V-ADCP

OPERATION MANUAL

TELEDYNE
RD INSTRUMENTS
Everywhereyoulook™

P/N 95B-6031-00 (March 2014)

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REVISION HISTORY

March 2015

- Updated styles and fonts.
- Combined Operation Manual and V-ADCP Quick Start Guide into one manual.
- Added the Index Velocity and Discharge Commands for flow calculations and output.
- Added the #V commands.
- Added PD19 and PD23 output data formats.
- Added corrections from ICN 090 and 119.

April 2011

- Manual documents 40.11 firmware.
- Added TD, VR, and MU commands.
- Added table of recommended settings for WV command.
- Voltage range changed from 10 to 24VDC to 10 to 28VDC.
- Fixed figures 7 and 10 where beams 3 and 4 were swapped.

February 2008

- Manual documents 40.08 firmware.

March 2007

- Preliminary release.

EXCLUSIONS AND OMISSIONS

1: None

Chapter 1

AT A GLANCE

In this chapter, you will learn:

- System overview
- Power requirements
- Setting up the V-ADCP
- Testing the V-ADCP
- V-ADCP care

How to Contact Teledyne RD Instruments

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

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

Conventions Used in this Manual

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

Software menu items are printed in bold: **File** menu, **Collect Data**. Items that need to be typed by the user or keys to press will be shown as **F1**. If a key combination were joined with a plus sign **(ALT+F),** you would press and hold the first key while you press the second key. Words printed in italics include program names (*PlanCV*) and file names (*default.txt*).

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

```
ADFM
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All rights reserved.
Firmware Version: 40.11

>
>?
```

You will find three other visual aids that help you: Notes, Cautions, and Recommended Settings.

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

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

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

System Overview

The V-ADCP is designed to measure real-time flow rates from a fixed mount. The V-ADCP system consists of a V-ADCP sensor, electronics housing, cables, and software. The input power requirements for the V-ADCP are +10 to 28 VDC. The V-ADCP system can work either in the Real-Time mode (through a PC or telemetry system) or in the Self-Contained mode (recording data on its internal recorder).

V-ADCP Sensor

The V-ADCP sensor contains three angled and one vertical transducer ceramics and the electronics. The standard acoustic frequency for the angled transducers is 2400 kHz. The standard frequency for the vertical beam is 600 kHz. See Outline Installation Drawings for dimensions and weights.

Velocity Transducers - The three larger transducers generate the sound waves that the V-ADCP uses to measure velocities.

Vertical Transducer – The smaller transducer measures water depth.

Temperature Sensor - Located on the face between the transducers.

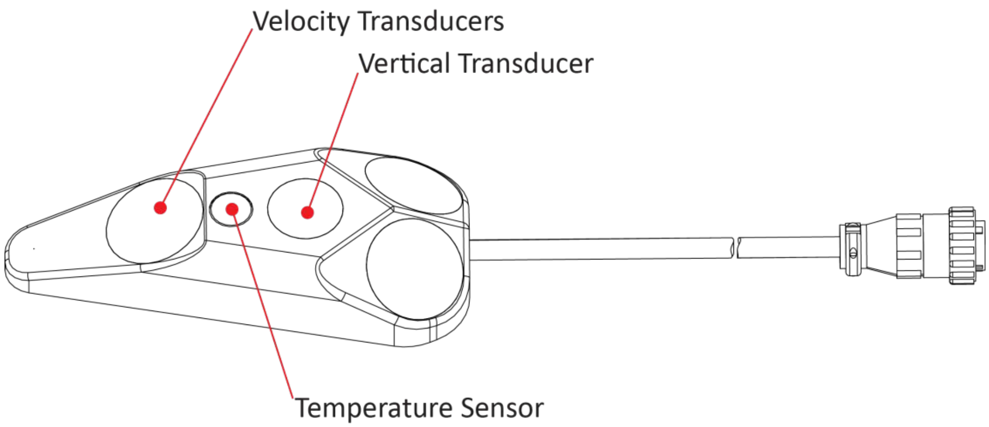


Figure 1. V-ADCP Sensor

V-ADCP Electronic Housing

Figure 2 identifies the connectors on the V-ADCP electronic housing.

The blue plastic housing protects the electronics and is intended for indoor or outdoor use to provide protection against the entry of water during use (2 meters for 24 hours per NEMA 6P).

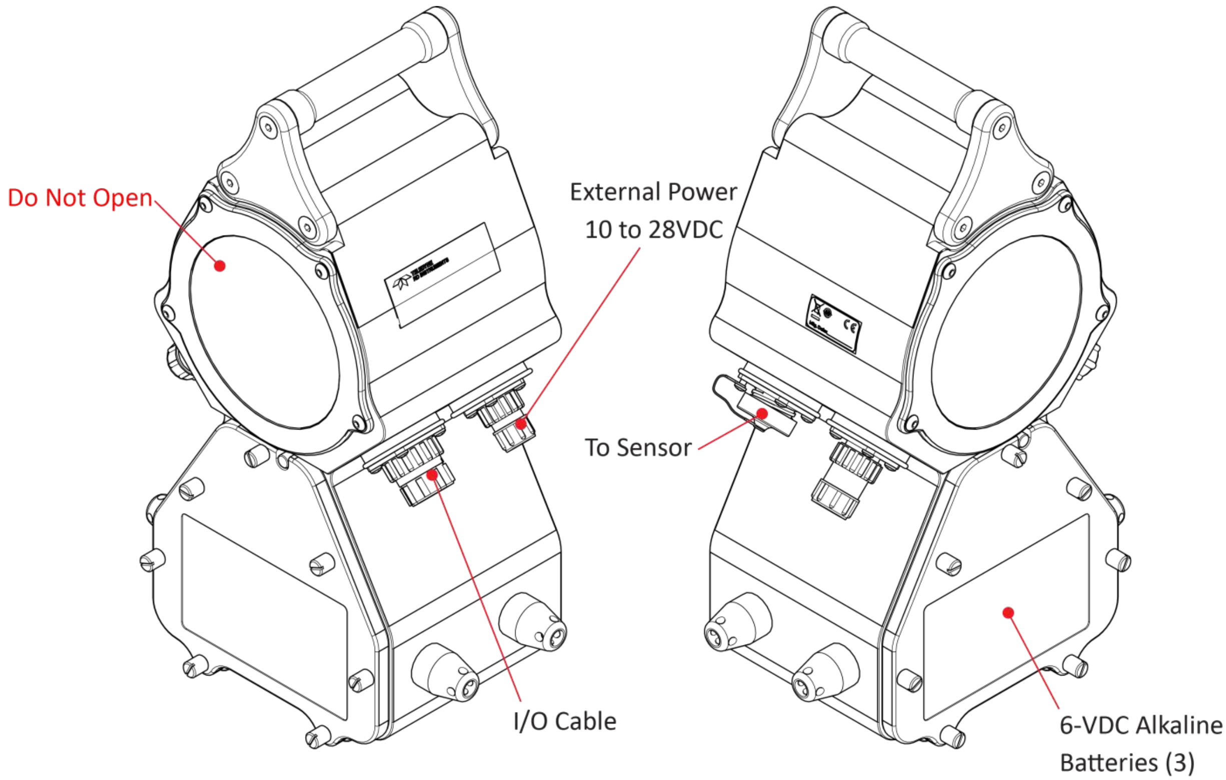


Figure 2. V-ADCP Electronic Housing Overview

Inventory

Included with the V-ADCP system:

Part Number	Description
V-ADCP-I	The V-ADCP system includes the Sensor and Electronics Housing. When unpacking, use care to prevent physical damage to the sensor faces and connectors. Use a soft pad to protect the transducer.

Included with the V-ADCP: Accessories Kit (VADCP-A) and Tools and Spares Kit (75BK6015-00):

	Part Number	Name	Description
V-ADCP Accessories Kit (VADCP-A)	73B-6021-003	I/O cable	The I/O cable is used for serial communications.
	73B-6022-003	External Power	This cable is used for an external power source.
	71B-7005-00	Shipping case	Shipping case with custom foam cutouts.
	90B-8009-00	V-ADCP Documentation CD	This CD has PDF version of the V-ADCP documentation. Please read the manual!
	907-8040-00	RDI Tools Software CD	Utility and testing software package including *BBTalk* that can be used to test the ADCP.
	90B-8013-00	Q-Monitor-V Software CD	Software package for collecting real-time data.
	90B-8014-00	PlanCV Software CD	Software package for creating V-ADCP command files.
	975-6009-00	Lantern Battery (3)	6VDC lantern batteries used to power the V-ADCP.
	81B-1139-00	Mounting Plate	Used to mount the V-ADCP sensor.
	M6X1.0X12FHSH	Mounting Hardware	Mounting hardware for the mounting plate.
Tools & Spares Kit (75BK6015-00)	425-M-00004	PLASTAB Anti Corrosion disk	Anti-Corrosion disk used inside the electronics housing battery compartment.
	5020	Silicone lubricant	Used on the electronics housing O-Ring.
	97Z-6050-00	O-Ring	Spare battery compartment 2-258 O-Ring.
	DES2	Desiccant	Spare desiccant bag used inside the electronics housing battery compartment.
	74B-6000-00	External Power dummy plug	Use dummy plugs to protect the electronics housing connectors whenever the cables are not connected.
	74B-6001-00	I/O dummy plug	
	74B-6002-00	Pressure dummy plug	

Power Requirements

The V-ADCP is designed to operate on 10 to 28 VDC from internal batteries or an external DC power supply. Both power sources may be used concurrently; the source that supplies the highest voltage will automatically supply power to the system.

By combining an external DC power supply with a voltage of at least 21 VDC to override the 18 VDC provided by the internal batteries, one could obtain uninterrupted operation of the V-ADCP during brief power outages.

Check that the battery voltage is above 10 Volts DC. The V-ADCP will work at 10 volts; however, batteries with voltages below 11 volts are at or near their end of life and are approaching uselessness.

Setting up the V-ADCP

To set up the V-ADCP:

1. Connect the I/O cable to the computer's serial port and the electronic housing.
2. Connect the sensor cable to the electronic housing.
3. Install the batteries. See Battery Replacement.

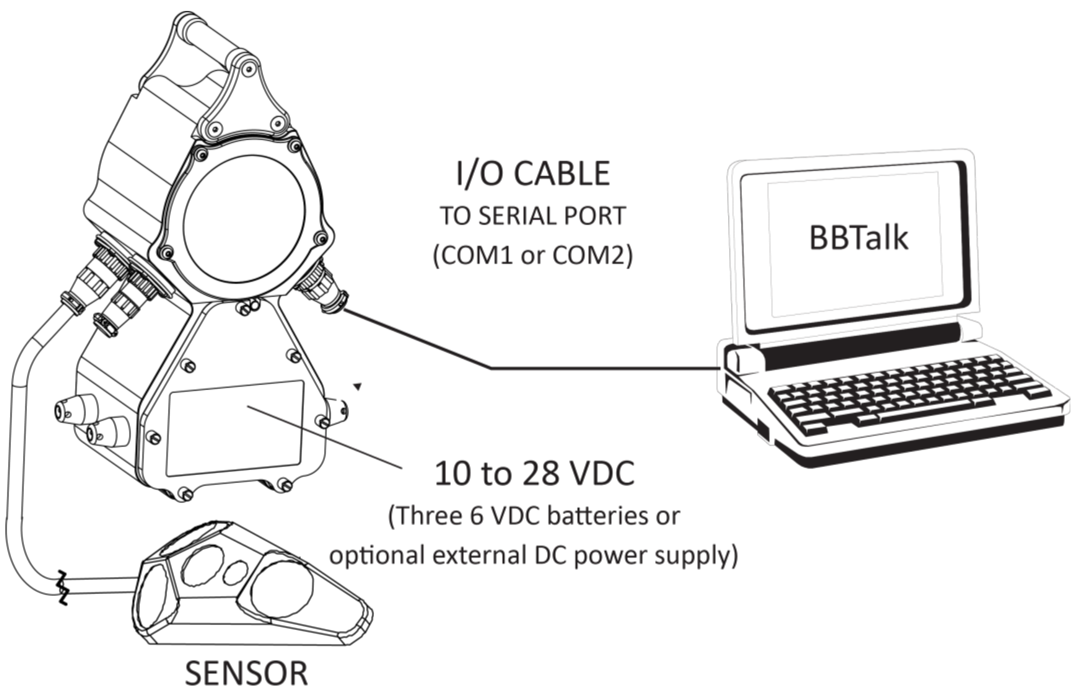
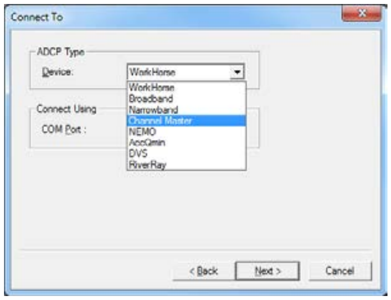


Figure 3. Testing the V-ADCP

Connecting to the V-ADCP

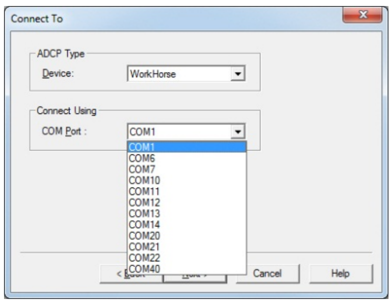
To connect to the V-ADCP:



Start BBTalk

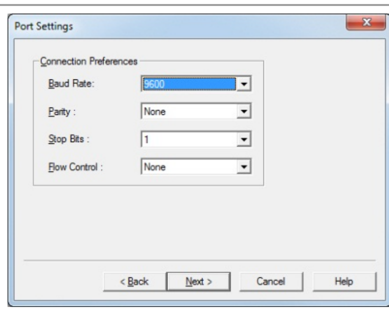
Start the *BBTalk* program (for help on using *BBTalk*, see the RDI Tools User's Guide).

