame	Stores the setting of the #EP command; a user input for the pitch, roll, and coordinate (instrument or ship) frame (EP - Pitch and Roll Angles).
47,48	24	Orientation	Stores the setting of the #EU command; a user input for the up/down orientation (EU - Up/Down Orientation).
49-52	25,26	Heading Offset	Stores the setting of the #EV command; a user input for the heading offset due to heading bias, variation, or synchro initialization (EV - Heading Bias).
53-68	27-34	Sensor Source	Stores the setting of the EZ command; a user input defining the use of internal, external, or fixed sensors (EZ - Sensor Source).
69-76	35-38	Transducer Depth	Stores the setting of the ED command; a user input defining depth of the transducer (see ED - Depth of Transducer).
77-78	39	Salinity	Stores the setting of the ES command; a user input defining the salinity of the water (see ES - Salinity).
79-82	40,41	Water Temp	Stores the setting of the ET command; a user input defining the temperature of the water (see ET - Temperature).

Table 41: Environmental Command Parameters Output Format

Hex Digit	Binary Byte	Field	Description
83-86	42,43	SoS	Stores the setting of the EC command; a user input defining the speed of sound (see EC - Speed of Sound).
87-88	44	Transform	Stores the setting of the right two digits of the EX command that describe the coordinate transformations (see EX – Coordinate Transformation).
89-90	45	3 Beam Solution	Stores the setting of the fourth bit of the EX command that allows 3 beams good (instead of 4) transformations.
91-92	46	Bin Map	Stores the setting of the fifth bit of the EX command that controls bin mapping.
93-94	47	MSB of EX transformation	Stores the setting of the left digit of the EX command that describes the coordinate transformations.

Bottom Track Command Output Format

BYTE	BIT POSITIONS								
	7	6	5	4	3	2	1	0	
1.	BOTTOM TRACK COMMAND ID								LSB 00h
2.									MSB 58h
3.	AMPLITUDE THRESHOLD								
4.	CORRELATION MAGNITUDE								
5.	DELAY BEFORE REACQUIRE								
6.	ERROR VELOCITY MAXIMUM								
7.	DEPTH GUESS								
8.	MINIMUM PERCENT GOOD								
9.	GAIN THRESHOLD LOW								
10.	GAIN THRESHOLD HIGH								
11.	GAIN SWITCH DEPTH								
12.	WATER MASS LAYER MODE								
13.	WATER MASS LAYER MIN SIZE								
14.	WATER MASS LAYER NEAR BOUNDARY								
15.	WATER MASS LAYER FAR BOUNDARY								
16.	BOTTOM TRACK MODE								

BYTE	BIT POSITIONS							
	7	6	5	4	3	2	1	0
24.	SPEED LOG HOLD TRACK							
25.	SPEED LOG TIME-OUT							
26.	SPEED LOG TIME-OUT							
27.	SPEED LOG FILTER TIME CONSTANT							
28.	PINGS PER ENSEMBLE							
29.	PINGS PER ENSEMBLE							
30.	RESOLUTION OF BOTTOM							
31.	TERRAIN BIAS CORRECTION							
32.	TERRAIN BIAS CORRECTION							
33.	BM7 BOTTOM BLANK							
34.	BM7 BOTTOM BLANK							
35.	BM7 CORRELATION THRESHOLD							
36.	BM7 SHORT LAG OUTPUT CONTROL							
37.	BT MAXIMUM TRACKING DEPTH							
38.	BT MAXIMUM TRACKING DEPTH							
39.	WATER REFERENCE INTERVAL							
40.	WATER REFERENCE INTERVAL							
41.	MAX TRANSMIT PERCENT							
42.	BT AMBIGUITY VELOCITY							
43.	BT AMBIGUITY VELOCITY							

Figure 50. Bottom Track Command Output Data Format

This format is selected via the #BJ command (see [BJ – Data Type Output Control](#)).

Table 42: Bottom Track Command Output Data Format

Binary Byte	Field	Description
1-2	ID	PD0 ID (MSB=58h LSB=00h)
3	BA	Evaluation Amplitude, 1 to 255 counts (BA - Evaluation Amplitude Minimum)
4	BC	Correlation Magnitude, 0 to 255 counts (BC - Correlation Magnitude Minimum)
5-6	Reserved	Delay before reacquire, 0 to 999 ensembles
7-8	BE	Error Velocity Maximum, 0 to 9999 mm/s (BE - Error Velocity Maximum)
9-10	BF	Depth Guess, 1 to 65535 dm (0 for automatic search) (BF - Depth Guess)
11	Reserved	Minimum Percent Good, 0 to 100%
12	Reserved	Gain Threshold Low
13	Reserved	Gain Threshold High
14-15	BI	Gain Switch Depth (BI - Gain Switch Altitude)
16	BK	Water Mass Layer Mode, 0 to 3 (BK - Water-Mass Layer Mode)
17-18	BL1	Water Mass Layer Min Size, 1 to 999 dm (BL - Water-Mass Layer Parameters)

Table 42: Bottom Track Command Output Data Format

Binary Byte	Field	Description
19-20	BL2	Water Mass Layer Near Boundary, 6 to 9999 dm
21-22	BL3	Water Mass Layer Far Boundary, 7 to 9999 dm
23	Reserved	Bottom Track Mode, 8
24	Reserved	Speed log param #1: Hold Distance or zero if timeout
25-26	Reserved	Speed log time-out
27	Reserved	Speed log filter time constant
28-29	BP	Pings Per Ensemble, 1 to 999 (BP – Bottom-Track Pings per Ensemble)
30	Reserved	BT (Vertical Depth) Resolution, 0 to 2 (not used in Pioneer)
31-32	Reserved	Terrain Bias Correction
33-34	Reserved	BM8 Bottom Blank
35	Reserved	BM8 Correlation Threshold for Ambiguity Resolution
36	Reserved	BM8 Short lag output control
37-38	BX	BT Maximum Tracking Depth, 10 to 65535 dm (BX – Maximum Tracking Depth)
39-40	Reserved	Water Reference Interval
41	Reserved	Max Transmit (or Feeler) Percent
42-43	Reserved	BT Ambiguity Velocity

Bottom Track High Resolution Velocity Format

BYTE	BIT POSITIONS								
	7	6	5	4	3	2	1	0	
1.	BOTTOM TRACK HIGH RESOLUTION VELOCITY ID								LSB 03h
2.									MSB 58h
3.	BT VELOCITY 1								
4.									
5.									
6.									
7.	BT VELOCITY 2								
8.									
9.									
10.									
11.	BT VELOCITY 3								
12.									
13.									
14.									

		BIT POSITIONS							
BYTE		7	6	5	4	3	2	1	0
15.		BT VELOCITY 4							
16.									
17.									
18.									
19.		BT DISTANCE MADE GOOD 1							
20.									
21.									
22.									
23.		BT DISTANCE MADE GOOD 2							
24.									
25.									
26.									
27.		BT DISTANCE MADE GOOD 3							
28.									
29.									
30.									
31.		BT DISTANCE MADE GOOD 4							
32.									
33.									
34.									
35.		WATER MASS VELOCITY 1							
36.									
37.									
38.									
39.		WATER MASS VELOCITY 2							
40.									
41.									
42.									
43.		WATER MASS VELOCITY 3							
44.									
45.									
46.									
47.		WATER MASS VELOCITY 4							

BYTE	BIT POSITIONS							
	7	6	5	4	3	2	1	0
48.								
49.								
50.								
51.								
52.	WATER MASS DISTANCE MADE GOOD 1							
53.								
54.								
55.								
56.	WATER MASS DISTANCE MADE GOOD 2							
57.								
58.								
59.								
60.	WATER MASS DISTANCE MADE GOOD 3							
61.								
62.								
63.								
64.	WATER MASS DISTANCE MADE GOOD 4							
65.								
66.								
67.								
68.	SPEED OF SOUND							
69.								
70.								

Figure 51. Bottom Track High Resolution Velocity Output Format



The PD0 Bottom Track High Resolution Velocity Output data format assumes that the bottom is stationary and that the DVL or vessel is moving.

- If Beam 3 is going forward, then the Y velocity is positive.
- If Beam 2 is going forward, then X velocity is positive.
- If the bottom is going towards the face of a down facing DVL, then Z is positive.

This format is selected via the #BJ command (see [BJ – Data Type Output Control](#)).

Table 43: Bottom Track High Resolution Velocity Output Format

Binary Byte	Field	Description
1-2	ID	PD0 ID (MSB=58h LSB=03h)
3-6	BT Velocity 1	Bottom Track Axis 1 Velocity in 0.01mm/s. Reference frame dependent on EX – Coordinate Transformation .
7-10	BT Velocity 2	Bottom Track Axis 2 Velocity in 0.01mm/s. Reference frame dependent on EX command.
11-14	BT Velocity 3	Bottom Track Axis 3 Velocity in 0.01mm/s. Reference frame dependent on EX command.
15-18	BT Velocity 4	Bottom Track Axis 4 Velocity in 0.01mm/s. Reference frame dependent on EX command.
19-22	BT DMG 1	Bottom Track Axis 1 Distance in 0.01mm made good. Reference frame dependent on EX command.
23-26	BT DMG 2	Bottom Track Axis 2 Distance in 0.01mm made good. Reference frame dependent on EX command.
27-30	BT DMG 3	Bottom Track Axis 3 Distance in 0.01mm made good. Reference frame dependent on EX command.
31-34	BT DMG 4	Bottom Track Axis 4 Distance in 0.01mm made good. Reference frame dependent on EX command.
35-38	WM Velocity 1	Water Mass Axis 1 Velocity in 0.01mm/s. Reference frame dependent on EX command.
39-42	WM Velocity 2	Water Mass Axis 2 Velocity in 0.01mm/s. Reference frame dependent on EX command.
43-46	WM Velocity 3	Water Mass Axis 3 Velocity in 0.01mm/s. Reference frame dependent on EX command.
47-50	WM Velocity 4	Water Mass Axis 4 Velocity in 0.01mm/s. Reference frame dependent on EX command.
51-54	WM DMG 1	Water Mass Axis 1 Distance in 0.01mm made good. Reference frame dependent on EX command.
55-58	WM DMG 2	Water Mass Axis 2 Distance in 0.01mm made good. Reference frame dependent on EX command.
59-62	WM DMG 3	Water Mass Axis 3 Distance in 0.01mm made good. Reference frame dependent on EX command.
63-66	WM DMG 4	Water Mass Axis 4 Distance in 0.01mm made good. Reference frame dependent on EX command.
67-70	SoS	Speed of Sound * 10 ⁶ .

Bottom Track Range Format

BYTE	BIT POSITIONS								
	7	6	5	4	3	2	1	0	
1.	BOTTOM TRACK RANGE ID								LSB 04h
2.									MSB 58h
3.	Slant Range								
4.									
5.									
6.									
7.	Axis Delta Range								
8.									
9.									
10.									
11.	Vertical Range								
12.									
13.									
14.									
15.	% Good 4 Bm								
16.	% Good Bm 1&2								
17.	% Good Bm 3 & 4								
18.	BEAM 1 Raw Range								
19.									
20.									
21.									
22.	BEAM 2 Raw Range								
23.									
24.									
25.									
26.	BEAM 3 Raw Range								
27.									
28.									
29.									

BYTE	BIT POSITIONS							
	7	6	5	4	3	2	1	0
30.	BEAM 4 Raw Range							
31.								
32.								
33.								
34.	BEAM 1 Raw Max BT Filter							
35.	BEAM 2 Raw Max BT Filter							
36.	BEAM 3 Raw Max BT Filter							
37.	BEAM 4 Raw Max BT Filter							
38.	BEAM 1 RAW MAX BT AMPLITUDE							
39.	BEAM 2 RAW MAX BT AMPLITUDE							
40.	BEAM 3 RAW MAX BT AMPLITUDE							
41.	BEAM 4 RAW MAX BT AMPLITUDE							

Figure 52. Bottom Track Range Output Data Format

This format is selected via the #BJ command (see [BJ – Data Type Output Control](#)).

Table 44: Bottom Track Range Output Data Format

Binary Bytes	Field	Description
1-2	ID	PD0 ID (MSB=58h LSB=04h)
3-6	Slant Range	Average range to bottom along the Z axis of the instrument frame, averaged over the ensemble. Valid only for at least 2 beams good on axis; zero is output for invalid data. Units are 0.1mm.
7-10	Axis Delta Range	Difference in slant range between beam 1 & 2 estimate and beam 3 & 4 estimate averaged over the ensemble. Valid only for 4 beam good pings. Units are 0.1mm.
11-14	Vertical Range	Average vertical range (altitude) of bottom depth (accounting for instrument tilt) over the ensemble. Zero is output if vertical range cannot be calculated because less than three beams are good, etc. Units are 0.1mm.
15	% Good 4 Bm	Percent Good 2 axis (4 Bm) slant range solutions.
16	% Good Bm 1&2	Percent Good axis Bm 1 & 2 slant range solutions.
17	% Good Bm 3 & 4	Percent Good axis Bm 3 & 4 slant range solutions.
18-21	BM 1 Raw Range	Slant range to the bottom along beam 1 multiplied by cos(Janus), averaged over the ensemble, even if fewer than 3 beams detect the bottom. Units 0.1mm
22-25	BM 2 Raw Range	Slant range to the bottom along beam 2 multiplied by cos(Janus), averaged over the ensemble, even if fewer than 3 beams detect the bottom. Units 0.1mm
26-29	BM 3 Raw Range	Slant range to the bottom along beam 3 multiplied by cos(Janus), averaged over the ensemble, even if fewer than 3 beams detect the bottom. Units 0.1mm
30-33	BM 4 Raw Range	Slant range to the bottom along beam [n] multiplied by cos(Janus), averaged over the ensemble, even if fewer than 3 beams detect the bottom. Units 0.1mm
34	BM 1 Raw Max BT Filter	Maximum Bottom detection filter output in counts averaged over the ensemble for beam 1 even if less than 3 beams detecting bottom.
35	BM 2 Raw Max BT Filter	Maximum Bottom detection filter output in counts averaged over the ensemble for beam 2 even if less than 3 beams detecting bottom.

