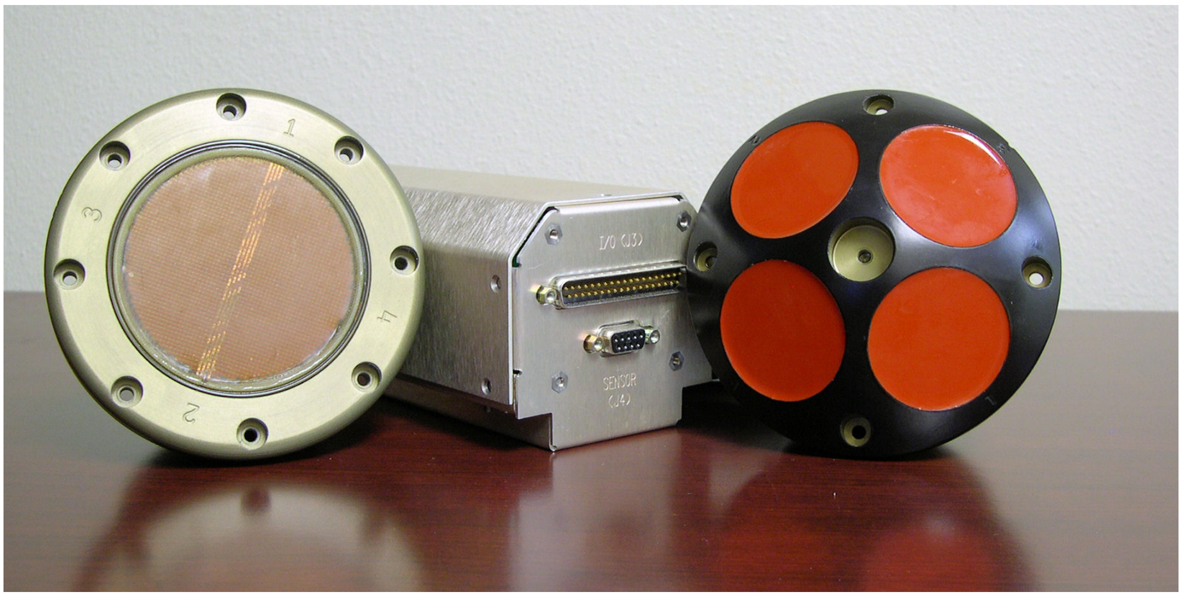
ExplorerDVL
Operation Manual



P/N 95B-6027-00 (July 2007)

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ExplorerDVL Operation Manual

1 Introduction

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

1.1 Getting Started

You are probably eager to get started, but take a moment to read a few words of guidance. We strongly recommend you read *all* of the provided documentation to learn the full capabilities of your ExplorerDVL.

All documentation is being provided to you on CD in a fully searchable, printable, electronic format. This way, information is always available, whether you are at the office or in the field, and the electronic format is an environmentally friendly way to provide a large set of technical manuals. The documentation for each software program is located on the software program's CD.

To purchase a printed copy of the system documentation (includes the ExplorerDVL Operation Manual and software guides), contact our Customer Service department at rdifs@teledyne.com or call (858)-842-2600 and order the ExplorerDVL Manual kit.

NOTE. When an addition or correction to the manual is needed, an Interim Change Notice (ICN) will be posted to our web site on the Customer Service page (www.rdinstruments.com). Please check our web site often.

1.2 How to Contact Teledyne RD Instruments

If you have technical problems with your instrument, contact our field service group in any of the following ways:

Teledyne RD Instruments	**Teledyne RD Instruments Europe**
14020 Stowe Drive	5 Avenue Hector Pintus
Poway, California 92064	06610 La Gaude, France
(858) 842-2600	+33(0) 492-110-930
FAX (858) 842-2822	+33(0) 492-110-931
Sales – rdisales@teledyne.com	rdie@teledyne.com
Field Service - rdifs@teledyne.com	rdiefs@teledyne.com

Web: http://www.rdinstruments.com
After Hours Emergency Support +1 858-842-2700

1.3 Conventions Used in this Manual

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

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**), you would press and hold the first key while you press the second key. Words printed in italics include program names (*BBTalk*) and file names (*default.txt*).

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

```
ExplorerDVL
Teledyne RD Instruments (c) 2007
All rights reserved.
Firmware Version: 34.xx

>
```

You will find three other visual aids that help you.

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

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

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

1.4 Safety Precautions

Follow all safety rules while operating or troubleshooting the ExplorerDVL.

⚠	**CAUTION.** Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so.

⚠	**CAUTION.** Only fuses with the required rated current, voltage, and specified type must be used. Do not repair fuses or short circuit fuse-holders. To do so could cause a shock or fire hazard.

⚠	**CAUTION.** Do not operate the ExplorerDVL in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

⚠	**CAUTION.** Do not install substitute parts or perform any unauthorized modifications to the instrument.

⚠	**CAUTION.** Any maintenance and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

⚠	**CAUTION.** Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

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

2 System Overview

The transducer assembly contains the transducer ceramics. The standard acoustic frequency is 600 kHz. See the outline drawing for dimensions and weights ("Outline Installation Drawings," page 40).

Transducer – The standard piston transducer (see Figure 1) housing allows deployment depths to 300 meters and the Phased Array transducer (see Figure 2, page 5) allows deployment depths to 100 meters. The transducer ceramics are mounted to the transducer housing.

Urethane Faces – The urethane faces cover the transducer ceramics. Never set the transducer on a hard surface. The urethane faces may be damaged.

Electronics Chassis – The Electronic Chassis contains all of the interfaces to and from the transducer, computer, vessel, and power.

Transmit and Receive Cables – These cables connect the ExplorerDVL transducer to the Electronics Chassis.

Figure 1. ExplorerDVL Piston Transducer

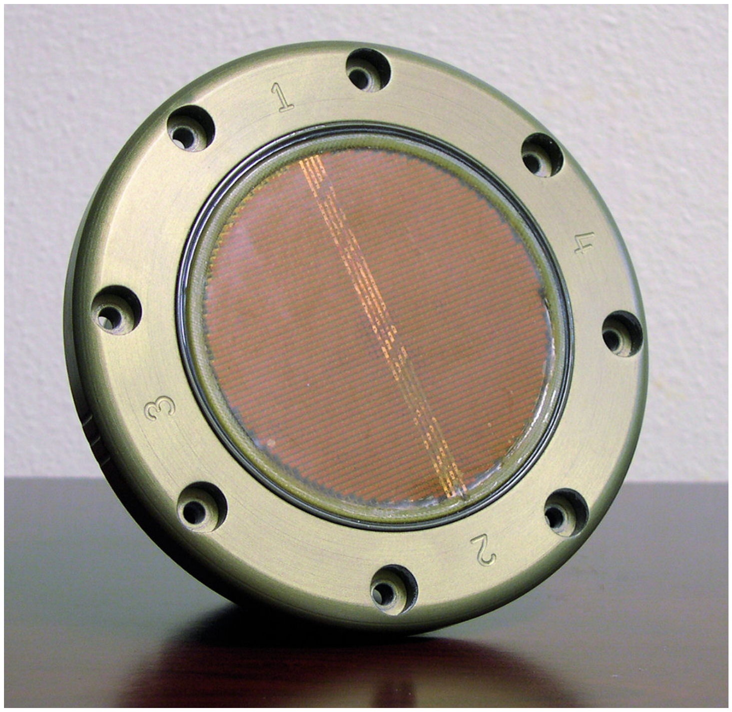

Figure 2. ExplorerDVL Phased Array Transducer

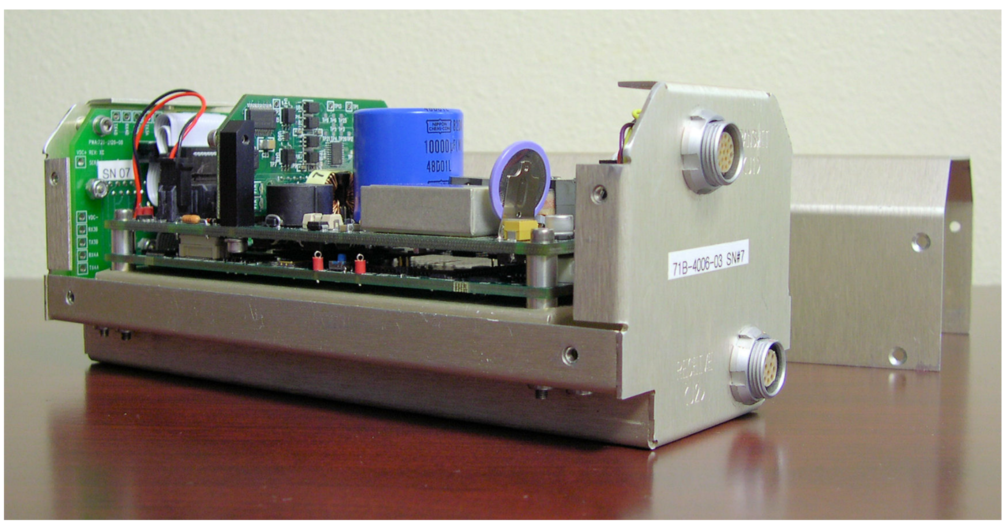

Figure 3. ExplorerDVL Electronics Chassis (Cover Removed)

2.1 ExplorerDVL 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 is rated to 100 meters and the Janus piston transducer provides a 300 meters depth rating.

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.

2.2 Inventory

You should have the following items

- ExplorerDVL
- Electronics chassis
- Transmit/Receive cables
- Documentation CD
- *RDI Tools* software CD
- Tools and Spare Parts kit
- Shipping box (please save all foam for reshipping use)

2.3 Visual Inspection of the ExplorerDVL

Inspect the ExplorerDVL using Table 1 and Figure 1, page 4 through Figure 3, page 5. If you find any discrepancies, call Teledyne RD Instruments (TRDI) for instructions.

Table 1: Visual Inspection Criteria

Item	Inspection Criteria
Transducer	Check the urethane face(s). There should be no gouges, dents, scrapes, or peeling.
Connectors	Check the connectors on the transducer and electronic housing for cracks or bent pins.
Cables	Check the cable connectors for cracks or bent pins.
O-rings	Check o-rings for cuts, cracks or other damage

3 ExplorerDVL Care

This section contains a list of items you should be aware of every time you handle, use, or deploy your ExplorerDVL. *Please refer to this list often*.

3.1 General Handling Guidelines

- Never set the ExplorerDVL transducer on a hard or rough surface. **The urethane faces or anodized finish may be damaged.**
- Do not expose the transducer faces to prolonged sunlight (24 hours or more). **The urethane faces may develop cracks.** Cover the transducer faces 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 urethane faces may be damaged.**
- Do not scratch or damage the O-ring surfaces or grooves on the transducer. **If scratches or damage exists, they may provide a leakage path and cause the ExplorerDVL and/or vessel to flood.** Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support an ExplorerDVL by the external cables. **The connector or cable will break.**
- Do not connect or disconnect the cables with power applied. When you connect the cable with power applied, you may see a small spark. **The connector pins may become pitted and worn.**

3.2 Installation Guidelines

- Make sure the O-rings stay in their groove when you install the ExplorerDVL in your 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 transducer is 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) is dry**.

4 Setup the ExplorerDVL

Figure 4 illustrates how to connect the ExplorerDVL cable to your 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).

ExplorerDVL units are configured to use 4xRS232, or 3xRS232 and 1xRS422, or 2xRS232and 2xRS422 communications protocols. Your computer's communication port must match the ExplorerDVL communication lines on its port, or use an adapter. To change the communication protocol, see "Personality Module Replacement," page 19.

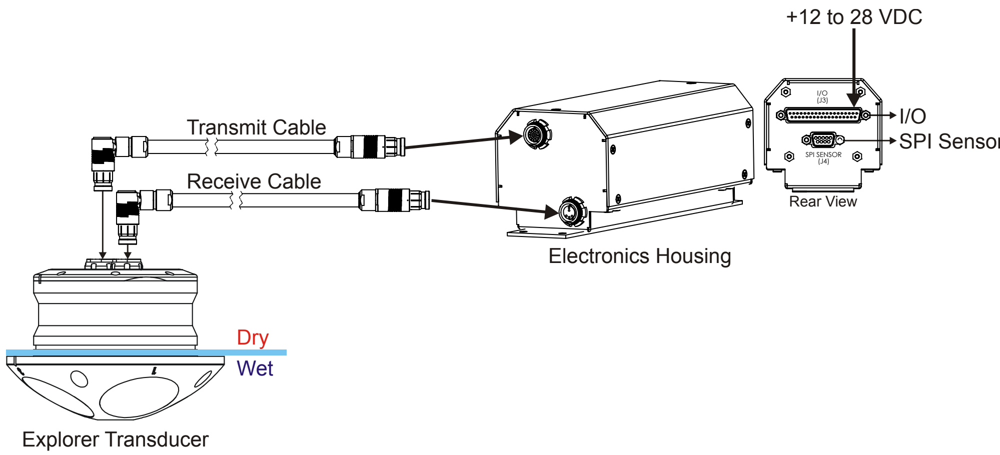

Figure 4. ExplorerDVL Connections (RS-232)

4.1 Power Requirements

The ExplorerDVL requires a DC supply between 12 and 28 VDC. Either an external DC power supply or battery can provide this power. If you are using a battery, use the largest rated amp-hour battery as possible. A fully charged 48Ah battery should last five days powering a 600-kHz ExplorerDVL.

4.2 Input Power and Communications Cable Wiring

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

NOTE. This cable is provided by the user.

CAUTION. 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 2: 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	
3	TX1A	TX1A	TX1A	TX1
4	TX1B	TX1B	TX1B	
5	COMM 1_2	COM1_2	COM1_2	COM1_2
6	RX2A	RX2A	RX2	RX2
7	RX2B	RX2B		
8	TX2A	TX2A	TX2	TX2
9	TX2B	TX2B		
10	Unused			
11	RX3A	RX3	RX3	RX3
12	RX3B			
13	TX3A	TX3	TX3	TX3
14	TX3B			
15	COMM 3_4	COM3_4	COM3_4	COM3_4
16	RX4A	RX4	RX4	RX4
17	RX4B			
18	TX4A	TX4	TX4	TX4
19	TX4B			
20	Unused			
21	TRIG_IN Voltage			
22	Unused			
23	TRIG_OUT Voltage			
24	Unused			
25	Unused			
26	Unused			
27	Unused			
28	Unused			
29	Unused			
30	Unused			
31	Unused			
32	Unused			
33	CHAS_GRND			
34	VDC +			
35	VDC +			
36	VDC -			
37	VDC -			

NOTE. To change the communication protocol, see “Personality Module Replacement,” page 19.

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

4.3 Sensor Interface Cable Wiring

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

NOTE. This cable is provided by the user.

Table 3: 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

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

4.4 Transmit and Receive Cables

The Transmit and Receive cables connect the ExplorerDVL transducer to the Electronics Housing. Use care when routing the Transmit and Receive cables through bulkheads and cable runs. Make allowances in cable length and engineering design plans for cable routing. When necessary, use a strain relief on the cables. The cable is custom-made in lengths specified by the user (maximum length 2.0 meters).

Route these cables so:

- It does not have kinks or sharp bends (bend radius 0.1 meters).
- You can easily replace it if it fails.

The Transmit and Receive cables connect to the electronics housing and transducer using keyed connectors. To make the connection, pull the outer barrel back to release the locking mechanism, insert the cable connector into the receptacle, matching the red dots until the keyed portions are properly aligned. Push straight onto the receptacle to complete the connection and then push the barrel down to lock the connector. You should be able to pull up lightly on the right angle portion of the connector without the disconnecting the connector if it is locked.

To remove the cable, pull the barrel back to release the locking mechanism, grasp the cable connector and pull straight out away from the connector.

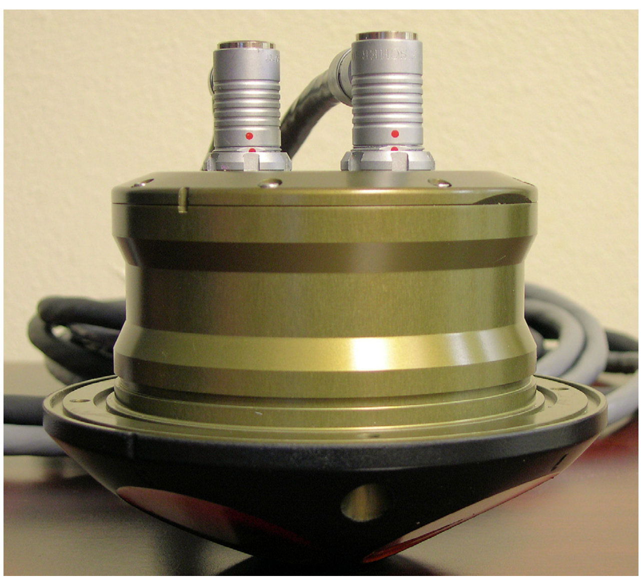

Figure 5. Transmit and Receive Cable Connections

NOTE. Match the Red Dots to Connect the cables.

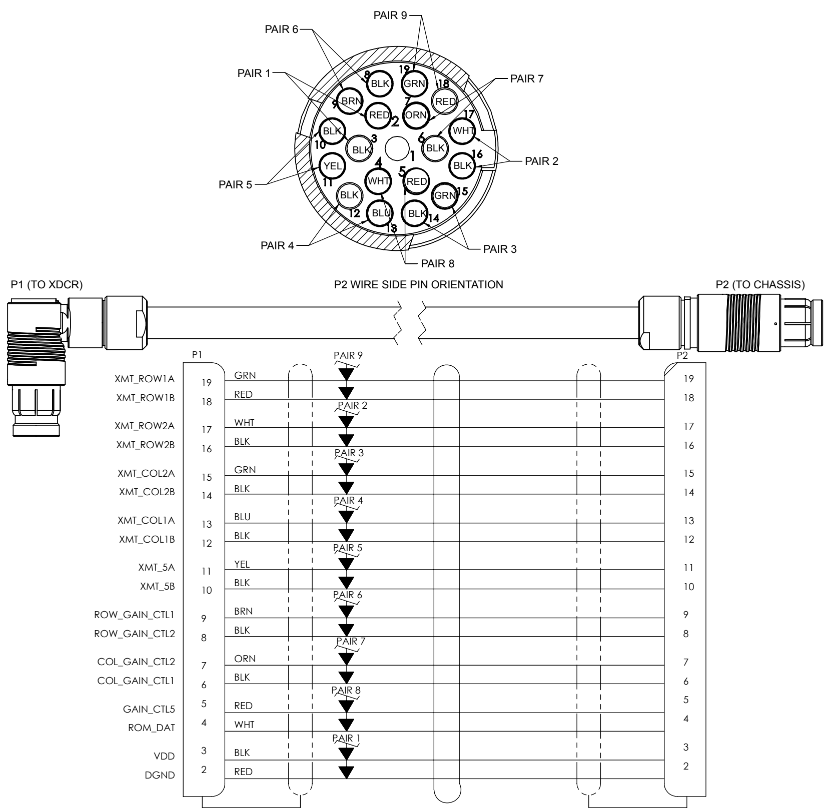

Figure 6. Transmit Cable

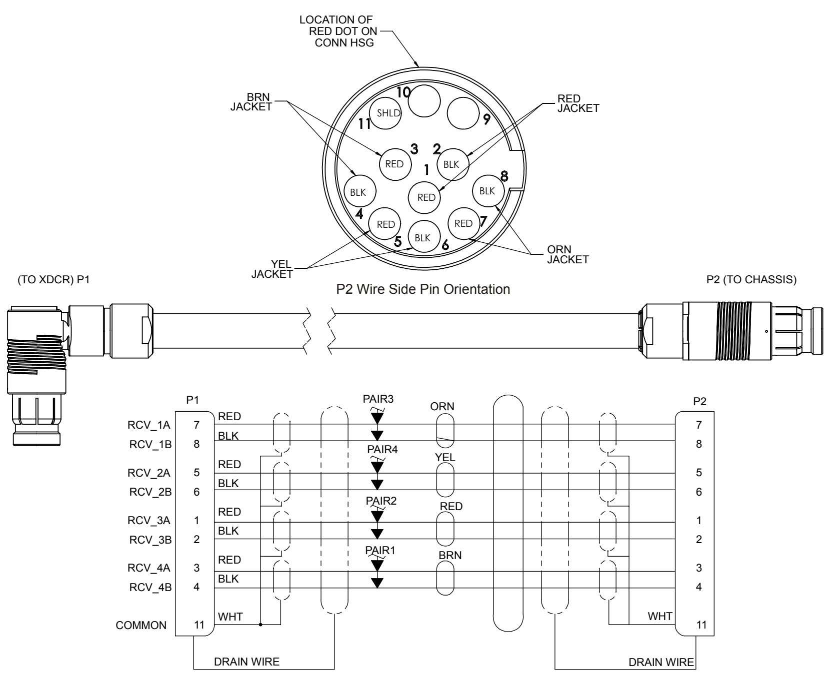

Figure 7. Receive Cable

5 Software

The ExplorerDVL system includes the utility program *BBTalk* to help you set up, use, test, and trouble-shoot your ExplorerDVL. Use this program to "talk" to the ExplorerDVL and to run script files (see "Creating or Modifying Command Files," page 48 and "Use BBTalk to Send the Commands to the ExplorerDVL," page 52). *BBTalk* is included on the RDI Tools CD. For detailed information on how to use *BBTalk*, see the RDI Tools User's Guide.