On the **Connect To** screen, select **Channel-Master**.



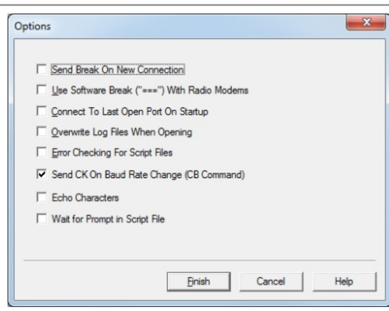
Select the COM port the V-ADCP cable is connected to.

Click **Next**.



Enter the **Baud Rate**, **Parity**, **Stop Bits**, and **Flow Control**. If you are unsure of the set-tings, leave them at the default settings as shown.

Click **Next**.



Click **Finish**.

```
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Firmware Version: 40.11

>
```
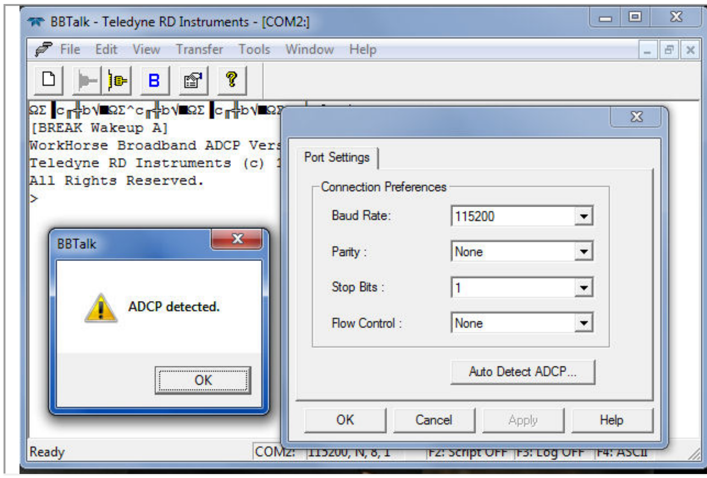

Wakeup

On the **File** menu, click **Break** (you can also press the **End** key to send a break or press the **B** button on the Toolbar).

You should see the wakeup message appear on the log file window.

If the V-ADCP does not respond, check the serial port, cables, and battery connection.



If the wakeup message is not readable or visible:

On the **File** menu, click **Properties**.

Click the **Auto Detect ADCP** button.

Click **OK** when the V-ADCP is detected. Try to wake up the V-ADCP again.

Both *BBTalk* and the V-ADCP must use the same Baud rate.

Changing the Baud Rate in the V-ADCPs

The V-ADCP 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 V-ADCP. This procedure assumes that you will be using the program *BBTalk* that is supplied by Teledyne RD Instruments.

```
ADFM
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Firmware Version: 40.11
>cr1
[Parameters set to FACTORY defaults]
>
```

Connect the V-ADCP to the computer and apply power.

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

At the ">" prompt in the communication window, type **CR1** then press the Enter key. This will set the V-ADCP to the factory default settings.

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

Send the CB-command that selects the baud rate you wish. The table on the left shows the CB-command settings for different baud rates with no parity and 1 stop bit.

For example, to change the baud rate to 115200, at the ">" prompt in the communication window, type **cb811** then press the Enter key.

The **CB?** command will identify the communication setting.

```
>cb?
CB = 411 ----------------- Serial Port Control (Baud
[4=9600]; Par; Stop)
>cb811
>CK
[Parameters saved as USER defaults]
>cb?
CB = 811 ----------------- Serial Port Control (Baud
[8=115200]; Par; Stop)
>
```

BBTalk will send the command **CK** to save the new baud rate setting.

Exit *BBTalk*.

The V-ADCP 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.

Exit *BBTalk* so the communication port is available for use with other programs.

Testing the V-ADCP

To test the V-ADCP:

1. Interconnect and apply power to the system as shown in Figure 3.
2. Start the *BBTalk* program.
3. 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.

```
ADFM
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Firmware Version: 40.11

>
```

4. Observe the LED on the electronic housing is green. If the LED is red, check the cables and dummy plugs are connected. If the LED is not illuminated, check the power.
5. At the “>” prompt in the communication window, enter the direct command **CR1** then press the **Enter** key. This will set the V-ADCP to the factory defaults.

```
>CR1
[Parameters set to FACTORY defaults]
```

6. At the “>” prompt in the communication window, enter the direct command **CK** then press the **Enter** key. This will save the setting as the user defaults.

```
>CK
[Parameters saved as USER defaults]
>
```

7. At the “>” prompt in the communication window, enter the direct command **PS0** then press the **Enter** key. This will display the V-ADCP system configuration data.

```
>ps0
Serial Number: 0
Frequency: 2457600 Hz
Configuration: V-ADCP: 3-beam velocity + vertical stage.
Transducer Type: PISTON
Beam Angle: 20 Degrees
Beam Pattern: CONVEX
Sensors: I/O Expander  1-w TEMP
CPU Firmware: 40.11
FPGA Version: 2.00.003
Sensor Firmware: ----
Board Serial Number Data:
76 00 00 00 78 45 6F 28 DS18B20 TMP SNS
11 00 00 00 32 00 72 23 RCV72B-2003-13X
18 00 00 00 0E 9D 3E 23 PIO72B-2001-13A
F6 00 00 00 20 C7 25 23 PER72B-2020-00X
59 00 00 00 34 A7 CD 23 XDC72B-1009-00X
8C 00 00 00 15 1F DD 23 IOE72B-2017-00X
FF 00 00 00 0E A1 7F 23 DSP72B-2002-00A
>
```

8. At the ">" prompt in the communication window, enter the direct command **PT3** then press the **Enter** key. This will run the V-ADCP Receive Path test.

```
>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  90  89  89  97     82  80  83  97     77  80  75  99     80  80  82  98
```

```
  2  68  64  65  89     50  47  50  90     35  43  33  95     47  49  50  94
  3  46  39  38  78     26  21  24  81      5  18   8  89     20  23  25  87
  4  30  17  18  68     12   7  14  69      7   7  18  83      9  12  11  79
  5  19   4   1  57      3  11  10  58      2   9  12  76      7   7   2  70
  6   8   5  14  43      5   8   5  47     13  12   8  67      7   7   3  60
  7   2   8  21  30      6   3   2  36     15  11  11  58     14  10   8  52
Sin Duty Cycle (percent)
     46  53  50  56     54  51  54  54     46  58  55  63     56  53  52  65
Cos Duty Cycle (percent)
     55  52  54  51     52  54  51  57     56  52  53  70     57  52  53  64
RSSI Noise Floor (counts)
     78  58  81  65     66  49  68  51     83  63  86  72     66  48  68  51

>
```

If the wakeup, PS0, and PT3 messages display, the V-ADCP is functioning normally.

What if the V-ADCP Does Not Respond

If the V-ADCP does not respond (no LED or Red LED light is on), check the following items.

- Make sure that all connectors on the electronic housing have either a cable or dummy plug connected. **The V-ADCP will not function unless all connectors are protected (Red LED is on).**
- Is power connected to the V-ADCP electronic housing (internal lantern batteries and/or external power)?
- If wakeup (Green LED is on) still does not occur, contact Teledyne RDI (see Technical Support).

V-ADCP Care

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

General Handling Guidelines

- Never set the V-ADCP sensor face down on a hard or rough surface. **The transducer faces or blue urethane body may be damaged.**
- Do not store the V-ADCP sensor in temperatures over 75 degrees C. **The transducer faces may be damaged.**
- Do not lift or support a V-ADCP sensor by its cable. **The connectors or cables may break.**

Assembly Guidelines

- Do not open the electronics bay or disassemble the electronics into the bay. **There are no user replaceable parts inside the electronics bay.** The electronics bay is the round, upper bay of the electronics housing.
- Carefully replace the battery cover after replacing the internal 6 VDC alkaline lantern batteries. **Loose, missing, stripped hardware, or a damaged battery cover plate O-ring can lead to corrosive gas or water ingress, and cause damage to the V-ADCP.**
- Make sure that all connectors on the electronic housing have either a cable or dummy plug connected. **Dummy plugs protect the connector contacts.**
- Use caution when mating or un-mating the cables to the Electronics Housing to avoid damage to the connector hardware. **Under all circumstances, the intrusion of water or any other foreign matter into the connector contact area must be avoided, since this may result in permanent damage to the connector and may render the V-ADCP inoperable.**
- Use rubber tape around the cable connectors to add an extra level of protection from moisture or gas ingress and increase the life of the connector pins.

Deployment Guidelines

- Use the V-ADCP Quick Start Guide to help remember how to connect to the V-ADCP.

Chapter 2

INSTALLATION

In this chapter, you will learn:

- V-ADCP Preparation
- Electronic Housing Mounting
- V-ADCP Sensor Installation

V-ADCP Preparation

Before placing the V-ADCP sensor into the water, you must prepare it for deployment.

Electronic Housing Mounting

If the housing is not properly sealed prior to deployment, the V-ADCP may be destroyed. Visually inspect the mating surfaces of the housing to ensure that there are no obstructions. The faces should be parallel to one another and there should be no gaps. Check to ensure that the fasteners holding the housing together are tight.

The V-ADCP electronic housing should be mounted in an environmental enclosure on site. Before placing the electronic housing in a corrosive atmosphere, make sure that all connectors on the housing have either a cable or dummy plug connected. **The V-ADCP will not power up unless all connectors are protected (red LED on).**

V-ADCP Sensor Installation

This section is a guide for installing the V-ADCP. Use this section to plan your installation layout. We recommend you distribute this information to your organization's decision-makers and installation engineers.

Sensor Orientation and Coordinates

Install the sensor on the bottom in the middle of the channel. Make sure the channel bottom is flat and horizontal. Place the sensor so that Beam 1 faces upstream, Beams 2 and 3 face downstream. Beam 4 faces straight up. The sensor must not be rotated about the vertical.

The V-ADCP uses three types of coordinates: beam, instrument (X,Y,Z), and Streamwise coordinate. The V-ADCP will collect velocity data in either beam or instrument coordinates, depending on the user setting of the EX command. Beam velocity or Vx, Vy, and Vz will be recorded, but not both. The V-ADCP always collects data in Streamwise coordinate and always records Streamwise velocity data regardless the EX settings (see data output format).

Beam Coordinate

The V-ADCP uses three slant beams (Beams 1, 2, and 3) for velocity measurement. The beam coordinate is defined as the three radial directions of the three slant beams. The V-ADCP first collects the beam velocity at individual cells on the three beams.

Instrument Coordinate (X, Y, Z)

Figure 4 shows the V-ADCP instrument coordinate: X, Y, and Z.

Y-Axis - The Y-axis runs parallel to the channel flow direction.

X-Axis - The X-axis is perpendicular to the channel flow.

Z-Axis –Z-axis is perpendicular to the X,Y plane.

The V-ADCP, by default, transforms the beam velocities to the X, Y, and Z velocity components: V_x, V_y, and V_z.