Table 44: Bottom Track Range Output Data Format

Binary Bytes	Field	Description
36	BM 3 Raw Max BT Filter	Maximum Bottom detection filter output in counts averaged over the ensemble for beam 3 even if less than 3 beams detecting bottom.
37	BM 4 Raw Max BT Filter	Maximum Bottom detection filter output in counts averaged over the ensemble for beam 4 even if less than 3 beams detecting bottom.
38	BM 1 Raw Max BT Amp	Bottom amplitude at measured range in counts, averaged over the ensemble, for beam 1 even if fewer than 3 beams detect the bottom. Amplitude value corresponds to the middle of the bottom return.
39	BM 2 Raw Max BT Amp	Bottom amplitude at measured range in counts, averaged over the ensemble, for beam 2 even if fewer than 3 beams detect the bottom. Amplitude value corresponds to the middle of the bottom return.
40	BM 3 Raw Max BT Amp	Bottom amplitude at measured range in counts, averaged over the ensemble, for beam 3 even if fewer than 3 beams detect the bottom. Amplitude value corresponds to the middle of the bottom return.
41	BM 4 Raw Max BT Amp	Bottom amplitude at measured range in counts, averaged over the ensemble, for beam 4 even if fewer than 3 beams detect the bottom. Amplitude value corresponds to the middle of the bottom return.

Navigation Parameters Data Format

BYTE	BIT POSITIONS								
	7	6	5	4	3	2	1	0	
1	ID_NAV_PARAMS (0x2013)								13h
2									20h
3	TIME-TO-BOTTOM BEAM 1								LSB
4									
5									
6									MSB
7	TIME-TO-BOTTOM BEAM 2								LSB
8									
9									
10									MSB
11	TIME-TO-BOTTOM BEAM 3								LSB
12									
13									
14									MSB
15	TIME-TO-BOTTOM BEAM 4								LSB
16									
17									
18									MSB
19	BOTTOM TRACK STANDARD DEVIATION BEAM 1								LSB
20									MSB

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
21	BOTTOM TRACK STANDARD DEVIATION BEAM 2							LSB	
22								MSB	
23	BOTTOM TRACK STANDARD DEVIATION BEAM 3							LSB	
24								MSB	
25	BOTTOM TRACK STANDARD DEVIATION BEAM 4							LSB	
26								MSB	
27	SHALLOW OPERATION FLAG								
28								LSB	
29	TIME-TO-WATER MASS LAYER BEAM 1								
30									
31								MSB	
32								LSB	
33	TIME-TO-WATER MASS LAYER BEAM 2								
34									
35								MSB	
36								LSB	
37	TIME-TO-WATER MASS LAYER BEAM 3								
38									
39								MSB	
40								LSB	
41	TIME-TO-WATER MASS LAYER BEAM 4								
42									
43								MSB	
44	RANGE TO WATER MASS CELL							LSB	
45								MSB	
46	WATER TRACK STANDARD DEVIATION BEAM 1							LSB	
47								MSB	
48	WATER TRACK STANDARD DEVIATION BEAM 2							LSB	
49								MSB	
50	WATER TRACK STANDARD DEVIATION BEAM 3							LSB	
51								MSB	
52	WATER TRACK STANDARD DEVIATION BEAM 4							LSB	
53								MSB	
54								LSB	
55	BOTTOM TRACK TIME-OF-VALIDITY BEAM 1								
56									
57								MSB	

BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0
58	BOTTOM TRACK TIME-OF-VALIDITY BEAM 2							LSB
59								
60								
61								MSB
62	BOTTOM TRACK TIME-OF-VALIDITY BEAM 3							LSB
63								
64								
65								MSB
66	BOTTOM TRACK TIME-OF-VALIDITY BEAM 4							LSB
67								
68								
69								MSB
70	WATER TRACK TIME-OF-VALIDITY BEAM 1							LSB
71								
72								
73								MSB
74	WATER TRACK TIME-OF-VALIDITY BEAM 2							LSB
75								
76								
77								MSB
78	WATER TRACK TIME-OF-VALIDITY BEAM 3							LSB
79								
80								
81								MSB
82	WATER TRACK TIME-OF-VALIDITY BEAM 4							LSB
83								
84								
85								MSB

Figure 53. Navigation Parameters Data Format

This format is selected via the #BJ command (see [BJ – Data Type Output Control](#)).

Table 45. Navigation Parameters Data Format

Hex Digit	Binary Byte	Field	Description																
1-4	1, 2	ID_NAV_PARAMS / Navigation Parameters ID	Stores the navigation parameters identification word, ID_NAV_PARAMS, defined as 0x2013																
5-36	3-18	TIME-TO-BOTTOM BEAMS 1-4	Stores T_{bot} , the time interval between the hardware trigger (defined by the CX command) and the center time, or “time the ping hits the bottom,” of the bottom track measurement for Beams 1-4. Unit is 8 carrier cycles (52.08 μ s for 153.6 kHz). Unsigned integer.																
<table border="1"> <thead> <tr> <th>DVL Type</th> <th>Frequency</th> <th>Carrier Cycle</th> <th>8 x Carrier Cycles</th> </tr> </thead> <tbody> <tr> <td>600</td> <td>614.4 KHz</td> <td>1.628 uSec</td> <td>13.02 uSec</td> </tr> <tr> <td>300</td> <td>307.2 KHz</td> <td>3.255 uSec</td> <td>26.04 uSec</td> </tr> <tr> <td>150</td> <td>153.6 KHz</td> <td>6.510 uSec</td> <td>52.08 uSec</td> </tr> </tbody> </table>				DVL Type	Frequency	Carrier Cycle	8 x Carrier Cycles	600	614.4 KHz	1.628 uSec	13.02 uSec	300	307.2 KHz	3.255 uSec	26.04 uSec	150	153.6 KHz	6.510 uSec	52.08 uSec
DVL Type	Frequency	Carrier Cycle	8 x Carrier Cycles																
600	614.4 KHz	1.628 uSec	13.02 uSec																
300	307.2 KHz	3.255 uSec	26.04 uSec																
150	153.6 KHz	6.510 uSec	52.08 uSec																
37-52	19-26	BOTTOM TRACK STD DEVIATION BEAMS 1-4	Stores a prediction of the single ping bottom-track standard deviation calculated with the velocity variance model. Units are mm/sec.																
53	27	SHALLOW OPERATION FLAG	Stores the flag indicating whether the Pioneer is operating in shallow mode or not. If this value is set to 1, then the Pioneer is operating in shallow mode with one beam pinging at a time. If this value is 0, then the Pioneer is operating in Deep Mode with all beams pinging at the same time.																
54-86	28-43	TIME-TO-WATER MASS BEAMS 1-4	Stores T_{wm} , the time interval between the hardware trigger (defined by the CX command) and the center time, or “time the ping hits the center of the water mass layer,” of the water mass measurement for Beams 1-4. Unit is 8 carrier cycles (52.08 μ s for 153.6 kHz). Unsigned integer.																
87-90	44-45	RANGE TO WATER MASS CELL	The range to the water mass cell being tracked. Units are in carrier cycles (6.51 μ s for 153.6 kHz).																
91-106	46-53	WATER TRACK STD DEVIATION BEAMS 1-4	Stores a prediction of the single ping water-track standard deviation calculated with the velocity variance model. Units are mm/sec.																
107-138	54-69	BOTTOM TRACK TIME-OF-VALIDITY BEAMS 1-4	When CX=1, stores the time interval between the center time, or “time the ping hits the bottom”, and the time the Trigger was received by the DVL for the Bottom Track ping transmission. When CX=0 (i.e. trigger disabled), stores time elapsed between the center and the first character in the PD0 sentence. Unit is 1 μ sec. Accuracy is within \pm 5msec. Unsigned integer. Note the value will be set to zero if the bottom track velocity for the corresponding beam is bad.																
139-170	70-85	WATER TRACK TIME-OF-VALIDITY BEAMS 1-4	When CX=1, stores the time interval between the center time, or “time the ping hits the center of the water mass layer”, and the time the Trigger was received by the DVL for the water mass ping transmission. When CX=0 (i.e. trigger disabled), stores time elapsed between the center and the first character in the PD0 sentence. Unit is 1 μ sec. Accuracy is within \pm 5msec. Unsigned integer. Note the value will be set to 0 if the water track ping is bad or if there is a valid bottom track velocity solution.																

Sensor Source for Doppler Processing Format

		BIT POSITIONS									
BYTE		7	6	5	4	3	2	1	0		
1.	SENSOR SOURCE FOR DOPPLER PROCESSING FORMAT ID									01h LSB	
2.										30h MSB	
3.	HEADING										
4.											
5.											
6.	HEADING STATUS										
7.											
8.											
9.	HEADING SOURCE										
10.											
11.											
12.	PITCH										
13.											
14.											
15.	PITCH STATUS										
16.											
17.											
18.	PITCH SOURCE										
19.											
20.											
21.	ROLL										
22.											
23.											
24.	ROLL STATUS										
25.											
26.											
27.	ROLL SOURCE										
28.											
29.											
30.	SOS										
31.											
32.											
33.	SOS STATUS										
34.											
35.											
36.	SOS SOURCE										
37.											
38.											
39.	TEMPERATURE										
40.											
41.											
42.	TEMPERATURE STATUS										
43.											
44.											

BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0
36.	TEMPERATURE SOURCE							
37.								
38.	SALINITY							
39.								
40.								
41.	SALINITY STATUS							
42.								
43.	SALINITY SOURCE							
44.								
45.	DEPTH							
46.								
47.								
48.								
49.	DEPTH STATUS							
50.	DEPTH SOURCE							
51.								
52.	PRESSURE							
53.								
54.								
55.	PRESSURE STATUS							
56.								
57.	PRESSURE SOURCE							
58.								
59.	ENSEMBLE TIMER TICKS							
60.								
61.								
62.								

This format is selected via the #EE command (see [EE - Environmental Data Output](#)).

Table 46: Sensor Source for Doppler Processing Output Format

Binary Bytes	Field	Description
1-2	ID	PDO ID (MSB=30h LSB=01h)
3-6	Heading	Heading in 1/100ths of a degree.
7	Heading Status	A value of 0 indicates no valid data; 1 indicates sensor data valid from sensor specified by EZ - Sensor Source ; A value of 2 indicates sensor data valid from alternate sensor or user input.
8-9	Heading Source	See notes, below.
10-13	Pitch	Pitch in 1/100ths of a degree.

Table 46: Sensor Source for Doppler Processing Output Format

Binary Bytes	Field	Description
14	Pitch Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
15-16	Pitch Source	See notes, below.
17-20	Roll	Roll in 1/100ths of a degree.
21	Roll Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
22-23	Roll Source	See notes, below.
24-27	SOS	Speed of Sound 1/100ths of a m/s.
28	SOS Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
29-30	SOS Source	See notes, below.
31-34	Temperature	Temperature in 1/100ths of a °C.
35	Temperature Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
36-37	Temperature Source	See notes, below.
38-41	Salinity	Salinity in parts-per-ten thousand
42	Salinity Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
43-44	Salinity Source	See notes, below.
45-48	Depth	Depth in centimeters
49	Depth Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
50-51	Depth Source	See notes, below.
52-55	Pressure	Pressure in kPa.
56	Pressure Status	A value of 0 indicates no valid data; A value of 1 indicates sensor data valid from sensor specified by EZ; A value of 2 indicates sensor data valid from alternate sensor or user input.
57-58	Pressure Source	See notes, below.
59-62	Ensemble Timer Ticks	Timer Ticks Recorded when the RTC clock was read at the start of the ensemble. Intended for use in matching sensor TimeTags to RTC based ensemble time.

This data corresponds to the last ping of the ensemble for those sensors sampled at ping intervals. It is intended for single ping ensembles.

Output of this data is controlled by the 7th bit of the EE command ([EE - Environmental Data Output](#)).

The sensor source is identified by the detailed list of sensors in the table of the main text or the #EY description ([EY – Sensor Source Override for Doppler Parameters](#)). In addition to the sensors in that command, a sensor ID of -1 indicates that the parameter has been calculated based on other parameters (for example, speed of sound calculated based on salinity, pressure and temperature). A sensor ID of 0 indicates the parameter is from a user input command.



Binary Checksum Data Format

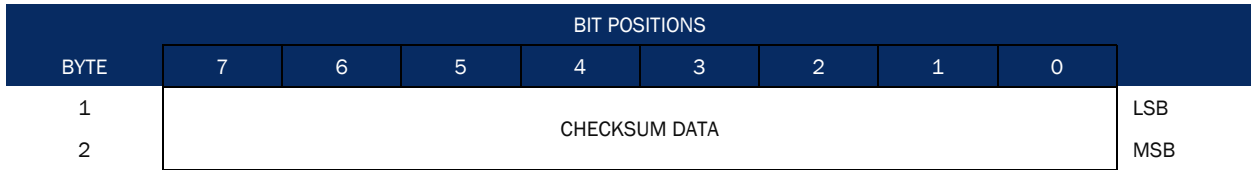


Figure 54. Binary Checksum Data Format

Table 47: Checksum Data Format


Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum Data	This field contains a modulo 65535 checksum. The ExplorerDVL computes the checksum by summing all the bytes in the output buffer excluding the checksum.