5.1 Software System Requirements

The *BBTalk* software requires the following:

- Windows 95®, Windows 98®, or Windows® NT 4.0 with Service Pack 4 installed, Windows 2000®, Windows XP®
- Pentium class PC 233 MHz (350 MHz or higher recommended)
- 32 megabytes of non-volatile memory (64 MB non-volatile memory recommended)
- 6 MB Free Disk Space (20 MB recommended)
- One Serial Port (two High Speed UART Serial Ports recommended)
- Minimum display resolution of 800 x 600, 256 color (1024 x 768 recommended)

5.2 Software Installation

To install the *BBTalk* software, do the following.

a. Insert the compact disc into your CD-ROM drive and then follow the browser instructions on your screen. If the browser does not appear, complete Steps "b" through "d."

b. Click the **Start** button, and then click **Run**.

c. Type **<drive>:launch**. For example, if your CD-ROM drive is drive D, type **d:launch**.

d. Follow the browser instructions on your screen

6 Testing Your ExplorerDVL

Use the following steps to test the ExplorerDVL.

a. Interconnect and apply power to the system as described in "Setup the ExplorerDVL," page 9.

b. Start the *BBTalk* program (for help on using *BBTalk*, see the RDI Tools User's Guide).

c. On the **File** menu, click **Break** (you can also press the **End** key to send a break or use the Toolbar and press the **B** button). You should see the wakeup message appear on the log file window.

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

>
```

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

e. At the ">" prompt in the communication window, enter the direct command **CK** then press the **Enter** key. This will save the factory default setting.

f. 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:  1
       Frequency:  614400 Hz
   Configuration:  ExplorerDVL : 4-beam velocity.
 Transducer Type:  PISTON
      Beam Angle:  30 Degrees
    Beam Pattern:  CONVEX
         Sensors:SB_GMV::Could not get V response
  NONE
    CPU Firmware:  34.xx
    FPGA Version:  3.00.005
 Sensor Firmware:  ----

Board Serial Number Data:
 19 00 00 00 15 58 3B 28
 66 00 00 00 34 A7 80 23   BFT72B-1101-03X
 EB 00 00 00 3D 94 C8 23   RCV72B-2103-03X
 23 00 00 00 34 A6 68 23   PIO72B-2101-00X
 24 00 00 00 34 A6 D8 23   PER72B-2104-00X
 0E 00 00 00 41 52 92 23   DSP72B-2102-00X
 CA 00 00 00 34 A7 67 23   BFP72B-1102-03X

>
```

g. At the “>” prompt in the communication window, enter the direct 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    100 100 100 100
  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
```

h. If the wakeup displays, PS0 displays and PA message displays with a result of “…PASSED”, the ExplorerDVL is functioning normally.

i. To test communication to external sensors in the system, assign the sensors to the ports using the SP command and then issue the SR command to verify the sensors initialize.

7 Maintenance

The following maintenance items should be done on a yearly basis or whenever the system is removed from the vessel.

7.1 Spare Parts

The following parts are required for maintenance and installation.

Table 4: Spare Parts

Description	Part number
O-ring, bore	2-043
O-ring, face, inner	2-044
O-ring, face, outer	2-047
Anode, Transducer	810-4006-00
Lubricant, silicone, 4-pack	5020
Screw, Flat Head, SST	M3X0.5X5FH

7.2 Transducer Inspection

The urethane coating on the transducers is critical to watertight integrity. Mishandling, chemicals, abrasive cleaners, and excessive depth pressures can damage the transducer ceramics or urethane coating. Inspect the faces for dents, chipping, peeling, urethane shrinkage, hairline cracks, and damage that may affect watertight integrity or transducer operation. Repair of the faces should only be done by TRDI.

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

7.3 Removal of Biofouling

Before storing or shipping the ExplorerDVL, remove all foreign matter and biofouling. Remove soft-bodied marine growth or foreign matter with soapy water. Waterless hand cleaners remove most petroleum-based fouling. Rinse with fresh water to remove soap residue. Dry the transducer faces with low-pressure compressed air or soft lint-free towels.

CAUTION. The soft, thin urethane coating on the transducer faces is sensitive. 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.

CAUTION. 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.

CAUTION. Clean and inspect the I/O connectors for water or salt residue.

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. We do however 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. After using Lime-Away®, rinse the ExplorerDVL with fresh water to remove all residues. If barnacles have entered more than 1.0 mm (0.04 in.) into the transducer face urethane, you should send the ExplorerDVL to TRDI for repair. If you do not think you can remove barnacles without damaging the transducer faces, contact TRDI.

7.4 O-ring Inspection and Replacement

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. Read all instructions before doing the required actions.

We strongly recommend replacing these O-rings whenever you remove the transducer from the vessel. Inspecting and replacing the O-rings should be the last maintenance task done before installation.

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

a. 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 then 0.1 mm (0.004 in.).

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

b. 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.

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

c. 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.

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

CAUTION. 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.

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

7.5 Personality Module Replacement

Personality modules can be replaced to change the ExplorerDVL communications protocols (i.e. switch from RS-232 to RS-422). **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 5: 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

NOTE. 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.

a. Remove all power to the ExplorerDVL.

b. Remove the cover on the Electronics Chassis by removing the 10 screws.

CAUTION. 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.

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

c. With your 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 8). Pull out the Personality Module and replace it with the new module. Replace the screws to hold the new Personality Module in place.

d. Replace the cover.

e. Test the ExplorerDVL (see "Testing Your ExplorerDVL," page 15).

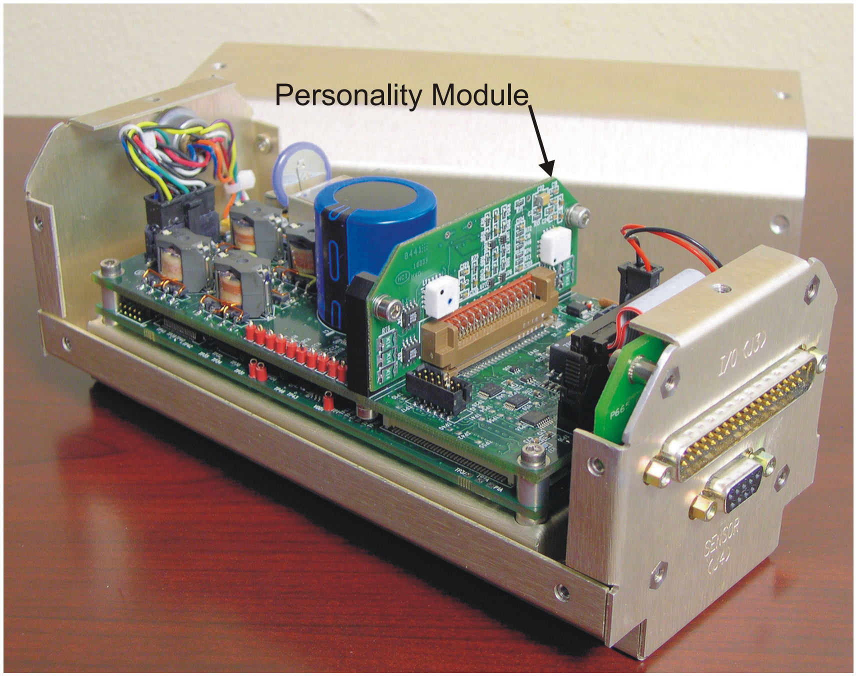

Figure 8. Personality Module Location

7.6 Zinc Anode Inspection and Replacement

The ExplorerDVL has one zinc anode located on the transducer. If the ExplorerDVL does not have exposed bare metal, a properly installed anode helps protect the ExplorerDVL from corrosion while deployed. Read all instructions before doing the required actions.

7.6.1 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 anode has been six months or more, replace the anode. If you expect the next deployment to last six months or more, replace the anode. Inspect the anodes as follows.

a. Inspect the anode on the transducer assembly for corrosion and pitting. If most of an anode still exists, you may not want to replace it.

b. Inspect the RTV-covered screw that fastens the anode. If the RTV has decayed enough to let water enter between the screws and the anode, replace the RTV.

c. If you have doubts about the condition of the anode, remove and replace the anode.

7.6.2 Zinc Anode Electrical Continuity Check

Check the electrical continuity using a digital multi-meter (DMM). All measurements must be less than five ohms. If not, reinstall the affected anode. Measure the resistance between the anode and any one of the eight screws holding the end-cap to the transducer. The resistance should be less than one ohm.

7.6.3 Zinc Anode Replacement

The following steps explain how to remove and replace the zinc anode.

a. Remove the RTV from the anode screw head. Remove the screw.

b. The anode may stick to the ExplorerDVL because of the RTV used during assembly. To break this bond, first place a block of wood on the edge of the anode to protect the housing anodizing. Carefully strike the block to loosen the anode.

c. Clean the bonding area under the anode. Remove all foreign matter and corrosion.

d. Set a new anode in place and fasten with a new screw.

e. Fill the counter bore above the screw head with RTV. The RTV protects the screw heads from water and prevents breaking the electrical continuity between the anode, screw, and housing.

f. Check the electrical continuity. If the measurement is greater than one ohm, reinstall the affected anode.

CAUTION.

1. 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.

2. Do not use magnesium anodes. Magnesium rapidly corrodes the aluminum housing.

3. 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.

4. If the transducer is bolted to the vehicle, the internal threads in the vehicle should be kept dry.

8 Installation Guide

This section is a *guide* for installing the ExplorerDVL on either ROVs, AUVs, ASVs, Towfish, or vessels. Use this section to plan your installation layout. You can also use this information to see what requirements you must consider before purchasing an ExplorerDVL. We recommend you distribute this information to your organization's decision-makers and installation engineers.

We are not experts in installing the ExplorerDVL aboard a ship. There are too many installation methods. We suggest you seek expert advice in this area because of its importance in ExplorerDVL performance. However, we can give you 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.

CAUTION. 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.

8.1 Mounting the ExplorerDVL Transducer

8.1.1 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 9, page 23). 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," page 24).

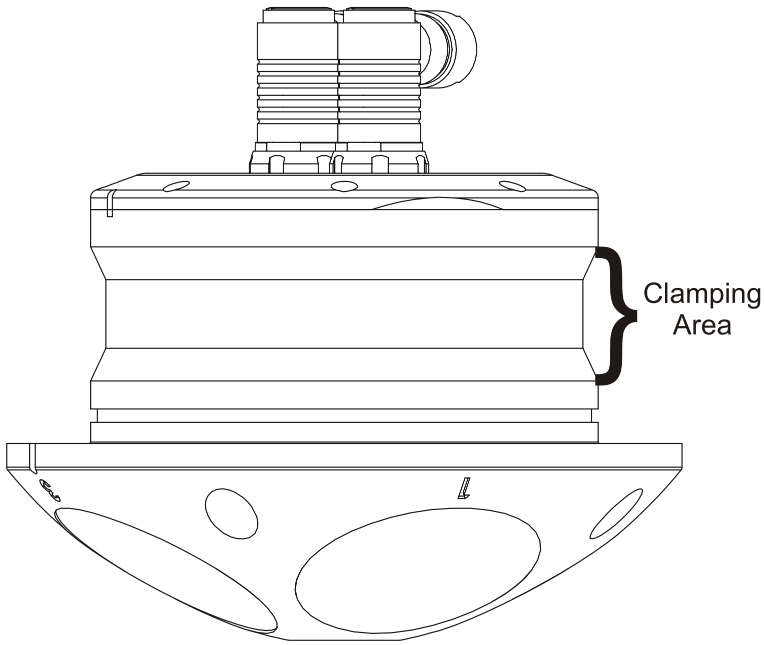

Figure 9. Transducer Profile

8.1.2 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 10, page 24).

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.

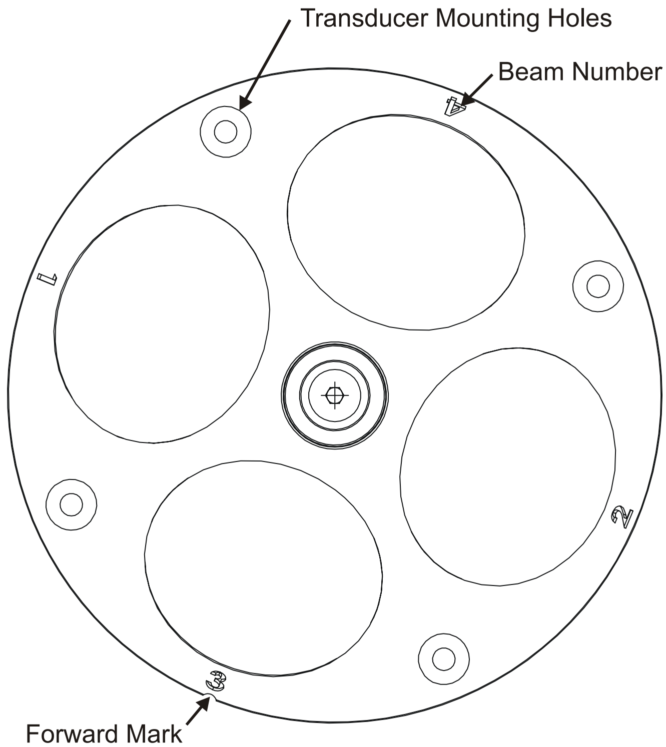

Figure 10. Transducer Mounting Holes

> **CAUTION.** Whatever mounting solution you choose, 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.

8.2 General Mounting Considerations

Now that we have presented you the main methods of mounting the ExplorerDVL, you must be aware of several mounting considerations that may cause reduction in range, biased data, fouling, and other performance related considerations.

8.2.1 Orientation

We recommend you mount 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,” page 30), and increases the ExplorerDVL’s effective velocity range by a factor of 1.4. If you align Beam 3 at an angle other than zero, you must use the EA command to describe the rotation between instrument y axis (beam 3) and ship forward axis. You see “EA - Heading Alignment,” page 71.

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," page 79) and #EJ (see "EJ - Pitch Misalignment Angle," page 80) commands to align them.

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

8.2.2 Air Bubbles

Design your 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 get 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.

> **NOTE.** If you need to make an adapter plate to connect your hardware to our transducer head and/or to our electronic chassis, please refer to "Mechanical Specifications," page 38 for the exact dimensions and layout of our transducer head and/or electronic chassis bolt holes for your installation.

- Divert the bubble layer so it flows around the transducers - You can use fairings to alter the bubble flow. An acoustic window may help reduce the bubble problem, but can cause ringing (see "Acoustic Isolation," page 30) and attenuation problems.

8.2.3 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, you should 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, you should 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," page 28.
- 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," page 29.
- 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 you should 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 6 shows the maximum thickness you should use when using Polycarbonate material as it was proven to work great with TRDI systems:

Table 6: 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: λm=Cm/FDVL, Where Cm = Speed of Sound in the material
FDVL= Center Frequency of your ExplorerDVL unit
λm= wavelength of the signal in the material

Approximate one-way wavelengths of sound in seawater are given below in Table 7. Using standard neoprene wet suit material has been found to work well with 600hKz ExplorerDVLs.

Table 7: 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 you're using a special fluid inside the window, your ExplorerDVL needs to know what the speed of sound is in this specific fluid (see "EC - Speed of Sound," page 77). 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," page 74 and "ES – Salinity," page 72 (if no salinity sensor is present) commands).

NOTE. Set the profile blank ("WF – Blank after Transmit," page 104) and bottom blanking interval(See "BB – Bottom Blanking Interval," page 57) considerably longer than the distance from the transducer to the acoustic window to avoid corrupted profile due to ringing of the window material data and bottom tracking locking on to the acoustic layer/water interface rather than on the actual bottom.

8.2.4 Flow Noise

Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the ExplorerDVL. You can reduce the flow across the transducer faces with a fairing, or an acoustic window (see "Fairing/Hull/Acoustic Window," page 25).

8.2.5 Corrosion and Cathodic Disbondment

Your 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, you should plan regular inspections of the mounting hardware for signs of corrosion. TRDI disposes many corroded hardware sets during inspections. By returning your system for a Refurbishment Service at signs of important corrosion, we 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 your ExplorerDVL will have a long service life.

NOTE. Corrosion can be further reduced if the well is covered with a window and then filled with fresh water.

8.2.6 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. We refer 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." Which ever 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," page 104) or minimum water mass layer (see "BL - Water-Mass Layer Parameters ," page 61). 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.

8.2.7 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," page 104 and "BL - Water-Mass Layer Parameters ," page 61 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.

You can attain acoustic isolation several ways. Design your 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).
- You also should 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. You can 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.

8.2.8 Interference

Interference from other acoustic devices can cause velocity and direction bias. In extreme cases it the 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 you may want to 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 11.

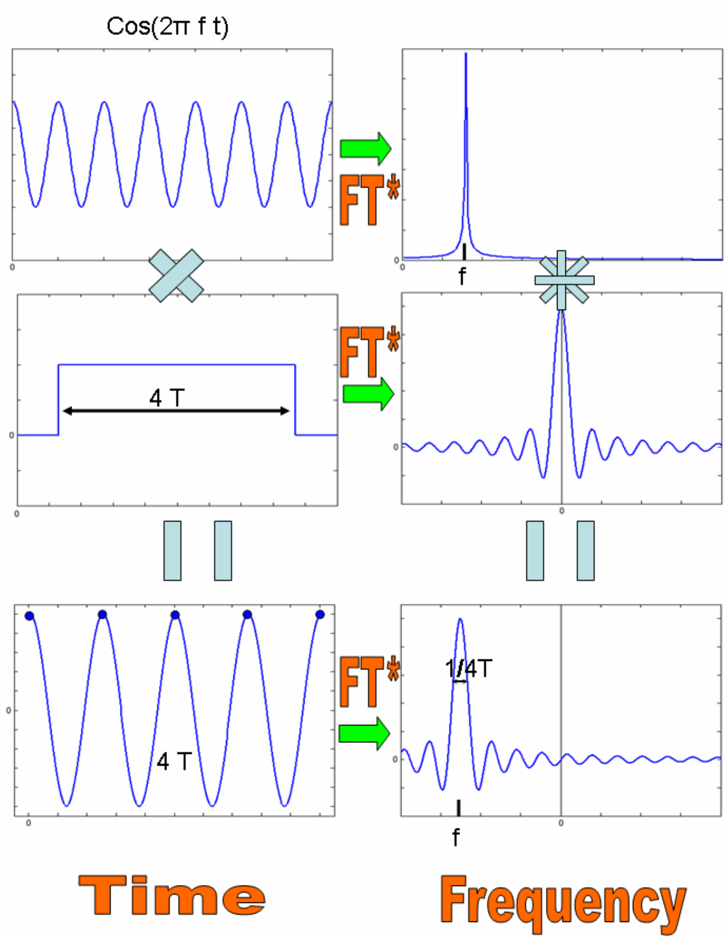

Figure 11. ExplorerDVL Carrier Cycles

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

As depicted in Figure 11, a narrow band acoustic wave is sent into the water by exciting the transducers with a electric sinusoidal signal, cos(2πft) –

(Figure 11, page 31 - top left corner). Its Fourier Transform is approximately Dirac function centered on f the frequency of the sinusoidal signal (Figure 11, page 31 - 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. sinc $(\chi) = \sin(\chi) / \chi$ (Figure 11, page 31 - 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 11, page 31 - 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 11, page 31 - bottom right corner). The resulting transmit frequency bandwidth is 25% of the carrier frequency, i.e. 1/4T=f/4=f.25%. 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 8: 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.

NOTE. 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 you feel the system must be grounded, use only one, short connection to ground.

8.2.9 Biofouling

The Maintenance section explains routine maintenance procedures. You rarely need access to the electronics inside the transducer head. However, one external maintenance item is important enough to mention here as it may affect how you install the transducer head.

Objects deployed within about 100 meters (328 feet) of the surface are subject to the buildup of organic sea life (biofouling). This means ExplorerDVL transducer heads are subject to 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 12).

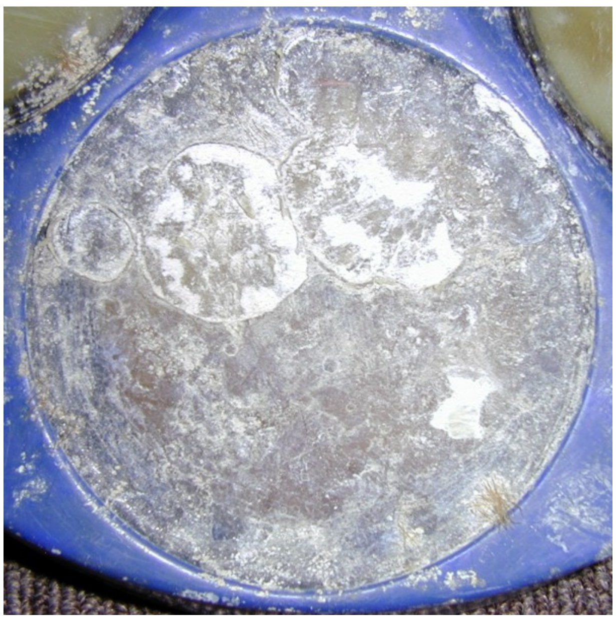

Figure 12. Barnacle Damage to Urethane Face

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. At present, we recommend the following antifouling paint manufacturer and paint brand: Courtalds Finishes Interlux brand paints, US Telephone: 908-686-1300, Web Page: www.interlux.com.

CAUTION.

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, dezincificatioin will rapidly destroy the brass.
4. TRDI no longer recommends the use of Nopcocide 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.

9 Specifications

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

> **NOTE.** 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. 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:

a. Except where noted, this specification table 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.

b. 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.

c. Because individual pings are independent, the statistical uncertainty of the measurement can be reduced according to the equation:

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

9.1 Performance Specifications

Table 9: Bottom Track Specifications

Parameter	Value	
	Phased Array	Piston
Velocity Range	+/- 5 m/s	+/- 5 m/s
Accuracy	+/- 0.4% +/- 0.2 cm/s	+/- 0.4% +/- 0.2 cm/s
Horizontal Single Ping Precision at ½ Range & 1 m/s	1.2 cm/s	1.2 cm/s
Horizontal Single Ping Precision at ½ Range & 3 m/s	2.0 cm/s	2.0 cm/s
Horizontal Single Ping Precision at ½ Range & 5 m/s	2.4 cm/s	2.4 cm/s
Minimum Altitude	0.5 m	0.5 m
Maximum Altitude @ 24V, 5C, 35ppt Salinity	75 m	65 m

Table 10: Water Profiling Specification (Optional Feature)

Parameter	Value	
	Phased Array	**Piston**
Velocity Range	+/- 5 m/s	+/- 5 m/s
Accuracy	+/- 0.75% +/- 0.2 cm/s	+/- 0.75% +/- 0.2 cm/s
Single Ping Precision at ½ Range & 1 m/s	6 cm/s	6 cm/s
Minimum Range	0.7 m	0.7 m
Maximum Range	30 m	20 m

Table 11: Acoustic Specifications

Parameter	Value	
	Phased Array	**Piston**
Center Frequency	614.4 KHz	614.4 KHz
1-Way Beam Width (Typical)	2.4 Degrees	3.6 Degrees
Number of Beams	4	4
Beam Angle	30 Degrees	30 Degrees
Sound Pressure Level	213 dB re 1 uPa@1m	205 dB re 1 uPa@1m

Table 12: Environmental Specifications

Parameter	Value	
	Phased Array	**Piston**
Operating Temperature	-5 to 40 Degrees C	-5 to 40 Degrees C
Storage Temperature	-25 to 60 Degrees C	-25 to 60 Degrees C
Vibration (Operation)	IEC 60945, 4th ED, 2002-08	IEC 60945, 4th ED, 2002-08
Vibration (Transport)	IEC 60721-3-2, 2Nd Ed, 1997-3	IEC 60721-3-2, 2Nd Ed, 1997-3
Shock (Transport)	IEC 60721-3-2, 2Nd Ed, 1997-3	IEC 60721-3-2, 2Nd Ed, 1997-3
Shock (Operation)	IEC 1010-1	IEC 1010-1
Maximum Operating Depth	100 m	300 m

9.2 Electrical Specifications

Table 13: Input Power Specifications

Parameter	Value
Voltage Range	12 to 28 VDC
Average Power @ 24VDC	4 W
Typical Quiescent (not transmitting) power	1 W
Peak Input Current, Transmitting @ 24VDC	1.5 A
Inrush Current @ 24VDC	6 A max, 5A typical for 2ms, 3A after that for 35ms

NOTE. Applies to both piston and phased array transducers.

Table 14: 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

NOTE. Applies to both piston and phased array transducers.

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

9.3 Mechanical Specifications

Table 15: Transmit and Receive Cables Specifications

Parameter	Value
Maximum Length	2.0 m
Bend Radius	0.1 m

NOTE. Applies to both piston and phased array transducers.

Table 16: Component Weights

Parameter	Value	
	Phased Array	Piston
Electronics Enclosure	0.85 Kg	0.85 Kg
Transducer	1.00 Kg	1.10 Kg
Cable Assembly (2m)	0.54 Kg	0.54 Kg

Table 17: 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	TCM3/5	Ping
Pitch, Roll, Temp, Pres	10	TRDI Sensor Package	72B-1000-00	P/R: Ping T/P: Ensemble

NOTE. Applies to both piston and phased array transducers.

9.4 Outline Installation Drawings

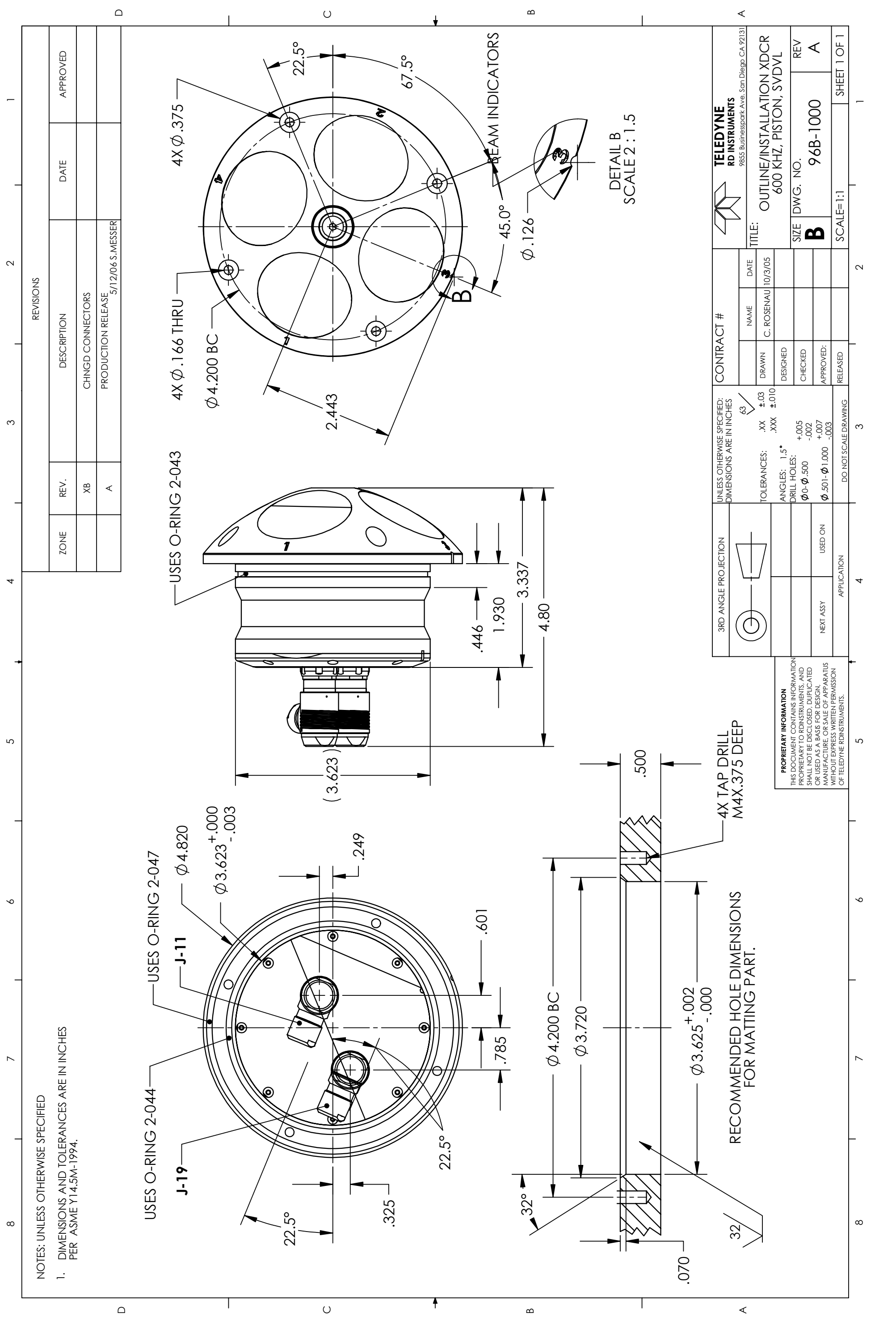

Figure 13. Outline Installation Drawing – 600 kHz Piston ExplorerDVL

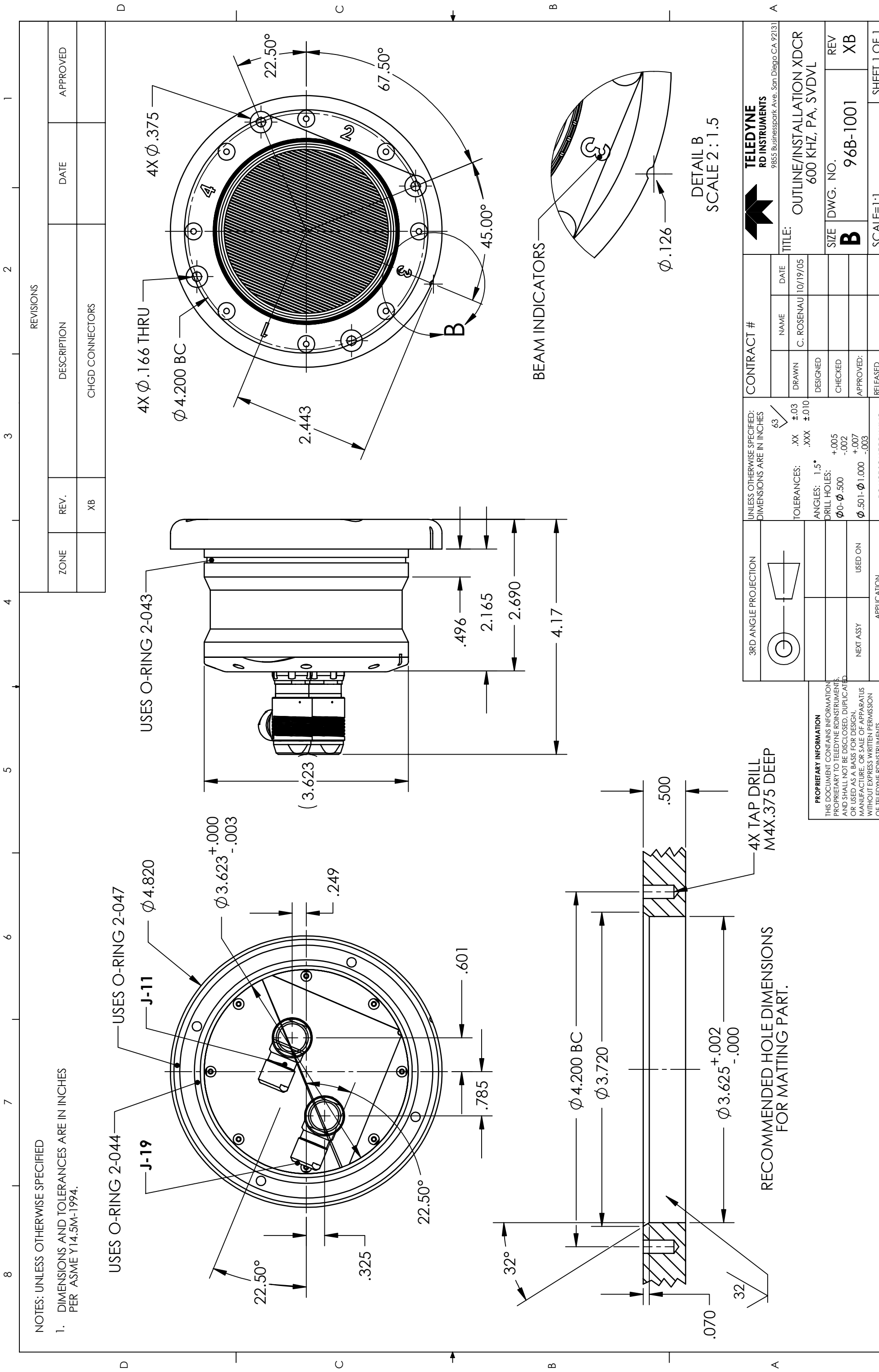

Figure 14. Outline Installation Drawing – 600 kHz Phased Array ExplorerDVL

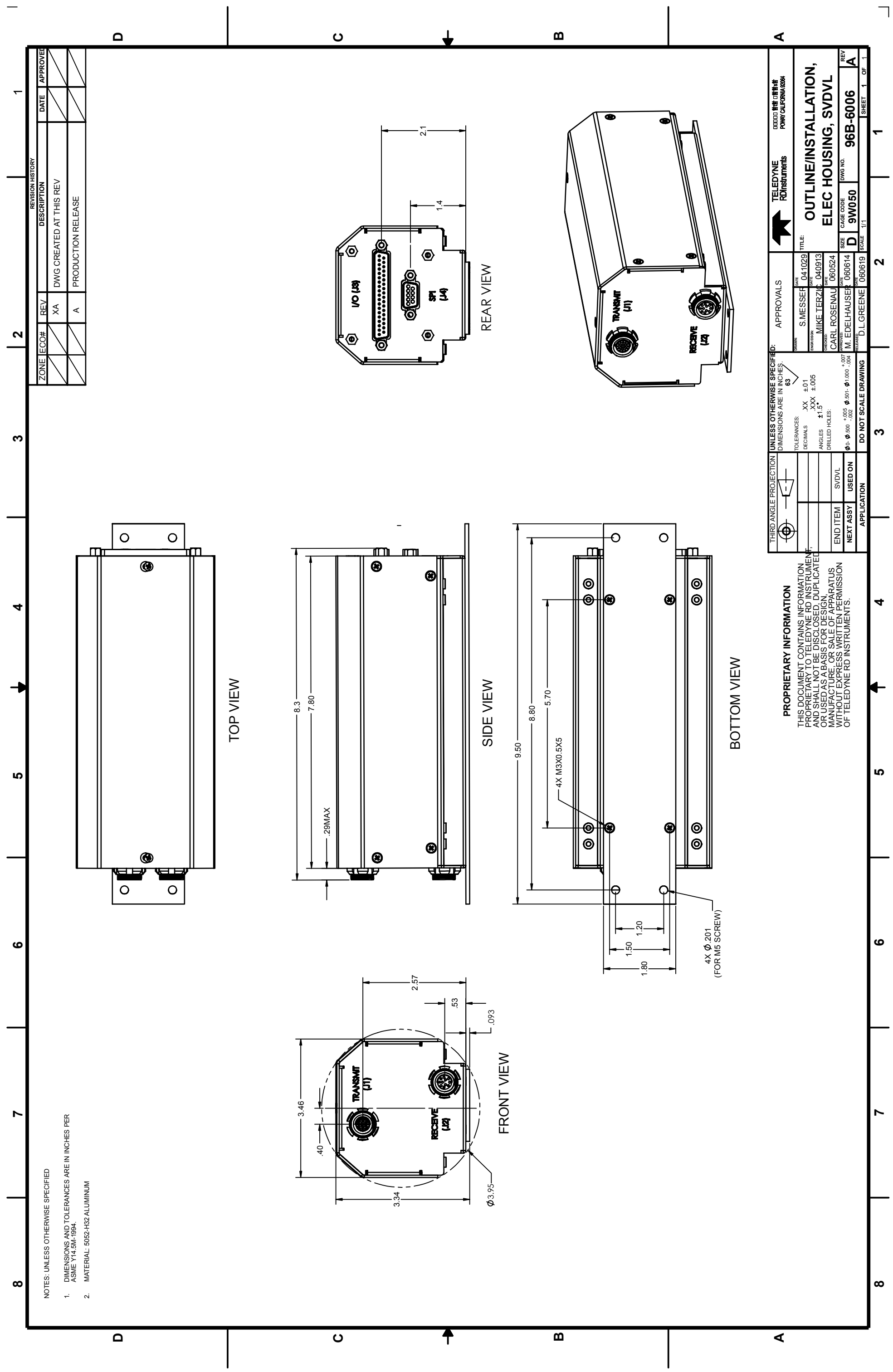

Figure 15. Outline Installation Drawing –ExplorerDVL Electronic Housing

10 ExplorerDVL Commands

This section defines the commands to set up and control the ExplorerDVL. Teledyne RD Instruments recommend you use a *BBTalk* script file to control the ExplorerDVL because entering commands directly from a terminal can be difficult. *Make sure you read and understand "Creating or Modifying Command Files," page 48 before deploying your ExplorerDVL.* Most ExplorerDVL command settings use factory-set values (Table 18, page 46). If you change these values without thought, you could ruin your deployment. *Be sure you know what effect each command has before using it.* Call Teledyne RD Instruments if you do not understand the function of any command.

> **NOTE.** This section applies to ExplorerDVL firmware 34.xx.
>
> When new firmware versions are released, some commands may be modified, added, or removed. Read the README file on the upgrade disk or online. When an addition or correction to this manual is needed, an Interim Change Notice (ICN) will be posted to our web site. Please check our Teledyne RD Instrument's web site often at www.rdinstruments.com.

10.1 Data Communication and Command Format

You can enter commands with an IBM-compatible computer running TRDI's *BBTalk*. The ExplorerDVL communicates with the computer through an RS-232 (or RS-422) serial interface. We initially set the ExplorerDVL at the factory to communicate at 9600 baud, no parity, and one stop bit.

Immediately after you apply power to the ExplorerDVL, it enters the STANDBY mode. Send a BREAK signal using *BBTalk* 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
>
```