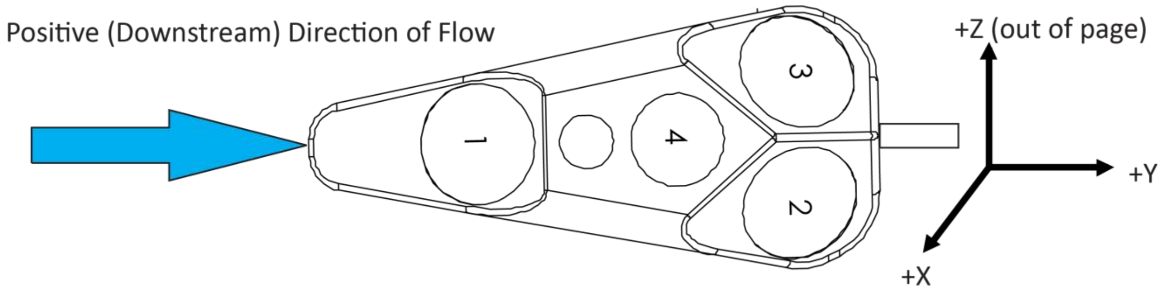


Figure 4. V-ADCP Instrument Coordinates

Streamwise Coordinate

The Streamwise coordinate is a one dimension coordinate. Its axis is assumed to be in the same direction as the Y direction. However, the Streamwise velocity is measured at individual cells on the three beams. Thus, there will be 60 Streamwise velocities for a 20-cell setting; while there will be only 20 V_y for the same setting.

Sensor Mounting Plate

The V-ADCP sensor assembly includes three drilled and tapped mounting holes. To avoid damage to the sensor assembly and ceramics, these holes are the only locations that should be used to mount the sensor assembly to the sensor mounting plate. These mounting holes are drilled and tapped for a metric size machine screw, size M6-1.0.

Make sure that the I/O cable is routed so that it is not subject to becoming entangled or snagged.

Figure 5. Rear View of Sensor Mounting Plate

Installing the V-ADCP on Site

The recommended installation procedure is described below.

1. Connect all cables required for use to the electronics housing.
2. Mount the sensor to the mounting plate.
3. Attach the sensor to any custom-made mounting structure.
4. Place the sensor into the water.
5. Secure the cable by attaching it to the channel bottom and the side wall.

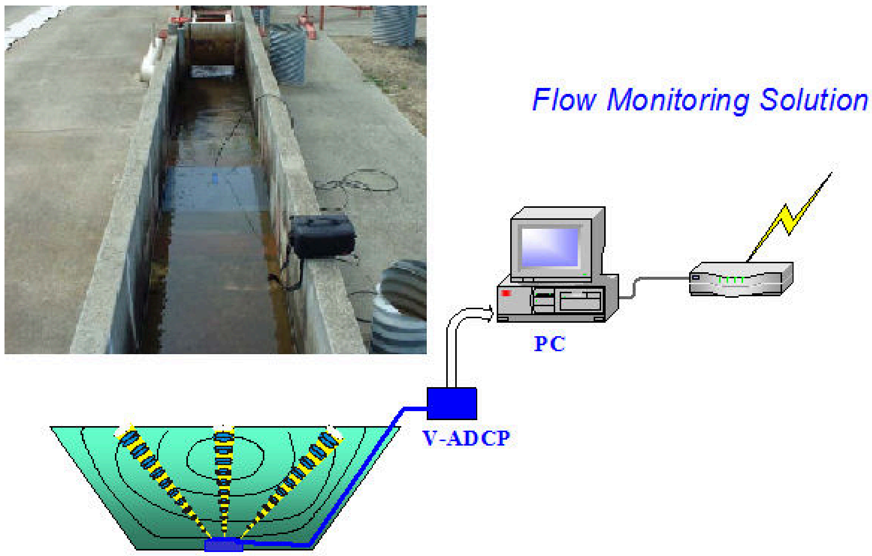


Figure 6. V-ADCP Installation Example

Chapter 3

COLLECTING DATA

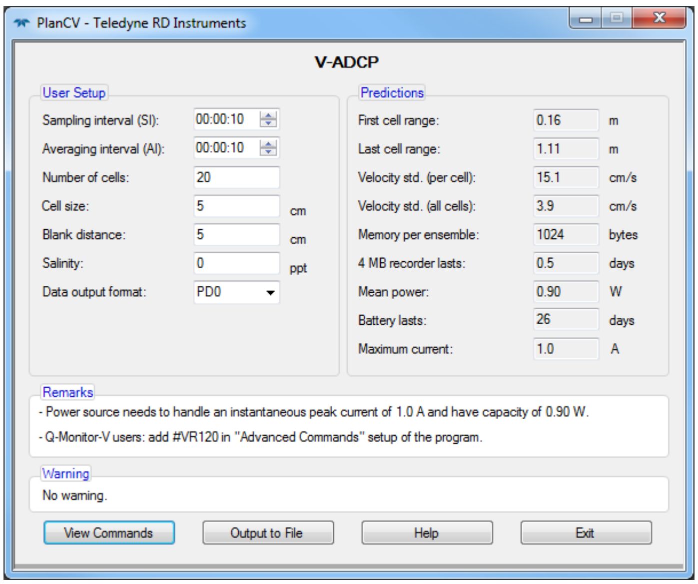
In this chapter, you will learn:

- Sending Commands to the V-ADCP
- Collecting Data

Creating Command Files

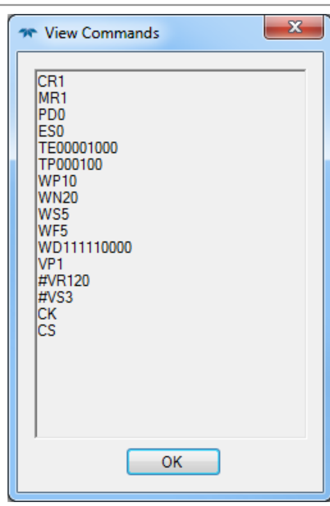
Use *PlanCV* to create a command file used to configure the V-ADCP for a self-contained deployment.

At the opening screen, select **V-ADCP**.



Use the PlanCV page to configure the **User Setup** and view the **Predictions**.

See the PlanCV User's Guide located on the software CD.

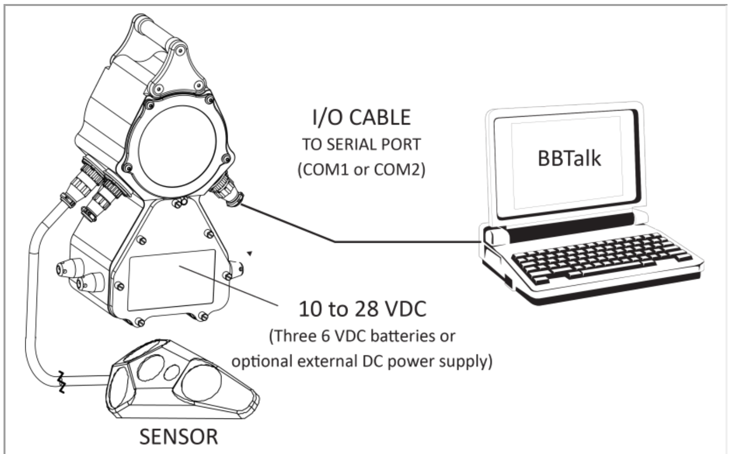


Click the **View Commands** button to review the commands. Click **OK**.

Click the **Output to File** button to save the command file.

Sending Commands to the V-ADCP

Use *BBTalk* to send the commands to the V-ADCP.



Connect the I/O cable to the computer's serial port and the electronic housing.

Interconnect and apply power to the system as shown.

```
V-ADCP
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Firmware Version: 40.08

>
```
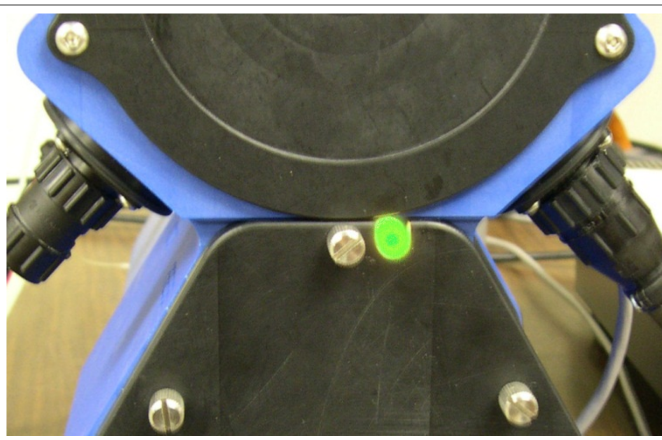

Start *BBTalk*.

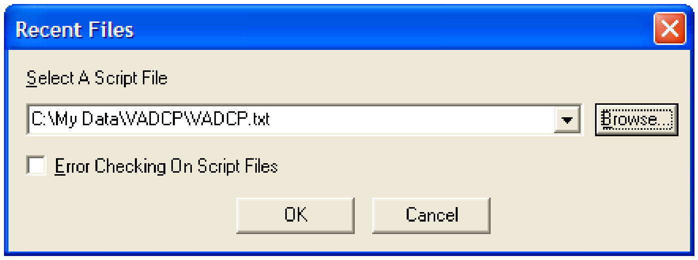
Send a BREAK to the V-ADCP by pressing the **End** key. When the V-ADCP receives a BREAK signal, it responds with a wake-up message similar to the one shown. The V-ADCP is now ready to accept commands at the ">" prompt.



Observe the LED on the electronic housing is green.

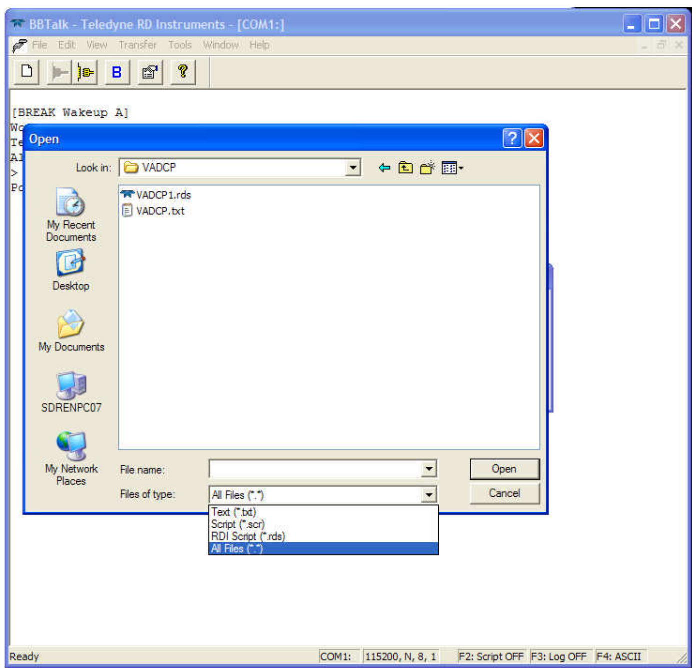
If the LED is red, check the cables and dummy plugs are connected. If the LED is not illuminated, check the power/batteries.

Make sure that all connectors on the electronic housing have either a cable or dummy plug connected. **Dummy plugs protect the connector contacts.**



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

On the **Select a Script File** box, select the command file from the scroll-down list or click the **Browse** button.



When browsing for a file, if no extension is given for the command file, an extension of *.txt* is assumed.

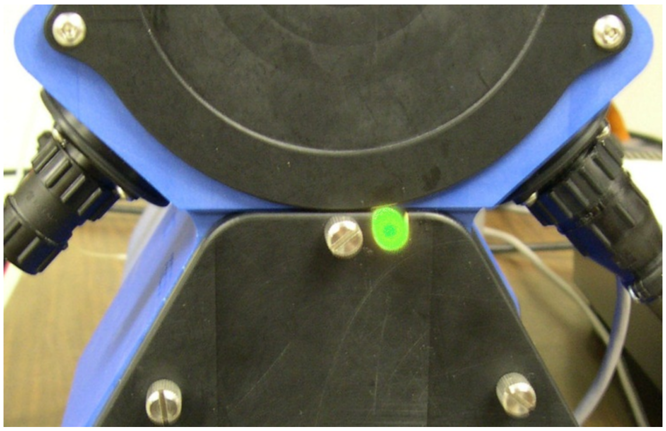
On the **Files of Type** box, select **All Files (*.*)** if your command file uses a different extension.

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).

Collecting Self-Contained Data

This section has simple instructions for collecting V-ADCP data. **Once the V-ADCP sensor has power applied, it begins to collect data.**

The command file does not need to be re-sent unless you want to change the commands (see Send the Commands to the V-ADCP).