Special Output Data Formats

The PD4, PD5 and PD6 commands select the desired ExplorerDVL (speed log) output data format.

The ExplorerDVL binary output data buffers can contain header, configuration, bottom-velocity, water-mass reference-layer, range to bottom, status, built-in test, sensor, and distance made good data (plus a checksum). The ExplorerDVL collects all data in the output buffer during an ensemble.

Figure 55 through Figure 56 shows the format of these buffers and the sequence in which the ExplorerDVL sends the data. Table 48 through Table 50 lists the format, bytes, fields, scaling factors, and a detailed description of every item in the ExplorerDVL binary output buffers.

 The ExplorerDVL output data formats are available with or without bottom-track. However, if bottom-track is not available, they will contain no data.

 The ExplorerDVL output data formats assume that the bottom is stationary and that the ExplorerDVL or vessel is moving. The PD0 Bottom Track output data format (see [Binary Bottom-Track Data Format](#)) assumes that the instrument is stationary and the bottom is moving.

ExplorerDVL Binary Data Format (PD4/PD5)

Byte	BIT POSITION								
	7	6	5	4	3	2	1	0	
1	ExplorerDVL DATA ID 7Dh								
2	DATA STRUCTURE*								
3	NO. OF BYTES								LSB
4									MSB
5	SYSTEM CONFIG								
6	X-VEL BTM								LSB
7									MSB
8	Y-VEL BTM								LSB
9									MSB
10	Z-VEL BTM								LSB
11									MSB
12	E-VEL BTM								LSB
13									MSB
14	BM1 RNG TO BTM								LSB
15									MSB
16	BM2 RNG TO BTM								LSB
17									MSB
18	BM3 RNG TO BTM								LSB
19									MSB
20	BM4 RNG TO BTM								LSB
21									MSB
22	BOTTOM STATUS								

23	X-VEL REF LAYER	LSB MSB
24		
25	Y-VEL REF LAYER	
26		
27	Z-VEL REF LAYER	
28		
29	E-VEL REF LAYER	
30		
31	REF LAYER START	
32		
33	REF LAYER END	
34		
35	REF LAYER STATUS	
36	TOFP-HOUR	
37	TOFP-MINUTE	
38	TOFP-SECOND	
39	TOFP-HUNDREDTHS	
40	BIT RESULTS	
41		
42	SPEED OF SOUND	
43		
44	TEMPERATURE	
45		
46	CHECKSUM	
47		

Figure 55. ExplorerDVL Binary Data Format (PD4/PD5)



*IF 0, THEN PD4 (BYTES 1-47)

*IF 1, THEN PD5 (BYTES 1-45 + Table 49)

ExplorerDVL Output Data Format (PD4/PD5) Details

The ExplorerDVL sends this data format only when the PD4 or PD5 command is used.

Table 48: ExplorerDVL Output Data Format (PD4/PD5) Details

Hex Digit	Binary Byte	Field	Description
1,2	1	ExplorerDVL Data ID	Stores the ExplorerDVL (speed log) identification word (7Dh).
3,4	2	Data Structure	Identifies which data pattern will follow based on the PD-command (PDO Output Data Format). 0 = PD4 = Bytes 1 through 47 from Figure 55. 1 = PD5 = Bytes 1 through 45 from Figure 55 and bytes 46 through 88 from Figure 56.
5-8	3,4	No. of Bytes	Contains the number of bytes sent in this data structure, not including the final checksum.
9,10	5	System Config	Defines the ExplorerDVL hardware/firmware configuration. Convert to binary (see Decoding Flags and Set Bits) and interpret as follows. BIT 76543210 00xxxxxx BEAM-COORDINATE VELOCITIES 01xxxxxx INSTRUMENT-COORDINATE VELOCITIES 10xxxxxx SHIP-COORDINATE VELOCITIES 11xxxxxx EARTH-COORDINATE VELOCITIES xx0xxxxx TILT INFORMATION NOT USED IN CALCULATIONS xx1xxxxx TILT INFORMATION USED IN CALCULATIONS xxx0xxxx 3-BEAM SOLUTIONS NOT COMPUTED xxx1xxxx 3-BEAM SOLUTIONS COMPUTED xxxxx001 150-kHz ExplorerDVL xxxxx010 300-kHz ExplorerDVL xxxxx011 600-kHz ExplorerDVL xxxxx100 1200-kHz ExplorerDVL
11-14	6,7	X-Vel Btm	These fields contain the velocity of the vessel in relation to the bottom in mm/s. Positive values indicate vessel motion to east (X), north (Y), and up (Z). LSD = 1 mm/s (see NOTES at end of this table).
15-18	8,9	Y-Vel Btm	
19-22	10,11	Z-Vel Btm	
23-26	12,13	E-Vel Btm	
27-30	14,15	Bm1	These fields contain the vertical range from the ExplorerDVL to the bottom as determined by each beam. This vertical range does not compensate for the effects of pitch and roll. When a bottom detection is bad, the field is set to zero. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm
31-34	16,17	Bm2 Rng to	
35-38	18,19	Bm3 Bottom	
39-42	20,21	Bm4	
43,44	22	Bottom Status	This field shows the status of bottom-referenced correlation and echo amplitude data. Convert to binary (see Decoding Flags and Set Bits) and interpret as follows. A zero code indicates status is OK. BIT 76543210 1xxxxxxx BEAM 4 LOW ECHO AMPLITUDE x1xxxxxx BEAM 4 LOW CORRELATION xx1xxxxx BEAM 3 LOW ECHO AMPLITUDE xxx1xxxx BEAM 3 LOW CORRELATION xxxx1xxx BEAM 2 LOW ECHO AMPLITUDE xxxxx1xx BEAM 2 LOW CORRELATION xxxxxx1x BEAM 1 LOW ECHO AMPLITUDE xxxxxxx1 BEAM 1 LOW CORRELATION

Table 48: ExplorerDVL Output Data Format (PD4/PD5) Details

Hex Digit	Binary Byte	Field	Description																														
45-48	23,24	Velocity 1	These fields contain the velocity of the vessel in relation to the water-mass reference layer in mm/s. The setting of the EX-command (Coordinate Transformation) determines how the Navigator references the velocity data .																														
49-52	25,26	Velocity 2																															
53-56	27,28	Velocity 3																															
57-60	29,30	Velocity 4																															
			<table border="1"> <thead> <tr> <th>EX-CMD</th> <th>COORD SYS</th> <th>Velocity 1</th> <th>Velocity 2</th> <th>Velocity 3</th> <th>Velocity 4</th> </tr> </thead> <tbody> <tr> <td>xxx00xxx</td> <td>Beam</td> <td>To Beam 1</td> <td>To Beam 2</td> <td>To Beam 3</td> <td>To Beam 4</td> </tr> <tr> <td>xxx01xxx</td> <td>Instrument</td> <td>Bm1-Bm2</td> <td>Bm4-Bm3</td> <td>To Xducer</td> <td>Err Vel</td> </tr> <tr> <td>xxx10xxx</td> <td>Ship</td> <td>Port-Stbd</td> <td>Aft-Fwd</td> <td>To Surface</td> <td>Err Vel</td> </tr> <tr> <td>xxx11xxx</td> <td>Earth</td> <td>To East</td> <td>To North</td> <td>To Surface</td> <td>Err Vel</td> </tr> </tbody> </table>	EX-CMD	COORD SYS	Velocity 1	Velocity 2	Velocity 3	Velocity 4	xxx00xxx	Beam	To Beam 1	To Beam 2	To Beam 3	To Beam 4	xxx01xxx	Instrument	Bm1-Bm2	Bm4-Bm3	To Xducer	Err Vel	xxx10xxx	Ship	Port-Stbd	Aft-Fwd	To Surface	Err Vel	xxx11xxx	Earth	To East	To North	To Surface	Err Vel
EX-CMD	COORD SYS	Velocity 1	Velocity 2	Velocity 3	Velocity 4																												
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xxx10xxx	Ship	Port-Stbd	Aft-Fwd	To Surface	Err Vel																												
xxx11xxx	Earth	To East	To North	To Surface	Err Vel																												
			Positive values indicate water movement (see notes at end of this table).																														
61-64	31,32	Ref Layer Start	These fields contain the starting boundary (near surface) and the ending boundary (near bottom) of the water-mass layer (BL-command). If the minimum size field is zero, the ExplorerDVL does not calculate water mass data. Scaling: LSD = 1 dm; Range = 0-9999 dm																														
65-68	33,34	Ref Layer End																															
69,70	35	Ref Layer Status	<p>This field shows the status of water mass depth and correlation data. Convert to binary (see Decoding Flags and Set Bits) and interpret as follows. A zero code indicates status is OK.</p> <pre> BIT 76543210 xxx1xxxx ALTITUDE IS TOO SHALLOW xxxx1xxx BEAM 4 LOW CORRELATION xxxxx1xx BEAM 3 LOW CORRELATION xxxxxx1x BEAM 2 LOW CORRELATION xxxxxxx1 BEAM 1 LOW CORRELATION </pre>																														
71,72	36	TOFP Hour	These fields contain the time of the first ping of the current ensemble.																														
73,74	37	TOFP Minute																															
75,76	38	TOFP Second																															
77,78	39	TOFP Hundredth																															
79-82	40,41	BIT Results	Reserved																														
83-86	42,43	Speed of Sound	Contains either manual or calculated speed of sound information (EC - Speed of Sound). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s																														
87-90	44,45	Temperature	Contains the temperature of the water at the transducer head. Scaling: LSD = 0.01 C; Range = -5.00 to +40.00 C																														
91-94	46,47	Checksum	This field contains a modulo 65536 checksum. The ExplorerDVL computes the checksum by summing all the bytes in the output buffer excluding the checksum. NOTE: This field contains the checksum only when the PD4-command is used. If PD5 is used, the remaining bytes are explained in Table 49.																														



The ExplorerDVL packs velocity data into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The ExplorerDVL scales velocity data in millimeters per second (mm/s). A value of -32768 (8000h) indicates a bad velocity.

Bottom or reference-layer velocities will be all valid or all invalid. That is, if the X-velocity is valid then the Y and Z-velocities are valid; if X is not valid, Y and Z are not valid.

The ExplorerDVL allows 3-beam transformations when the fourth beam is invalid. Indication of a 3-beam transformation for bottom-track is valid bottom velocities and one and only one beam's range to bottom is marked bad (zero).

There is no indication that a 3-beam transformation was performed for water mass velocity data.

ExplorerDVL Binary Data Format (PD5)

BIT POSITION									
Byte	7	6	5	4	3	2	1	0	
46	SALINITY								
47	DEPTH								LSB
48									MSB
49	PITCH								LSB
50									MSB
51	ROLL								LSB
52									MSB
53	HEADING								LSB
54									MSB
55	DISTANCE MADE GOOD/BTM (EAST)								LSB
56									
57									
58									MSB
59	DISTANCE MADE GOOD/BTM (NORTH)								LSB
60									
61									
62									MSB
63	DISTANCE MADE GOOD/BTM (UP)								LSB
64									
65									
66									MSB
67	DISTANCE MADE GOOD/BTM (ERROR)								LSB
68									
69									
70									MSB
71	DISTANCE MADE GOOD/REF (EAST)								LSB
72									
73									
74									MSB

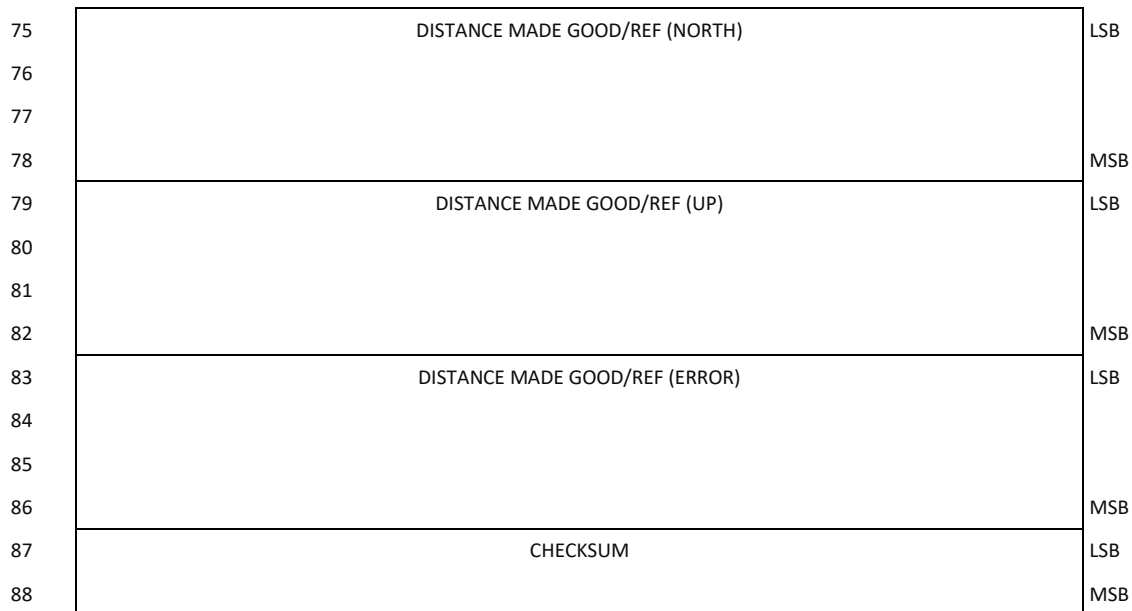


Figure 56. ExplorerDVL Binary Data Format (PD5)

ExplorerDVL Output Data Format (PD5) Details

The ExplorerDVL sends this data format (Figure 55 and Figure 56) only when the PD5 command is used. Table 48 explains the first part of this data structure.