> **NOTE.** If you use a terminal/program other than *BBTalk*, 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.

NOTE. 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,” page 70).

10.1.1 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> [Your 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>     [Your original input]
>                [ExplorerDVL response to a valid, no-output command]
```

If you enter a valid command that produces output data, the ExplorerDVL executes the command, displays the output data, and then redisplays 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>                                            [Your input]
>BPA  BPA  ERR:  Bad command parameters!<CR><LF>    [ExplorerDVL re-
sponse]
>
```

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

10.1.2 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,” page 100). 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,” page 66). The Hex-ASCII mode is useful when you use a terminal to communicate with, and view data from the ExplorerDVL. The binary mode is useful for high-speed communication with a computer program. You would not use the binary mode to view data on a terminal because the terminal could interpret some binary data as control codes.

> **NOTE.** Most of Teledyne RD Instruments' software supports binary PD0 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 setting are saved (see "CK - Keep Parameters," page 66) 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," page 66).
3. The user can recall the factory default-settings at any time (see "CR – Retrieve Parameters," page 67).

The ExplorerDVL will continue to be configured from non-volatile memory until it receives a CR-command or until the non-volatile memory loses its backup power. If the ExplorerDVL receives a CR0 it will load into non-volatile memory the command set you last stored in non-volatile memory (semi-permanent user settings) through the CK-command. If the ExplorerDVL receives a CR1, it will load into non-volatile memory the factory default command set stored in ROM (permanent or factory settings).

10.2 Command Summary

Table 18 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.

NOTE. 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.

NOTE. When an addition or correction to the manual is needed, an Interim Change Notice (ICN) will be posted to our web site on the Customer Service page (www.rdinstruments.com). Please check our web site often.

Table 18: ExplorerDVL Input Command Summary

Command	Default	Change between Ensembles?	Description
?	N/A		Shows command menu
<BREAK> End	N/A		Interrupts or wakes up ExplorerDVL and loads last settings used
#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)
#BI*nnn*	003	Yes	Bottom Gain switch depth (0 to 999 meters)
#BJnnnnnnnnn	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)
#BO*k*	25	Yes	Distance measure filter constant (0 to 100 1/100th 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
#CTn	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	Yes	Set Input Trigger [mode, dly, timeout]
EA±*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]; Intrp[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±*nnnn*	+00000, +00000,1	Yes	Tilts {pitch; roll; frame}
#ER±*nnnn*	+00000	Yes	Roll [.01 deg cw]
ES*nn*	35	Yes	Salinity (0 to 40 parts per thousand)

Continued Next Page

Table 18: ExplorerDVL Input Command Summary (continued)

Command	Default	Change between Ensembles?	Description
#ET±*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 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)
PA	N/A	No	Pre-deployment tests
PC	N/A	No	Display Pressure, Temperature, Heading, Pitch, Roll Built-in test
#PD*n*	PD0	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 Snsr 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	No	Set real-time clock (year/month/day, hours:minutes:seconds)
TTccyy/mm/dd, hh:mm:ss	N/A	No	Set real-time clock (Y2k compatible) (century year /month/day, hours:minutes:seconds)
#WA*nnn*	050	Yes	False target threshold maximum (0 to 255 counts)
WB*n*	0	Yes	Mode 1 Bandwidth Control (0 = Wide, 1 = Narrow)
#WC*nnn*	064	Yes	Correlation threshold (0 to 255 counts)
WD*nnn nnn nnn*	111110000	No	Data Out {v;c;a;p;s;*;*;*;*}
#WE*nnnn*	2000	Yes	Error velocity threshold (0 to 5000 mm/s)
WF*nnnn*	0088	Yes	Blanking Distance [0 to 999 cm]
#WJn	1	Yes	BroadBand Receiver gain (0 = Low, 1 = High)
WN*nnn*	030	Yes	Number of Bins (1 to 255)
WP*nnnn*	000	Yes	Pings per ensemble (0 to 16384)
WS*nnnn*	0200	Yes	Bin size 10 to 800 cm
#WT*nnnn*	0000	Yes	Transmit length (0 to 3200 cm)
WV*nnn*	0175	Yes	Ambiguity velocity (020 to 700 cm/s radial)

NOTE. Highlighted commands are "expert" commands. Changing these command parameters can have severe consequences to your data collection.

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

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

10.3 Creating or Modifying Command Files

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

- 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.

To create your own command file, copy the command file into *NotePad* and edit the commands as needed. Refer to the "Command Descriptions," page 53 for detailed information on each command.

NOTE. The example command file has comments that explain the function of each command. It is a good idea to keep the comments and edit them when you make command changes.

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: 14 November 2005
;-------------------------------------------------------------------------
; **************************************
; 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
EZ22222220
; **************************************
; 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
;           you to set items that if set incorrectly can cause your 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).
#EV00000
; 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 19, page 50 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 19, page 50 be the ***minimum*** commands you send to the ExplorerDVL.

> **CAUTION.** Although these are our recommended minimum commands, **they may not be the only commands you need for your deployment to be successful!**

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

NOTE. Your 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 19: 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," page 64).
CF11110	See manual for description	Flow control - Recommended to leave at default setting of CF11110 (see "CF - Flow Control," page 66).
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," page 55).
BX01000	BX80 to BX9999	Sets the Maximum Tracking Depth to 100 meters (1000 decimeters) (see "BX – Maximum Tracking Depth," page 56)
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," page 71)
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," page 72).
ES35	ES0 to ES40	Salinity of water is set to 35 (saltwater) (see "ES – Salinity," page 72).
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," page 73).
EZ22222220	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," page 74).
TE00:00:00.00	Time per ensemble	Ping as fast as possible (see "TE – Time Per Ensemble," page 100).
TP00:00.00	Time per ping	Ping as fast as possible (see "TP – Time Between Pings," page 101).