Disconnect the serial cable from the electronic housing and connect the dummy plug.

Observe the LED to determine if data collection is correct.

When deployed, the LED has the following meaning:

- GREEN = all is OK. When the unit is asleep, the LED is not on.
- RED = Open interlock.

When the V-ADCP system begins to collect a sample, the LED stays on at the end of pinging and during data output. The LED is off when pinging to save energy. This cycle repeats for each ensemble.

To collect Real-Time data, see the Q-Monitor-V software User's Guide.

Recovering Data from the Loop Recorder

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

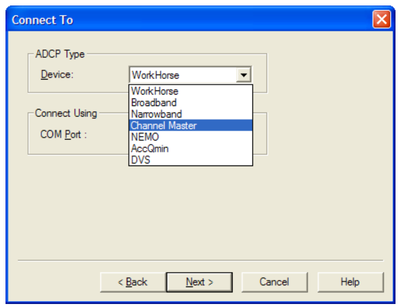
Using BBTalk to Recover Data

Use *BBTalk* to recover data from the loop recorder.

You must use *BBTalk* version 3.04 or greater. Older versions of *BBTalk* do not have the Loop Recorder functions.

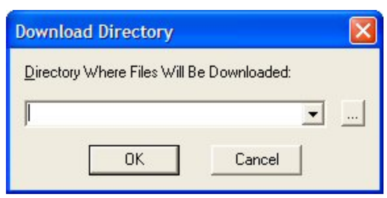
To recover data:

1. Start *BBTalk*. Configure *BBTalk* to connect to a Channel Master ADCP type device (see the RDI Tools User's Guide for details on using *BBTalk*).

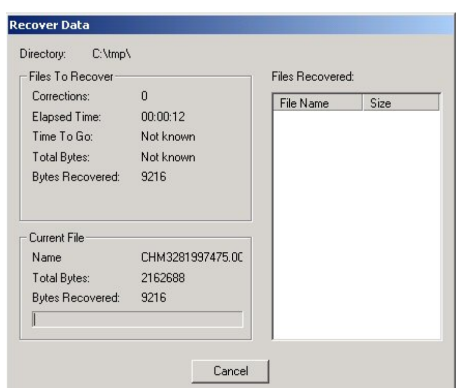


Make sure to select **Channel Master** as the **Device**. *BBTalk* will communicate with the V-ADCP if you select **WorkHorse** as the device, but will not be able to recover the recorder.

2. On the **File** menu, click **Recover Loop Recorder**.
3. Enter the directory where the files will be downloaded. Click the "…" button to browse for the directory. Click **OK**.



4. *BBTalk* displays current protocol status, filename being received, total size of receiving file and current number of bytes received.



Chapter 4

V-ADCP MAINTENANCE

In this chapter, you will learn:

- Visual Inspection of the V-ADCP
- Cables and Dummy Plugs
- Battery Replacement
- Periodic Maintenance

This section explains how to prepare the V-ADCP for deployment, how to do certain maintenance, and how to prepare the V-ADCP for storage or shipment.

Do not open the electronics bay or disassemble the electronics in the bay. The electronics bay is the round, upper bay of the electronics housing. **There are no user serviceable parts inside. You will void the warranty if you open the electronics bay.**

Spare Parts

The following parts are included in the spare parts kit.

Table 1: Spare Parts

Part number	Description	Where Used
97Z-6050-00	2-258 O-ring, battery cover, bore seal	Electronics Assembly battery compartment
5020	Lubricant, silicone	
DES2	Desiccant	
425-M-00004	PLASTAB anti-corrosive disk with adhesive	
74B-6000-00	Dummy plug, external power	Electronics Assembly connectors
74B-6001-00	Dummy plug, I/O	
74B-6002-00	Dummy plug, secondary depth sensor	

Visual Inspection of the V-ADCP

Inspect the V-ADCP using Table 2 and Figure 1 before and after every deployment. If you find any discrepancies, call TRDI for instructions.

Table 2: Visual Inspection Criteria

Item	Inspection Criteria
V-ADCP Sensor	Check the orange transducer faces on the sensor. The urethane coating on the sensor's transducer faces is important to V-ADCP watertight integrity. Mishandling, chemicals, abrasive cleaners, and excessive pressures can damage the transducer ceramics or Rexolite coating. Inspect the transducer faces for dents, chipping, peeling, shrinkage, hairline cracks, and damage that may affect watertight integrity or transducer operation. Repair of the transducer faces should only be done by TRDI. Never set the sensor on a rough surface; always use foam padding to protect the transducers.
I/O connectors	Check the I/O connectors for cracks or bent pins. The dummy plugs should be installed any time a cable is removed, when the V-ADCP is in storage, or is being handled.
I/O Cable	Check the cable connectors for cracks or bent pins.

Cables and Dummy Plugs

Use the following procedure to connect the cables and dummy plugs on the V-ADCP housing.

> Make sure that all connectors on the electronic housing have either a cable or dummy plug connected. **The V-ADCP will not function unless all connectors are protected (Red LED on).**

> The dummy plugs should be installed any time cables are removed. Use the dummy plugs when the V-ADCP is in storage or is being handled.

The cables connect to the electronics housing using keyed connectors.

To connect a cable:

1. To make the connection, remove the Dummy Plug from the receptacle on the electronics housing.
2. Insert the cable connector into the receptacle, rotating it until the keyed portions are properly aligned.
3. Thread the coupling ring onto the receptacle to complete the connection.

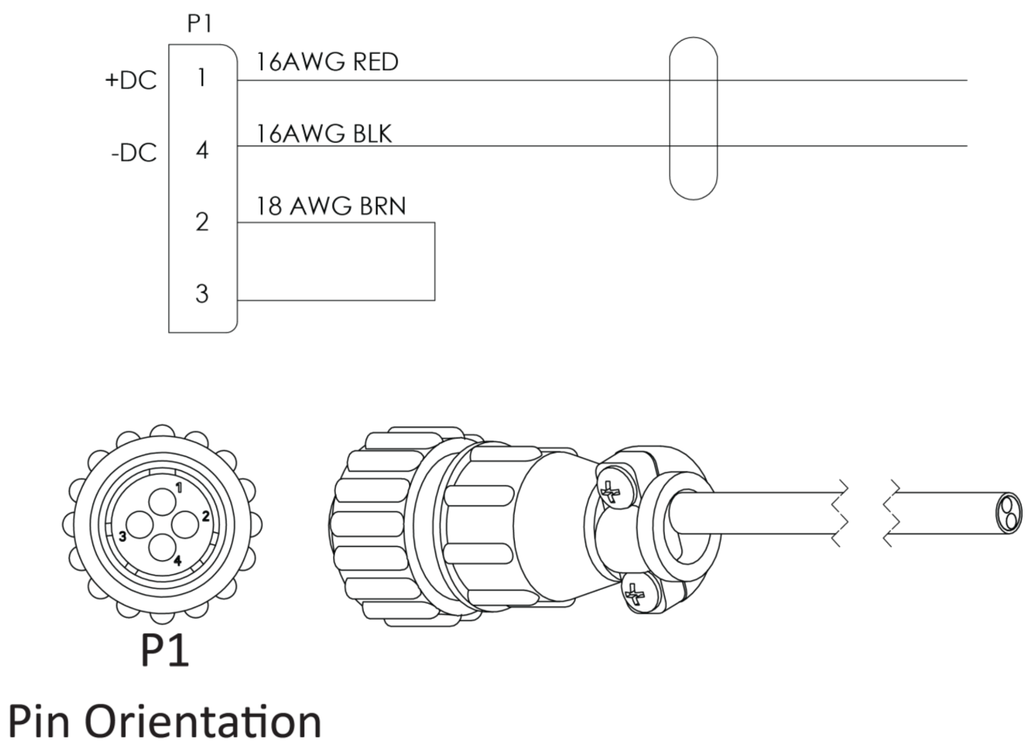


Figure 7. External Power Pigtail Cable

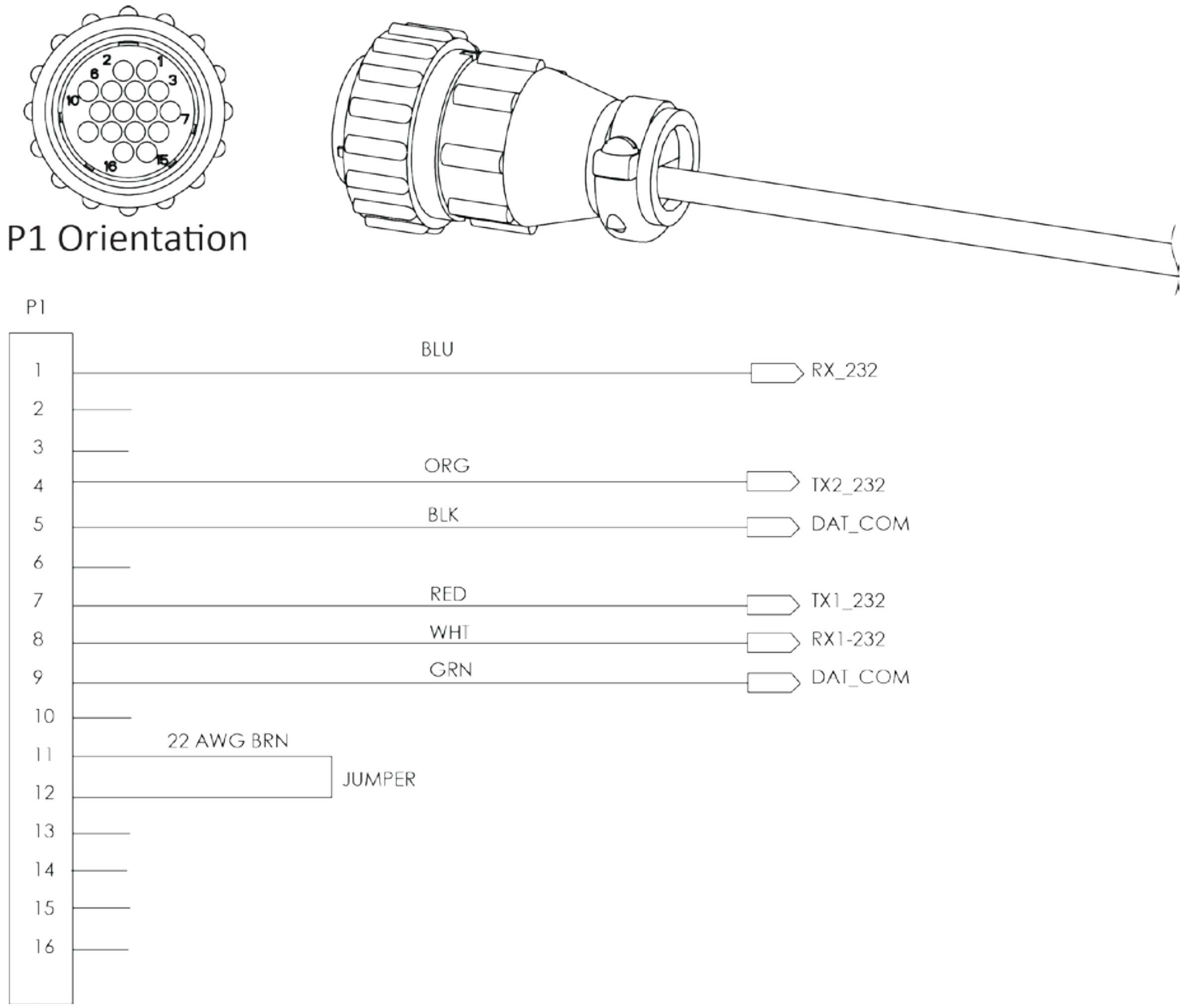


Figure 8. I/O Pigtail Cable

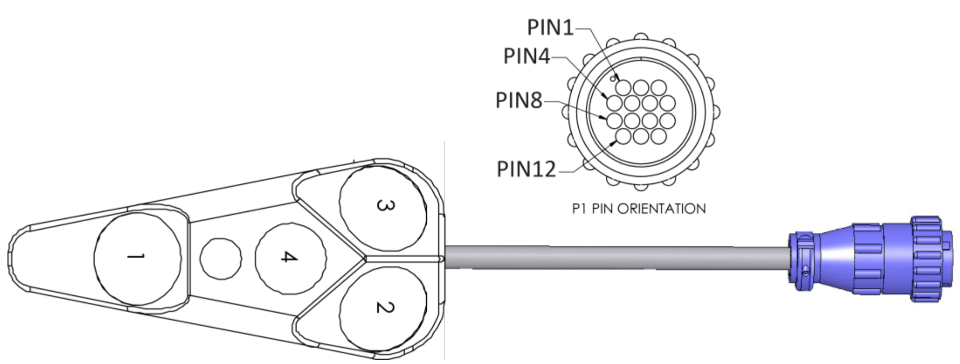


Figure 9. Sensor Cable Assembly

The Sensor cable is molded to the sensor housing. Do not attempt to remove.