Table 49: ExplorerDVL Output Data Format (PD5) Details

Hex Digit	Binary Byte	Field	Description
91,92	46	Salinity	Contains the salinity value of the water at the transducer head (ES – Salinity). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
93-96	47,48	Depth	Contains the depth of the transducer below the water surface (ED - Depth of Transducer). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
97-100	49,50	Pitch	Contains the ExplorerDVL pitch angle (EP - Pitch and Roll Angles). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
101-104	51,52	Roll	Contains the ExplorerDVL roll angle (ER - Roll Angle). This value may be a manual setting or a reading from a tilt sensor. For an up-facing ExplorerDVL system, positive values mean that Beam #2 is spatially higher than Beam #1. For a down-facing ExplorerDVL system, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
105-108	53,54	Heading	Contains the ExplorerDVL heading angle (EH - Heading). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees

Table 49: ExplorerDVL Output Data Format (PD5) Details

Hex Digit	Binary Byte	Field	Description
109-116	55-58	DMG/Btm East	These fields contain the Distance Made Good (DMG) over the bottom since the time of the first ping after initialization or <BREAK>. Where: (DMG X) = (Sum of all X's) (DMG Y) = (Sum of all Y's) (DMG Z) = (Sum of all Z's) Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 mm
117-124	59-62	DMG/Btm North	
125-132	63-66	DMG/Btm Up	
133-140	67-70	DMG/Btm Error	
141-148	71-74	DMG/Ref East	These fields contain the distance made good over the water-mass layer since the time of the first ping after initialization or <BREAK>. Where: (DMG X) = (Sum of all X's) (DMG Y) = (Sum of all Y's) (DMG Z) = (Sum of all Z's) Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 mm
149-156	75-78	DMG/Ref North	
157-164	79-82	DMG/Ref Up	
165-172	83-86	DMG/Ref Error	
173-176	87,88	Checksum	This field contains a modulo 65536 checksum. The ExplorerDVL computes the checksum by summing all the bytes in the output buffer excluding the checksum.

ExplorerDVL Output Data Format (PD6)

The ExplorerDVL sends this data format only when the PD6 command is used. The ExplorerDVL outputs data in the following line order. Note that not all data items may be displayed. Examples: (1) If #BK = zero, the ExplorerDVL does not send water-mass data (line items beginning with W); (2) If #BK = three, the ExplorerDVL does not send bottom-track data (line items beginning with B).

Table 50: ExplorerDVL Output Data Format (PD6)

Line	Description																																														
1	<p>SYSTEM ATTITUDE DATA</p> <p>:SA,±PP.PP,±RR.RR,HH.HH <CR><LF></p> <p>where:</p> <p>PP.PP = Pitch in degrees RR.RR = Roll in degrees HHH.HH = Heading in degrees</p>																																														
2	<p>TIMING AND SCALING DATA</p> <p>:TS,YYMMDDHHmmsshh,SS.S,+TT.T,DDDD.D,CCCC.C,BBB <CR><LF></p> <p>where:</p> <p>YYMMDDHHmmsshh = Year, month, day, hour, minute, second, hundredths of seconds SS.S = Salinity in parts per thousand (ppt) TT.TT = Temperature in C DDDD.D = Depth of transducer face in meters CCCC.C = Speed of sound in meters per second BBB = Built-in Test (BIT) result code where the first B on the left is the number of BIT errors (MSB) and the last 2 BB (LSB) are the actual BIT error as describe below.</p> <table border="1"> <thead> <tr> <th>Error Code</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x01</td> <td>Transmitter Shutdown</td> </tr> <tr> <td>0x02</td> <td>Transmitter Overcurrent</td> </tr> <tr> <td>0x03</td> <td>Transmitter Undercurrent</td> </tr> <tr> <td>0x04</td> <td>Transmitter Undervoltage</td> </tr> <tr> <td>0x10</td> <td>FIFO interrupt missed</td> </tr> <tr> <td>0x11</td> <td>FIFO ISR re-entry</td> </tr> <tr> <td>0x21</td> <td>Sensor start failure</td> </tr> <tr> <td>0x22</td> <td>Temperature sensor failure</td> </tr> <tr> <td>0x23</td> <td>Pressure sensor failure</td> </tr> <tr> <td>0x24</td> <td>Tilt sensor failure</td> </tr> <tr> <td>0x27</td> <td>Bad Comms with sensor</td> </tr> <tr> <td>0x28</td> <td>Bad Comms with sensor</td> </tr> <tr> <td>0x60</td> <td>Sensor Cal Data checksum failure</td> </tr> <tr> <td>0x30</td> <td>Stuck UART</td> </tr> <tr> <td>0x31</td> <td>QUART Transmit timeout</td> </tr> <tr> <td>0x32</td> <td>QUART IRQ Stuck</td> </tr> <tr> <td>0x33</td> <td>QUART Buffer stuck</td> </tr> <tr> <td>0x34</td> <td>QUART IRQ Active</td> </tr> <tr> <td>0x35</td> <td>QUART cannot clear interrupt</td> </tr> <tr> <td>0x50</td> <td>RTC low battery</td> </tr> <tr> <td>0x51</td> <td>RTC time not set</td> </tr> <tr> <td>0xFF</td> <td>Power failure</td> </tr> </tbody> </table> <p>If there is more than one BIT error, then it will take several ensembles to output all the BIT errors. For example, if there are 3 BIT errors detected, then the output will be BBB = 3xx on ensemble n, BBB = 3yy on ensemble n+1, and BBB = 3zz on ensemble n+2, where xx, yy, and zz are the three different error messages detected.</p>	Error Code	Description	0x01	Transmitter Shutdown	0x02	Transmitter Overcurrent	0x03	Transmitter Undercurrent	0x04	Transmitter Undervoltage	0x10	FIFO interrupt missed	0x11	FIFO ISR re-entry	0x21	Sensor start failure	0x22	Temperature sensor failure	0x23	Pressure sensor failure	0x24	Tilt sensor failure	0x27	Bad Comms with sensor	0x28	Bad Comms with sensor	0x60	Sensor Cal Data checksum failure	0x30	Stuck UART	0x31	QUART Transmit timeout	0x32	QUART IRQ Stuck	0x33	QUART Buffer stuck	0x34	QUART IRQ Active	0x35	QUART cannot clear interrupt	0x50	RTC low battery	0x51	RTC time not set	0xFF	Power failure
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0x50	RTC low battery																																														
0x51	RTC time not set																																														
0xFF	Power failure																																														

Table 50: ExplorerDVL Output Data Format (PD6)

Line	Description
3	<p>WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA</p> <p>:WI,±XXXXX,±YYYYY,±ZZZZ,±EEEE,S <CR><LF></p> <p>where:</p> <p>±XXXXX = X-axis vel. data in mm/s (+ = Bm1 Bm2 xdcr movement relative to water mass)</p> <p>±YYYYY = Y-axis vel. data in mm/s (+ = Bm4 Bm3 xdcr movement relative to water mass)</p> <p>±ZZZZ = Z-axis vel. data in mm/s (+ = transducer movement away from water mass)</p> <p>±EEEE = Error velocity data in mm/s</p> <p>S = Status of velocity data (A = good, V = bad)</p>
4	<p>BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA</p> <p>:BI,±XXXXX,±YYYYY,±ZZZZ,±EEEE,S <CR><LF></p> <p>where:</p> <p>±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom)</p> <p>±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom)</p> <p>±ZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom)</p> <p>±EEEE = Error velocity data in mm/s</p> <p>S = Status of velocity data (A = good, V = bad)</p>
5	<p>WATER-MASS, SHIP-REFERENCED VELOCITY DATA</p> <p>:WS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF></p> <p>where:</p> <p>±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement rel. to water mass)</p> <p>±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement rel. to water mass)</p> <p>±NNNNN = Normal velocity data in mm/s (+ = ship movement away from water mass)</p> <p>S = Status of velocity data (A = good, V = bad)</p>
6	<p>BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA</p> <p>:BS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF></p> <p>where:</p> <p>±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement relative to bottom)</p> <p>±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement relative to bottom)</p> <p>±NNNNN = Normal velocity data in mm/s (+ = ship movement away from bottom)</p> <p>S = Status of velocity data (A = good, V = bad)</p>
7	<p>WATER-MASS, EARTH-REFERENCED VELOCITY DATA</p> <p>:WE,±EEEE,±NNNNN,±UUUUU,S <CR><LF></p> <p>where:</p> <p>±EEEE = East (u-axis) velocity data in mm/s (+ = ADCP movement to east)</p> <p>±NNNNN = North (v-axis) velocity data in mm/s (+ = ADCP movement to north)</p> <p>±UUUUU = Upward (w-axis) velocity data in mm/s (+ = ADCP movement to surface)</p> <p>S = Status of velocity data (A = good, V = bad)</p>
8	<p>BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA</p> <p>:BE,±EEEE,±NNNNN,±UUUUU,S <CR><LF></p> <p>where:</p> <p>±EEEE = East (u-axis) velocity data in mm/s (+ = ADCP movement to east)</p> <p>±NNNNN = North (v-axis) velocity data in mm/s (+ = ADCP movement to north)</p> <p>±UUUUU = Upward (w-axis) velocity data in mm/s (+ = ADCP movement to surface)</p> <p>S = Status of velocity data (A = good, V = bad)</p>
9	<p>WATER-MASS, EARTH-REFERENCED DISTANCE DATA</p> <p>:WD,±EEEEEE.EE,±NNNNNNN.NN,±UUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF></p> <p>where:</p> <p>+EEEEEE.EE = East (u-axis) distance data in meters</p> <p>+NNNNNNN.NN = North (v-axis) distance data in meters</p> <p>+UUUUUUU.UU = Upward (w-axis) distance data in meters</p> <p>DDDD.DD = Range to water-mass center in meters</p> <p>TTT.TT = Time since last good-velocity estimate in seconds</p>

Table 50: ExplorerDVL Output Data Format (PD6)

Line	Description
10	<p>BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA</p> <p>:BD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF></p> <p>where:</p> <p>+EEEEEEEE.EE = East (u-axis) distance data in meters</p> <p>+NNNNNNNN.NN = North (v-axis) distance data in meters</p> <p>+UUUUUUUU.UU = Upward (w-axis) distance data in meters</p> <p>DDDD.DD = Range to bottom in meters</p> <p>TTT.TT = Time since last good-velocity estimate in seconds</p>

The PD6 output does not pad spaces with zeroes. The spaces are left intact. The example below shows a realistic output from a ExplorerDVL locked onto the bottom.

```
:SA, -2.31, +1.92, 75.20
:TS, 04081111563644, 35.0, +21.0, 0.0, 1524.0, 0
:WI, -32768, -32768, -32768, -32768, V
:BI, +24, -6, -20, -4, A
:WS, -32768, -32768, -32768, V
:BS, -13, +21, -20, A
:WE, -32768, -32768, -32768, V
:BE, +17, +18, -20, A
:WD, +0.00, +0.00, +0.00, 20.00, 0.00
:BD, -0.02, -0.03, +0.02, 7.13, 0.21
```

PDDecoder Library in C language

The Teledyne Marine PDDecoder library is an open source library written in C language to decode the PDO data formats that are commonly output by Teledyne Marine/Teledyne RD Instruments ADCPs. The definition and details of the PDO format can be found in any of the manuals under the section, Output Data Format.

Available for download from the Teledyne Marine software portal:

<https://tm-portal.force.com/TMsoftwareportal>

NOTES

Chapter 9

EXTERNAL SENSORS



In this chapter:

- External Sensor Suite Interface Description
- Detailed Discussion of Individual Sensors
- Commands Downloaded to the External Sensors
- External Sensor Commands Supported by the Pioneer
- External Sensor Commands Not Allowed by the Pioneer
- External Sensor Output Format

External Sensor Suite Interface Description

The ExplorerDVL has reduced the user's integration effort by having a built in interface to a suite of sensors. This capability includes:

- Initializing and configuring the sensor
- Sending default or user defined commands to the sensor at various predefined events during ExplorerDVL operation,
- Intelligently using the sensors data in the ExplorerDVL's velocity calculation and automatically using alternate sensor data in the event of a sensor fault,
- Including extensive sensor data in PDO output upon request,
- Allowing troubleshooting of a sensor via a dumb terminal,
- Supporting special sensor needs, such as compass calibration.

Up to three sensors can be supported on serial ports 2 through 4 of the ExplorerDVL at one time. Port 1 is reserved for as the master port for communication with the vehicle computer. The list of sensors that are supported can be found in the description of the EY command (see [EY – Sensor Source Override for Doppler Parameters](#)). It should be noted that the ExplorerDVL does not directly power these sensors: this must be supplied from the vehicle.



Use caution not to create a ground loop when powering external sensors. The ExplorerDVL has a communications ground that is isolated from the power ground. External sensors that use the same ground for power and communications should be powered with a separate supply.

By default, the ExplorerDVL assumes that each sensors' baud rate is set for the factory default setting. If that is not the case, the baud rate of the ExplorerDVL port can be changed via the particular sensor menu of the SM command (see [SM – Auxiliary Sensor Menu](#)).