Continued Next Page

Table 19: Recommended Commands (continued)

Command	Choices	Description
WP0	WP0 to WP16384	Water Profiling – The default setting WP0 will turn off water profiling (see "WP – Pings Per Ensemble," page 105).
WS0200	WS10 to WS800	Sets the depth cell size in cm. Recommended to leave at default setting of WS0200 (see "WS – Depth Cell Size," page 106).
WN030	WN1 to WN255	Sets the number of depth cells. Recommended to leave at default setting of WN030 (see "WN – Number of Depth Cells," page 105).
#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," page 60). 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 ," page 61).
#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," page 60).
#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," page 70).
#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," page 77).
#EV00000	#EV-17999 to #EV18000	Sets the Heading Variation in degrees. Set #EV = [(local magnetic declaration)*100] + (-4500) to compensate for the transducer misalignment (if used) (see "EV - Heading Bias," page 82).
#PDx	PD0 (default), PD4, PD5, PD6	Sets the output data format (see "PD0 Output Data Format," page 112).
#EY 0 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," page 83).
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," page 66). Sent right before the CS-command.
CS	Start pinging	Last command sent to begin collecting data (see "CS – Start Pinging (Go)," page 67).

NOTE. 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.

10.4 Use *BBTalk* to Send the Commands to the ExplorerDVL

Use *BBTalk* to send the commands to the ExplorerDVL.

a. Start *BBTalk*.

b. Send a BREAK to the ExplorerDVL by pressing the **End** key. 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) 2005
All rights reserved.
Firmware Version: 34.xx
>
```

c. To send the command file, press **<F2>**.

d. On the **Select a Script File** box, select the command file from the scroll-down list or click the **Browse** button. If no extension is given for the command file, an extension of *.txt* is assumed. On the **Files of Type** box, select **All Files (*.*)** if your command file uses a different extension.

NOTE. Script files can have *.rds, *.txt, *.scr, or any other extension as long as they are ASCII text files. Double-clicking a *.rds file will automatically start *BBTalk* and run the script file if the **Connect to Last Open Port** is selected on the **Options** screen (see the RDI Tools User's Guide for details).

CAUTION. 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," page 53 and "Introduction to Output Data Format," page 111 sections for information on each command setting.

10.5 Command Descriptions

Each listing includes the command's purpose, format, default setting (if applicable) range, recommended setting, and description. When appropriate, we include amplifying notes and examples. 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	*x*? (see description)
Description	Entering ? by itself displays all command groups. To display help for one command group, enter *x*?, where *x* is the command group you wish 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 WP?.
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
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>

> **Recommended Setting.** Use as needed.

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 *BBTalk*, 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 *BBTalk*. Configure *BBTalk* to use a Software break by using the **Tools**, **Options** screen. The ExplorerDVL will use the "= = =" string instead of a break.

10.6 Bottom Track Commands

The ExplorerDVLs use 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 BP0 command.

10.6.1 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]
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

Recommended Setting. 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.

NOTES.

The ExplorerDVL interleaves Bottom-Track pings with Water-Track pings if water profiling is enabled (see “TP – Time Between Pings,” page 101, “WP – Pings Per Ensemble,” page 105 and “BK - Water-Mass Layer Mode,” page 60).

If BP = zero, the ExplorerDVL does not collect bottom-track data.

The ExplorerDVL automatically extends the ensemble interval (TE) if BP x TP > TE (see “TE – Time Per Ensemble,” page 100).

BX – Maximum Tracking Depth

Purpose	Sets the maximum tracking depth in bottom-track mode.
Format	BX*nnnn*
Range	*nnnn* = 10 to 65535 decimeters (meters x 10)
Default	BX01000

> **Recommended Setting.** 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 you know 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), which is the maximum bottom tracking range.

10.6.2 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:

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
```

#BA - Evaluation Amplitude Minimum

Purpose	Sets the minimum value for valid bottom detection.
Format	#BA*nnn*
Range	*nnn* = 1 to 255 counts
Default	#BA24

Recommended Setting. 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	#BB*nnnn*
Range	*nnnn* = 0 to 9999 cm
Default	#BB5

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

Description	The unit 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: #BC*nnn*

Range: *nnn* = 0 to 255 counts

Default: #BC220

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description: Sets a minimum threshold for good bottom-track data. The ExplorerDVL flags as bad any bottom-track data with a correlation magnitude less than this value.

> **NOTE.** 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: #BE*nnnn*

Range: *nnnn* = 0 to 9999 mm/s

Default: #BE1000

> **Recommended Setting.** The default setting for this command is recommended for most applications.

> **CAUTION.** 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," page 73) 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	#BF*nnnnn*
Range	*nnnnn* = 1 to 65535 dm (0 = automatic)
Default	#BF0

Recommended Setting. 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

Recommended Setting. 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* * *hr* * ***

*: not used; reserved for future use (set to zero).

t: Standard bottom track output (see "Binary Bottom-Track Data Format," page 133)

c: Commands output (see "Bottom Track Command Output Format," page 141 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," page 142 for a data type definition)

r: Range (corrected) output. See "Bottom Track Range Format," page 143 for a data type definition.

Range: 0 or 1 for each digit

Default: #BJ 100 000 000

> **Recommended Setting.** 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*n*

Range: *n* = 0 to 3

Default: #BK0

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description: The #BK command selects how often the ExplorerDVL performs a water-mass layer ping while bottom tracking (see Table 20, page 61). The number of water-mass layer pings per ensemble is dependent on the BP-command (see "BP – Bottom-Track Pings per Ensemble," page 55) and this command setting. Use the #BL-command to set the location of the water-mass layer (see "BL - Water-Mass Layer Parameters ," page 61).

Table 20: 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.

#BL - Water-Mass Layer Parameters

Purpose: Sets bottom-track water-mass layer boundaries and minimum layer size.

Format: #BL*mmm*,*nnnn*,*ffff*

Range: *mmm* = Min Layer Size (1 to max profile bin decimeters) [meters x 10]
nnnn = Near Layer Boundary (0 - 9999 decimeters) [meters x 10]
ffff = 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

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

Description: The #BL-command sets a water-mass layer. You can 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," page 60) and BP (see "BP – Bottom-Track Pings per Ensemble," page 55) 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 16, page 62, B), the layer compresses in size until the minimum water-mass layer size is reached. When the boundary moves closer to the transducer (Figure 16, page 62, C), no water mass ping will be sent.

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

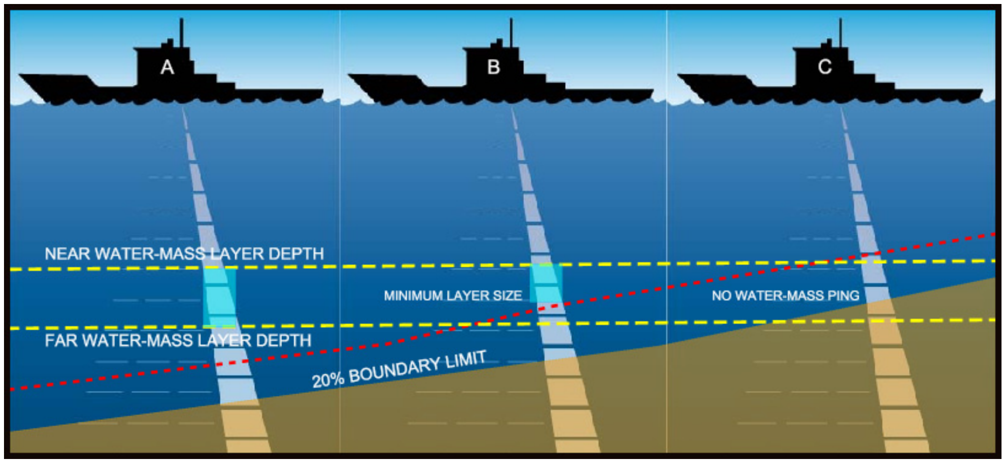

Figure 16. Water-Mass Layer Processing

#BN - Speed Log Hold/Drop Control

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

Format: #BNx,y

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

Default: #BN0,999

Recommended Setting. 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

Recommended Setting. 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:

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

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

Recommended Setting. Use as needed.

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

- PD0 high resolution output (see “BJ – Data Type Output Control,” page 60 and “Bottom Track High Resolution Velocity Format,” page 142)
- PD5 (see “ExplorerDVL Binary Data Format (PD5),” page 153).
- PD6 (see “ExplorerDVL Output Data Format (PD6),” page 156)

The accumulator is zeroed on <BREAK> or by using this command in the manual ensemble cycling mode (see “CF - Flow Control,” page 66).

10.7 Control System Commands

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

10.7.1 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 ---------- Set Input Trigger [mode, dly, timeout]
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	CB*nnn*
Range	*nnn* = baud rate, parity, stop bits (see description)
Default	CB411

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

Description: The ExplorerDVL and your external device (dumb terminal, computer software) MUST use the same communication parameters to *talk* to each other. After you enter valid CB parameters, the ExplorerDVL responds with a “>” prompt. You must now change the external device’s communication parameters to match the ExplorerDVL parameters before sending another command.

Table 21: 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		

Setting the Baud Rate in the ExplorerDVL. The ExplorerDVL can be set to communicate at baud rates from 300 to 115200. The factory default baud rate is always 9600 baud. The baud rate is controlled via the CB-command. The following procedure explains how to set the baud rate and save it in the ExplorerDVL. This procedure assumes that you will be using the program *BBTalk* that is supplied by Teledyne RD Instruments.

a. Connect the ExplorerDVL to the computer and apply power (see "Setup the ExplorerDVL," page 9).

b. Start the *BBTalk* program and establish communications with the ExplorerDVL. Wakeup the ExplorerDVL by sending a break signal with the **End** key.

c. Send the command CR1 to place the ExplorerDVL in the factory default setup (see "CR – Retrieve Parameters," page 67).

d. Send the CB-command that selects the baud rate you wish. The following are the typical CB-command settings for different baud rates with no parity and 1 stop bit:

Table 22: Baud Rate

BAUD RATE	CB-command
300	CB011
1200	CB111
2400	CB211
4800	CB311
9600	CB411 (Default)
19200	CB511
38400	CB611
57600	CB711
115200	CB811

e. In *BBTalk*, press **F5** and change the settings to match your CB command settings. Press **OK** to exit the communication setup screen.

f. Send the command CK to save the new baud rate setting (see "CK - Keep Parameters," page 66).

g. Click **File**, **Close** to exit the terminal window.

The ExplorerDVL is now set for the new baud rate. The baud rate will stay at this setting until you change it back with the CB-command.

> **NOTE.** If you send a BREAK before changing the external device's communication parameters, the ExplorerDVL returns to the communication parameters stored in non-volatile memory (user settings).

CF - Flow Control

Purpose Sets various ExplorerDVL data flow-control parameters.

Format CF*nnnnn*

Range Firmware switches (see description)

Default CF11110

Recommended Setting. 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 23: 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 lets you manually control ping timing within the ensemble.
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

Recommended Setting. Use as needed.

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. You can recall parameters stored in non-volatile memory with the CR command (see “CR – Retrieve Parameters,” page 67).

CR – Retrieve Parameters

Purpose Resets the ExplorerDVL command set to factory settings.

Format CR*n*

Range *n* = 0 (User), 1 (Factory)

Recommended Setting. Use as needed.

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

Table 24: Retrieve Parameters

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

NOTE. 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

Recommended Setting. Use as needed.

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

NOTE. 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*
Range	*n*: n = 0 to 5 per Table 25. *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.
Default	CX 0 0 65535
Description	The unit will ping once within 1ms after the trigger transitions as indicated in Table 25 for CX = 1 to 3. For CX 4 to 5, the ExplorerDVL will trigger while the trigger is in the state described in Table 25.

Table 25: 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

NOTES.

The polarity is defined as the electrical level at the connector (J3) on the electronics enclosure (see Table 2, page 10 and Table 14, page 38).

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 pinging 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 is ready to transmit again.

CAUTION. 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," page 101).

CAUTION. The Trigger In and Out lines must each be referenced to COMM 1_2 (pin 5 of J3 I/O Serial DB37) (see Table 2, page 10).

10.7.2 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

Recommended Setting. 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 2, page 10) on the electronics enclosure during transmit, receive or both transmit and receive as indicated in Table 26.

Table 26: Output Trigger State

CO (n)	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 n=1 for BM8 when shallow due to multi-pulse transmission.
#CO 3	Trigger active during receive interval only. Reverts to n=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.

CAUTION. The Trigger In and Out lines must each be referenced to COMM 1_2 (pin 5 of J3 I/O Serial DB37) (see Table 2, page 10).

#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

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description Setting the #CT command to #CT1 lets the ExplorerDVL automatically initialize to a predefined command set during any power up or after a break.

To place the ExplorerDVL in turnkey mode, you must first set all other commands to the desired configuration. You must then send the #CT1 and CK commands to save this configuration (see “CK - Keep Parameters,” page 66). 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.

You can interrupt this mode 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.

10.8 Environmental Commands

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

10.8.1 Available Environmental Commands

This section lists the available Environmental commands.

```
>e?
Available Commands:

EA +00000 ----------------- Heading Alignment [.01 deg cw]
ED 00000 ------------------ Xdcr Depth(+)/Keel Offset(-) [dm]
ES 35 --------------------- Salinity [ppt]
EX 11111 ------------------ Coordinate Transformations
EZ 22222220 --------------- 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

> **Recommended Setting.** For systems that are stationary, EA is typically set to zero (default), since Beam 3 is used as the heading reference.

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," page 82, 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 starboard (+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 × 100 = +4500 = EA+04500
```

ED - Depth of Transducer

Purpose Sets the ExplorerDVL transducer depth.

Format ED*nnnnn*

Range *nnnnn* = 0 to 65535 decimeters (meters x 10)

Default ED00000

> **Recommended Setting.** Use the EZ-command (see “EZ - Sensor Source,” page 74).

Description ED sets the ExplorerDVL transducer depth. This measurement is taken from sea level to the transducer faces. 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.

> **NOTE.** 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 29, page 84 of the #EY command for more information.

ES – Salinity

Purpose Sets the water’s salinity value.

Format ES*nn*

Range *nn* = 0 to 40 parts per thousand

Default ES35

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description The ES command sets the water’s salinity value. 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 EX*xxptb*

Range *xx* = Transformation
p = Pitch and Roll
t = 3 beam solutions
b = Bin mapping

Default EX11111

Recommended Setting. 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.

Table 27: 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
EXxxxx1	Allow bin mapping (see Note 4, next page)

NOTES.

1. For ship and earth-coordinate transformations to work properly, you must set the Heading Alignment (“EA - Heading Alignment,” page 71) and Heading Bias (“EV - Heading Bias,” page 82) correctly. You also must ensure that the tilt and heading sensors are active (“EZ - Sensor Source,” page 74).

2. Setting EX bit 3 (Use Tilts) to 0 lets you collect tilt data without using it in the ship or earth-coordinate transformations.

Continued Next Page

NOTES.

3. Each ExplorerDVL 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 you output beam-coordinate data, you will need to apply the beam corrections yourself if you want 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.

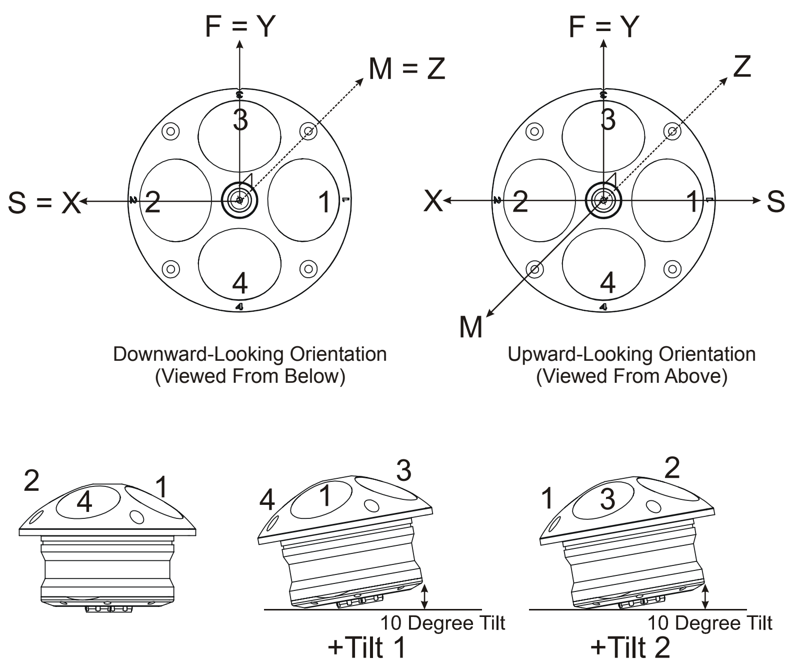

Figure 17. ExplorerDVL Coordinate Transformation

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	+	-

EZ - Sensor Source

Purpose Selects the source of environmental sensor data.

Format EZ*cdhprstu*

Range Firmware switches (see description)

Default EZ22222220

Recommended Setting. 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," page 83 command for more information).

Refer to Figure 18, page 76 for a description of how the EV and EA commands are used for internal and external heading sensors.

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

Table 28: Sensor Source Switch Settings

FIELD		VALUE = 0	VALUE = 1	VALUE = 2
C	Speed of sound	Manual #EC (see "EC - Speed of Sound," page 77)	Calculates using available depth, salinity and temperature.	External Speed of Sound Sensor
D	Depth	Manual ED (see "ED - Depth of Transducer," page 72)	TRDI Sensor Package Module	External Depth Sensor
H	Heading	Manual #EH (see "EH - Heading," page 78)	Not Allowed	External Compass
P	Pitch (tilt 1)	Manual #EP (see "EP - Pitch and Roll Angles," page 80)	TRDI Sensor Package Module	External Compass
R	Roll (tilt 2)	Manual #ER (see "ER - Roll Angle," page 81)	Not used (Roll source specified by Pitch field)	Not used (Roll source specified by Pitch field)
S	Salinity	Manual ES (see "ES – Salinity," page 72)	Not Allowed	External Salinity Sensor
T	Temp	Manual #ET (see "ET - Temperature," page 81)	TRDI Sensor Package Module, if available or Internal transducer sensor	External Temp Sensor
U	Up/Down Orientation	Manual #EU (see "EU - Up/Down Orientation," page 82)	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.

NOTES.

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,” page 83).

When you send a PS1-command, 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,” page 78 and “EP - Pitch and Roll Angles,” page 80 for more details.

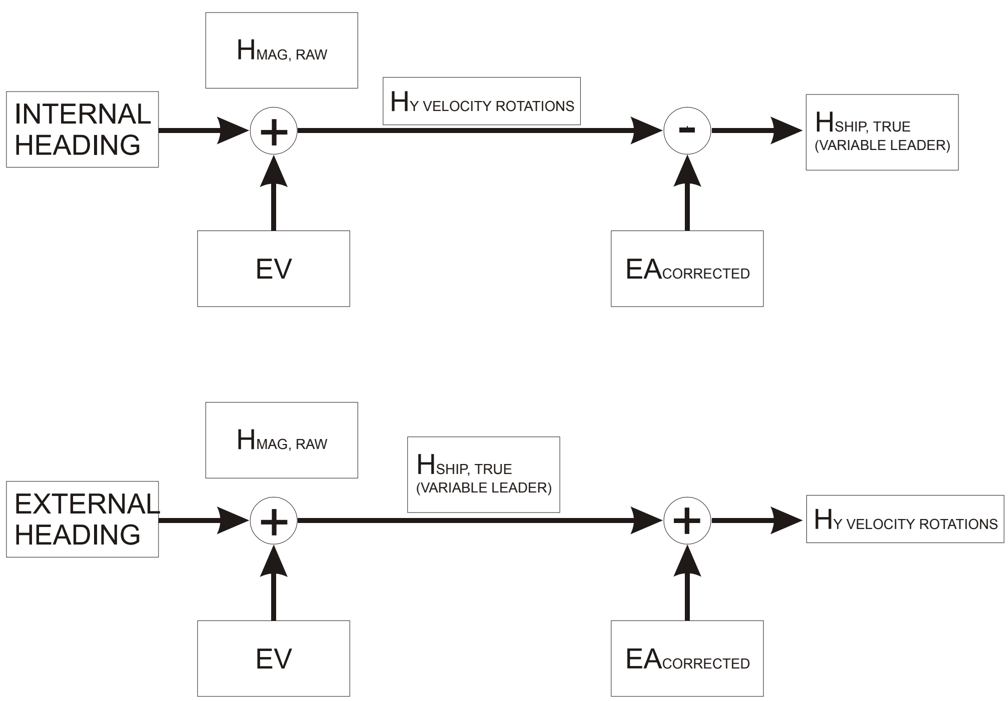

Figure 18. Heading Sensor Source and the Application of EV and EA

10.8.2 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 0000101 ---------------- Att[2]; Intrp[2]; 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 -------- Doppler Param Source {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	#EC*nnnn*
Range	*nnnn* = 1400 to 1600 meters per second
Default	#EC1500

Recommended Setting. 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.

NOTE. 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," page 72), ES ("ES – Salinity," page 72), and #ET ("ET - Temperature," page 81). EZ also selects the source for ED, ES, and #ET.

#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 *abcdefg*

Range Firmware switches (see description)

Default #EE 0000000 (Piston)
#EE 0000010 (Phased Array)

Recommended Setting. 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,” page 138 for a description of this data type.

Bit *f* controls the type of beam velocity data. Setting bit *f* set to one results in nominal 30° beam coordinate velocities output in the ensemble. Setting Bit *f* to zero results in raw beam velocities output in the ensemble.

For phased array systems, 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.

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,” page 74) and EY (“EY – Sensor Source Override for Doppler Parameters,” page 83) commands depending on whether a sensor failed. Setting bit *g* to one causes this data type to be output. See Table 49, page 144 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*xxxx, y*

Range *xxxx* = 0 to 35999 1/100ths of a degree

y = 0 for instrument coordinates
y = 1 for ship coordinates

Default #EH0,0 (Stationary systems), #EH0,1 (Vessel)

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

Description — #EH sets the ExplorerDVL heading and heading coordinate frame if both arguments are entered.

#EH sets the ExplorerDVL heading if only one argument is entered. This heading value is assumed to be in instrument coordinates. Figure 17, page 74 shows transducer beam axes and tilt signs.