Periodic Maintenance

Cleaning the V-ADCP

Before storing or shipping the V-ADCP, remove all foreign matter and biofouling. Clean the Electronics Housing and sensor assembly with mild soap and water prior to storage, packaging, and shipment. Waterless hand cleaners remove most petroleum-based fouling. Rinse with fresh water to remove soap residue.

DO NOT use abrasive agents or solvents, as they may damage the V-ADCP surfaces. **MILD** chlorine bleach solutions may be used if odors persist or if disinfection of the unit is desired. Use caution to prevent water from entering the Electronics Housing while cleaning. Ensure that the unit is completely dry prior to packaging and shipment to avoid mold, corrosion, or other damage during shipment.

> Do not use power scrubbers, abrasive cleansers, scouring pads, high-pressure marine cleaning systems, or brushes stiffer than hand cleaning brushes on the sensor faces.

> Always dry the V-ADCP before placing it in storage to avoid fungus or mold growth. Do not store the V-ADCP in wet or damp locations.

Battery Replacement

> If the Electronics Unit is connected to an external power supply, for your own personal safety TRDI recommends disconnecting the power supply first before opening the battery compartment.

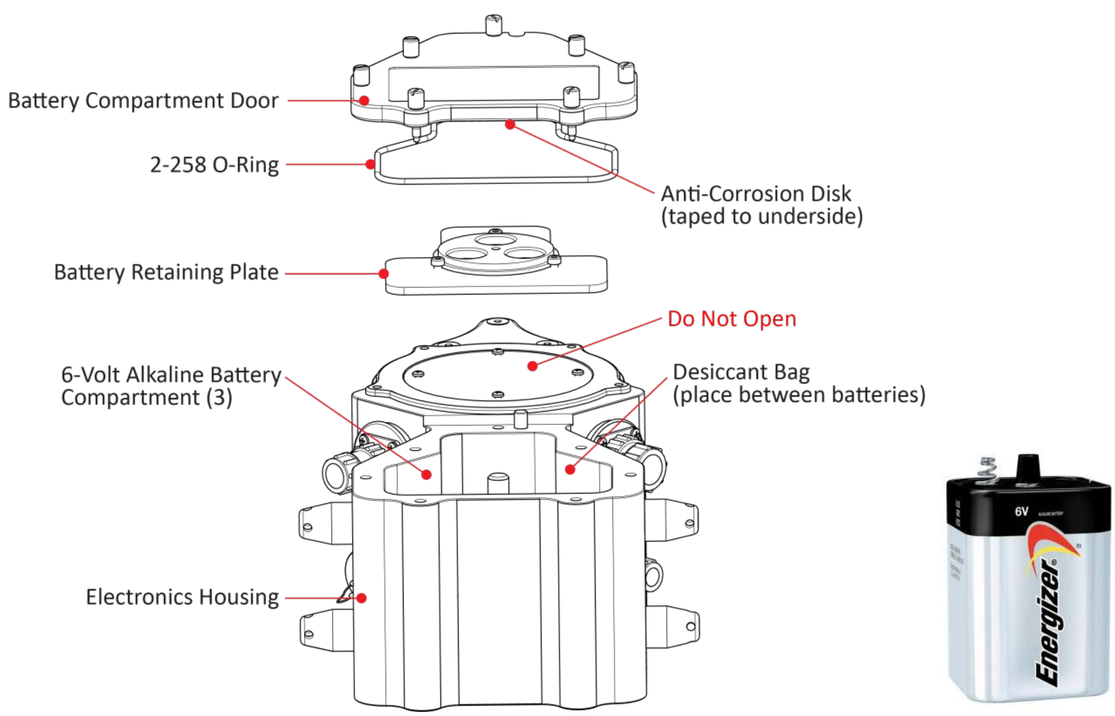


Figure 10. Battery Replacement

The V-ADCP uses three internal alkaline type batteries, with a nominal capacity of 26,000 mAh each. The nominal voltage is 18V for all batteries connected in series, while the low voltage is 10V. These batteries are commonly available. TRDI recommends purchasing spare batteries.

To replace the batteries:

1. In a non-corrosive atmosphere, remove the battery compartment door by loosening the seven thumbscrews.
2. Remove the Battery Retaining Plate Assembly.
3. Remove all of the old batteries.
4. Replace with three new 6-volt alkaline lantern batteries with spring terminals. The recommended replacement alkaline batteries are the Eveready Energizer, Model 529.
5. Replace the desiccant (Desiccant Bags) and anti-corrosion disk (Anti-Corrosion Disk).
6. Check that the battery compartment O-ring is in the O-ring groove and it is in good condition (see Battery Cover Plate O-Ring Inspection and Replacement).
7. Install the Battery Retaining Plate Assembly by placing the plate over the batteries and threading the center nut down on the Battery Stud until finger tight.

Figure 11. Battery Retaining Plate Assembly

8. Install the Battery Cover Assembly over the battery well. Tighten all seven screws one by one in a star pattern around the cover. **Tighten the thumbscrews "hand" tight only.**

Although each thumbscrew has a screwdriver slot, do NOT use any tools to tighten the screws. **Over-tightening can cause the threads to strip.**

Do not short out battery leads when removing the batteries. High currents may flow during shorts, and fire or personal injury may result. THERE IS NO FUSE IN SERIES WITH THESE BATTERIES!

Do not mix old and new batteries

Do not mix alkaline with non-alkaline batteries

Do not mix batteries of different brands

Do not use damaged batteries

Do not use expired batteries (See battery expiration Date)

Do not leave the batteries inside the V-ADCP for extended periods. The batteries may leak, causing damage to the electronics. Store the batteries in a cool, dry location (0 to 21 degrees C).

Inspecting the O-Ring

This section explains how to inspect/replace the V-ADCP battery compartment O-ring. A successful deployment depends on the condition of the O-ring and the retaining groove. Read all instructions before doing the required actions.

TRDI strongly recommends inspecting the O-ring whenever you disassemble the V-ADCP. Inspecting and replacing the O-ring should be the last maintenance task done before sealing the V-ADCP.

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

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

   If the O-ring appears compressed from prior use, replace it. **Weak or damaged O-rings will cause the V-ADCP to flood.**

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

   Check the O-ring groove thoroughly. **Any foreign matter in the O-ring groove may cause the V-ADCP to flood.**

3. If a scratch is on the plastic housing flange O-ring groove, it may be gently sanded using 600-grit (wet) sandpaper. Use care not to cause further damage.
4. 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.

   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.

Replacing the Desiccant Bags

Desiccant is used to dehumidify the battery housing interior. Desiccant is essential in deployments with plastic housings. The factory-supplied desiccant lasts a year at specified deployment depths and temperatures. Remember that desiccant rapidly absorbs moisture from normal room air. As a minimum, replace the desiccant bags whenever the batteries are replaced.

Do not open the desiccant bag. Contact with the silica gel can cause nose, throat, and skin irritation.

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

To replace the desiccant:

1. Remove the battery cover assembly.
2. Remove the new desiccant bags from the airtight aluminum bag.
3. Remove the old desiccant bag and install a new one. Place the desiccant bag in one of the corner pockets of the battery compartment.
4. Install the battery cover assembly.

Replacing the Anti-Corrosion Disk

The anti-corrosion disk is used to protect the battery housing interior. As a minimum, replace the anti-corrosion disks whenever the alkaline batteries are replaced.

To replace the anti-corrosion disk:

1. Remove the battery cover assembly.
2. Remove the new anti-corrosion disk from the airtight aluminum bag.
3. Remove the anti-corrosion disk and install a new one. The anticorrosion disk is affixed to the underside of the battery cover assembly.
4. Install the battery cover assembly.

Installing Firmware Upgrades

Firmware upgrades can be downloaded from TRDI's website support page: (http://www.rdinstruments.com/support/softwarefirmware/cc_software.aspx#vadcp), item 52a.

If the firmware upgrade is not available via the web, then please contact Field Service (rdifs@teledyne.com) to request a copy.

V-ADCP firmware packages may contain updates to one or more of the following: CPU, FPGA firmware, and/or Sensor firmware.

To install a firmware upgrade:

1. Connect the V-ADCP to the computer as shown in Setting up the V-ADCP.
2. Download and unzip the *V_ADCP_FW_xxxx.zip* (where *xxxx* is the firmware version) file onto your computer.
3. View the *Readme.txt* file for details on what is new in this version of the firmware.
4. Double-click *WinFlash.exe* to start the firmware installation.
5. Click **Next** and follow the on-screen prompts.
6. If you are not able to install the new firmware, contact Customer Service.
7. After successfully upgrading the firmware, use *BBTalk* to test the V-ADCP (see).

Chapter 5

RETURNING SYSTEMS TO TRDI FOR SERVICE

In this chapter, you will learn:

- How to pack and ship the V-ADCP
- How to get a RMA number
- Where to send your V-ADCP for repair

Shipping the V-ADCP

This section explains how to ship the V-ADCP.

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

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

TRDI strongly recommends using the original shipping crate whenever transporting the V-ADCP.

If you need to ship the V-ADCP, use the original shipping crate whenever possible. If the original packaging material is unavailable or unserviceable, additional material is available through TRDI.

For repackaging with commercially available materials:

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

Returning Systems to the TRDI Factory

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

Step 1 - Request a Return Material Authorization

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

- Open the RMA using the web link: http://adcp.com/support/sendADCP.aspx
- Contact Customer Service Administration at rdicsadmin@teledyne.com
- Call +1 (858) 842-2700

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship via air freight, prepaid

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

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

Mark the Package(s)

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

Airport of Destination = San Diego
Notify Paxton, Shreve and Hayes

Phone: +1 (619) 232-8941
Fax: +1 (619) 232-8976

Step 4 - Urgent shipments

Send the following information by fax or telephone to TRDI.

Attention: Customer Service Administration

Fax: +1 (858) 842-2822

Phone: +1 (858) 842-2700

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

Returning Systems to TRDI Europe Factory

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

Step 1 - Request a Return Material Authorization

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

- Open the RMA using the web link: http://adcp.com/support/sendADCP.aspx
- Contact Customer Service Administration at rdiefs@teledyne.com
- Call +33(0) 492-110-930

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship Via Air Freight, Prepaid

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

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

Mark the package(s) as follows:

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

Step 4 - Include Proper Customs Documentation

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

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

Step 5 - Send the Following Information by Fax or Telephone to TRDI

Attention: Sales Administration

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

Fax: +33(0) 492-110-931

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

NOTES

Chapter 6

COMMANDS

In this chapter, you will learn:

- Control System Commands
- Environmental Commands
- Index Velocity and Discharge Commands
- Loop/Slate Recorder Commands
- Performance and Testing Commands
- Timing Commands
- Vertical Beam Commands
- Water Profiling Commands

Data Communication and Command Format

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

Immediately after you apply power to the V-ADCP, it responds with a wake-up message and then it either enters the command mode or begins pinging. You can send a BREAK signal to the V-ADCP using *BBTalk* by pressing the **End** key. When the V-ADCP receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The V-ADCP is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
ADFM
Teledyne RD Instruments (c) 2011
All rights reserved.
Firmware Version: 40.11

>
```

Command Input Processing

Input commands set V-ADCP 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,

```
>WP0001<CR> [Your input]
```

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

```
>WP00001<CR>     [Your original input]
>                [V-ADCP response to a valid, no-output command]
```

If you enter a valid command that produces output data, the V-ADCP 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 V-ADCP responds with an error message similar to the following.