The goal of the sensor interface in the ExplorerDVL is to work with a set of sensors in a default setup for the majority of applications. However, should the user need to tailor the sensor setup or data collected from the sensor, the interface allows the user to store and download to the sensors commands as explained in the following paragraphs.

The ExplorerDVL communicates with the sensors at three well defined events during ExplorerDVL operation: sensor initialization, variable data sampling and setup data sampling. These will be explored in the following paragraphs.

The sensor initialization event occurs prior to the first ping of the ExplorerDVL after the CS command has been sent or after the ExplorerDVL enters a deployment from the turnkey mode (see [CT - Turnkey Operation](#)). Most commands downloaded during sensor initialization are related to setup, such as specific data that the sensor is to sample, the units of the data, etc.

The variable data sampling event occurs prior to every ping. The variable data is composed of each sensor's basic measurement output (pressure for a pressure sensor, heading, pitch and roll for a compass, etc.) in addition to some status information. Variable data is sampled if the sensor is assigned to a serial port (see [SP - Sensor Port Assignment](#)), regardless of whether the data is commanded to be output in the PDO output (see [SD - Sensor PDO Data Output](#)).

The way variable data is sampled depends on the type of sensor. Attitude sensors' data is more dynamic and is needed for transformation of velocity data for every ping. Environmental sensors' data (e.g., speed of sound, temperature, depth) changes more slowly and can be used for Doppler calculations for several pings or even ensembles. Also, these sensors typically take longer to obtain their sample compared to attitude sensors and waiting for their output would adversely affect ExplorerDVL ping rates.

The ExplorerDVL polls the attitude sensors every ping for variable data, uses that data from velocity transformations of the ping and averages that data over an ensemble for multi-ping ensembles. The environmental sensors' variable data is sampled over the course of several pings. Commands to these sensors are sent one ping, any output from the sensor is collected while the ExplorerDVL pings and is processed on the next ping or subsequent ping when the response is complete. This approach avoids the ExplorerDVL wasting time waiting for the sensors' response. If several commands must be sent to obtain one sample, then the period of the sample will be a multiple of pings. However, for multi-ping ensembles the environmental sensors are sampled at most once per ensemble. The reason for this is to avoid wasted power by over sampling the environmental sensors. Most ExplorerDVL users setup the ExplorerDVL for single ping ensembles, so this is typically not a factor.

There are two exceptions to this behavior:

1. The Garmin GPS: this sensor broadcasts NMEA sentences continuously. The ExplorerDVL receive buffer is sampled once per ping and any complete sentences are processed each ping.
2. To avoid acoustic interference with the ExplorerDVL the echo sounder is polled once per ensemble. Therefore, the ExplorerDVL will wait for its response and this sensor will add to the total ensemble time of the ExplorerDVL.

Some sensors have additional data that can be sampled that includes their setup configuration. This data is assumed to not change over the course of a deployment. The setup sampling event occurs at the start of every ensemble for attitude sensors and at the start of the ensemble prior to the variable sampling event for environmental sensors. All setup data is retrieved from a sensor at once, instead of piecemeal as described for variable data of environmental sensors. To avoid setup sampling colliding with variable sampling, setup data is not sampled during an ensemble when a variable sample is not yet complete. Also, setup data is only sampled if the SD command is set so that the setup data is output in a PDO ensemble. The reason for this is that the data is not needed for a Doppler velocity calculation and only needs to be sampled for output in a PDO ensemble.

Both variable and sampled data have their own data types in the PDO output and these are detailed in [Garmin G-15 GPS PGRMT NMEA Sentence](#) and [Garmin G-15 GPS GPRMC NMEA Sentence](#).

If the user does not enter commands (see [SC - Sensor Command](#)), a default set of commands will be downloaded at sensor initialization and variable data sampling (no user commands are allowed to be sent during sampling of setup data).

It is instructive to sub-divide the user input sensor commands into four categories:

1. Some commands are not allowed to be sent because some can interfere with communication. These are intercepted at command entry to the ExplorerDVL and are not stored by the ExplorerDVL.
2. Some commands can be entered and are stored by the ExplorerDVL but will be overridden after they are sent to the sensor since they cause other problems, such as changing the units of the sensor, etc.
3. Some commands can be entered, stored and are sent to the sensor without being overridden, but since they need special support (such as parsing), they may not be effective. An exception to this general rule is the TCM3/5. Since that sensor has a binary interface and commands are entered with ASCII, a conversion must take place. Not all commands are supported yet in this conversion.
4. The remaining commands either don't need special support, or do and have that support in the ExplorerDVL interface. Teledyne RDI supports the commands for each sensor that should be needed for almost all applications.

The ExplorerDVL interface dumb terminal mode ([SM – Auxiliary Sensor Menu](#)) will allow all commands (even 1 & 2, above) to be sent down to the sensor so care must be taken when accessing the sensor via the dumb terminal mode.

When communication to a sensor is lost (i.e., a time-out occurs waiting for a sensor response), the last good data is output in the PDO data type but error bits indicating the data is stale and that a communication error has occurred are set in the ErrorBits word of the sensor's data type. The data available word also is zeroed and the time tags are not updated until a good sample is acquired. Other less severe errors such as errors in parsing generally result in similar behavior except the data available word is not zeroed and data may or may not be available depending on the type of error. The ExplorerDVL will use the sensor's last good parameter in a Doppler velocity calculation if the data available bit is set for that parameter.

Detailed Discussion of Individual Sensors

This section highlights special considerations that need to be made for some sensors. To find an example of how to setup your ExplorerDVL with an external sensor, please refer to [External Sensor Setup Example](#), page 45.

Garmin G-15 GPS

As mentioned above, this sensor broadcasts its data at regular intervals. All sentences are broadcast at 1Hz output except for the PGRMT sentence that is transmitted at 1minute intervals.

Paroscientific 8000 Series Pressure Sensor

Care must be taken when setting up commands to this sensor since the sensor does not respond to undefined commands. Because the sensor does not supply a response, the ExplorerDVL interface times-out and the sensor is assumed to be not available.

This sensor is capable of being connected in a network of similar sensors and responds to commands with a specific ID in them. The ID that the pressure sensor is assigned at initialization is 01.

The pressure sensor requires a line feed following any command, but most dumb terminals (e.g., *Hyperterminal*, *TRDI Toolz*) will not send this following entry of a command by entering a carriage return. The ExplorerDVL sensor interface handles this automatically so that communication with the sensor is possible even using in the dumb terminal mode (see [SM – Auxiliary Sensor Menu](#)).

The sensor trades off resolution of a measurement with sample acquisition time. Be careful to increase the time-out (see [SP - Sensor Port Assignment](#) or [SC - Sensor Command](#)) for a sensor to respond to allow for increased sample time.

Two pressure and two temperature acquiring commands are supported but only the response to the last one sent is used by the system for Doppler velocity calculations and output in PDO.

Applied Microsystems SVP&T

The SVP&T allows continuous sampling and output of data as well as polled sampling of data. Continuous sampling of the SVP&T is not supported currently in the ExplorerDVL because of the chance that the ExplorerDVL input buffer could overflow and because polled sampling should be fast enough for almost all applications.

Care should be taken in mounting this sensor because it may interfere with the ExplorerDVL acoustically. Teledyne RDI recommends mounting this sensor 1m away from the ExplorerDVL or verifying through test that there is no interference. To test for this, set up the ExplorerDVL to profile with 128 8m bins. Turn bottom track and water mass off. Any interference should be obvious in the correlation and amplitude profiles.

Commands that can disrupt parsing of the sensor response are only overridden during initialization. Therefore, if such a command is sent to the sensor before a “SCAN” command is sent, then a parsing error may result. The additional time required to override these commands for every sample is considered too great a penalty.

Honeywell HMR3000

The HMR3000 has a command interface that uses standard and proprietary NMEA strings in addition to proprietary non-NMEA commands. The checksum is calculated automatically by the ExplorerDVL interface when commands are downloaded to this compass using the SC command (see [SC - Sensor Command](#)).

SBG IG-500 AHRS Attitude Sensor

The SBG IG-500 is supported through the same sensor driver as the Honeywell HMR3000. Please refer to <ADD LINK TO Chapter 3.4 External Sensor Setup Example > for more info. The SBG IG-500 supports autonomous and triggered modes and can output binary as well as NMEA output format. Autonomous mode with NMEA output is solely supported currently.

The SBG IG-500 is a miniature Attitude and Heading Reference System (AHRS). It uses a set of three MEMS based gyroscopes, accelerometers, and magnetometers, to provide a drift-free and precise attitude, even in severe dynamic conditions. This lightweight, robust and reliable device delivers consistent information over a wide temperature and magnetic ranges thanks to an advanced calibration procedure and a configurable Extended Kalman filter (EKF) which makes it an excellent complement to the ExplorerDVL.

SeaBird SBE-49 Fast Cat CTD

The Fast Cat CTD supports autonomous (referred to as broadcasting elsewhere in this document) and polled sampling. Autonomous sampling of the CTD is not supported currently because of the chance that the ExplorerDVL input buffer could overflow and because polled sampling should be fast enough for almost all applications.

The Fast Cat CTD has an integral pump that it uses to minimize salinity spiking. This pump is turned on prior to a sample and turned off after the sample is taken if the default command set is used during variable data sampling. If a break is received by the ExplorerDVL prior to turning the pump off, there is a chance that the pump will be left on. This should not be a problem if the sensor is powered down soon after the ExplorerDVL receives the break. Alternatively, the pump can be commanded off after the break by entering the dumb terminal mode and directly commanding the CTD pump off.

PSA-916 Echo Sounder

The PSA-916 has a continuous sampling mode and a polled operating mode. To avoid acoustic interference with the ExplorerDVL, only the polled operating mode is used.

The PSA-916 is polled by asserting a trigger line that is common with its RS-232 receive line. Selection of this mode is made by changing the dip switches on the instrument’s electronics board – see the PSA-916 manual for more details.

Electrical conversion from RS-232 levels to the 5V trigger input of the PSA-916 is made using the circuit in the following diagram. This circuit limits the input voltage to the trigger of the PSA-916 (see Figure 57).

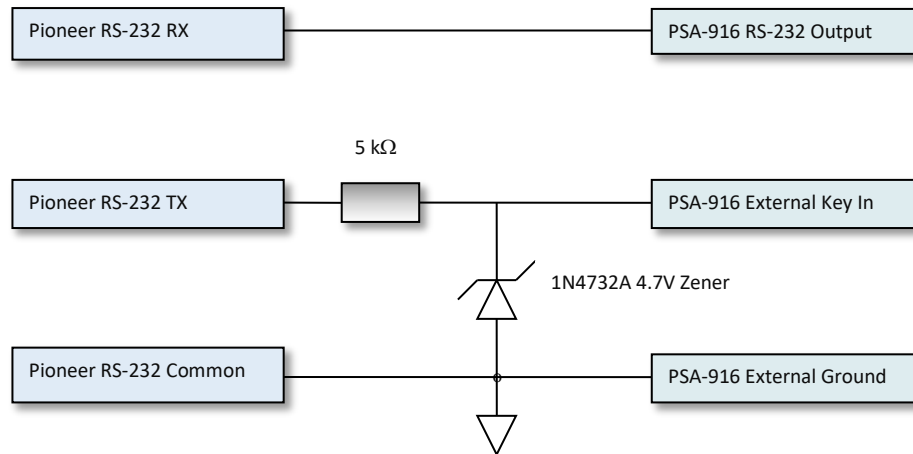


Figure 57. PSA-916 Echo Sounder Trigger

TCM5-TRAX AHRS Attitude Sensor

Trax employs a patented Kalman filtering algorithm that intelligently fuses PNI's patented geomagnetic sensors with gyroscopes and accelerometers to overcome errors due to erratic motion and changes in the local magnetic field. Also, Trax is priced for commercial use, delivering more reliable heading than AHRS modules that cost twice as much.

Trax can either be used as an older generation TCM5 (called 'Compass Mode' in the PNI literature) or in AHRS mode which enables Kalman Filtering which improves the attitude ability to overcome magnetic changes in the vicinity of the sensor. Please refer to [External Sensor Setup Example](#), page 45.

The TCM5-TRAX is unique in that it has a binary interface. Several vital functions are supported by the ExplorerDVL through a dedicated [Trax sensor menu](#).

Default Commands Downloaded to the External Sensors

Commands related to retrieving setup data are not included here since user commands are not allowed during sampling setup data.

Event Definitions:

- IN: Initialization event
- VS: Variable data sampling event
- SS: Setup data sampling event
- BT: Built in Test. event
- All: All events

Table 51: Garmin G-15H GPS Default Commands

Command	Event	Description
\$PGRMO,,2	IN	Turn off all NMEA sentences being broadcast
\$PGRMO,GPRMC,1	IN	Turns on GPRMC sentence.
\$PGRMO,GPGGA,1	IN	Turns on GPGGA sentence.

Table 52: Paroscientific 8000 Series Pressure Sensor Default Commands

Command	Event	Description
*9900ID	IN	Initialize ID of device to first available (01).
*0100EW, *0100PR=0012	IN	Set pressure resolution to 20ppm or 33ms integration time
*0100P3	VS	Sample and send one pressure.
*0100Q3	VS	Sample and send one temperature.