#EH may be entered after the unit is commanded to ping (CS command) and will be used in subsequent pings.

Example — Convert heading values of -21.5 degrees to #EH-command values referenced to ship coordinates.

```
Heading in hundredths = 21.50° × 100 = 2150
EH 2150, 1            (+ in front of 2150 is optional)
```

> **NOTE.** If the EZ *Roll and Pitch* fields = 1, the ExplorerDVL overrides the manually-set #EP value and uses roll from the transducer's internal tilt sensor. If the EZ *Roll and Pitch* fields = two the ExplorerDVL takes roll from an external synchro. If EZ *Roll and Pitch* fields are zero the ExplorerDVL uses the manual EP command settings.
>
> See "EZ - Sensor Source," page 74 for more details and on restrictions for the case of mixed pitch and roll 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

> **Recommended Setting.** Set as needed.

Description — #EI is a rotation about the ship's forward axis. It is defined as the roll of the ship when the instrument is level.

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.

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.

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.

#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 #EJ0

Recommended Setting. Set as needed.

Description #EJ is a rotation about the ship's starboard axis. It is defined as the roll of the ship when the instrument is level.

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.

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," page 77).

#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 #EP command pitch and roll inputs 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

Recommended Setting. Set as needed.

Description	#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.
	If only two fields are entered, a command entry error is issued. Figure 17, page 74 shows transducer beam axes and tilt signs.
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	#ER0

Recommended Setting. 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," page 80). See the description of the EZ command ("EZ - Sensor Source," page 74) 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

Recommended Setting. Use the EZ-command (see “EZ - Sensor Source,” page 74).

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
```

NOTE. 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*n*
Range	*n* = 0 or 1 (0 = down, 1 = up)
Default	#EU0

Recommended Setting. Use the EZ-command (see “EZ - Sensor Source,” page 74).

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

NOTE. 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,” page 79).

#EV - Heading Bias

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

Recommended Setting. Set as needed.

Description

#EV is the heading angle that counteracts the local biasor 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.

Use the EA-command to correct for physical heading misalignment between the ExplorerDVL and a vessel's centerline (see "EA - Heading Alignment," page 71).

Examples

1. An ExplorerDVL 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, you must 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 provides 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.

#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 29, page 84 is not the desired source.

Format #1

#EY c d h p r t s 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," page 74. 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 29, page 84:

Table 29: External Sensor Source Range (1-10)

Sensor	ID	Manufacturer	Model
Gyro Compass	1	--	--
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	TCM3/5
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

Recommended Setting. Set as needed.

Example Setting the #EY command to #EY 0 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 30 shows the effect of #EY on the firmware logic for selecting sensor data for a Doppler parameter:

Table 30: Selecting Sensor Data

			Alternate Source					
Doppler Data Input	Source when EY bit not 0	Primary Sensor Source when EY bit 0	#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

NOTES.

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.

10.9 Performance and Testing Commands

The ExplorerDVL uses the following commands for calibration and testing.

10.9.1 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
Range	N/A
Default	N/A
Description	These diagnostic tests check the major modules and signal paths. We recommend you run 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,” page 89 and “PT5 – Transmit/Receive Continuity Check Test,” page 90 for more details.
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:
  (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
```

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," page 83 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)
/     24.94/10     99.063/10   10.104/10    0.00/0     0.18/10     0.59/10

>
```

NOTE. Transducer should be in water when running this test.

PS – Display System Parameters

Purpose	Displays ExplorerDVL system configuration data.
Format	PS*n*
Range	*n* = 0 to 1

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," page 116). For example, a Hex-ASCII output may look like this:

```
>PS1
3B00001C0D4C21003502320A00190019000148030OE8030000320A941100007D2D3D00230001
01FF000C000
0000000000000000000000DC1200001914
>
```

NOTE. The output format of the PS1 command is determined by the CF command (see "CF - Flow Control," page 66).

PT – Diagnostic Tests

Purpose	Displays results of the system diagnostic tests.
Format	PT*nnn*
Range	*n* = 0 to 200
Description	See below

PT0 - Help

The PT0 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
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

>
```

Note: 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

The 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 can be run with the transducer in air or 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

>
```

Note: 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 130 counts for the transducer electronics to be considered connected.
3. The amplitude level immediately after transmit must be no more than 50 counts below the transmit level for the piston system and 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.

10.9.2 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

Recommended Setting. 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 31).

Table 31: 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.

NOTE. Most of TRDI's software supports PD0 formatted data.

10.10 Sensor Commands

The ExplorerDVL uses the following commands for the sensors.

10.10.1 Available Sensor Commands

This section lists the available Sensor commands.

```
>s?
Available Commands:

SC ------------------------ Sensor Commands [ID Event "Command"]
SD ------------------------ Sensor Data Out [ID abcd..., a-d=1/0]
SM ------------------------ Aux Snsr Aux Menu [sid]
SP 0 99;0 99;0 99;0 99 ---- Sensor-port Assignment [sid0 to0 ...]
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 32: 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," page 96.

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)).

Recommended Setting. 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," page 164.

Only one command at a time can be entered in the "c" string of the SC command. Thus, if one of your sensors needs several commands to be sent at events 0 or 1 (see description in Table 32, page 92), 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," page 165. 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," page 168.

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," page 147 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 PD0 Data Output

Purpose Controls the ensemble data types that are output.

Format SD *n abc def ghi*

Range *n:* sensor id per Table 33. 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 33, which also indicates the tables that describes the format of the data:

Table 33: Sensor PD0 Data Output

Sensor	ID	a	b	c	d
Gyro Compass	01	--	--	--	--
GPS	02	PGRMT NMEA Sentence (Table 73, page 171)	GPRMC NMEA Sentence (Table 74, page 172)	GPGGA NMEA Sentence (Table 75, page 173)	GPVTG NMEA Sentence (Table 76, page 175)
Pressure	03	Variable (Table 77, page 176)	Setup (Table 78, page 177)	N/A	N/A
Speed of Sound	04	Variable (Table 79, page 179)	N/A	N/A	N/A
Mag Compass #1	05	Variable (Table 80, page 181)	Setup (Table 81, page 184)	N/A	N/A
CTD	06	Variable (Table 82, page 187)	TBD	TBD	TBD
Echo Sounder	07	Variable (Table 83, page 188)	N/A	N/A	N/A
Internal Temperature	08	N/A	N/A	N/A	N/A
Mag Compass #2	09	Variable (Table 84, page 189)	Setup (Table 85, page 191)	N/A	N/A
TRDI Sensor Board (Pitch/Roll, T, Pr)	10	N/A	N/A	N/A	N/A

NOTES.

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

Recommended Setting. Set as needed.

Description This command controls the output of data types in PD0 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 *n*

Range 1 to 10 corresponding to each of the sensors listed in "EY – Sensor Source Override for Doppler Parameters," page 83.

Default There is no default.

Description If no argument (n, above) is entered with the command, then a list of sensors with there corresponding numbers is presented for the user to choose from.

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.

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.

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. 8CDP 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 you to enter 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 *p sid* or SP *p sid t*
Range	*p*: port 2 to 4
	sid: 0 for no sensor on the port; Corresponding to the sensor ID in Table 34, page 97. This table corresponds directly to the manufacturers and models of sensors listed in "EY – Sensor Source Override for Doppler Parameters," page 83.
	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 34, page 97.

CAUTION. 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 34: 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

NOTE. 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

Recommended Setting. 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 PD0 Data Output," page 94 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 [*n*], where [] indicates an optional parameter.
Range	*n*: specifies a sensor ID corresponding to table of the EY command (see "EY – Sensor Source Override for Doppler Parameters," page 83).
Default	N/A

Recommended Setting. Use 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.

10.10.2 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 *f*
Range	*f* = 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

> **Recommended Setting.** 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 later is displayed when this command is queried.

10.11 Timing Commands

These commands let you set the timing of various profiling functions.

10.11.1 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	*hh* = 00 to 23 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TE00:00:00.00

Recommended Setting. 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," page 105). 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.

NOTES.

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 *minimum* time between pings.

Format: TP*mm:ss.ff*

Range:
mm = 00 to 59 minutes
ss = 00 to 59 seconds
ff = 00 to 99 hundredths of seconds

Default: TP00:00.05

> **Recommended Setting.** 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-command (see "WP – Pings Per Ensemble," page 105). 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," page 104, "WN – Number of Depth Cells," page 105, "WS – Depth Cell Size," page 106, and actual water depth).

Example: TP00:00.10 sets the time between pings to 0.10 second.

> **NOTE.** The ExplorerDVL automatically increases TE if (WP x TP) > TE.

TS – Set Real-Time Clock

Purpose: Sets the ExplorerDVL's internal real-time clock.

Format: TS*yy/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

> **Recommended Setting.** Set using *BBTalk*.

Example TS98/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 1998.

NOTES.

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 TT*ccyy/mm/dd, hh:mm:ss*

Range
cc = century 19 - 20
yy = year 00 - 99
mm = month 01 - 12
dd = day 01 - 31
hh = hour 00 - 23
mm = minute 00 - 59
ss = second 00 - 59

Recommended Setting. Set using *BBTalk*.

Example TT2000/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2000.

NOTES.

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.

10.12 Water Profiling Commands

These commands define the criteria used to collect the water-profile data.

10.12.1 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,” page 60) 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 — WB*n*

Range — *n* = 0 (Wide), 1 (Narrow)

Default — WB0

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

Description — The firmware interprets this command based on which type of transducer is attached. It then sets the transmit/receive bandwidths and sample rate appropriate to either a piston or phased array transducer (see Table 35 and Table 36).

Table 35: Bandwidth Control Effect on Performance

Bandwidth	Sample rate	Data variance	Profiling range
0 = Wide	High	Low	Low
1 = Narrow	Low	High	High

Table 36: Transmit & Receive Bandwidth for Each Transducer Type

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 *abc def ghi*

Range Firmware switches (see description)

Default WD 111 100 000

Recommended Setting. 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:

a = Velocity	*d* = Percent good	*g* = Reserved
b = Correlation	e = Status	*h* = Reserved
c = Echo Intensity	*f* = Reserved	*I* = Reserved

Example WD 111 100 000 (default) tells the ExplorerDVL to collect velocity, correlation magnitude, echo intensity, and percent-good.

NOTES.

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*nnnn*

Range *nnnn* = 0 to 9999 cm

Default WF0088

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

Description WF 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.

> **NOTES.**
>
> 1. The distance to the middle of depth cell #1 is a function of WF, "WS – Depth Cell Size," page 106, 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	WN*nnn*
Range	*nnn* = 001 to 255 depth cells
Default	WN030

> **Recommended Setting.** 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," page 106).

> **CAUTION.** 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. The maximum number of bins processed is approximated by the following relationship:
>
> WN < max(255, 381 – 0.29 * WS), where WS is in cm.

WP – Pings Per Ensemble

Purpose	Sets the number of pings to average in each data ensemble.
Format	WP*nnnnn*
Range	*nnnnn* = 0 to 16384 pings
Default	WP00000

> **Recommended Setting.** Set as needed.

Description WP sets the number of pings to average in each ensemble before sending/recording the data.

NOTES.

1. If WP = zero the ExplorerDVL does not collect water-profile data.
2. The ExplorerDVL automatically extends the ensemble interval (“TE – Time Per Ensemble,” page 100) if WP x TP > TE.

WS – Depth Cell Size

Purpose Selects the volume of water for one measurement cell.

Format WS*nnnn*

Range 10 to 800 cm

Default WS0200

Recommended Setting. 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.

NOTE. If you set WS to a value less than its minimum value or greater than its maximum value, the ExplorerDVL will accept the entry, but uses the appropriate minimum or maximum value. For example, if you enter WS0001, the ExplorerDVL uses a value of 10 cm for WS. Similarly, if you enter WS8000, the ExplorerDVL uses a value of 800 cm for WS.

WV – Ambiguity Velocity

Purpose Sets the radial ambiguity velocity for profile and water mass mode (see “BK - Water-Mass Layer Mode,” page 60).

Format WV*nnn*

Range *nnn* = 020 to 700 cm/s

Default WV175

Recommended Setting. It is strongly recommended that the WV command be left at its’ default value of 175.

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. If you narrow the bandwidth of the system, the profiling range is increased. An increase in range of approximately 10% is obtained each time the bandwidth is reduced by one-half.

You are required to 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 = (Max. Apparent Vel. cm/s) * sin(beam angle) * 1.2

NOTE. 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.

10.12.2 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

Recommended Setting. 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.

NOTE. 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," page 60).

Format #WC*nnn*

Range *nnn* = 0 to 255 counts

Default #WC64

Recommended Setting. 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," page 106). 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.

NOTE. 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 WE*nnnn*

Range *nnnn* = 0 to 5000 mm/s

Default #WE2000

CAUTION. 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," page 60).

Format #WJn

Range n = 0 (low), 1 (high)

Default #WJ1

Recommended Setting. 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," page 106).

Format #WT*nnnn*

Range *nnnn* = 0 to 3200 cm

Default #WT0000

Recommended Setting. 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 then the area depth cell size (sampling length).

11 Introduction to Output Data Format

This section shows the output data format of the ExplorerDVL. ExplorerDVL output data can be in either hexadecimal-ASCII or binary format. You can select this option through the CF-command (see the "CF - Flow Control," page 66). We explain the output data formats in enough detail to let you create your own data processing or analysis programs (see "How to Decode a ExplorerDVL Ensemble," page 193).

11.1 Hexadecimal-ASCII Output Data

Use the hexadecimal-ASCII (Hex ASCII) format (CFxx0xx) when you are 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.

NOTE. Hex ASCII PD0 data is not supported by TRDI's software.

11.2 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.

NOTE. PD0 formatted data is supported by most of TRDI's software.

12 PD0 Output Data Format

The following description is for the standard PD0 ExplorerDVL output data format. Figure 20, page 114 through Figure 28, page 146 shows the ASCII and binary data formats for the ExplorerDVL PD0 mode. Table 37, page 115 through Table 51, page 146 defines each field in the output data structure.

After completing a data collection cycle, the ExplorerDVL immediately sends a data ensemble. The following pages show the types and sequence of data that you may include in the ExplorerDVL output data ensemble and the number of bytes required for each data type. The ExplorerDVL sends all the data for a given type for all depth cells and all beams before the next data type begins.

The ExplorerDVL by default is set to collect bottom track data. The data, preceded by ID code 7F7F, contains header data (explained in Table 37, page 115). The fixed and variable leader data is preceded by ID codes 0000 and 8000, (explained in Table 38, page 118 and Table 39, page 124). The ExplorerDVL always collects Header and Leader. Bottom Track data is preceded by ID codes 0600 (explained in Table 44, page 136).

The byte order of multi-byte data elements in the ensemble is “little endian” meaning the least significant byte is output before the most significant byte. If water profiling is enabled, the remaining lines include velocity (ID Code: 0001), correlation magnitude (0002), echo intensity (0003), and percent good (0004). The final field is a data-validity checksum.