```
>WPA<CR>                                    [Your input]
>WPA  ERR 002:  NUMBER EXPECTED<CR><LF>     [V-ADCP response]
>
```

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

Data Output Processing

After the V-ADCP completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected and averaged during the ensemble interval. A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, and status data.

When data collection begins, the V-ADCP uses the settings last entered (user settings) or the factory-default settings. The same settings are used for the entire deployment.

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

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 V-ADCP uses it to set a processing value (time, range, percentage, processing flags). All measurement values are in metric units (mm, cm, and dm).

Miscellaneous Commands

? – 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 V-ADCP 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 CB-command setting enter CB?.

V-ADCP Command Groups:

```
>?
Available Commands:

C ----------------------- Control Commands
E ----------------------- Environment Commands
M ----------------------- Loop Recorder Commands
P ----------------------- Performance Test Commands
T ----------------------- Time Commands
V ----------------------- Vertical Beam Commands
Y ----------------------- Display Banner
W ----------------------- Water Profiling Commands
? ----------------------- Display Main Menu

>C?
Available Commands:

CA   300 ---------------- Communication Timeout (0=Off,10-65536 sec)
CB 811 ------------------ Serial Port Control {baud;parity;stop}
CF 11111 ---------------- Set Ctrl Flags {e;p;b;s;*}
CK ---------------------- Save Command Parameters to Flash
CL 1 -------------------- Sleep Enable ( 1=Enabled, 0=Disabled )
CR ---------------------- Restore Cmd defaults [0=user,1=factory]
CS ---------------------- Start Pinging
CT 1 -------------------- Turnkey (0 = OFF, 1 = ON)
CZ ---------------------- Put the ADCP to sleep.
C? ---------------------- Display C-Command Menu

>CB?
CB 811 ------------------ Serial Port Control {baud;parity;stop}
>
```

Break

Purpose Interrupts V-ADCP without erasing present settings.

Format <BREAK>

Recommended Setting. Use as needed.

Description A BREAK signal interrupts V-ADCP processing. It is leading-edge triggered and must last at least 300 ms. A BREAK initializes the system, sends a wake-up (copyright) message, and places the V-ADCP 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>

```
ADFM
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All rights reserved.
Firmware Version: 40.11

>
```

If the message "WARNING: RTC not set!" appears under the wakeup message, use the TS command to set the clock (see TS – Set Real-Time Clock).

Y – Display Banner

Purpose Displays the banner.

Format Y

Description Use the Y command to display the V-ADCP banner.

```
>Y
ADFM
Teledyne RD Instruments (c) 2011
All rights reserved.
Firmware Version: 40.11

>
```

Control System Commands

The V-ADCP uses the following commands to control certain system parameters.

```
>C?
Available Commands:

CA 300, 30 -------------- CommTimeout (0=Off,10-65536sec),Blink(0=OFF,2-999sec)
CB 811 ------------------ Serial Port Control {baud;parity;stop}
CF 11111 ---------------- Set Ctrl Flags {e;p;b;s;*}
CK ---------------------- Save Command Parameters to Flash
CL 1 -------------------- Sleep Enable ( 1=Enabled, 0=Disabled )
CR ---------------------- Restore Cmd defaults [0=user,1=factory]
CS ---------------------- Start Pinging
CT 1 -------------------- Turnkey (0 = OFF, 1 = ON)
CZ ---------------------- Put the ADCP to sleep.
C? ---------------------- Display C-Command Menu
```

Standard Control System Commands

This section lists the most often used Control System commands.

CA – Communication Timeout

Purpose: Sets the number of seconds to wait after the last input from the user before auto-starting the deployment: also sets the blink rate.

Format: CA*nnnnn*,*bbb*

Range: *nnnnn* = Timeout – 10 to 65536 seconds (0 = Off)
bbb = Blink – 2 to 999 seconds (0 = OFF)

Default: CA300, 30

Description: The communication timeout determines when the V-ADCP will stop waiting for command input and restart. The restart behavior is dependent on the CT command (see CT - Turnkey Operation).

The second parameter sets the LED blink rate while the system is asleep. With default value of 30, a sleeping system will wake-up every 30 seconds and briefly flash the LED on the front of the V-ADCP. To disable the wake-up blink set the second parameter to zero. The flash color is blue if the system was put to sleep using the CZ command. During normal deployment the flash color is the same as last set by the BIT.

The RS-232 TX line will toggle on each wake-up blink.

CB – Serial Port Control

Purpose: Sets the RS-232 serial port communications parameters (Baud Rate/Parity/Stop Bits).

Format: CB*nnn*

Range: *nnn* = baud rate, parity, stop bits (see description)

Default: CB811

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

Description The V-ADCP 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 V-ADCP responds with a ">" prompt. You may now change the external device's communication parameters to match the V-ADCP parameters before sending another command.

Table 3: Serial Port Control

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

See Changing the Baud Rate in the V-ADCPs for instructions on using the CB command.

CF – Flow Control

Purpose Sets various V-ADCP 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 V-ADCP: 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 loop recorder (see Table 4).

Table 4: 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 V-ADCP 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 (see below).
CFxx0xx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled (see below).
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.
CFxxxx1	Enable Loop Recorder – Records data ensembles on the Loop Recorder.
CFxxxx0	Disable Loop Recorder – No data ensembles are recorded on the Loop Recorder.
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 V-ADCP 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 CR0-command.

CL - Sleep Enable

Purpose Determines whether the V-ADCP will attempt to power down between pings and ensembles.

Format CLn

Range n = 0 to 1 (0 = sleep disabled, 1 = sleep enabled)

Default CL1

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

Description CL0 means the V-ADCP will not make any attempt to conserve power. Setting the CL command to CL1 means the V-ADCP will attempt to conserve power by going to sleep at every opportunity.

CR – Retrieve Parameters

Purpose Resets the V-ADCP command set to factory settings.

Format CR*n*

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

Recommended Setting. Use as needed.

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

Table 5: Retrieve Parameters

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

The CR command keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the V-ADCP 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 V-ADCP to start pinging its transducers and collecting data as programmed by the other commands.

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

CT - Turnkey Operation

Purpose Allows the V-ADCP to initialize to predefined parameters and start pinging immediately after power is applied.

Format CT*n*

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 V-ADCP automatically initialize to a predefined command set during any power up. To place the V-ADCP 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. When power is cycled, the V-ADCP will start up with the desired configuration and begin the data collection process. You can interrupt (not remove) this mode by sending a <BREAK>. This will place the V-ADCP in the command mode, ready to accept inputs. Cycling the power, however, will again start the data collection process.

To turn off the turnkey mode, first send a <BREAK> to the V-ADCP. Now send the CT0 and CK commands to save this configuration. When power is cycled, the V-ADCP will NOT begin the data collection process.

CZ – Power Down V-ADCP

Purpose Tells the V-ADCP to power down.

Format CZ

Recommended Setting. Use as needed.

Description Sending the CZ-command powers down the V-ADCP. V-ADCP processing is interrupted and the V-ADCP goes in the STANDBY mode (RAM is maintained).

1. When powered down using the CZ-command, the V-ADCP still draws up to 30µa.
2. This command should be used whenever batteries have been installed and you do not send commands to start a deployment. If you do not use the CZ-command, the V-ADCP will draw up to 100 milli-amps of current. *A new battery will be discharged in a few days.*
3. The V-ADCP will only wakeup if a BREAK is received once the CZ command is sent.

Environmental Commands

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

```
>E?
Available Commands:

EC 1500 ----------------- Speed Of Sound (m/s)
ED 00000 ---------------- Xdcr Depth (deci-meters)
EP +00000 --------------- Pitch (+-18000 1/100 degrees)
ER +00000 --------------- Roll  (+-18000 1/100 degrees
ES 00 ------------------- Salinity (ppt)
ET 2100 ----------------- Water Temperature (.01 deg C)
EX 01111 ---------------- Coordinate Transformations (cct3m)
EZ 1000001 -------------- Sensor Source {c;d;h;p;r;s;t}
E? ---------------------- Display E-Command Menu
```

The EDCNT, EDoff, EDSPN commands are not applicable for the V-ADCP and are not documented. They will display if the user does E?.

Standard Environmental Commands

This section lists the most often used Environmental commands.

EC – Speed of Sound

Purpose	Sets the speed of sound value used for V-ADCP 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 V-ADCP to scale velocity data, cell size, and range to the bottom. The V-ADCP assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

If the EZ Speed of Sound field = 1, the V-ADCP overrides the manually-set EC value and calculates speed of sound using the values determined by transducer depth (ED), salinity (ES), and transducer temperature (ET). EZ also selects the source for ED, ES, and ET.

ED – Depth of Transducer

Purpose Sets the V-ADCP transducer depth.

Format ED*nnnnn*

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

Default ED00000

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

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

ES – Salinity

Purpose Sets the water's salinity value.

Format ES*nn*

Range *nn* = 0 to 50

Default ES00

Recommended Setting. Set to match the water's salinity.

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

ET – Temperature

Purpose Sets the water's temperature value.

Format ET±*nnnn*

Range ±*nnnn* = -5.00 C to +40.00 C

Default ET2100

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

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

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

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

EX – Coordinate Transformation

Purpose Sets the coordinate transformation processing flags.

Format EX*nnnnn*

Range Firmware switches (see description)

Default EX01010

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 6: Coordinate Transformation Processing Flags

Setting	Description
EX 00xxx	Output beam radial velocities
EX 01xxx	Transform velocities to instrument coordinates (X, Y where X is parallel to the transducer face; Y is normal to the transducer face)
EX xx0xx	Reserved, must be zero
EX xxx1x	Reserved, must be one
EX xxxx0	Reserved, must be zero

Bit 2 is reserved, and must be set to one for the V-ADCP systems to get any velocity solution.

The V-ADCP will only transform the data if all three beams are OK.

EZ – Sensor Source

Purpose Selects the source of environmental sensor data.

Format EZ*cdhprst*

Default EZ1000001

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

Range Firmware switches (see description)

Description Setting the EZ-command firmware switches tells the V-ADCP to use data from a manual setting or from an associated sensor. When a switch value is non-zero, the V-ADCP over-rides the manual E_ command setting and uses data from the appropriate sensor. If no sensor is available, the V-ADCP defaults to the manual E_ command setting. The following table shows how to interpret the sensor source switch settings.

Table 7: Sensor Source Switch Settings

	Field	Value = 0	Value = 1	Value = 2	Value = 3
c	Speed Of Sound	Manual EC	Calculate using ED, ES, and ET	N/A	N/A
d	Depth	Manual ED	Depth Sensor	N/A	N/A
h	Heading	Manual EH	N/A	N/A	N/A
p	Pitch (Tilt 1)	Manual EP	N/A	N/A	N/A
r	Roll (Tilt 2)	Manual ER	N/A	N/A	N/A
s	Salinity	Manual ES	N/A	N/A	N/A
t	Temperature	Manual ET	Internal Transducer Sensor	N/A	N/A

Example: EZ1000001 means calculate speed of sound from readings and use the transducer temperature sensor.

Index Velocity and Discharge Commands

The Index Velocity and Discharge Commands allow the user to input data and scale outputs to obtain average velocity, stage, cross-sectional area, discharge, and integrated volume directly from the V-ADCP either via serial RS-232.

Rather than describe the commands in alphabetic order, it will be clearer to describe them by functional grouping and logical order of their application. The commands can be grouped into three distinct groups:

- See Channel Description Commands (IA, IC, ID, IE, IP, and IW)
- See Computation Commands (IV)
- See Output Commands (IF, IO, IT, IU, and IZ)