Table 53: Applied Microsystems SVP&T Sensor Default Commands

Command	Event	Description
REAL	IN	Set to Real mode (outputs sensor data in engineering units)
SCAN	VS	Scan data

Table 54: Honeywell HMR3000 Compass Default Commands

Command	Event	Description
\$PTNT,HPR	VS	HPR sentence request

Table 55: SeaBird SBE-49 CTD Default Commands

Command	Event	Description
PUMPON	VS	Turns pump on
TS	VS	Take Sample
PUMPOFF	VS	Turns pump off

Table 56: TCM5/TRAX Compass Default Commands

Frame[Identifier]	Event	Description
SetConfig [kTrueNorth]=False	IN	Set output to Magnetic
SetConfig [kMountingRef]=1 (Standard)	IN	Set coordinate frame relative to ship frame.
SetConfig [kUserCalNumPoints]=12	IN	Number of data points to complete calibration.
SetDataComp	IN	Set: Temperature, Heading, Distortion, PCalibrated, RCalibrated, IZCalibrated, PAngle, RAngle, XAligned, YAligned, ZAligned as data components in response to GetData
GetData	VS	Sample compass data.

External Sensor Commands Supported by the ExplorerDVL System

This section describes what sensor commands the user can store in the ExplorerDVL using the SC command (see [SC - Sensor Command](#)) for transmission to the sensors during pinging of the ExplorerDVL. This section does not pertain to the dumb terminal mode of the ExplorerDVL. In the dumb terminal mode most commands are supported there, except for the commands of the next appendix that are listed as intercepted).

In general, if the command the users stores using the SC command needs special processing for it to be sent or if special parsing of the response to the command, the command will not work unless it has an event associated with it other than “None” in the following tables of this appendix. *However, commands not listed in these tables should work since no special support should be needed. An example of this type of command would be a configuration parameter change that has a response that does not need to be parsed.*

Commands related to retrieving setup data are not included here since user commands are not allowed during sampling setup data.

Event Definitions:

- IN: Initialization event
- VS: Variable data sampling event
- SS: Setup data sampling event
- BT: Built in Test event
- All: All events
- None: No events

Table 57: Garmin G-15H GPS Specific NMEA Sentences Supported

Command	Event	Description
GPRMC	VS	Recommended Minimum Specific GPS.
GPGGA	VS	System Fix Data.
GPVTG	VS	Track Made Good and Ground Speed.
PGRMT	VS	Sensor Status Information.
GPGSA	None	GPS DOP and Active Satellites.
GPGSV	None	GPS Satellites in view.
GPGLL	None	Geographic Position.
PGRME	None	Estimated Error.
PGRMF	None	GPS Fix Data.
PGRMM	None	Map Datum.
PGRMV	None	3D Velocity Info
PGRMB	None	DGPS Beacon Info

Table 58: Paroscientific 8000 Series Pressure Sensor Specific Commands Support

Command	Event	Description
P1	VS	Sample and send one pressure sensor period.
P3	VS	Sample and send one pressure.
P5	None	Sample and hold one pressure.
P6	None	Sample and hold one pressure period.
P7	None	Burst and sample pressure: read temperature once; then continuously send pressure...
Q1	VS	Sample and send one temperature sensor period.
Q3	VS	Sample and send one temperature.
Q5	None	Sample and hold temperature
Q6	None	Sample and hold one temperature period
DB	None	Dump buffer
DS	None	Dump buffer sequentially
BR	None	Baud rate
PT	None	Change serial transmit parameters
UN	None	Read/Enter choice of units.
UF	None	Read/Enter user definable set of units.
MD	None	Read or set the mode parameter.
ZS	None	Read position of zero switch
ZV	None	Set or read offset value.
MC	None	Memory check
CS	None	Check stack of processor
CT	None	Check counter timebase
CX	None	Check crystal of microprocessor

Table 59: Applied Microsystems SVP&T Specific Commands Support

Command	Event	Description
SCAN	VS	Outputs one scan (sample) in either real or raw mode.
VERSION	None	Outputs version of firmware
DISPLAY SAMPLE	None	Display scan rate
DISPLAY INCREMENT	None	Display pressure increment setting
DUMP	None	Dumps instrument logged data from memory
DISPLAY SCAN	None	Displays current scan options
DISPLAY STARTUP	None	Displays current startup options
DISPLAY MEMORY	None	Display current memory status

Table 60: Honeywell HMR3000 Compass Specific Commands Support

Command	Event	Description
\$TNHCQ,XDR	VS	XDR sentence request
\$TNHCQ,HDT	VS	HDT sentence request
\$TNHCQ,HDG	VS	HDG sentence request
\$PTNT,HPR	VS	HPR sentence request
\$PTNT,RCD	VS	RCD sentence request
\$PTNT,CCD	VS	CCD sentence request

Table 61: SeaBird SBE-49 CTD Specific Commands Support

Command	Event	Description
OUTPUTSAL	All	Turns on calculation and output of salinity
OUTPUTSV	All	Turns on calculation and output of
TS	VS	Take 1 sample and output data
PUMPON	All	Turns pump on
PUMPOFF	All	Turns pump off

Table 62: TCM5/TRAX Compass Specific Commands Support

Frame	Event	Description
SetDataComponents	IN	Frame sent by the ExplorerDVL that Specifies the components that are included in the response to the GetData frame.
GetData	VS	Frame sent by the ExplorerDVL commands the compass to sample and send data.
DataResponse	VS	Frame sent by the compass with data in it.
SetConfig	IN	Frame sent by the ExplorerDVL to configure the compass.
FactoryUserCal	IN	Frame sent by the ExplorerDVL to return the user calibration matrices to the factor user calibration matrices.
Save	IN	Frame sent by ExplorerDVL to save all configurations, including calibration.
kGetParam	None	Get data associated with ID
kParamResp	None	Response to kGetParam
kGetAcqParams	None	Gets 4 acquisition parameters

External Sensor Commands Not Allowed by the ExplorerDVL System

This section details which commands are not allowed to be entered via the SC command of the ExplorerDVL. There are two methods of preventing the use of the commands. The first is at command entry and this is referred to as intercepting the command. The second is by overriding the command even if it is downloaded. Note that overriding occurs only at initialization, so if an errant command to be sent at variable sampling could still cause a problem.

Event Definitions:

- IN: Initialization event
- VS: Variable data sampling event
- SS: Setup data sampling event
- BT: Built in Test. event
- All: All events

Table 63: Garmin G-15H GPS Specific Commands Not Allowed

Command	Event	Description	Method
PGRMC	All	Sensor Configuration Information Sentence	Intercepted

Table 64: Paroscientific 8000 Series Pressure Sensor Specific Commands Not Allowed

Command	Event	Description	Method
BR	All	Baud rate	Intercepted
PT	All	Change serial transmit parameters	Intercepted
P2	All	Continuously sample and send pressure periods	Intercepted
P4	All	Continuously sample and send pressure.	Intercepted
Q2	All	Continuously sample and send temperature periods.	Intercepted
Q4	All	Continuously sample and send temperature	Intercepted
UN	All	Read/Enter choice of units.	Overridden to hecta-pascals at initialization
UF	All	Read/Enter user definable set of units.	Overridden to 1.0000 at initialization
MD	All	Read or set the mode parameter.	Overridden to turn off all background tasks at initialization
ID	IN	Sensor ID	Overridden to 01 at initialization

Table 65: Applied Microsystems SVP&T Specific Commands Not Allowed

Command	Event	Description	Method
SET RXOFF	All	Disables the reception of characters at next power-up	Intercepted and Overridden to RXON
SET TIMEOUT	All	Timeout before entering logging mode.	Overridden to 0 (disabled) at initialization
SET SCAN NOTIME	All	Disable display of time in scan output.	Overridden to set time in scan at initialization
SET SCAN NODATE	All	Disable display of date in scan output.	Overridden to set date in scan at initialization
SET SCAN DELAY	All	Time between the sensor board powering up and a scan of the data.	Overridden to 1 at initialization
SET STARTUP DELAY	All	Difference of time between logger and sensor boards are powered up.	Overridden to 0 at initialization
SET DETECT	All	Controls autobaud at next power-up and default baud if it fails	Overridden to turn on autobaud and default to 4800 if autobaud fails at initialization
MONITOR	All	Sets sensor to multiple scans continuously	Overridden at initialization
TALK	All	Allows viewing and editing of calibration coefficients	Intercepted

Table 66: Honeywell HMR3000 Commands Not Allowed

Command	Event	Description	Method
#BA4H	All	Baud Rate Change	Intercepted
#FA0.5=1	All	Set base to decimal or hexadecimal	Overridden to decimal at initialization
#FA0.4=1	All	Set units to degrees or mils	Overridden to degrees at initialization
#BA0A to #BA11=0	All	Set output rates	Overridden to zero at initialization

Table 67: SeaBird SBE-49 CTD Commands Not Allowed

Command	Event	Description	Method
BAUD	All	Baud Rate Change	Intercepted
OUTPUTFORMAT	All	Selects format for output (decimal, hex, etc.)	Overridden to 3 (decimal) at initialization
AUTORUN	All	Autonomous sampling on from power up	Overridden by turning off at initialization
START	All	Starts autonomous sampling	Overridden by sending the STOP command at initialization.

Table 68: TCM5/TRAX Compass Commands Not Allowed

Command	Event	Description	Method
kBaudRate	All	Baud Rate Config Change (ID 14 of Frame 6)	Intercepted
PollingMode	All	Polled or Interval Mode sampling and broadcast (in Frame 24)	Overridden to Polled Mode at initialization
FlushFilter	All	Flushes the filter prior to sample	Overridden so flushing is off at initialization
SensorAcqTime	All	Sensor Acquisition Time	Overridden to zero at initialization
IntervalRespTime	All	Broadcast interval mode.	Overridden to zero at initialization

External Sensor Output Format

Garmin G-15 GPS PGRMT NMEA Sentence

Table 69: Garmin G-15 GPS PGRMT NMEA Sentence Output Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=1Bh)
4	Time Tag	Sample Time in 100ths of second since last power up or TS command.
4	Sample Time	Sample Time in 100ths of a second from between this sample and the last sample (approximately the time between ensembles unless the sensor fails and recovers).
4	Data Available	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Model and Firmware Version bit 1: ROM Checksum bit 2: Receiver Pass/Fail bit 3: Stored data lost bit 4: Real time clock lost bit 5: Oscillator drift discrete bit 6: Data collection discrete bit 7: GPS sensor temperature bit 8: GPS sensor configuration bit 9-31: spare
4	Error Bits[0]	Error Status from the device. Bit definitions TBD. Bit Assignment: bit 0: Communications Error (no data in 15 read attempts) bit 1: bit 2: bit 3: bit 4-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit definitions TBD. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
30	Product-FW Version	Product, model and software version. Null terminated string.
1	ROM Checksum	Built in Test. Pass (1) or Fail (0).
1	Receiver Test	Built in Test. Pass (1) or Fail (0).
1	Stored Data	Status indicating whether stored data is retained (1) or lost (0).
1	RTC	Status indicating whether real time clock time is retained (1) or lost (0).
1	Oscillator Drift	Built in Test. Pass (1) or Fail (0).
1	Data Collection	Collecting data (1) or not (0).
2	Temperature	Temperature in 1/100ths degree C.
1	Config Data	Sensor configuration data retained (1) or lost (0).

See the Garmin G-15H GPS manual for more details regarding these fields.

Garmin G-15 GPS GPRMC NMEA Sentence

Table 70: Garmin G-15 GPS GPRMC NMEA Sentence Output Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=10h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second between this sample and the last sample (approximately the time between ensembles unless the sensor fails and recovers).
4	Data Available	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Status bit 1: UTC Date/Time bit 2: Latitude bit 3: Longitude bit 4: Ground Speed (knots) bit 5: Ground Course bit 6: Variation bit 7-31: spare
4	Error Bits[0]	Error Status from the device. Bit definitions TBD. Bit Assignment: bit 0: Communications Error (no data in 15 read attempts) bit 1: bit 2: bit 3: bit 4-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit definitions TBD. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
1	Fix Status	Status of position fix: Valid (1) or invalid (0).
1	UTC Month	UTC Month.
1	UTC Day	UTC Days.
1	UTC Year	UTC Years.
1	UTC Hour	UTC Hours.
1	UTC Minute	UTC Minutes.
1	UTC Second	UTC Seconds.
1	Latitude Degrees	Latitude dd, where dd is degrees.
4	Latitude Dec Minutes	Latitude fractional Decimal minutes.
1	Latitude N/S	Latitude North/South in hexadecimal
1	Longitude Degrees	Longitude degrees.
4	Longitude Dec Minutes	Longitude fractional Decimal minutes.

Table 70: Garmin G-15 GPS GPRMC NMEA Sentence Output Format

Length in Bytes	Field	Description
1	Longitude E/W	Longitude East/West in hexadecimal
4	Ground Speed	Ground Speed x10 ⁵ in knots
4	Ground Course	Ground course x10 ⁵ in degrees
4	Variation	Variation in degrees x10 ⁵

See the Garmin G-15H GPS manual for more details regarding these fields.

Garmin G-15 GPS GPGGA NMEA Sentence

Table 71: Garmin G-15 GPS GPGGA NMEA Sentence Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=11h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second between this sample and the last sample (approximately the time between ensembles unless the sensor fails and recovers).
4	Data Available	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Date/Time bit 1: Latitude bit 2: Longitude bit 3: Quality Index bit 4: Number of satellites bit 5: HDOP bit 6: Altitude bit 7: Geodal Separation bit 8: DGPS Age bit 9: Reference Station ID bit 10-31: spare
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: Communications Error (no data in 15 read attempts) bit 1: bit 2: bit 3: bit 4-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
1	UTC Hour	UTC Hours.
1	UTC Minute	UTC Minutes.
1	UTC Second	UTC Seconds.
1	Hundredth of Second	Hundredth of a second (not output by G-15H)
1	Latitude Degrees	Latitude degrees.