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (58 BYTES)
	VARIABLE LEADER DATA (60 BYTES)
WATER PROFILING DATA WD-command WP-command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
BP-command	**BOTTOM TRACK DATA** (81 BYTES)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 19. PD0 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 111 100 000 (default), WP command > 0, BP command > 0, the required data buffer storage space is 831 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)
 81   BYTES OF BOTTOM TRACK DATA (FIXED)
  2   BYTES OF RESERVED FOR TRDI USE (FIXED)
  2   BYTES OF CHECKSUM DATA (FIXED)
831   BYTES OF DATA PER ENSEMBLE
```

NOTE. Teledyne RD Instrument's software *WinRiver* and *VmDas* may add additional bytes.

For example, *WinRiver* does not add any bytes to the Bottom Track data, but does insert data in place of other bytes. The Navigation NMEA strings (up to 275 bytes) are stored in the *r.000 raw data between the Bottom Track data and the Reserved/Checksum data. *WinRiver* output data format is described in the WinRiver User's Guide.

VmDas adds 78 bytes of Navigation data between the Bottom Track data and the Reserved/Checksum data. The ENR file (raw data from the ExplorerDVL) does not have these bytes, only the ENS, ENX, STA and LTA files. *VmDas* output data format is described in the VmDas User's Guide.

12.1 Header Data Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	HEADER ID (7Fh)								
2	DATA SOURCE ID (7Fh)								
3	NUMBER OF BYTES IN ENSEMBLE								LSB
4									MSB
5	SPARE								
6	NUMBER OF DATA TYPES								
7	OFFSET FOR DATA TYPE #1								LSB
8									MSB
9	OFFSET FOR DATA TYPE #2								LSB
10									MSB
11	OFFSET FOR DATA TYPE #3								LSB
12									MSB
↓	(SEQUENCE CONTINUES FOR UP TO N DATA TYPES)								↓
2N+5	OFFSET FOR DATA TYPE #N								LSB
2N+6									MSB

See Table 37, page 115 for a description of the fields.

Figure 20. Binary Header Data Format

NOTE. This data is always output in this 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 37: 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 28, page 146).
9,10	5	Spare	Undefined.
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).

12.2 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									
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

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29	HEADING BIAS	LSB
30		MSB
31	SENSOR SOURCE	
32	SENSORS AVAILABLE	
33	BIN 1 DISTANCE	
34		
35	XMIT PULSE LENGTH	LSB
36		MSB
37	(starting cell) WP REF LAYER AVERAGE (ending cell)	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 38, page 118 for a description of the fields

Figure 21. Fixed Leader Data Format

Fixed Leader data refers to the non-dynamic ExplorerDVL data that only changes when you change certain commands. Fixed Leader data also contain hardware information. The ExplorerDVL always sends Fixed Leader data as output data (LSBs first).

Table 38: 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	This field defines the ExplorerDVL hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows. 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 CFIG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD) Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).
13,14	7	PD / Real/Sim Flag	This field is set by default as real data (0).

Continued next page

Table 38: Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
15,16	8	Lag Length	Lag Length. The lag is the time period between sound pulses. This is varied, and therefore of interest in, at a minimum, for the WM5, WM8 and WM11 and BM7 commands.
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 43, page 132 (Percent-Good Data Format) has more information.
19,20	10	WN / Number of Cells	Contains the number of depth cells over which the ExplorerDVL collects data ("WN – Number of Depth Cells," page 105). Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble ("WP – Pings Per Ensemble," page 105). 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 = 0 to 16,384 pings
25-28	13,14	WS / Depth Cell Length	Contains the length of one depth cell ("WS – Depth Cell Size," page 106). Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 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," page 104). 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," page 108). 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," page 109). 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," page 101.

Table 38: Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description

51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (“EX – Coordinate Transformation,” page 73). These firmware switches indicate how the ExplorerDVL collected data.
			`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`

53-56	27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (“EA - Heading Alignment,” page 71). 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,” page 82). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees

61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (“EZ - Sensor Source,” page 74). These firmware switches indicate the following.
			`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`
			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 you can enter a “2” in the EZ-command string, the ExplorerDVL only displays a 0 (manual) or 1 (int/ext sensor).

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	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. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)

Table 38: Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
69-72	35,36	WT Xmit pulse length	This field, set by the WT-command (“WT - Transmit Length,” page 110), 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,” page 106). This means the ExplorerDVL uses a WT command of zero. However, the WT field contains the actual length of the transmit pulse used. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
73,74 75,76	37,38	WL / WP Ref Lyr Avg (Starting cell, Ending cell)	Contains the starting depth cell (LSB, byte 37) and the ending depth cell (MSB, byte 38) used for water reference layer averaging (WL-command). Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells
77,78	39	#WA / False Target Threshold	Contains the threshold value used to reject data received from a false target, usually fish (“WA - False Target Threshold Maximum,” page 108). Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
79,80	40	Spare	Contains the CX-command setting. Range = 0 to 5
81-84	41,42	LagD / Transmit lag distance	This field, determined mainly by the setting of the WM-command, contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters
85-100	43-50	Spare	Spare
101-105	51-52	WB / System Bandwidth	Contains the WB-command setting (“WB - Mode 1 Bandwidth Control,” page 103). Range = 0 to 1
106-107	53	Spare	Spare
108-109	54	Spare	Spare
110-119	55-58	System Serial Number	System Serial Number

12.3 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								

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Byte	Field	
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		MSB
47	SPARE	
48		
49	PRESSURE	LSB
50		
51		
52		MSB
53	PRESSURE SENSOR VARIANCE	LSB
54		
55		
56		MSB
57	SPARE	
58		
59		
60		

See Table 39, page 124 for a description of the fields.

Figure 22. Variable Leader Data Format

NOTE. This data is always output in this 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 39: 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	This field contains the sequential number of the ensemble to which the data in the output buffer apply.
			
			Scaling: LSD = 1 ensemble; Range = 1 to 65,535 ensembles
			
			NOTE: The first ensemble collected is #1. At "rollover," we have the following sequence:
			`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.`

9,10 11,12 13,14 15,16 17,18 19,22 21,22	5 6 7 8 9 10 11	RTC Year RTC Month RTC Day RTC Hour RTC Minute RTC Second RTC Hundredths	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," page 101) initially sets the clock. The ExplorerDVL does account for leap years.
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	This field contains the results of the ExplorerDVL's Built-in Test function. A zero code indicates a successful BIT result.
			`BYTE 13   BYTE 14   (BYTE 14 RESERVED FOR FUTURE USE)`
			`1xxxxxxx xxxxxxxx = RESERVED`
			`x1xxxxxx xxxxxxxx = RESERVED`
			`xx1xxxxx xxxxxxxx = RESERVED`
			`xxx1xxxx xxxxxxxx = DEMOD 1 ERROR`
			`xxxx1xxx xxxxxxxx = DEMOD 0 ERROR`
			`xxxxx1xx xxxxxxxx = RESERVED`
			`xxxxxx1x xxxxxxxx = TIMING CARD ERROR`
			`xxxxxxx1 xxxxxxxx = RESERVED`

29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information ("EC - Speed of Sound," page 77). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s

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Table 39: Variable Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface ("ED - Depth of Transducer," page 72). 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," page 78)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," page 80) 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," page 81)or a reading from a tilt sensor. For up-facing ExplorerDVLs, positive values mean that Beam #2 is above the earth's horizontal while than Beam #1is below the earth's horizontal. For down-facing ExplorerDVLs, positive values mean that Beam #1 is above the earth's horizontal and than 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," page 72). This value may be a manual setting ("ES – Salinity," page 72) 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," page 81) or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees
57,58 59,60 61,62	29 30 31	MPT minutes MPT seconds MPT hundredths	This field contains the Minimum Pre-Ping Wait Time between ping groups in the ensemble.
63,64 65,66 67,68	32 33 34	H/Hdg Std Dev P/Pitch Std Dev R/Roll 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°

Table 39: Variable Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
69-70	35	ADC Channel 0	These fields contain the outputs of the Analog-to-Digital Converter (ADC)..
71-72	36	ADC Channel 1	Here is the description for each channel:
73-74	37	ADC Channel 2	CHANNEL DESCRIPTION 0 Not Used
75-76	38	ADC Channel 3	1 XMIT VOLTAGE 2 Not Used
77-78	39	ADC Channel 4	3 Not Used
79-80	40	ADC Channel 5	4 Not Used 5 Not Used
81-82	41	ADC Channel 6	6 Not Used
83-84	42	ADC Channel 7	7 Not Used Note that the ADC values may be "noisy" from sample-to-sample, but are useful for detecting long-term trends.
85-86	43	Error Status Word	Reserved for TRDI use.
87-88	44		Reserved for TRDI use.
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

12.4 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 40, page 128 for description of fields

Figure 23. Velocity Data Format

NOTE. The number of depth cells is set by the WN-command ("WN – Number of Depth Cells," page 105).

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
xxx00xxx	BEAM	TO BEAM 1	TO BEAM 2	TO BEAM 3	TO BEAM 4
xxx01xxx	INST	Bm1-Bm2	Bm4-Bm3	TO XDUCER	ERR VEL
xxx10xxx	SHIP	PRT-STBD	AFT-FWD	TO SURFACE	ERR VEL
xxx11xxx	EARTH	TO EAST	TO NORTH	TO SURFACE	ERR VEL

POSITIVE VALUES INDICATE WATER MOVEMENT

Table 40: 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," page 105). These fields follow the same format as listed above for depth cell 1.

12.5 Correlation Magnitude, Echo Intensity, and Percent-Good Data Format

BIT POSITIONS

BYTE	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 41, page 130 through Table 43, page 132 for a description of the fields.

Figure 24. Binary Correlation Magnitude, Echo Intensity, and Percent-Good Data Format

NOTE. The number of depth cells is set by the WN-command (“WN – Number of Depth Cells,” page 105).

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 41: 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," page 105) 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 42: 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," page 105) 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 ("EX – Coordinate Transformation," page 73) determines how the ExplorerDVL references percent-good data as shown below.

EX-Command	Coord. Sys	Velocity 1	Velocity 2	Velocity 3	Velocity 4
			Percentage Of Good Pings For:		
		Beam 1	BEAM 2	BEAM 3	BEAM 4
xxx00xxx	Beam		Percentage Of:		
xxx01xxx	Inst	3-Beam Transformations (note 1)	Transformations Rejected (note 2)	More Than One Beam Bad In Bin	4-Beam Transformations
xxx10xxx	Ship				
xxx11xxx	Earth				

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the ExplorerDVL 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 ExplorerDVL to reject some of its depth cell data. This causes the ExplorerDVL to calculate velocities with three beams instead of four beams. When the ExplorerDVL does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further depth cell, the ExplorerDVL 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 - Low Correlation Threshold," page 108). Here, beam 1=50%, beam 2=5%, beam 3=0%, and beam 4=45%. These are not typical nor desired percentages. Typically, you would want all four beams to 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.

FIELD 2 – Percentage of transformations rejected – Shows percent of error velocity (5%) that was higher than the WE-command setting (see "WE - Error Velocity Threshold," page 109). WE has a default of 5000 mm/s. This large WE setting effectively prevents the ExplorerDVL 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 43: 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," page 105), following the same format as listed above for depth cell 1.

12.6 Binary Bottom-Track Data Format

BIT POSITIONS

BYTE	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	BT DELAY BEFORE RE-ACQUIRE	LSB
6		MSB
7	BT CORR MAG MIN	
8	BT EVAL AMP MIN	
9	BT PERCENT GOOD MIN	
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

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33	BEAM#1 BT CORR.	
34	BEAM#2 BT CORR.	
35	BEAM#3 BT CORR.	
36	BEAM#4 BT CORR.	
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	

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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
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 25. Binary Bottom-Track Data Format

NOTE. This data is output only if the BP-command is > 0 and PD0 is selected. See Table 44, page 136 for a description of the fields.

NOTE. The PD0 output data format assumes that the **instrument** is stationary and the **bottom** is moving. ExplorerDVL (Speed Log) output data formats (see "Special Output Data Formats," page 147) assume that the bottom is stationary and that the ExplorerDVL or vessel is moving.

This data is output only if the BP-command is greater than zero and PD0 is selected. The LSB is always sent first.

Table 44: 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,” page 55). If BP = 0, the ExplorerDVL does not collect bottom-track data. The ExplorerDVL automatically extends the ensemble interval (“TE – Time Per Ensemble,” page 100) if BP x TP > TE. Scaling: LSD = 1 ping; Range = 0 to 999 pings
9-12	5,6	BD/BT delay before reacquire	Stores the number of ExplorerDVL ensembles to wait after losing the bottom before trying to reacquire it (BD-command). Scaling: LSD = 1 ensemble; Range = 0 to 999 ensembles
13,14	7	BC/BT Corr Mag Min	Stores the minimum correlation magnitude value (“BC - Correlation Magnitude Minimum,” page 58). 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,” page 57). Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	BG/BT %Gd Minimum	Stores the minimum percentage of bottom-track pings in an ensemble that must be good to output velocity data (BG-command).
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,” page 58). 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,” page 73). The four velocities 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.

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Table 44: Bottom-Track Data Format (continued)

Hex Digit	Binary Byte	Field	Description
73-80	37-40	BTEA/Beam #1-4	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo.
		BT Eval Amp	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 ," page 61).
			Scaling (minimum layer size): LSD = 1 dm; Range = 0-999 dm
			Scaling (near/far boundaries): LSD = 1 dm; Range = 0-9999 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 40, page 128). The BL-command explains the water mass.
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," page 56).
			Scaling: LSD = 1 decimeter; Range = 80 to 9999 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 ≈ 0.45 dB per count; Range = 0 to 255 counts
153, 154	77	GAIN	Contains the Gain level for shallow water. See "WJ - Receiver Gain Select," page 109.
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

12.7 Environmental Command Parameters Output Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	FIXED ATTITUDE ID	LSB 00h
2		MSB 30h
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		
14	FIXED HEADING COORDINATE FRAME (#EH)	
15	ROLL MISALIGNMENT (#EI)	
16		
17	PITCH MISALIGNMENT (#EJ)	
18		
19	USER INPUT FOR PITCH, ROLL, and COORDINATE FRAME (#EP)	
20		
21		
22		
23		
24	USER INPUT FOR UP/DOWN ORIENTATION (#EU)	
25	USER INPUT FOR HEADING BIAS/VARIATION/SYNCHRO OFFSET (#EV)	
26		
27	SENSOR SOURCE (EZ)	
↓		↓
34		

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35	TRANSDUCER DEPTH (ED)
36	
37	
38	
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 26. 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,” page 53 for detailed descriptions of commands used to set these values.

Table 45: 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,” page 77).
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,” page 78).
28	14	Fixed Heading Coordinate Frame	Stores the setting of the #EH command coordinate frame: 1 is ship, 0 is instrument (“EH - Heading,” page 78).
29-32	15,16	Roll Misalignment	Stores the setting of the #EI command; a user input for the roll misalignment (“EI - Roll Misalignment Angle,” page 79).
33-36	17,18	Pitch Misalignment	Stores the setting of the #EJ command; a user input for the pitch misalignment (“EJ - Pitch Misalignment Angle,” page 80).
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,” page 80).
47,48	24	Orientation	Stores the setting of the #EU command; a user input for the up/down orientation (“EU - Up/Down Orientation,” page 82).
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,” page 82).
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,” page 74).
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,” page 72).
77-78	39	Salinity	Stores the setting of the ES command; a user input defining the salinity of the water (see “ES – Salinity,” page 72).
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,” page 81).
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,” page 77).
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,” page 73).
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.

12.8 Bottom Track Command Output Format

This format is selected via the #BJ command (see "BJ – Data Type Output Control," page 60).

Table 46: Bottom Track Command Output Data Format

Length in Bytes	Field	Description
	ID	PD0 ID (MSB=58h LSB=00h)
	Time Tag	UTC Time at start of transmit.
1	BA	Evaluation Amplitude, 1 to 255 counts ("BA - Evaluation Amplitude Minimum," page 57)
1	BC	Correlation Magnitude, 0 to 255 counts ("BC - Correlation Magnitude Minimum," page 58)
2	Reserved	Delay before reacquire, 0 to 999 ensembles
2	BE	Error Velocity Maximum, 0 to 9999 mm/s ("BE - Error Velocity Maximum," page 58)
2	BF	Depth Guess, 1 to 65535 dm (0 for automatic search) ("BF - Depth Guess," page 59)
1	Reserved	Minimum Percent Good, 0 to 100%
1	Reserved	Gain Threshold Low
1	Reserved	Gain Threshold High
2	BI	Gain Switch Depth ("BI - Gain Switch Altitude," page 59)
1	BK	Water Mass Layer Mode, 0 to 3 ("BK - Water-Mass Layer Mode," page 60)
2	BL1	Water Mass Layer Min Size, 0 to 999 dm ("BL - Water-Mass Layer Parameters ," page 61)
2	BL2	Water Mass Layer Near Boundary, 0 to 9999 dm
2	BL3	Water Mass Layer Far Boundary, 0 to 9999 dm
1	Reserved	Bottom Track Mode, 1 or 8
1	Reserved	Speed log param #1: Hold Distance or zero if timeout
2	Reserved	Speed log time-out
1	Reserved	Speed log filter time constant
2	BP	Pings Per Ensemble, 0 to 999 ("BP – Bottom-Track Pings per Ensemble," page 55)
1	Reserved	BT (Vertical Depth) Resolution, 0 to 2 (not used in ExplorerDVL)
2	Reserved	Terrain Bias Correction
2	Reserved	BM7 Bottom Blank
1	Reserved	BM7 Correlation Threshold for Ambiguity Resolution
1	Reserved	BM7 Short lag output control
2	BX	BT Maximum Tracking Depth, 80 to 9999 dm ("BX – Maximum Tracking Depth," page 56)
2	Reserved	Water Reference Interval
1	Reserved	Max Transmit (or Feeler) Percent
2	Reserved	BT Ambiguity Velocity

12.9 Bottom Track High Resolution Velocity Format

This format is selected via the #BJ command (see "BJ – Data Type Output Control," page 60).

Table 47: Bottom Track High Resolution Velocity Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=58h LSB=03h)
4	BT Velocity 1	Bottom Track Axis 1 Velocity in 0.01mm/s. Reference frame dependent on "EX – Coordinate Transformation," page 73.
4	BT Velocity 2	Bottom Track Axis 2 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	BT Velocity 3	Bottom Track Axis 3 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	BT Velocity 4	Bottom Track Axis 4 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	BT DMG 1	Bottom Track Axis 1 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	BT DMG 2	Bottom Track Axis 2 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	BT DMG 3	Bottom Track Axis 3 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	BT DMG 4	Bottom Track Axis 4 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	WM Velocity 1	Water Mass Axis 1 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	WM Velocity 2	Water Mass Axis 2 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	WM Velocity 3	Water Mass Axis 3 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	WM Velocity 4	Water Mass Axis 4 Velocity in 0.01mm/s. Reference frame dependent on EX command.
4	WM DMG 1	Water Mass Axis 1 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	WM DMG 2	Water Mass Axis 2 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	WM DMG 3	Water Mass Axis 3 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	WM DMG 4	Water Mass Axis 4 Distance in 0.01mm made good. Reference frame dependent on EX command.
4	SoS	Speed of Sound * 10^6.

12.10 Bottom Track Range Format

This format is selected via the #BJ command (see "BJ – Data Type Output Control," page 60).

Table 48: Bottom Track Range Output Data Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=58h LSB=04h)
4	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.
4	Axes 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.
4	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.
1	% Good 4 Bm	Percent Good 2 axis (4 Bm) slant range solutions.
1	% Good Bm 1&2	Percent Good axis Bm 1 & 2 slant range solutions.
1	% Good Bm 3 & 4	Percent Good axis Bm 3 & 4 slant range solutions.
4	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
4	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
4	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
4	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
1	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.
1	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.
1	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.
1	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.

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Table 48: Bottom Track Range Output Data Format (continued)

Length in Bytes	Field	Description
1	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.
1	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.
1	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.
1	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.

12.11 Sensor Source for Doppler Processing Format

This format is selected via the #EE command (see "EE - Environmental Data Output," page 77).

Table 49: Sensor Source for Doppler Processing Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=30h LSB=01h)
4	Heading	Heading in 1/100ths of a degree.
1	Heading Status	A value of 0 indicates no valid data; 1 indicates sensor data valid from sensor specified by "EZ - Sensor Source," page 74; A value of 2 indicates sensor data valid from alternate sensor or user input.
2	Heading Source	See notes, below.
4	Pitch	Pitch in 1/100ths of a degree.
1	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.
2	Pitch Source	See notes, below.
4	Roll	Roll in 1/100ths of a degree.
1	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.
2	Roll Source	See notes, below.
4	SOS	Speed of Sound 1/100ths of a m/s.
1	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.
2	SOS Source	See notes, below.
4	Temperature	Temperature in 1/100ths of a °C.

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Table 49: Sensor Source for Doppler Processing Output Format (continued)

Length in Bytes	Field	Description
1	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.
2	Temperature Source	See notes, below.
4	Salinity	Salinity in parts-per-ten thousand
1	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.
2	Salinity Source	See notes, below.
4	Depth	Depth in centimeters
1	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.
2	Depth Source	See notes, below.
4	Pressure	Pressure in kPa.
1	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.
2	Pressure Source	See notes, below.
4	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.

NOTES.

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," page 77).

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," page 83). 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.

12.12 Binary Reserved BIT Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	RESERVED FOR TRDI USE								LSB
2									MSB

Figure 27. Binary Reserved BIT Data Format

NOTE. The data is always output in this format. See Table 50 for a description of the fields.

Table 50: Reserved for TRDI Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Reserved for TRDI's use	This field is for TRDI (internal use only).

12.13 Binary Checksum Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	CHECKSUM DATA								LSB
2									MSB

Figure 28. Binary Checksum Data Format

NOTE. The data is always output in this format. See Table 51 for a description of the fields.

Table 51: 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.

13 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 29, page 149 through Figure 30, page 154 shows the format of these buffers and the sequence in which the ExplorerDVL sends the data. Table 52, page 150 through Table 54, page 156 lists the format, bytes, fields, scaling factors, and a detailed description of every item in the ExplorerDVL binary output buffers.

NOTE. The ExplorerDVL output data formats are available with or without bottom-track. However, if bottom-track is not available, they will contain no data.

NOTE. 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," page 133) assumes that the instrument is stationary and the bottom is moving.

13.1 ExplorerDVL Binary Data Format (PD4/PD5)

BIT POSITION

Byte	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
24									MSB
25	Y-VEL REF LAYER								
26									
27	Z-VEL REF LAYER								
28									

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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 29. ExplorerDVL Binary Data Format (PD4/PD5)

NOTES.

*IF 0, THEN PD4 (BYTES 1-47)

*IF 1, THEN PD5 (BYTES 1-45 + TABLE 9)

13.2 ExplorerDVL Output Data Format (PD4/PD5) Details

The ExplorerDVL sends this data format only when the PD4 or PD5 command is used.

Table 52: 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 ("PD0 Output Data Format," page 112). 0 = PD4 = Bytes 1 through 47 from Figure 29, page 149. 1 = PD5 = Bytes 1 through 45 from Figure 29, page 149 and bytes 46 through 88 from Figure 30, page 154.
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 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`
			`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	

Continued next page

Table 52: ExplorerDVL Output Data Format (PD4/PD5) Details (continued)

Hex Digit	Binary Byte	Field	Description

43,44	22	Bottom Status	This field shows the status of bottom-referenced correlation and echo amplitude data. Convert to binary 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`

45-48	23,24	X-Vel Ref Layer	These fields contain the velocity of the vessel in relation to the water-mass reference layer 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.)
49-52	25,26	Y-Vel Ref Layer	
53-56	27,28	Z-Vel Ref Layer	
57-60	29,30	E-Vel Ref Layer	
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	This field shows the status of water mass depth and correlation data. Convert to binary and interpret as follows. A zero code indicates status is OK.
			`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`

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	These fields contain the results of the ExplorerDVL's Built-in Test function. A zero code indicates a successful BIT result.
			`BYTE 40  BYTE 41 (BYTE 41 RESERVED FOR FUTURE USE)`
			`1xxxxxxx xxxxxxxx = RESERVED`
			`x1xxxxxx xxxxxxxx = RESERVED`
			`xx1xxxxx xxxxxxxx = RESERVED`
			`xxx1xxxx xxxxxxxx = DEMOD 1 ERROR`
			`xxxx1xxx xxxxxxxx = DEMOD 0 ERROR`
			`xxxxx1xx xxxxxxxx = RESERVED`
			`xxxxxx1x xxxxxxxx = DSP ERROR`
			`xxxxxxx1 xxxxxxxx = RESERVED`

83-86	42,43	Speed of Sound	Contains either manual or calculated speed of sound information ("EC - Speed of Sound," page 77). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s

Table 52: ExplorerDVL Output Data Format (PD4/PD5) Details (continued)

Hex Digit	Binary Byte	Field	Description
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 53, page 155.

NOTES.

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.

13.3 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

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75	DISTANCE MADE GOOD/REF (NORTH)	LSB
76		
77		
78		MSB
79	DISTANCE MADE GOOD/REF (UP)	LSB
80		
81		
82		MSB
83	DISTANCE MADE GOOD/REF (ERROR)	LSB
84		
85		
86		MSB
87	CHECKSUM	LSB
88		MSB

Figure 30. ExplorerDVL Binary Data Format (PD5)

13.4 ExplorerDVL Output Data Format (PD5) Details

The ExplorerDVL sends this data format (Figure 29, page 149 and Figure 30, page 154) only when the PD5 command is used. Table 52, page 150 explains the first part of this data structure.

Table 53: 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," page 72). 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," page 72). 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," page 80). 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," page 81). This value may be a manual setting or a reading from a tilt sensor. For up-facing ExplorerDVLs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing ExplorerDVLs, 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," page 78). 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
109-116 117-124 125-132 133-140	55-58 59-62 63-66 67-70	DMG/Btm East DMG/Btm North DMG/Btm Up DMG/Btm Error	These fields contain the Distance Made Good (DMG) over the bottom since the time of the first ping after initialization or <BREAK>. Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 dm
141-148 149-156 157-164 165-172	71-74 75-78 79-82 83-86	DMG/Ref East DMG/Ref North DMG/Ref Up DMG/Ref Error	These fields contain the distance made good over the water-mass layer since the time of the first ping after initialization or <BREAK>. Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 dm
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.

13.5 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 54: ExplorerDVL Output Data Format (PD6)

Line	Description
1	**SYSTEM ATTITUDE DATA** **:SA,±PP.PP,±RR.RR,HH.HH <CR><LF>** where: PP.PP = Pitch in degrees RR.RR = Roll in degrees HHH.HH = Heading in degrees
2	**TIMING AND SCALING DATA** **:TS,YYMMDDHHmmsshh,SS.S,+TT.T,DDDD.D,CCCC.C,BBB <CR><LF>** where: 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
3	**WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA** **:WI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF>** where: ±XXXXX = X-axis vel. data in mm/s (+ = Bm1 Bm2 xdcr movement relative to water mass) ±YYYYY = Y-axis vel. data in mm/s (+ = Bm4 Bm3 xdcr movement relative to water mass) ±ZZZZZ = Z-axis vel. data in mm/s (+ = transducer movement away from water mass) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
4	**BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA** **:BI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF>** where: ±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom) ±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom) ±ZZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
5	**WATER-MASS, SHIP-REFERENCED VELOCITY DATA** **:WS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF>** where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement rel. to water mass) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement rel. to water mass) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from water mass) S = Status of velocity data (A = good, V = bad)

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Table 54: ExplorerDVL Output Data Format (PD6) (continued)

Line	Description
6	**BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA** **:BS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF>** where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement relative to bottom) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement relative to bottom) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from bottom) S = Status of velocity data (A = good, V = bad)
7	**WATER-MASS, EARTH-REFERENCED VELOCITY DATA** **:WE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF>** where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = ADCP movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = ADCP movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = ADCP movement to surface) S = Status of velocity data (A = good, V = bad)
8	**BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA** **:BE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF>** where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = ADCP movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = ADCP movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = ADCP movement to surface) S = Status of velocity data (A = good, V = bad)
9	**WATER-MASS, EARTH-REFERENCED DISTANCE DATA** **:WD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF>** where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to water-mass center in meters TTT.TT = Time since last good-velocity estimate in seconds
10	**BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA** **:BD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF>** where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to bottom in meters TTT.TT = Time since last good-velocity estimate in seconds

The PD6 output does not pad spaces with zeroes. The spaces are left intact. The example below shows a realistic output from an 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
```

14 External Sensor Suite Interface Description

14.1 Overview

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 PD0 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," page 83). It should be noted that the ExplorerDVL does not directly power these sensors: this must be supplied from the vehicle.

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," page 95).

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," page 70). 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," page 96), regardless of whether the data is commanded to be output in the PD0 output (see "SD - Sensor PD0 Data Output," page 94).

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:

a. 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.

b. 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 PD0 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 PD0 ensemble.