```
>I?
Available Commands:
IA  1.000, 1.000, 1.000 - Area Rating Constants (-10000000 to 10000000)
IC 1 -------------------- Channel 0=cir,1=tra,2=rec,3=arb
ID   1.000 -------------- Diameter (0.5 to 100m)
IE    0.000,   0.000 ---- Xdcr Elev.(-200 to 5000m), Bot Elev. (-100 to 5000m)
IF  10 ------------------ Flag Counter (1 to 100)
IO 0 -------------------- Q Calc. 0=off, 1=on
IP ---------------------- XZ pairs IP0=help
IT   0,  0 -------------- Output Exponent Dis,Vol (0 to 6)
IU   1,  1,  1,  1,  1 -- Output Units Vel,Dis,Vol,Area,Stage 0=help
IV  1.000, 1.000,  1.000  V. Equation Const. (-5to5,-5to5,-10to10)
IW   1.000,  1.000 ------ BotWidth (0 to 500 m), SideSlope (run/rise)
IZ  +0, -329.95 ------ ------- ZeRo Volume Accumulator
I? ---------------------- Display I-Command Menu
```

Channel Description Commands

In order to compute cross-sectional area from stage, the shape of the channel needs to be described. The IA, IC, ID, IE, IP, and IW commands are used for this purpose.

IA - Area Rating Constants

Purpose	Used to compute area of a rated channel using a rating equation.
Format	IA *a.aaa*, *b.bbb*, *c.ccc*
Range	-10000000 to 10000000
Default	IA 1.000, 1.000, 1.000

> Recommended Setting. Set using *BBTalk*.

Description

These three parameters are used to compute area using a rating equation for cross-sectional area of a rated channel where

Area = a.aaa + b.bbb * H + c.ccc * H^2

H is the stage in meters

H = range to surface + V-ADCP mounting elevation

Range to surface is the range measured by the vertical acoustic beam and mounting elevation is from the first parameter of the IE command.

IC – Channel Type

Purpose Sets the shape of the channel.

Format IC*n*

Range *n* = 0 (circular), 1 (trapezoidal), 2 (rectangular), 3 (arbitrary), 4 (rated)

Default IC3

Recommended Setting. Set using *BBTalk*.

Description The IC command is used to select the overall shape of the channel.

ID - Diameter

Purpose Sets the diameter of a circular channel.

Format ID *n.nnn*

Range *n.nnn* = 0.5 to 100 meters

Default ID 1.000

Recommended Setting. Set using *BBTalk*.

Description The ID commands sets the diameter of a circular channel in meters. Diameters from 0.5 to 100 meters are allowed.

IE - Transducer Elevation

Purpose Sets the mounting elevation of the V-ADCP.

Format IE *m.mmm*, *n.nnn*

Range *m.mmm* = -200 to 5000 meters, *n.nnn* = -100 to 5000 meters

Default IE 1.000, 0.000

Recommended Setting. Set using *BBTalk*.

Description the first value is the mounting elevation of the V-ADCP. The second value is the elevation of the bottom of the channel (for circular, trapezoidal and rectangular channels). Both values are in meters. The range of allowed values for the first parameter is -200 to 5000 meters and the allowed range for the second parameter is -100 to 5000 meters.

IP - XZ pairs

Purpose Used to provide the geometric details of the channel shape for an arbitrary channel.

Format IP *n*, *x.xxx*

Range *n* = 1 to 99, *x.xxx* = -9999 to 9998 meters, (IP0 = help)

Default N/A

Recommended Setting. Set using *BBTalk*.

Description The initial position command is a list of up to 99 x, y pairs describing the cross-section of the channel. The first value '*n*' is the number of the coordinate pair in order from one side to the other. The next two values are the horizontal distance across the channel and then the elevation of the bottom at that distance, both in meters. To end the list enter 9999, 9999 for x and y. Entries below this are disregarded. Each n, x, z triplet must be entered on a separate line. For example, a channel with six x, z pairs would be entered as:

```
IP 1, 0.0, 8
IP 2, 2, 3
IP 3, 6, 0.0
IP 4, 11, 0.0
IP 5, 15, 3
IP 6, 17, 8
IP 7, 9999, 9999
```

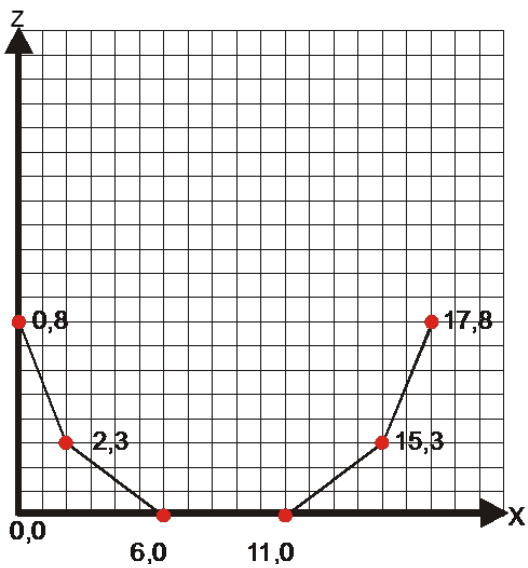

Figure 12. Channel X – Z Pairs

IW – Bottom Width and Side Slope

Purpose Used to provide the geometric details of the channel shape for a trapezoidal or rectangular channel.

Format IW *m.mmm*, *n.nnn*

Range *m.mmm* = Bottom Width (0 to 500 m),
n.nnn = Side Slope (run/rise)

Default IW 5.000, 1.000

Recommended Setting. Set using *BBTalk*.

Description the first value is the width of the bottom of the channel in meters. The second value is the slope of the sides as run/rise. The first value is used for trapezoidal and rectangular channels. The second value applies only for trapezoidal channels.

Computation Commands

The computation command IV is used for the index velocity model to calculate discharge.

IV – Velocity Equation Constant

Purpose Sets the constants for the index velocity rating.

Format IV *C1*, *C2*, *C3*

Range *C1* = -5 to 5, *C2* = -5 to 5, *C3* = -10 to 10

Default IV 0.000, 1.000, 0.000

Recommended Setting. Set using *BBTalk*.

Description The IV command is used to enter the constants for the index velocity rating using the equation:

V_{mean}= C1 + C2* V_{index} + C3 * $(V_{index})^2$

where V_{mean} is the channel mean velocity; V_{index} , the so-called index velocity, is the average velocity (streamwise velocity) of all valid cells. V_{index} and V_{mean} are in m/s. That is, the index velocity rating must be developed with velocities in m/s units.

V_{index} is calculated by:

$$V_{index} = \frac{1}{3n} \sum_{k=1}^{3} \left[\sum_{i=1}^{n} V_{k,i} \right]$$

where *n* is the number of valid cells at a beam. *n* is determined in the way to count all cells within the range to one cell distance below the water surface. $V_{k,i}$ is the streamwise velocity at cell i (i=1,2,,3...n) and beam k (k=1, 2, 3).

Output Commands

The following commands set parameters used to control the output of the computed flow, area, etc.

IF - Flag Counter

Purpose Sets how long to use the last good velocity and vertical range data for discharge calculation when invalid data is measured.

Format IF*n*

Range *n* = 1 to 100

Default IF10

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

Description The V-ADCP calculates cumulative volume by calculating a volume for each ensemble and adding it to the total. If a momentary problem causes a few ensembles to have invalid data, the volume is calculated from the last good data. The IF command sets the number of ensembles to hold the last good data. If the problem persists longer than this, the cumulative volume and other discharge values are not calculated or updated until more valid data is measured.

IO - Q Calculation

Purpose The IO commands enables and disables flow computation.

Format IO *n*

Range *n* = 0 (off), 1 (on)

Default IO 1

Recommended Setting. Set using *BBTalk*.

Description The IO commands enables/disables computation and output of flow, area, volume, and stage.

IU - Output Units

Purpose Selects the output units to be used.

Format IU Velocity, Discharge, Volume, Area, Stage

Range See description

Default IU 1, 1, 1, 1, 1

Recommended Setting. Set using BBTalk.

Description The IU command selects the units to be used for the output of velocity, discharge, volume, area, and stage via, RS-232 ASCII output, as well as internally recorded data. The various possible selections are:

Velocity Units:
1 = Meters per second
2 = Feet per second
3 = Centimeters per second

Discharge Units:
1 = Cubic meters per second
2 = Cubic feet per second (cfs)
3 = Liters per second
4 = Gallons per minute
5 = Million gallons per day (mgd)
6 = Million liters per day

Volume Units:
1 = Cubic meters
2 = Cubic ft
3 = Gallons
4 = Acre-ft
5 = Liters
6 = Thousand gallons
7 = Million gallons

Area Units:
1 = Square meters
2 = Square ft

Stage Units:
1 = meters
2 = ft

The IT command can modify some of the volume units.

IT - Output Exponent

Purpose	The IT command allows a scaling factor to be applied to the output of discharge and volume, respectively.
Format	IT *n1*,*n2*
Range	*n1*,*n2* = 0 to 6
Default	IT 0,0

Recommended Setting. Set using *BBTalk*.

Description

Volume and discharge can be inconveniently large numbers. The scale factors shifts the decimal point up to six places to the left. This effectively provides more units than the IU command alone does. For example, suppose the volume is 12345678.9 cubic feet. If the IT command is set to 3, this would become 12345.67 kilo cubic feet.

The IT command depends on the IU command (see IU - Output Units). The IT command only changes the volume if IU has set the volume unit to:

1 = Cubic meters
2 = Cubic ft
3 = Gallons

The discharge exponent is applied for all discharge units.

In order to be able to correctly interpret output at a later time, you should make careful records of the units and scale factors that you selected above.

IZ - Zero Volume Accumulator

Purpose	Resets or displays the cumulative volume.
Format	IZ ZeRo (Reset to zero) IZ ? (Display cumulative volume)
Range	N/A
Default	N/A

Recommended Setting. Use as needed. Reset using *BBTalk*.

Description

IZ ZeRo resets the cumulative volume to zero. This command is case sensitive and must be entered exactly as shown. Use “IZ ?” to display the cumulative volume in cubic meters.

Some instruments cannot handle values larger than one million. For this reason, the cumulative volume is split into two numbers. The first number is the millions part of the volume. The second part is the rest of the volume.

For example a volume of 12,345,678.90 cubic meters would be reported as the following:

```
iz 12, 345678.90 ------ -----. zeRo Volume Accumulator
```

Loop/Slate Recorder Commands

The internal recorder contains approximately four (two in older systems) megabytes of solid-state nonvolatile memory, which can be used to record data.

```
>M?
Available Commands:

ME ---------------------- ErAsE recoder
MU ---------------------- Show Recorder Size
MM ---------------------- Show memory usage
MN NGSP ----------------- Set file name [1..20 characters]
MR 1 -------------------- Set recorder on/off [0=off,1=on]
MS 0 -------------------- Set Slate mode on/off [0=off,1=on]
MY ---------------------- Y-Modem output
M? ---------------------- Display M-Command Menu
```

Standard Loop Recorder Commands

ME – Erase Recorder

Purpose Erase the contents of the loop recorder.

Format ME ErAsE

Recommended Setting. Use as needed.

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

Example See below.

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

Once erased, data is not recoverable.

MU – Show Recorder Size

Purpose Shows recorder memory size.

Format MU

Recommended Setting. Use as needed.

Description Shows memory size and the number of used and free bytes.

Example See below.

```
>mu Loop Recorder Size = 2.063M Bytes Used = 0.001M Bytes, Free = 2.061M Bytes
>
```

MM – Show Memory Usage

Purpose Shows recorder memory usage.

Format MM

Recommended Setting. Use as needed.

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

Example See below.

```
mm  Loop Recorder pages: used = 4096, free = 0

>
```

MN – Set File Name

Purpose Sets the file name for the recorder.

Format MN *xxx*

Range *xxx* = file name up to 32 characters long

Default MN ADFM

Recommended Setting. Use as needed.

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

MS – Enable Slate Mode

Purpose Turns the recorder slate mode on or off.

Format MS*n*

Range *n* = 0, turn slate mode off; *n* = 1, turn slate mode on

Default MS1

Recommended Setting. Use as needed.

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

In the slate mode, data is recorded to the recorder until it is full. With the slate mode disabled, also known as loop mode, and more data is collected than fits in the recorder memory, the oldest data will be overwritten with the newest data. The most recent data is always available for download.

MR – Set Recorder On/Off

Purpose Turns the recorder on or off.

Format MR*n*

Range *n* = 0, turn recorder off; *n* = 1, turn recorder on)

Default MR1

Recommended Setting. Use as needed.

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

MY – Y-Modem Output

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

Format MY

Recommended Setting. Use *BBTalk* to recover data.

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

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

Performance and Testing Commands

The V-ADCP uses the following commands for calibration and testing.

```
>P?
Available Commands:

PC --------------------- Built In Tests [0=help]
PD  0 ------------------ Data Stream Select
PS --------------------- System Info [0=config,1=fldr,2=vldr,3=xdcr/xfrm]
PT --------------------- Receive and Correlate Data
P? --------------------- Display P-Command Menu

>PC0
PC0          = Help
PC2          = Display Sensor Data
```

Standard Performance and Testing Commands

This section lists the most often used Performance and Testing commands.

PC – User-Interactive Built-In Tests

Purpose Sends/displays results of user-interactive V-ADCP system diagnostic tests.

Format PC*nnn*

Range *nnn* = 0, 2 (PC0 = Help menu; see below for others)

Recommended Setting. Use as needed.

Description These diagnostic tests check beam continuity and sensor data.

Examples See below.

PC0 – Help Menu

Sending **PC0** displays the help menu.