Table 71: Garmin G-15 GPS GPGGA NMEA Sentence Output Format

Length in Bytes	Field	Description
4	Latitude Dec Degrees	Latitude fractional degrees multiplied by 1000, so that the LSB is 0.001 degrees. For example, if the Latitude Degrees field is 48, and the Latitude Dec Degrees field is 117, then the actual latitude is 48.117 degrees. Another example: The GPS outputs latitude as a string, in DDmm.nnn format, where DD is degrees, and mm.nnn is minutes. If the GPS outputs the string 4807.032, that represents 48 degrees and 7.032 minutes, which is also 48.1172 degrees. In this case, the firmware will output 48 for "Latitude Degrees", and 117 for "Latitude Dec Degrees" (i.e., the fractional degrees are truncated to the thousandths position).
1	North/South	North/South hexa.
1	Longitude Degrees	Longitude Degrees
4	Longitude Dec Degrees	Longitude fractional Decimal minutes.
1	East/West	East/West hexa.
1	Quality Indicator	Quality Indicator: Fix not available (0); Non-differential fix available (1)
1	Number Satellites	Number of satellites in use (0 to 12).
4	HDOP	Horizontal dilution of precision x10 ⁵ in meters
4	Altitude	Altitude x10 ⁴ in meters
4	Geoidal Separation	Geoidal separation x10 ⁵ in meters.
4	DGPS Age	Differential data age in seconds.
4	DGPS Ref Station ID	Differential Reference station ID: 0 to 1023.

See the Garmin G-15H GPS manual for more details regarding these fields.

Garmin G-15 GPS GPVTG NMEA Sentence

Table 72: Garmin G-15 GPS GPVTG NMEA Sentence Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=16h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS - Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second between this sample and the last sample (approximately the time between ensembles unless the sensor fails and recovers).
4	Data Available	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Ground True Course bit 1: Ground Magnetic Course bit 2: Speed in knots bit 3: Speed in kph bit 4: Mode. bit 5-31: spare

Table 72: Garmin G-15 GPS GPVTG NMEA Sentence Output Format

Length in Bytes	Field	Description
4	Error Bits[0]	Error Status from the device. Bit definitions TBD. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit definitions TBD. Bit Assignment: bit 0: Communications Error (no data in 15 read attempts) bit 1: bit 2: bit 3: bit 4-31: spare
4	True Ground Course	True ground course x10 ⁵ in degrees
4	Mag Ground Course	Magnetic ground course x10 ⁵ in degrees
4	Ground Speed in knots	Ground speed x10 ⁵ in knots.
4	Ground Speed in knots	Ground speed x10 ⁵ in kph.
4	Mode	Mode indicator (output only if in NMEA 3.0. ExplorerDVL forces this setting by default): Autonomous (0), Differential (1), Estimated (2), Data not valid (3).

See the Garmin G-15H GPS manual for more details regarding these fields.

Paroscientific 8CDP Pressure Variable

Table 73: Paroscientific 8CDP Pressure Variable Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=02h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second from the start of the last sample to the start of this sample.
4	Data Available [0]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type). The lsb corresponds to the Pressure field. Bit Assignment: bit 0: Pressure. bit 1: Temperature bit 2-31: spare
4	Data Available [1]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0-31: spare

Table 73: Paroscientific 8CDP Pressure Variable Output Format

Length in Bytes	Field	Description
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: Time-out of response from sensor. bit 1: Too much data from sensor (impending buffer overflow). bit 2: Sensor received an invalid command. bit 3: Sensor response could not be parsed. Bit 4: Unsupported command; could not parse response. bit 5-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit Assignment: bit 0-31: spare
4	Pressure	If the P1 command is used: Pressure x 10 ⁴ in units as indicated in the setup data of the setup data type, below. See Paroscientific Intelligent RS-232 manual (P1). If the P3 command is used: Pressure x 10 ⁵ in units as indicated in the setup data of the setup data type, below. See Paroscientific Intelligent RS-232 manual (P3).
4	Temperature	If the Q1 command is used: Temperature x 10 ⁰ in Celsius. See Paroscientific Intelligent RS-232 manual (Q1). If the Q3 command is used: Temperature x 10 ⁵ in Celsius. See Paroscientific Intelligent RS-232 manual (Q3).

Paroscientific 8CDP Pressure Setup

Table 74: Paroscientific 8CDP Pressure Setup Output Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=0Ah)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second from when the sample was requested to when it was output by the device
4	Data Available [0]	<p>Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type). The LSB corresponds to the Pressure field.</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: Pressure units bit 1: Pressure Resolution bit 2: Unit Conversion Factor bit 3: Temperature Resolution bit 4: Power Up Mode bit 5: ID Mode bit 6: FW Version bit 7: Over pressure bit 8: Zero Switch bit 9: Zero Value bit10: Num Unused Bytes bit11: Serial Number bit12: Pressure Adder Units bit13: Pressure Multiplier bit14: Time Base Correction Factor bit 15: Pressure Cal Coefficient C1 bit 16: Pressure Cal Coefficient C2 bit 17: Pressure Cal Coefficient C3 bit 18: Pressure Cal Coefficient D1 bit 19: Pressure Cal Coefficient D2 bit 20: Pressure Cal Coefficient T1 bit 21: Pressure Cal Coefficient T2 bit 22: Pressure Cal Coefficient T3 bit 23: Pressure Cal Coefficient T4 bit 24: Pressure Cal Coefficient T5 bit 25: Pressure Cal Coefficient U0 bit 26: Pressure Cal Coefficient Y1 bit 27: Pressure Cal Coefficient Y2 bit 28: Pressure Cal Coefficient Y3 bit 29-31: spare
4	Data Available [1]	<p>Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type)</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0-31: spare
4	Error Bits[0]	<p>Error Status from the device.</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: bit 1: bit 2: bit 3: bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	<p>Error Status from the device.</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
1	Pressure Units	See Paroscientific Intelligent RS-232 manual (UN).

Table 74: Paroscientific 8CDP Pressure Setup Output Format

Length in Bytes	Field	Description
2	Pressure Resolution	See Paroscientific Intelligent RS-232 manual (PR)
4	Unit Conversion Factor	See Paroscientific Intelligent RS-232 manual (UF) x 10 ⁵ .
2	Temp Resolution	See Paroscientific Intelligent RS-232 manual (TR).
1	Power Up Mode	See Paroscientific Intelligent RS-232 manual (MD).
1	ID #	See Paroscientific Intelligent RS-232 manual (ID).
2	Firmware Version	See Paroscientific Intelligent RS-232 manual (VR) x 10 ³
4	Overpressure	See Paroscientific Intelligent RS-232 manual (OP) x 10 ⁵ .
1	Zero Switch	See Paroscientific Intelligent RS-232 manual (ZS).
4	Zero Value	See Paroscientific Intelligent RS-232 manual (ZV) x 10 ⁵ .
2	# of unused bytes on stack	See Paroscientific Intelligent RS-232 manual (CS).
4	Serial Number	See Paroscientific Intelligent RS-232 manual (SN).
4	Pressure Adder Units	See Paroscientific Intelligent RS-232 manual (PA) x 10 ⁵ .
4	Pressure Multiplier	See Paroscientific Intelligent RS-232 manual (PM) x 10 ⁵ .
4	Time Base Correction	See Paroscientific Intelligent RS-232 manual (TC) x 10 ⁵ .
4	C1 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (C1) x 10 ⁵ .
4	C2 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (C2) x 10 ⁵ .
4	C3 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (C3) x 10 ⁵ .
4	D1 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (D1) x 10 ⁵ .
4	D2 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (D2) x 10 ⁵ .
4	T1 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (T1) x 10 ⁵ .
4	T2 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (T2) x 10 ⁵ .
4	T3 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (T3) x 10 ⁵ .
4	T4 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (T4) x 10 ⁵ .
4	T5 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (T5) x 10 ⁵ .
4	U0 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (U0) x 10 ⁵ .
4	Y1 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (Y1) x 10 ⁵ .
4	Y2 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (Y2) x 10 ⁵ .
4	Y3 Pr Coefficient	See Paroscientific Intelligent RS-232 manual (Y3) x 10 ⁵ .



This data is sampled only on the first ping of an ensemble and only if the corresponding bit in the SD command is set.

Applied Micro Systems SVP&T (Speed of Sound) Variable

Table 75: Applied Micro Systems SVP&T (Speed of Sound) Variable Output Data Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=03h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second from the start of the last sample to the start of this sample.
4	Data Available[0]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Time Tag bit 1: Pressure bit 2: Speed of Sound bit 3: Temperature bit 4: Npt bit 5: Np bit 6: NI bit 7: Nsv bit 8: Nh bit 9: Nt bit 10-31: spare
4	Data Available[1]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type). Bit Assignment: bit 0-31: spare
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: Time-out of response from sensor. bit 1: Too much data from sensor (impending buffer overflow). bit 2: Sensor received an invalid command. bit 3: Sensor response could not be parsed. bit 4: Unsupported command; could not parse response. bit 5-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
1	SVPT Month	Month as reported by SVPT.
1	SVPT Day	Day as reported by SVPT.
1	SVPT Year	Year as reported by SVPT.
1	SVPT Hour	Hour as reported by SVPT.
1	SVPT Minute	Minute as reported by SVPT.
1	SVPT Second	Second as reported by SVPT.
1	SVPT Hundredth Second	Hundredth of a second as reported by SVPT.
4	Pressure	Pressure x 10 ⁵ in deci-bar.
4	Speed of Sound	Speed of sound x 10 ⁶ in meters per second.

Table 75: Applied Micro Systems SVP&T (Speed of Sound) Variable Output Data Format

Length in Bytes	Field	Description
4	Temperature	Temperature x 10 ⁶ in Celsius
2	Npt	Raw pressure count measurement #1. See SVP&T manual for details.
2	Np	Raw pressure count measurement #2. See SVP&T manual for details.
2	Nl	Raw speed of sound measurement #1. See SVP&T manual for details.
2	Nsv	Raw speed of sound measurement #2. See SVP&T manual for details.
2	Nh	Raw speed of sound measurement #3. See SVP&T manual for details.
2	Nt	Raw speed of sound measurement #4. See SVP&T manual for details.

Honeywell HMR3000 Magnetic Compass Variable

Table 76: Honeywell HMR3000 Magnetic Compass Variable Output Data Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=04h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS - Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second between this sample and the last sample (approximately the time between ensembles unless the sensor fails and recovers).
4	Data Available[0]	<p>Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output this data)</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: Heading bit 1: Pitch bit 2: Roll bit 3: MagX bit 4: MagY bit 5: MagZ bit 6: MagT bit 7: TiltAp bit 8: TiltAm bit 9: TiltBp bit 10: TiltBm bit 11: MagA bit 12: MagB bit 13: MagC bit 14: MagAsr bit 15: MagBsr bit 16: MagCsr bit 17: TiltX bit 18: TiltY bit 19: MagX of CCD sentence bit 20: MagY of CCD sentence bit 21: MagZ of CCD sentence bit 22: MagT of CCD sentence bit 23: Heading of CCD sentence bit 24-31: spare

Table 76: Honeywell HMR3000 Magnetic Compass Variable Output Data Format

Length in Bytes	Field	Description
4	Error Bits[0]	<p>Error Status from the device.</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: Communications error. bit 1: Unsupported command; could not parse response. Bit 2-11: spare bit 12: Heading low alarm bit 13: Heading low warn bit 14: Heading high warn bit 15: Heading high alarm bit 16: Heading tuning analog circuit bit 17: Pitch low alarm bit 18: Pitch low warn bit 19: Pitch high warn bit 20: Pitch high alarm bit 21: Pitch tuning analog circuit bit 22: Roll low alarm bit 23: Roll low warn bit 24: Roll high warn bit 25: Roll high alarm bit 26: Roll tuning analog circuit Bit 27-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	<p>Error Status from the device.</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
4	Heading	Heading, True (hundredths of degree or hundredths of mils). HDT, HDG, HPR & CCD NMEA string.
4	Pitch	Pitch (hundredths of degree or mils). XDR & HPR NMEA string.
4	Roll	Roll (hundredths of degree or mils). XDR & HPR NMEA string.
4	MagX	Magnetic field in X axis (milli-Gauss or mils). XDR NMEA string.
4	MagY	Magnetic field in Y axis (milli-Gauss or mils). XDR NMEA string.
4	MagZ	Magnetic field in Z axis (milli-Gauss or mils). XDR NMEA string.
4	MagT	Magnetic field in Total axis (milli-Gauss or mils). XDR NMEA string.
2	TiltAp	TiltXAp (counts). RCD NMEA string.
2	TiltAm	TiltXAm (counts). RCD NMEA string.
2	TiltBp	TiltXBp (counts). RCD NMEA string.
2	TiltBm	TiltBm (counts). RCD NMEA string.
4	MagA	MagA (counts). RCD NMEA string.
4	MagB	MagB (counts). RCD NMEA string.
4	MagC	MagC (counts). RCD NMEA string.
4	MagAsr	MagAsr (counts). RCD NMEA string.
4	MagBsr	MagBsr (counts). RCD NMEA string.
4	MagCsr	MagCsr (counts). RCD NMEA string.
4	TiltX	Conditioned TiltX (counts). CCD NMEA string.
4	TiltY	Conditioned TiltY (counts). CCD NMEA string.
4	TiltZ	Conditioned TiltZ (counts). CCD NMEA string.