Both variable and sampled data have their own data types in the PD0 output and these are detailed in "Garmin G-15 GPS PGRMT NMEA Sentence," page 171 and "Garmin G-15 GPS GPRMC NMEA Sentence," page 172.

If the user does not enter commands (see "SC - Sensor Command," page 92), 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," page 95) 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 PD0 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.

14.2 Detailed Discussion of Individual Sensors

This section highlights special considerations that need to be made for some sensors.

14.2.1 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.

14.2.2 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*, *BBTalk*) 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," page 95).

The sensor trades off resolution of a measurement with sample acquisition time. Be careful to increase the time-out (see "SP - Sensor Port Assignment," page 96 or "SC - Sensor Command," page 92) 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 PD0.

14.2.3 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 with128 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.

14.2.4 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," page 92).

14.2.5 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.

14.2.6 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 31).

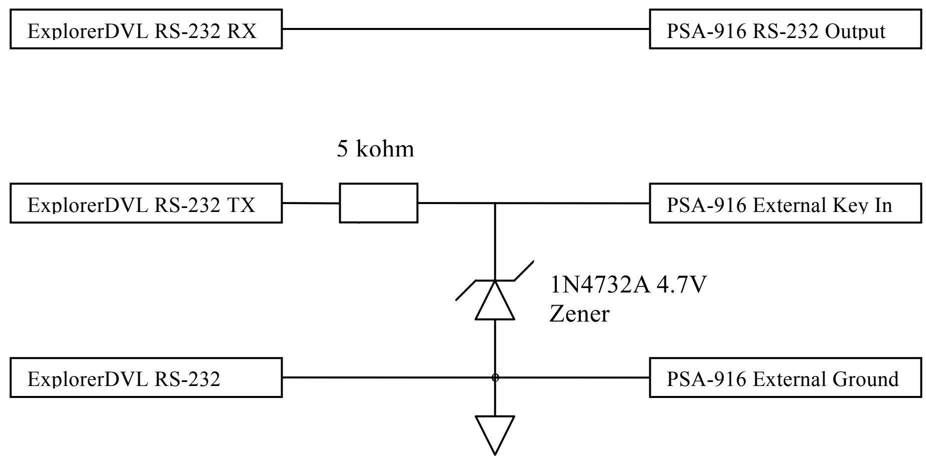

Figure 31. PSA-916 Echo Sounder Trigger

14.2.7 TCM3/5 Compass

The TCM3/5 is unique in that it has a binary interface. The SC command allows the user to enter commands in ASCII that are then stored by the ExplorerDVL and sent to the sensor during initialization and sampling (see "SC - Sensor Command," page 92). A conversion from ASCII to binary format is handled in the ExplorerDVL sensor interface code, but not all commands are supported to minimize the complexity of the interface. TRDI has chosen to support commands that will support the majority of applications.

When using the SC command, the user should enter in quotes the frame id followed by any identifiers, if needed for that frame, followed by any data corresponding to each identifier, if needed for that id. It should be noted that the TCM3/5 requires only one configuration parameter be downloaded per set config frame (6). This is in contrast to specifying output of multiple data components in the set data components frame (3).

14.3 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 55: 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 56: 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 57: 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 58: Honeywell HMR3000 Compass Default Commands

Command	Event	Description
$PTNT,HPR	VS	HPR sentence request

Table 59: SeaBird SBE-49 CTD Default Commands

Command	Event	Description
PUMPON	VS	Turns pump on
TS	VS	Take Sample
PUMPOFF	VS	Turns pump off

Table 60: TCM3/5 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 [kUserCalStableCheck]=True	IN	Stable field and acceleration are required prior to taking sample
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.

14.4 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,” page 92) 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 61: 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 62: 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

Command	Event	Description
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 63: 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 64: 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 65: 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 66: TCM3/5 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

14.5 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 67: Garmin G-15H GPS Specific Commands Not Allowed

Command	Event	Description	Method
PGRMC	All	Sensor Configuration Information Sentence	Intercepted

Table 68: 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 initiali-zation
ID	IN	Sensor ID	Overridden to 01 at initiali-zation

Table 69: 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 Overrid-den 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 initiali-zation
SET STARTUP DELAY	All	Difference of time between logger and sen-sor boards are powered up.	Overridden to 0 at initiali-zation
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 70: 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 71: 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 72: TCM3/5 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 Acquistion Time	Overridden to zero at initialization
IntervalRespTime	All	Broadcast interval mode.	Overridden to zero at initialization

14.6 Garmin G-15 GPS PGRMT NMEA Sentence

Table 73: Garmin G-15 GPS PGRMT NMEA Sentence Output Format

Length in Bytes	Field	Description
2	ID	PD0 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 Check-sum	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.

14.7 Garmin G-15 GPS GPRMC NMEA Sentence

Table 74: Garmin G-15 GPS GPRMC NMEA Sentence Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=10h)
4	Time Tag	Sample Time in 100ths of second since last power up or "TS – Set Real-Time Clock," page 101.
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 Frac Minutes	Latitude fractional minutes x10^9.

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Table 74: Garmin G-15 GPS GPRMC NMEA Sentence Output Format (continued)

Length in Bytes	Field	Description
1	Longitude Degrees	Longitude degrees.
4	Longitude Frac Minutes	Longitude fractional minutes x10^9.
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.

14.8 Garmin G-15 GPS GPGGA NMEA Sentence

Table 75: 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," page 101.
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

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Table 75: Garmin G-15 GPS GPGGA NMEA Sentence Output Format (continued)

Length in Bytes	Field	Description
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.
4	Latitude Frac Minutes	Latitude fractional minutes $x10^9$.
1	Longitude Degrees	Longitude Degrees
4	Longitude Frac Minutes	Longitude fractional minutes $x10^9$.
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.

14.9 Garmin G-15 GPS GPVTG NMEA Sentence

Table 76: 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," page 101.
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
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.

14.10 Paroscientific 8CDP Pressure Variable

Table 77: 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,” page 101.
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
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^x 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^y in Celsius. See Parosci-entific Intelligent RS-232 manual (Q1). If the Q3 command is used: Temperature x 10^5 in Celsius. See Parosci-entific Intelligent RS-232 manual (Q3).

14.11 Paroscientific 8CDP Pressure Setup

Table 78: Paroscientific 8CDP Pressure Setup Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=0Ah)
4	Time Tag	Sample Time in 100ths of second since last power up or "TS – Set Real-Time Clock," page 101.
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]	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 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]	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

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Table 78: Paroscientific 8CDP Pressure Setup Output Format (continued)

Length in Bytes	Field	Description
4	Error Bits[0]	Error Status from the device. Bit Assignment: bit 0: bit 1: bit 2: bit 3: 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	Pressure Units	See Paroscientific Intelligent RS-232 manual (UN).
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 10^2
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.

Table 78: Paroscientific 8CDP Pressure Setup Output Format (continued)

Length in Bytes	Field	Description
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.

NOTE. This data is sampled only on the first ping of an ensemble and only if the corresponding bit in the SD command is set.

14.12 Applied Micro Systems SVP&T (Speed of Sound) Variable

Table 79: Applied Micro Systems SVP&T (Speed of Sound) Variable Output Data Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=03h)
4	Time Tag	Sample Time in 100ths of second since last power up or “TS – Set Real-Time Clock,” page 101.
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: Nl bit 7: Nsv bit 8: Nh bit 9: Nt bit 10-31: spare

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Table 79: Applied Micro Systems SVP&T (Speed of Sound) Variable Output Data Format (continued)

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 0-31: 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.
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.

14.13 Honeywell HMR3000 Magnetic Compass Variable

Table 80: Honeywell HMR3000 Magnetic Compass Variable Output Data Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=04h)
4	Time Tag	Sample Time in 100ths of second since last power up or “TS – Set Real-Time Clock,” page 101.
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]	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: 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

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Table 80: Honeywell HMR3000 Magnetic Compass Variable Output Data Format (continued)

Length in Bytes	Field	Description
4	Error Bits[0]	Error Status from the device. Bit Assignment: 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]	Error Status from the device. Bit Assignment: 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.

Table 80: Honeywell HMR3000 Magnetic Compass Variable Output Data Format (continued)

Length in Bytes	Field	Description
4	TiltX	Conditioned TiltX (counts). CCD NMEA string.
4	TiltY	Conditioned TiltY (counts). CCD NMEA string.
4	TiltZ	Conditioned TiltZ (counts). CCD NMEA string.
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.

NOTE. Refer to HMR3000 Users Guide for more details of these fields.

14.14 Honeywell HMR3000 Magnetic Compass Setup

Table 81: Honeywell HMR3000 Magnetic Compass Setup Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54 LSB=05h)
4	Time Tag	Sample Time in 100ths of second since last power up or “TS – Set Real-Time Clock,” page 101.
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]	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: 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
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

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Table 81: Honeywell HMR3000 Magnetic Compass Setup Format (continued)

Length in Bytes	Field	Description
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 Smooth-ing	L parameter for non-linear heading filter.
1	Baud	Baud Rate

Table 81: Honeywell HMR3000 Magnetic Compass Setup Format (continued)

Length in Bytes	Field	Description
1	HDG Rate	HDG NMEA string update rate.
1	HDT Rate	HDT NMEA string update rate.
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.

NOTES.

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.

14.15 SeaBird SBE-49 FastCat CTD Variable

Table 82: 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,” page 101.
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.

14.16 Benthos PSA-916 Echo Sounder Variable

Table 83: Benthos PSA-916 Echo Sounder Variable Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=07h)
4	Time Tag	Sample Time in 100ths of second since last power up or “TS – Set Real-Time Clock,” page 101.
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.

14.17 PNI TCM3 & TCM5 Data Variable

Table 84: PNI TCM3 & TCM5 Data Variable Output Format

Length in Bytes	Field	Description
2	ID	PD0 ID (MSB=54h LSB=08h)
4	Time Tag	Sample Time in 100ths of second since last power up or "TS – Set Real-Time Clock," page 101.
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
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.

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Table 84: PNI TCM3 & TCM5 Data Variable Output Format (continued)

Length in Bytes	Field	Description
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 0^5.
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.

14.18 PNI TCM3 & TCM5 Configuration

Table 85: PNI TCM3 & TCM5 Configuration Output Format

Length in Bytes	Field	Description
2	ID	PD0 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.

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Table 85: PNI TCM3 & TCM5 Configuration Output Format (continued)

Length in Bytes	Field	Description
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.
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.

NOTE. 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 PD0 Data Output,” page 94).

15 How to Decode a ExplorerDVL Ensemble

Use the following information to help you write your own software.

15.1 Rules for the BroadBand Data Format PD0

a. All data types (i.e. fixed leader, variable leader, velocity, echo intensity, correlation, percent good, etc.) will be given a specific and unique ID number. The table below shows some of the most common IDs.

Table 86: Common Data Format IDs

ID	Description
0x7F7F	Header
0x0000	Fixed Leader
0x0080	Variable Leader
0x0100	Velocity Profile Data
0x0200	Correlation Profile Data
0x0300	Echo Intensity Profile Data
0x0400	Percent Good Profile Data
0x0500	Status Profile Data
0x0600	Bottom Track Data

b. Once a data type has been given an ID number and the format of that data has been published we consider the format for each field has being fixed. Fixed refers to units used for a given field, the number of bytes in a given field, and the order in which the fields appear within the data type. Fixed does not refer to the total number of bytes in the data type - see Rule "c".

c. Data may be added to an existing data type only by adding the bytes to the end of the data format. As an example, the variable leader data contains information on ensemble number, time, heading, pitch, roll, temperature, pressure, etc. The format for the bytes 1-53 are now specified by changes added in support to the ExplorerDVL. If additional sensor data is to be added to the variable leader data then it must be added to the end of the data string (bytes 54-x as an example).

d. The order of data types in an ensemble is not fixed. That is there is no guarantee that velocity data will always be output before correlation data.

e. The header data will include the number of data types in the files and the offset to each ID number for each data type.

f. The total number of the bytes in an ensemble minus the 2-byte checksum will be included in the header.

15.2 Recommended Data Decoding Sequence for BroadBand Data Format PD0

a. Locate the header data by locating the header ID number (in the case of PD0 profile data that will be 7F7F).

b. Confirm that you have the correct header ID by:

1. Locating the total number of bytes (located in the header data) in the ensemble. This will be your offset to the next ensemble.
2. Calculate the checksum of total number of bytes in the ensemble excluding the checksum. The checksum is calculated by adding the value of each byte. The 2-byte least significant digits that you calculate will be the checksum.
3. Read the 2-byte checksum word at the end of the ensemble, located by using the checksum offset in the header (determined in step “b-1”) and compare this checksum word to the value calculated in step “b-2”.
4. If the checksums match then you have a valid ensemble. If the checksums do not match then you do not have a valid ensemble and you need to go back to step “a” and search for the next header ID number occurrence.

c. Locate the number of data types (located in the header data).

d. Locate the offset to each data type (located in the header data).

e. Locate the data ID type you wish to decode by using the offset to each data type and confirm the data ID number at that offset matches the ID type you are looking for.

f. Once the proper ID type has been located, use the ExplorerDVL Technical Manual to understand what each byte represents in that particular data type.

15.3 Pseudo-Code for Decoding PD0 Ensemble Data

The following examples show the pseudo-code for decoding PD0 and PD5 ensemble data.

g. Define structures, which contain all fields in all data types of the PD0 format.

1. typedef struct { <lists of types and fields> } FixedLeader.
2. typedef struct { <lists of types and fields> } VariableLeader.
3. typedef struct { <lists of types and fields> } BottomTrack.
4. typedef struct { <lists of types and fields> } VelocityType
5. and so on for every available type.

h. Clear checksum.
i. Look for PD0 ID 0x7F. Add to checksum.
j. Is next byte a 0x7F? Add to checksum.
k. If no, return to step “b”.
l. Else, read next two bytes to determine offset to checksum. Add two bytes to checksum.
m. Read in X more bytes, where X = offset to checksum - 4. Adding all bytes to checksum.
n. Read in checksum word.
o. Do checksums equal?
p. If no, return to “b”.
q. For each available data type (the header contains the # of data types), go to the offset list in header.
    1. Create a pointer to type short to the data type at an offset in the list.
    2. Check the Type ID.
    3. Create a pointer of appropriate type to that location.
    4. Repeat for all available data types.
r. Work with data.
s. Return to “b” for next ensemble.

15.4 Pseudo-Code for Decoding PD5 Ensemble Data

a. Define structure that contains all fields in PD5 format.
    1. typedef struct { <lists of types and fields> } PD5_Format.
b. Clear checksum.
c. Look for ID, PD5 id is 0x7D. Add to checksum.
d. Is next byte a 0x01? Add to checksum.
e. If no, return to “b”.
f. Else, read next two bytes to determine offset to checksum. Add two bytes to checksum.
g. Read in X more bytes, where X = offset to checksum - 4. Adding all bytes to checksum.
h. Read in checksum word.
i. Do checksums equal?

j. If no, return to “b”.

k. Create a pointer of type PD5_Format.

   1. PD5_Format *PD5_ptr;

l. Point pointer at location of ID byte.

   1. PD5_ptr = &buf[<location of input buffer>];

m. If “k” and “l” don't appeal to you, you can create a variable of type PD5_Format.

   1. PD5_Format PD5_data;

n. And copy the data from the input buffer to PD5_data.

o. Work with data.

p. Return to “b” for next ensemble.

15.5 Example Code for Decoding BroadBand Ensembles

Here is an example of how to decode a BroadBand ensemble. It is written in “C.”

NOTE. Structures must be “packed”; i.e. Don’t let the compiler add “fill bytes” to align fields on word boundaries.

This is an example of a section of code, not a full executable program.

```
/****************************************************************************/
/* Data ID Words */
/****************************************************************************/

   #define FLdrSelected   0x0000
   #define VLdrSelected   0x0080
   #define VelSelected    0x0100
   #define CorSelected    0x0200
   #define AmpSelected    0x0300
   #define PctSelected    0x0400
   #define SttSelected    0x0500
   #define BotSelected    0x0600
   #define Prm0           0x0700

   #define VelGood        0x0701
   #define VelSum         0x0702
   #define VelSumSqr      0x0703
   #define Bm5VelSelected 0x0A00
   #define Bm5CorSelected 0x0B00
   #define Bm5AmpSelected 0x0C00
   #define AmbientData    0x0C02
   #define Bm5PctSelected 0x0D00
   #define Bm5SttSelected 0x0E00
   #define Prm0_5         0x1300
   #define VelGood_5      0x1301
   #define VelSum_5       0x1302
   #define VelSumSqr_5    0x1303

/****************************************************************************/
/* structures */
/****************************************************************************/

   typedef unsigned char  uchar;
   typedef unsigned short ushort;
```

```
typedef unsigned long  ulong;

typedef struct {
   uchar       Minute,
               Second,
               Sec100;
}  TimeType;

typedef struct {
   uchar       Year,
               Month,
               Day,
               Hour,
               Minute,
               Second,
               Sec100;
}  DateTimeType;

typedef struct {
   uchar       Version,
               Revision;
}  VersionType;

typedef struct {
   uchar       ID,
               DataSource;
   ushort      ChecksumOffset;
   uchar       Spare,
               NDataTypes;
   ushort      Offset [256];
}  HeaderType;

typedef struct {
   ushort      ID;
   VersionType CPUFirmware;
   ushort      Configuration;
   uchar       DummyDataFlag,
               Lag,
               NBeams,
               NBins;
   ushort      PingsPerEnsemble,
               BinLength,
               BlankAfterTransmit;
   uchar       ProfilingMode,
               PctCorrelationLow,
               NCodeRepetitions,
               PctGoodMin;
   ushort      ErrVelocityMax;
   TimeType    TimeBetweenPings;
   uchar       CoordSystemParms;
   short       HeadingAlignment,
               HeadingBias;
   uchar       SensorSource,
               AvailableSensors;
   ushort      DistanceToBin1Middle,
               TransmitLength;
}  FixLeaderType;

typedef struct {
   ushort      ID,
               EnsembleNumber;

   DateTimeType RecordingTime;
   uchar       Spare1;
   ushort      BITResult,
               SpeedOfSound,
               Depth,
               Heading;
   short       Pitch,
               Roll;
   ushort      Salinity;
   short       Temperature;
   TimeType    MaxTimeBetweenPings;
   uchar       HeadingStddev,
               PitchStddev,
               RollStddev;
   uchar       VMeas [8];
}  VarLeaderType;
```

```
typedef struct {
   ushort       ID,
                PingsPerEnsemble,
                EnsembleDelay;
   uchar        CorrelationMin,
                AmplitudeMin,
                PctGoodMin,
                BTMode;
   ushort       ErrVelocityMax,
                NSearchPings,
                NTrackPings;
   ushort       Range        [4];
   short        Velocity     [4];
   uchar        Correlation  [4],
                Amplitude    [4],
                PctGood      [4];
   ushort       WaterLayerMin,
                WaterLayerNear,
                WaterLayerFar;
   short        WVelocity    [4];
   uchar        WCorrelation [4],
                WAmplitude   [4],
                WPctGood     [4];
   ushort       MaxTrackingDepth;
   uchar        Amp [4];
   uchar        Gain;
   uchar        RangeMSB [4];
}  BottomTrackType;

typedef struct
{
  ushort        ID;
  short         Data [256];
} OneBeamShortType;

typedef struct
{
  ushort        ID;
  uchar         Data [256];
} OneBeamUcharType;

typedef struct {
   ushort       ID;
   short        Data [1024];
}  IntStructType;

typedef struct {
   ushort       ID;
   uchar        Data [1024];
}  ByteStructType;

typedef struct
{
  ushort        ID;
  uchar         Data [4];
}  AmbientType;

typedef struct
{
  ushort        ID;
  ushort        UaH;
  ushort        UaL;
  ushort        AmbBitsPerBin;
  ushort        AmbTrys;
  ushort        AmbNBins;
  short         AmbBinNum [ 5 ];
  short         Est [ 5 ];
  ushort        WAutoCor [ 5 ] [ 32 ];
  uchar         SysFreq;
  uchar         SampRate;
}  T01Type;

typedef struct
{
  ushort        ID;
  uchar         DAC [36];
}  T02Type;
```

```
   typedef struct
   {
     ushort        ID;
     ushort        RSSIBinLen;
     ushort        RSSIBins;
     uchar         RSSI [512] [4];
     ushort        AutoCor [32] [4];
     short         Est [4];
     ushort        Amb [4];
     uchar         SysFreq;
     uchar         SampRate;
     uchar         MLen;
     ushort        XmtSamples;
     ushort        FirstBin[4];
     ushort        LastBin[4];
     ulong         BM6Depth[4];
     ushort        BM6Ta[4];
   }  T03Type;

/****************************************************************************/
/* Global Pointers */
/****************************************************************************/
   HeaderType       *HdrPtr;
   FixLeaderType    *FLdrPtr;
   VarLeaderType    *VLdrPtr;
   BottomTrackType  *BotPtr;
   BottomTrackType  *WBotPtr;
   IntStructType    *VelPtr;
   ByteStructType   *CorPtr;
   ByteStructType   *AmpPtr;
   ByteStructType   *PctPtr;
   ByteStructType   *SttPtr;
   AmbientType      *AmbientPtr;
   T01Type          *T01Ptr;
   T02Type          *T02Ptr;
   T03Type          *T03Ptr;
   OneBeamShortType *Bm5VelPtr;
   OneBeamUcharType *Bm5CorPtr;
   OneBeamUcharType *Bm5AmpPtr;
   OneBeamUcharType *Bm5PctPtr;
   OneBeamUcharType *Bm5SttPtr;

/*--------------------------------------------------------------------------*/

unsigned char RcvBuff[8192];


void DecodeBBensemble( void )
{
    unsigned short i, *IDptr, ID;

    FLdrPtr = (FixLeaderType *)&RcvBuff [ HdrPtr->Offset[0] ];

    if (FLdrPtr->NBins > 128)
        FLdrPtr->NBins = 32;

    for (i=1; i<HdrPtr->NDataTypes; i++)
    {
        IDptr = (unsigned short *)&RcvBuff [ HdrPtr->Offset [i] ];
        ID = IDptr[0];

        switch (ID)
        {
        case VLdrSelected:
            {
                VLdrPtr = (VarLeaderType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case VelSelected:
            {
                VelPtr = (IntStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case CorSelected :
            {
                CorPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
```

```
            }
        case AmpSelected :
            {
                AmpPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case PctSelected :
            {
                PctPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case SttSelected :
            {
                SttPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case BotSelected :
            {
                BotPtr = (BottomTrackType*)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case AmbientData :
            {
                AmbientPtr = (AmbientType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        }
    }
}
```

16 Glossary

If, after reviewing this section, you are unable to find the word/jargon in question, please **send us an e-mail** containing that word. Your questions will ensure that our glossary remains an effective reference tool for our customers.

------ A ------

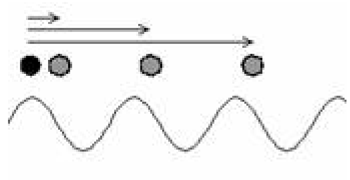
Acoustic Doppler Current Profiler (ADCP): An instrument that obtains profiles of water velocity by transmitting sound of known frequency into the water and measuring the Doppler shift of reflections from scatterers, which are assumed to be passively moving with the water.

Acoustic Window: A covering for the hull-side opening of a sea chest that is transparent to sound. A vessel mounted ADCP is typically mounted in a sea chest and the acoustic window helps to isolate it from biofouling organisms and also the flow noise generated by the vessel.

ADCP: Acoustic Doppler Current Profiler

ADCP Coordinates: Profile data is reported in an orthogonal coordinate system as referenced to the instrument. Beam 3 is forward. Sideways is to the right of forward (beam 2 for a down-looking ADCP, beam 1 for an up-looking ADCP).

Ambiguity: ADCPs determine the radial motion between a source and scatterer by measuring the phase change of the reflected signal. Because phase is periodic, this solution is multi-valued. For example, all three of the displacements shown below will return the same phase measurement, which results in ambiguity:



Ambiguity Resolution: A method to count the number of wavelengths included between two points where phase is measured, thereby removing the ambiguity associated with measuring only phase.

Ambiguity Velocity: The maximum allowable radial motion for phase measurements to be unambiguous, corresponding to a maximum observable velocity, beyond which ambiguity resolution is required.

Autonomous Underwater Vehicle (AUV): An unmanned submersible with propulsion, generally capable of navigation and accomplishing specific tasks (such as data gathering).

AUV: Autonomous Underwater Vehicle

------ B ------

Backscatter: 1) The portion of a sound wave that is reflected by scatterers directly back toward the source. 2) A qualitative measurement (in decibels) of scatterer concentration which is calculated in the *WinRiver* software. This calculation corrects the echo intensity data for sound absorption, beam spreading, transducer temperature, etc. and provides an excellent means of tracking relative concentration (e.g. “Is most of the sediment in the water here or is it there?”). Obtaining a quantitative measurement (e.g. “How many mg/L of bottom sediment are in this parcel of water?”) requires a field calibration at the measurement site. There is a third-party software package, *Sediview*, designed for this task.

BBBatch: Utility program to allow automated conversion of a series of raw binary ADCP files to ASCII files.

BBCheck: Utility program that checks the integrity and quality of raw binary ADCP files.

BBConv: Utility program to convert some portion of a raw binary ADCP file into an ASCII file using a decoder file. Several decoder files are included on the RDI Tools CD, for example: extract only distance to first bin, extract only navigation data, etc. Complete documentation on these decoder files as well as information on how to write your own is available.

BBList: Utility program for viewing and converting raw binary ADCP data files. It is a menu-driven program offering a step-by-step process to convert raw binary files to ASCII files.

BBMerge: Utility program to convert comma-delimited ASCII files back into raw binary ADCP format.

BBSlice: A raw data sub-sectioning utility program. BBSlice converts a raw data file into a series of ASCII files, opening a new ASCII file whenever there is a jump in the sequence of ensemble numbers.

BBss: Utility program to calculate the speed of sound when given temperature, salinity and depth.

BBSub: A raw data sub-sectioning utility program. BBSub allows you to extract subsets of raw data from a large raw data file by choosing the starting and ending ensemble number.

BBTalk: Terminal emulator program for direct communication with the CPU of an ADCP or ExplorerDVL.

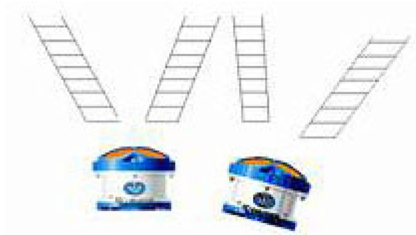
Beam Angle: The angle between a transducer beam's main axis and the vertical axis of the ADCP or ExplorerDVL (typically 20 or 30º).

Beam Coordinates: Profile data is reported as referenced along each beam (i.e. no coordinate transformation is performed upon the raw data).

Beam Spreading: The extent to which the main lobe of energy generated by a transducer fans out, or spreads as an acoustic wave front, with distance from the transducer. This is proportional to λ/d where λ is the wavelength of sound generated and d is the diameter of the transducer. Note: this is why ADCP transducer diameter increases with decreasing operating frequency (and increasing wavelength).

Bin (Depth Cell): A measurement within a profile, generally equivalent to a single-point current meter on a mooring.

Bin Mapping (Depth Cell Mapping): When the ADCP is tilted; the measurements taken at equal distances along each beam are no longer in the same horizontal layer of water. For example, in the image below the tilted ADCP bins do not line up horizontally, they are offset by one bin. In this case the tilted ADCP will offset the bins on the "right" beam by one bin in order to line them up horizontally with the bins on the "left" beam before combining the measurements to compute the velocity.



Blank Zone: The area near the head of an ADCP in which no measurements are taken. This is usually the minimum distance required to avoid collecting data that is potentially contaminated by ringing, but is sometimes extended for other reasons (e.g. to begin measurement well beyond the flow influence of a mounting structure).

Bottom Discharge: When using an ADCP to measure river discharge, it is not possible to measure all the way to the bottom (due to sidelobe contamination and the finite resolution of the depth cells). In order to get an accurate approximation of the total discharge, the flow in this area must be estimated and included, usually by extrapolating the measured velocities to the bottom using a power curve fit.

Bottom Track: In moving platform applications where the bottom is within range of the ADCP or ExplorerDVL, a special ping can be transmitted to measure the Doppler shift of the signal return from the bottom. If the bottom is not moving, this measurement is a very accurate measurement of the platform velocity. For ADCPs this velocity is typically used to extract the true water velocity profile from the measured velocity profile (by removing the vehicle motion from the measurements). For ExplorerDVLs, this IS the desired velocity.

Break: A wake up command to an ADCP or ExplorerDVL that places the instrument in command mode.

Broadband ADCP: An ADCP that uses broadband processing.

Broadband Processing: Use of coded pulses to make multiple measurements of phase with a single ping, and thereby greatly increase the precision of the measurement.

------ C ------

Channel Master: Model name for an ADCP designed to use horizontal profiling for flow monitoring in inland waterways.

Command Mode: The state into which an ADCP or ExplorerDVL goes upon receiving a break. In this mode the ADCP or ExplorerDVL is waiting to receive a command. It draws relatively high power, so the ADCP or ExplorerDVL will go to sleep if no command is received for five minutes.

Correlation: A key quality control parameter, this is essentially a measurement of how much the particle distribution has changed between phase measurements. The less the distribution has changed, the higher the correlation, and the more precise the velocity measurement.

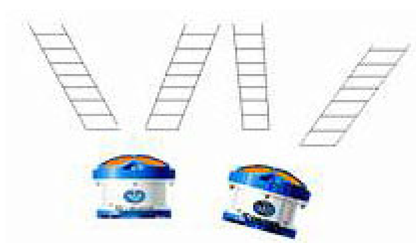
------ D ------

Dead Reckoning: A navigation method where position is estimated by measuring velocity, heading and time from the last known position.

Degaussing: Technique used to remove the magnetic field from TRDI battery packs before installation, done to minimize any effects the batteries will have on the magnetic compass.

Depth Cell (Bin): A measurement within a profile, generally equivalent to a single-point current meter on a mooring.

Depth Cell Mapping (Bin Mapping): When the ADCP is tilted; the measurements taken at equal distances along each beam are no longer in the same horizontal layer of water. For example, in the image below the tilted ADCP bins do not line up horizontally, they are offset by one bin. In this case the tilted ADCP will offset the bins on the "right" beam by one bin in order to line them up horizontally with the bins on the "left" beam before combining the measurements to compute the velocity.



DGPS: Differential Global Positioning System

Differential Global Positioning System (DGPS): Satellite-based navigation aid for precise measurement of location. When the bottom is out of range or moving, calculating the distance between DGPS position fixes and dividing by the time between those fixes can be used to measure the platform velocity.

Direct-Reading ADCP: An ADCP intended for real-time operation. Direct-Reading ADCPs do not have internal batteries or an internal recorder.

Discharge: The total flow through a section of a river. Rio Grande ADCPs obtain discharge measurements by transecting the river to measure water velocities, boat velocity, and the cross sectional area of the river and combining these measurements with estimates for the flow in the areas that can not be measured (edge estimates, bottom discharge and top discharge).

Distance Made Good: When measuring transects of data with a moving platform, this is a measure of the actual distance between the platform and the start point (i.e. variations in course track are removed).

Doppler Shift: Named for Johann Doppler (1803-1853), the German physicist who first predicted it: it is the shift in frequency caused by radial motion between a source and an observer. Specifically, $f_D = f_S\,(v/c)$: Where D is the Doppler-shifted frequency, f_S is the source frequency, v is the relative velocity between source and observer, and c is the speed of sound.

Doppler Velocity Log (DVL): An instrument designed to measure the velocity and elevation of a moving platform with bottom tracking. Most DVLs will switch to measuring velocity relative to the water when the bottom is out of range.

DVL: Doppler Velocity Log.

------ E ------

Earth Coordinates: Profile data is reported in an orthogonal coordinate frame as referenced to the Earth (East, North and Up). "North" can mean magnetic or true, depending on the heading input.

Echo Intensity: A key quality control parameter, echo intensity is a measure of the signal strength intensity returned to the transducer. High echo intensity can show solid targets (e.g. a boundary, obstruction or fish), while low echo intensity can show insufficient scatterers or the limits of profiling range for the environment.

Edge Estimate: When measuring river discharge with an ADCP it is not possible to measure to zero depth at the banks of the river. The flow through this unmeasured area must be approximated in order to obtain an accurate estimate of the total discharge.

Ensemble: A group of measurements (pings) considered together. An ensemble is usually the average of the individual measurements, and has a higher precision than any individual measurement.

Error Velocity: A key quality control parameter that derives from the four beam geometry of an ADCP. Each pair of opposing beams provides one measurement of the vertical velocity and one component of the horizontal velocity, so there are actually two independent measurements of vertical velocity that can be compared. If the flow field is homogeneous, the difference between these vertical velocities will average to zero. To put the error velocity on a more intuitive footing, it is scaled to be comparable to the variance in the horizontal velocity. In a nutshell, the error velocity can be treated as an indication of the standard deviation of the horizontal velocity measurements.

------ F ------

Fish Detection Threshold: Used to identify and mark as bad any velocity measurement that was potentially contaminated by a fish (because fish are generally not passively following the flow). It is a flag on the maximum allowable value for the measured echo intensity return.

Frequency: The number of wave crests passing a given point per unit time.

------ G ------

Gimbals: Frame that will support the weight of an object but allow its free rotation. Gimbals can be constructed to allow free rotation in one, two, or three axes.

Gyro: A rapidly spinning device mounted on gimbals to maintain a constant orientation. These devices are commonly used to measure heading on ships because, unlike magnetic compasses, they are unaffected by ferrous metals or by varying electromagnetic fields. They can also be used to measure pitch and roll because, unlike liquid level sensors, they are unaffected by accelerations.

------ H ------

Homogeneity: The extent to which the current measured by all four beams is the same. A key assumption of all ADCP processing is that the currents are horizontally homogeneous across the four beams. This assumption is checked for each measurement by using the error velocity measurement.

Horizontal ADCP (H-ADCP): Instrument designed to measure velocity profiles in a horizontal plane.

------ I ------

Inertial Navigation: Method for estimating the attitude and position of a moving platform (of primary interest here are AUVs) by integrating measurements from gyros and accelerometers. This integration is subject to large errors over time, so DVLs and pressure sensors are commonly incorporated as external inputs to measure and correct these errors.

------ J ------

------ K ------

------ L ------

Lag: A time delay between pulses or pings.

Long Ranger: Model name for Workhorse ADCPs of frequency 75 kHz.

Lowered ADCP (L-ADCP): Technique whereby one or two ADCPs are lowered through the water column (typically on a rosette) to obtain velocity profiles over the full ocean depth. Note that a whole body of research exists on how to properly remove the motion of the rosette from the velocity measurements obtained in this manner.

------ M ------

Main Lobe: The main focus of energy emitted from a transducer. If the transducer were a flashlight, the main lobe would be the visible beam of light.

Mariner: Model name for a Workhorse Monitor ADCP configured for underway current measurement in shallow water (as opposed to the deep water Ocean Surveyor systems).

Monitor: Model name for a direct reading Workhorse ADCP.

Moving Bottom: Some rivers carry such a heavy sediment load that they do not have a clearly identifiable bottom. In essence, the mud just keeps getting thicker and slower with depth. In such environments it is not uncommon for bottom tracking measurements to lock onto a sediment layer that is still moving, resulting in a bias to the bottom tracking velocity. This is especially important for river discharge measurements, where the vessel's navigation must be substituted for the bottom track velocity to obtain accurate results.

------ N ------

Navigator: Model name for the TRDI Doppler Velocity Log.

Narrowband ADCP: An ADCP that uses narrowband processing.

Narrowband Processing: Uses a single pulse per ping to measure velocity. The lack of coding in the pulse makes a narrowband measurement much less precise, but it allows profiling over a longer range. Narrowband processing generally requires much larger ensembles to get a precise measurement.

------ O ------

Ocean Observer: Low frequency Phased Array ADCP for cabled deployment, usually from an oilrig.

Ocean Surveyor: Low frequency Phased Array ADCP for vessel-mounted operations.

------ P ------

Percent Good: A key quality control parameter, percent good indicates what fraction of the pings passed the various error thresholds. Each depth cell reports four values for percent good, and the meaning depends on the coordinate frame. If data is collected in beam coordinates, then the four percent good values represent the percentage of the pings collected by each beam for that depth cell whose correlation exceeded a low correlation threshold. In the other coordinate frames (ADCP, Ship and Earth Coordinates), the four Percent Good values represent (in order): 1) The percentage of good three beam solutions (one beam rejected); 2) The percentage of good transformations (error velocity threshold not exceeded); 3) The percentage of measurements where more than one beam was bad; and 4) The percentage of measurements with four beam solutions.

Phase: An engineering measure of the propagation delay caused by radial motion between scatterer and source. Phase is ambiguous in that it is cyclical (e.g. 10 º is the same phase as 370 º).

Phased Array Transducer: A single, flat, multi-element transducer that uses an TRDI proprietary technique to simultaneously form all four beams. Available phased array transducers are generally low frequency (38 kHz, 75 kHz and 150 kHz) long range devices.

Ping: The entirety of the sound generated by an ADCP transducer for a single measurement cycle. A broadband ping contains a coded series of pulses and lags, while a narrowband ping contains a single pulse.

Ping Mode: Power conserving mode for a deployed ADCP or ExplorerDVL, where only the power needed for the immediate deployment task is drawn (as opposed to command mode, where the ADCP consumes considerable power while simply waiting for input). This mode saves the deployment configuration so that, in the event of a power interruption, the ADCP or ExplorerDVL will be able to automatically resume the configured deployment upon return of power.

PlanADCP: Windows-based software package allowing the user to configure, and evaluate the consequences of, a deployment command-set for an ADCP.

Profile: A series of regularly spaced depth cells in which the ADCP measures velocity along with several quality control parameters.

Pulse: A sound wave generated by a transducer.

Propagation Delay: The change in the travel time of sound between a source and scatterer, generally due to radial motion. As an example: if it takes longer for sound to reflect back from a scatterer than it did a short while ago (and the speed of sound has not changed), then the scatterer must be getting farther away.

------ Q ------

Quartermaster: The model name for a self-contained 150kHz Workhorse ADCP.

------ R ------

Radial Motion: Movement, which alters the distance between source and scatterer.

Range: The maximum profile length of an ADCP, it depends on several factors (note that these factors are inter-related in a complex way, and the generalizations below are intended only as rules of thumb – use PlanADCP to check specific combinations):

1. Frequency: the lower the frequency, the longer the range.
2. Depth cell size: the larger the cell, the longer the range.
3. Mode of operation: mode 1 has the longest range.
4. Bandwidth: the narrower the bandwidth, the longer the range.
5. Concentration of scatterers: generally, the more scatterers, the longer the range.
6. Temperature: generally, the colder the water, the longer the range.
7. Salinity: generally, the fresher the water, the longer the range.

Range Gating: After sending a ping into the water, the ADCP transducers listen for returned signal. The time series of the returned signal is then broken into a sequence of time segments, or range gates. Each segment is equivalent to a depth cell, with the last segment coming from the farthest range from the ADCP.

RDI Tools: Software package containing all of the BB* programs (*BBTalk*, *BBList*, etc.) as well as several commonly used decoder files.

Remotely Operated Vehicle (ROV): unmanned submersible controlled by an operator via a tethering cable.

Ringing: After transmission the ADCP electronics, transducer and immediate surrounding equipment (particularly in vessel mounted ADCPs) all require some finite time to dampen the transmit energy, during which time any signal return from scatterers will be contaminated.

Rio Grande ADCP: The model name for an ADCP optimally configured for measurement of river discharge. A distinguishing feature of Rio Grande ADCPs is that they are designed to operate from a 12 VDC power supply (all other ADCPs operate from 20 – 50 VDC).

Rosette: Oceanographic instrumentation package found on most research vessels. Rosettes are designed to be lowered to depths of interest while collecting data of various types. Most Lowered-ADCPs are mounted on rosettes.

ROV: Remotely Operated Vehicle

------ *S* ------

Scatterers: Small particles or plankton in the water which reflect sound waves.

Sea Chest: Cavity in the hull of a vessel to allow stream-lined, recessed mounting of equipment such as a Vessel Mount ADCP.

Sediview: Third party software designed to use ADCP echo intensity measurements and *in situ* sampling to obtain quantitative estimates of sediment concentration.

Self-Contained ADCP: An ADCP equipped with internal batteries and an internal recorder for autonomous operation.

Sentinel: The model name for a self-contained Workhorse ADCP.

Ship Coordinates: Profile data is reported in an orthogonal coordinate frame as referenced to the ship (if beam 3 is forward then ship coordinates are the same as instrument coordinates).

Sidelobes: Peaks in sound intensity generated by a transducer found to the side of the main lobe.

Sidelobe Contamination: This only need be considered when operating an ADCP near a boundary (e.g. in shallow water). The beam angle of the main lobe of an ADCP transducer is 20 or 30º off the vertical, which means that the distance to the boundary along the ADCP centerline is shorter than the distance to the boundary along a beam. Because most boundaries will reflect very strongly (much more strongly than the scatterers), sidelobe energy can travel the shorter path directly to the surface and thereby include the “velocity” of the boundary with the velocity measurements taken along the beams at any longer distance. This potential for interference depends strictly on the beam angle. An ADCP with a 20º beam angle has the potential for sidelobe contamination at (distance to the boundary)*cos(20º), or equivalently, the last 6% of the profile. Note: Sidelobe contamination is not relevant for DVLs, which specifically look for the bottom.

Software Break: When using radio or acoustic telemetry, it is usually not possible to send a break signal. Under these circumstances an ADCP can be configured to recognize a series of keystrokes (i.e. = = =) as a break.

Source: Originator of sound of known frequency, here typically the transducer of an ADCP.

StreamPro: Model name for ADCP designed for discharge measurement in shallow waterways.

------ T ------

Top Discharge: When using an ADCP to measure river discharge, it is not possible to measure all the way to the surface (due to the blank zone and to the need to mount the transducers at sufficient depth to remain submerged with no air entraining past the transducers). In order to get an accurate approximation of the total discharge, the flow in this area must be estimated and included, usually by extrapolating the measured velocities to the surface.

Transducer: A device to convert electrical energy into sound waves, and vice versa.

------ U ------

Unmanned Underwater Vehicle (UUV): Generic term referring to both AUVs and ROVs.

UUV: Unmanned Underwater Vehicle

------ V ------

Vessel Mount: An ADCP mounted to the hull of a vessel, typically in a sea chest, and having inputs from the vessel's navigation equipment.

VM-DAS: Windows-based data acquisition package for vessel mount ADCPs. This package includes the ability to incorporate the ship's navigation equipment.

------ W ------

Water Mass: This mode is used to determine vehicle motion relative to the water. This is especially useful when the bottom is out of range.

Wavelength: The distance between successive wave crests in a sound wave.

WinADCP: Windows-based post-processing package for ADCP data.

WinH-ADCP: Windows-based data acquisition and playback package for Horizontal ADCPs.

WinRiver: Windows-based software package for real time ADCP data gathering. It is designed primarily for measurement of river discharge and allows integration of the platform's navigation equipment. It also converts echo intensity measurements to qualitative estimates of backscatter.

WinSC: Windows-based software package for self-contained ADCPs includes configuring, testing, data recovery and viewing options.

Workhorse ADCP: The generic model name for all of the non-phased array broadband ADCPs currently produced by TRDI.

------ X ------

Xdcr: A common abbreviation for transducer.

------ Y ------

------ Z ------

ZedHed: TRDI trade name for a transducer designed to minimize ringing.

NOTES

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