Table 76: Honeywell HMR3000 Magnetic Compass Variable Output Data Format

Length in Bytes	Field	Description
4	MagXC	Conditioned MagX (counts). CCD NMEA string.
4	MagYC	Conditioned MagY (counts). CCD NMEA string.
4	MagZC	Conditioned MagZ (counts). CCD NMEA string.
4	MagTC	Conditioned MagT (counts). CCD NMEA string.
4	HeadingC	Conditioned Heading x 100 (counts). CCD NMEA string.



Refer to HMR3000 Users Guide for more details of these fields.

Honeywell HMR3000 Magnetic Compass Setup

Table 77: Honeywell HMR3000 Magnetic Compass Setup Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54 LSB=05h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second between this sample and the last sample (approximately the time between ensembles unless the sensor fails and recovers).
4	Data Available[0]	<p>Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type)</p> <p>Bit Assignment:</p> <ul style="list-style-type: none"> bit 0: Units bit 1: Radix bit 2: Deviation bit 3: Variation bit 4: Mag Sample Rate bit 5: Strobe Mode Count bit 6: Set/Reset bit 7: Set/Reset Interval bit 8: Mag Units bit 9: Mag X Offset bit 10: Mag Y Offset bit 11: Mag Z Offset bit 12: Mag High Alarm bit 13: Mag High Warn bit 14: Mag Low Alarm bit 15: Mag Low Warn bit 16: Pitch/Roll Alarm bit 17: Pitch/Roll Warn bit 18: Time Constant bit 19: S Smoothing Factor bit 20: L Smoothing Factor bit 21: Baud Rate bit 22: HDG Sentence Rate Update bit 23: HDT Sentence Rate Update bit 24: XDR Sentence Rate Update bit 25: HPR Sentence Rate Update bit 26: RCD Sentence Rate Update bit 27: CCD Sentence Rate Update bit 28: ASCII Sentence Rate Update bit 29: XDR has Pitch bit 30: XDR has Roll bit 31: XDR has MagX

Table 77: Honeywell HMR3000 Magnetic Compass Setup Format

Length in Bytes	Field	Description
4	Data Available[1]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: XDR has MagY bit 1: XDR has MagZ bit 2: XDR has MagT bit 3-31: Spare
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
1	Units	Units for H, P, R: Degrees or Mils
1	Radix	Number base
2	Deviation	Deviation (hundredths). HDG NMEA string.
2	Variation	Variation (hundredths). HDG NMEA string.
1	MagRate	Magnetometer sampling rate
1	Strobe Cnt	Strobe Mode Count
1	Set-Reset	Controls Set/Reset operation of compass.
1	S/R Interval	Set/Reset Interval in seconds.
2	MagUnits	Magnetic Units Factor (manual is unclear on the range of this).
2	MagX Ofs	Magnetic Field Offset in X axis.
2	MagY Ofs	Magnetic Field Offset in X axis.
2	MagZ Ofs	Magnetic Field Offset in X axis.
2	Mag Hi Alarm	Magnetometer over range alarm level in counts.
2	Mag Hi Warn	Magnetometer over range warning level in counts.
2	Mag Low Alarm	Magnetometer under range alarm level in counts.
2	Mag Low Warn	Magnetometer under range warning level in counts.
2	P/R Alarm	Pitch/Roll over range alarm level in counts.
2	P/R Warn	Pitch/Roll over range warning level in counts.
1	TC1	Heading filter time constant.
1	Smoothing	Heading non-linear filter smoothing factor.
1	L Smoothing	L parameter for non-linear heading filter.
1	Baud	Baud Rate
1	HDG Rate	HDG NMEA string update rate.
1	HDT Rate	HDT NMEA string update rate.

Table 77: Honeywell HMR3000 Magnetic Compass Setup Format

Length in Bytes	Field	Description
1	XDR Rate	XDR NMEA string update rate.
1	HPR Rate	HPR NMEA string update rate.
1	RCD Rate	RCD NMEA string update rate.
1	CCD Rate	CCD NMEA string update rate.
1	ASCII Rate	ASCII string update rate.
1	XDR has Pitch	XDR NMEA string parameter.
1	XDR has Roll	XDR NMEA string parameter.
1	XDR has MagX	XDR NMEA string parameter.
1	XDR has MagY	XDR NMEA string parameter.
1	XDR has MagZ	XDR NMEA string parameter.
1	XDR has MagT	XDR NMEA string parameter.



Refer to HMR3000 Users Guide for more details of these fields.

This data is sampled only on the first ping of the ensemble and only if the corresponding bit of the SD command is set.

SeaBird SBE-49 FastCat CTD Variable

Table 78: SeaBird SBE-49 FastCat CTD Variable Output Data Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=06h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second from the start of the last sample to the start of this sample.
4	Data Available[0]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output this data) Bit Assignment: bit 0: Temperature bit 1: Conductivity bit 2: Salinity bit 3: Pressure bit 4: Speed of Sound bit 5-31: Spare
	Data Available[1]	Spare.
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: Time-out of response from sensor. bit 1: Too much data from sensor (impending buffer overflow). bit 2: Sensor received an invalid command. bit 3: Sensor response could not be parsed. bit 4: Unsupported command; could not parse response. bit 5-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Spare
4	Temperature	Temperature x 10 ⁶ in Celsius
4	Conductivity	Conductivity x 10 ⁶ in Siemens per meter.
4	Pressure	Pressure x 10 ⁵ in decibar.
4	Salinity	Salinity x 10 ⁶ in psu.
4	Speed of Sound	Speed of sound x 10 ⁶ in meters per second.

Benthos PSA-916 Echo Sounder Variable

Table 79: Benthos PSA-916 Echo Sounder Variable Output Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=07h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second from the start of the last sample to the start of this sample.
4	Data Available	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output this data) Bit Assignment: bit 0: Depth bit 1-31: spare
4	Error	Bit Assignment: bit 0: Time-out of response from sensor. bit 1: Too much data from sensor (impending buffer overflow). bit 2: Sensor response could not be parsed. bit 3: bit 4-7: Spare bit 8: Echo missed or does not meet averaging criteria bit 9: Under range (if detection enabled via dip switch) bit 10: Unit not functioning correctly bit 11-31: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Range	Range in centimeters.

PNi TCM5/TRAX Data Variable

Table 80: PNi TCM5/TRAX Data Variable Output Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54h LSB=08h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS – Set Real-Time Clock .
4	Sample Time	Sample Time in 100ths of a second from when the sample was requested to when it was output
4	Data Available[0]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Heading bit 1: Temperature bit 2: Distortion bit 3: Pitch Calibrated bit 4: Roll Calibrated bit 5: Z Calibrated bit 6: Pitch bit 7: Roll bit 8: XAligned bit 9: YAligned bit 10: ZAligned bit 11-31: spare
4	Data Available[1]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0-31: spare

Table 80: PNi TCM5/TRAX Data Variable Output Format

Length in Bytes	Field	Description
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: Communications Error bit 1: Too much data from sensor (impending buffer overflow). bit 2: Sensor received an invalid command. bit 3: Sensor response could not be parsed. bit 4-30: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
4	Heading	Heading angle in degrees times 10^6 .
4	Temperature	Temperature in degrees Celsius times 10^6 .
1	Distortion	Flag indicating magnetic distortion exists (1) or does not (0). See TCM3/5 manual for details.
4	PCalibrated	P component of the calibrated acceleration vector in mG (gravity) times 10^6 .
4	RCalibrated	R component of the calibrated acceleration vector in mG (gravity) times 10^6 .
4	ZCalibrated	Z component of the calibrated acceleration vector in mG (gravity) times 10^6 .
4	Pitch	Pitch angle in degrees times 10^6 .
4	Roll	Roll angle in degrees times 10^6 .
4	XAligned	X component of the calibrated magnetic field vector in micro Tesla times 10^5 .
4	Yaligned	Y component of the calibrated magnetic field vector in micro Tesla times 10^5 .
4	ZAligned	Z component of the calibrated magnetic field vector in micro Tesla times 10^5 .

PNi TCM5/TRAX Configuration

Table 81: PNi TCM5/TRAX Configuration Output Format

Length in Bytes	Field	Description
2	ID	PDO ID (MSB=54 LSB=094h)
4	Time Tag	Sample Time in 100ths of second since last power up or TS command.
4	Sample Time	Sample Time in 100ths of a second from when the sample was requested to when it was output
4	Data Available[0]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type) Bit Assignment: bit 0: Declination bit 1: True North bit 2: Mounting Ref bit 3: User Cal Stable Check bit 4: User Cal Num Points bit 5: User Cal Auto Sampling bit 6: Baud Rate bit 7: Polling Mode bit 8: Flush Filter bit 9: Sensor Acquisition Time bit 10: Interval Response Time bit 11: Module Type bit 12: Revision bit 13-31: spare
4	Data Available[1]	Bits in this field indicate whether corresponding data field is available (sensor may not be set up to output certain data elements of this data type)
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare bit 31: Indicates data is stale (from a previous ensemble) when set.
4	Error Bits[1]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: bit 4-31: spare
4	Declination	Declination angle in degrees times 1e6.
1	True North	If set (1), then declination angle used in heading output. If 0, then declination not used.
1	MountingRef	Indicates mounting angle of compass relative to user coordinates. This is an index that ranges between 1 to 6. See TCM3/5 manual for details.
1	UserCalStableCheck	If set (1), stable acceleration and field is required prior to taking calibration sample point. See TCM3/5 manual for details.
1	UserCalNumPoints	Number of samples taking in user calibration. See TCM3/5 manual for details.
1	UserCalAutoSampling	If set (1), then compass automatically takes sample during calibration; if cleared (0), then compass waits for a command before sampling. See TCM3/5 manual for details.
1	Baudrate	This is an index to the baud rate of the system. See TCM3/5 manual for details.
1	PollingMode	If set (1), then the module waits for a GetData command. If cleared (0), the unit outputs data with period set by IntervalRespTime.
1	FlushFilter	If set (1), then filter is flushed prior to acquisition. See TCM3/5 manual for details.

Table 81: PNi TCM5/TRAX Configuration Output Format

Length in Bytes	Field	Description
2	SensorAcqTime	Used to set the time in seconds between sampling the sensors without outputting the data. See TCM3/5 manual for details.
2	IntervalRespTime	Time in seconds between output when in polling mode. See TCM3/5 manual for details.
4	Module Type	Module Type Identifier in response to GetModInfo command.
4	Revision	Revision number in response to GetModInfo command.



This data is sampled only on the first ping of the ensemble and only if the corresponding bit of the SD command is set (see [SD - Sensor PDO Data Output](#)).

NOTES

Appendix **A**

NOTICE OF COMPLIANCE



In this chapter:

- [China RoHS requirements](#)
- [Material disclosure table](#)

Date of Manufacture

China RoHS requires that all Electrical and Electronic Products are marked with a Date of Manufacture. This is the starting point for the Environmental Friendly Use Period, described below.

Environmental Friendly Use Period (EFUP)

Per SJ/T 11364-2006 – Product Marking, the EFUP is defined as the time in years in which hazardous/toxic substances within Electrical and Electronic Products (EIP) will not, under normal operating conditions, leak out of the Product, or the Product will not change in such a way as to cause severe environmental pollution, injury to health, or great damage to property. TRDI has determined the Environmental Friendly Use Period shall be Ten (10) years.

The purpose of the marking is to assist in determining the restricted substance content, recyclability, and environmental protection use period of our covered products, as required in Chinese law, and does not reflect in any way the safety, quality, or warranty associated with these TRDI products.



Some homogenous substance within the EIP contains toxic or hazardous substances or elements above the requirements listed in SJ/T 11363-2006. These substances are identified in Table 82.

WEEE



The mark shown to the left is in compliance with the Waste Electrical and Electronic Equipment Directive 2002/96/EC (WEEE).

This symbol indicates the requirement NOT to dispose the equipment as unsorted municipal waste, but use the return and collection systems according to local law or return the unit to one of the TRDI facilities below.

Teledyne RD Instruments USA
 14020 Stowe Drive
 Poway, California 92064

Teledyne RD Instruments Europe
 2A Les Nertieres
 5 Avenue Hector Pintus
 06610 La Gaude, France

Teledyne RD Technologies
 1206 Holiday Inn Business Building
 899 Dongfang Road, Pu Dong
 Shanghai 20122 China

Material Disclosure Table

In accordance with SJ/T 11364-2006, the following table disclosing toxic or hazardous substances contained in the product is provided.

Table 82. Toxic or Hazardous Substances and Elements Contained in Product

零件项目(名称) Component Name	有毒有害物质或元素 Toxic or Hazardous Substances and Elements					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr ⁶⁺)	多溴联苯 Polybrominated Biphenyls (PBB)	多溴二苯醚 Polybrominated Diphenyl Ethers (PBDE)
换能器配件 Transducer Assy.	X	O	O	O	O	O
声纳波束形成电路板 Beamformer PCB	X	O	O	O	O	O
换能器接口电路板 Transducer Intfc PCB	X	O	O	O	O	O
底座装配 End-Cap Assy.	X	O	O	O	O	O
机架装配 Chassis Assy.	X	O	O	O	O	O
接收机电路板 Receiver PCB	X	O	O	O	O	O
数据处理器电路板 DSP PCB	X	O	O	O	O	O
输入输出接口电路板 PIO PCB	X	O	O	O	O	O
通讯接口板 Personality Module	X	O	O	O	O	O
外接电缆 External Cables	X	O	O	O	O	O
专用装箱和泡沫塑料垫 Shipping Case w/Foam	O	O	O	O	O	O

O: 表示该有毒或有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。
O: Indicates that the toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit required in SJ/T 11363-2006.
X: 表示该有毒或有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。
X: Indicates that the toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T 11363-2006.

NOTES