```
>PC0
PC0          = Help
PC2          = Display Sensor Data

>PC2
Temp(degC)    Depth(m)    Batt(V)
\    20.50      -1.000      9.617
```

PD – Data Stream Select

Purpose: Selects the type of ensemble output data structure.

Format: PDn

Range n = 0, 19, 23

Default PD0

Recommended Setting. Set this command to PD0, PD19, or PD23 only.

Description The PD0 command selects the normal output data structure. PD19 selects the V-ADCP PD19 Output Data Format. PD23 selects the V-ADCP PD23 Output Data Format.

PS – Display System Parameters

Purpose Sends/displays V-ADCP system configuration data.

Format PS*n*

Range *n* = 0 (see description)

Recommended Setting. Use as needed.

Description See below.

PS0 – System Configuration

PS0 sends the V-ADCP hardware/firmware information. For example, the output may look like this:

```
>PS0
   Serial Number:  0
       Frequency:  2457600 Hz
   Configuration:  V-ADCP: 3-beam velocity + vertical stage.
 Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
         Sensors:  I/O Expander  1-w TEMP
    CPU Firmware:  40.11
    FPGA Version:  2.00.003
 Sensor Firmware:  ----

Board Serial Number Data:
 0F 00 00 00 3F 16 BF 28   DS18B20 TMP SNS
 0E 00 00 00 0E A4 C0 23   DSP72B-2002-00A
 8E 00 00 00 0E 96 D4 23   PIO72B-2001-13A
 AD 00 00 00 15 1C 5A 23   IOE72B-2017-00X
 6B 00 00 00 12 66 66 23   XDR72B-1010-00X
 FB 00 00 00 31 E2 19 23   RCV72B-2003-13A
 66 00 00 00 13 AE 23 23   PER72B-2020-00X

>
```

PS1 – Fixed Leader

PS1 sends the Fixed Leader parameters (i.e., fixed system commands and hardware/firmware information) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see Fixed Leader Data Format). For example, a Hex-ASCII output may look like this:

```
>PS1
3B00001C0D4C21003502320A001900190001480300E8030000320A941100007D2D3D0023000101FF000C000000000000000000000000000D
C1200001914
>
```

The output format of the PS1 command is determined by the CF command (see CF – Flow Control).

PS2 – Variable Leader

PS2 sends the Variable Leader parameters (i.e., variable system commands and sensor readings) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see Variable Leader Data Format). For example, a Hex-ASCII output may look like this:

```
>PS2
3D8000130004031E10320352000000D005000000000505A40D0000BD0833005F000000000000000000000000000000000FFFFFFFF00000
00000000000FA14
>
```

The output format of the PS1 command is determined by the CF command (see CF – Flow Control).

PS3 – Transducer and Coordinate Transform info

PS3 sends transducer and coordinate transformation data out the serial port. For example:

```
>PS3
Last Save Time: 05/11/03,10:15:04.03
Profiling Beams: 3
Freq(Hz) 2457600
Dia (mm) 38
Beam Positions:
 Bm         X        Y        Z        P        R        E
  1    0.0000   0.0000   0.0000  20.0000   0.0000  20.0000
  2    0.0000   0.0000   0.0000 -20.0000  25.0000  31.6100
  3    0.0000   0.0000   0.0000 -20.0000 -25.0000  31.6100
Instrument Transformation Matrix:
  0.0000 -1.1831  1.1831  0.0000
  1.4619 -0.8065 -0.8065  0.0000
  0.5321  0.2935  0.2935  0.0000
  0.0000  0.0000  0.0000  0.0000
Stage:
Freq(Hz) 614400
Dia (mm) 19
       X        Y        Z        P        R        E
  0.0000   0.0000  10.0000   0.0000   0.0000   0.0000

>
```

PT - Built-In Tests

Purpose Sends/displays results of V-ADCP system diagnostic test.

Format PT*nnn*

Range *nnn* = PT0, PT103, PT200, PT3 (see below)

Recommended Setting. Use as needed.

PT0 - Help

Displays the test menu (shown below). Sending PT103 will repeat the PT3 test continually until the V-ADCP receives a <BREAK>. Sending PT200 runs all tests.

```
>PT0
Built In Tests
----------------
PT0 = Help
PT3 = Receive Path
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT3 - Receive Path

This test displays receive path characteristics. This test has three parts.

Part 1 - The V-ADCP pings without transmitting and displays the result of an autocorrelation function performed over 14 lag periods (only the first 8 are displayed). Ideally, we should see high correlation at near-zero lags, and then see decorrelation as the lags get longer. High correlation values at longer lags indicate interference is present.

Part 2 - The V-ADCP displays the demodulator DAC values.

Part 3 - The V-ADCP compares the RSSI value at high gain versus low gain. These values give the noise floor for RSSI. A high noise floor indicates possible interference or a hardware problem. A low difference between high and low RSSI values can indicate a problem in the demodulator, receiver, or RSSI switching circuitry.

```
>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  85  86  87  88      83  80  79  90      80  82  82  95      78  77  81  93
  2  51  58  61  73      52  44  44  69      43  47  49  81      39  41  48  78
  3  25  35  36  54      25  19  23  46      19  22  24  65      15  16  25  63
  4   6  18  19  39       8   7  14  27       9  10   8  48       7   3  14  47
  5   9  12  12  27       8   3   7  10       6   8   4  32       6   3   9  32
  6  11   6   8  15      11   3   6   5       6   9   5  20       8   3   7  20
  7   9   5   7   7       9   4   6  12       4  11   4  13       7   2   5  13
Sin Duty Cycle (percent)
     45  52  48  60      52  48  52  49      40  49  42  65      52  52  50  60
Cos Duty Cycle (percent)
     50  50  50  49      51  49  47  52      51  48  51  59      54  46  52  58
RSSI Noise Floor (counts)
     42  40  66  68      29  27  58  58      52  52  73  77      28  27  57  57
>
```

Timing Commands

The following commands let you set the timing of various profiling functions.

```
>T?
Available Commands:

TD 00:01.00 ------------- Ping Cluster Duration (mm:ss.hh)
TE 00:01:00.00 ---------- Sampling Interval (Time Between Ensembles)
TF 00/00/00,00:00:00 ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TP 00:00.00 ------------- Time Between Ping Clusters
TS 05/11/04,08:23:09.07 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
T? --------------------- Display T-Command Menu
```

Standard Timing Commands

This section lists the most often used Timing commands.

TD – Ping Cluster Duration

Purpose Sets the time duration for each WP ping cluster.

Format TD*mm:ss.ff*

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

Default TD00:01.00

Recommended Setting. Set as required by the application.

Description During the sampling interval set by TE (see Figure 13), the V-ADCP collects the number of ping clusters set by the WP-command (see WP – Ping Clusters per Ensemble). The TD command sets the time duration for each ping cluster. The V-ADCP will collect one vertical ping and as many velocity pings as it has time for during each ping cluster.

Example TD00:05.00 tells the V-ADCP to spend 5 seconds pinging for each WP ping cluster.

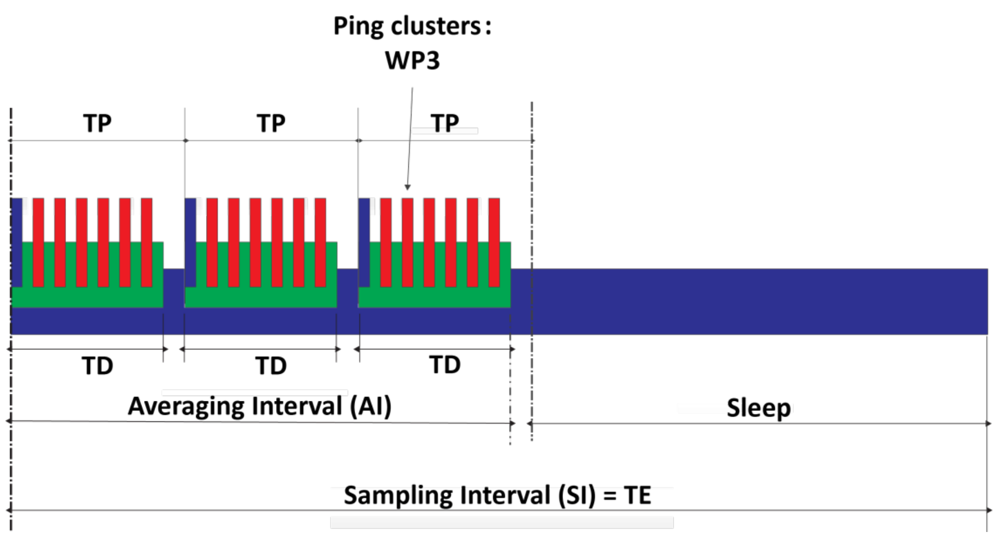

Figure 13. An Example of V-ADCP Ensembles

TE – Sampling Interval (Time Between Ensembles)

Purpose Sets the sampling interval (SI) 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 TE00:01:00.00

Recommended Setting. Set as required by the application.

Description The V-ADCP outputs ensemble data at the sampling interval set by TE. If TE = 00:00:00.00, the V-ADCP starts collecting the next ensemble immediately after processing the previous ensemble. Figure 13 shows an example V-ADCP ensemble, indicating the relation of TP, TD, and TE.

Example TE01:15:30.00 tells the V-ADCP to collect data ensembles every 1 hour, 15 minutes, 30 seconds.

1. The V-ADCP automatically increases TE if (WP x TP > TE) or WP x TD > TE.
2. The time tag for each ensemble is the time of the first ping of that ensemble, not the time of output.

TP – Time between Ping Clusters

Purpose Sets the *minimum* time between ping clusters.

Format TP*mm:ss.ff*

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

Default TP00:00.00

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

Description During the ensemble interval set by TE, the V-ADCP collects the number of ping clusters set by the WP-command. TP determines the spacing between the ping clusters.

Example TP00:01.00 sets the time between ping clusters to 1.00 second.

The V-ADCP automatically increases TE if WP x TP > TE or WP x TD > TE. TP will have no effect if TP ≤ TD, meaning there is no space between the ping clusters.

TS – Set Real-Time Clock

Purpose Sets the V-ADCP'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* or by pressing Ctrl+t on the PC keyboard while running *BBTalk*. This will set the V-ADCP clock to the same as the PC clock.

Example TS10/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2010.

1. When the V-ADCP 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. The internal clock *does* account for leap years.
3. If the entry is not valid, the V-ADCP sends an error message and does not update the real-time clock.

Vertical Beam Commands

The following commands define the criteria used to set the Vertical Beam data.

```
>V?
Available Commands:

VD 111000000 ------------ Data Out {a;c;s;*;*;*;*;*;*}
VF 0005 ----------------- Blank (cm)
VO 00000 00000 ---------- Set Offset (.1mm) and Scale (ppm)
VP 002 ------------------ Number of Pings per Ensemble (<100)
VR 1000 ----------------- Set Max Range (<=1000cm)
V? ---------------------- Display V-Command Menu

>#V?
Available Commands:
```

Standard Vertical Beam Commands

This section lists the most often used Vertical Beam commands.

VD – Vertical Beam Data Out

Purpose Selects the data types collected by the V-ADCP.

Format VD *abc def ghi*

Range Firmware switches (see description)

Default VD 111 000 000

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

Description VD uses firmware switches to tell the V-ADCP the types of data to collect. The V-ADCP always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the V-ADCP to collect that data type. The bits are described as follows:

a = amplitude	*d* = Reserved	*g* = Reserved
b = commands	e = Reserved	*h* = Reserved
c = status	*f* = Reserved	*I* = Reserved

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 VP = zero, the V-ADCP does not collect vertical beam amplitude or command data.
3. Spaces in the command line are allowed.

VF – Vertical Beam Blank after Transmit

Purpose Moves the start of the search away from the transducer head.

Format VF*nnnn*

Range *nnnn* = 0 to 9999 cm (328 feet)

Default VF0001

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

Description Set the VF command to start the search for the surface to some distance after transmit to avoid adjacent structures or to allow transmit recovery.

VO – Vertical Offset and Scale

Purpose Sets the height of the back of the transducer above a reference and an optional scale factor correction to the measured depth.

Format VOo,*s*

Range o = ±65535 (0.1 mm), s = ±65535 (ppm)

Default VO0,0

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

Description Use this offset parameter of this command to set the transducer height relative to the bottom of the channel. This value will be added to the corrected measured depth prior to ensemble data output. The Scale portion is normally set to 0 (no correction) however if the operator wishes to calibrate the depth sensor he can use this parameter to do so. A value of 100 ppm will increase the reported corrected depth by 0.01%.

VP – Enable Vertical Beam Ping

Purpose Turn the vertical beam ping on or off.

Format VP*nn*

Range *nn* = 0 (turn vertical beam ping off) or 1 (turn vertical beam ping on)

Default VP1

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

Description This command enables or disables the vertical ping depth detection. VP0 turns off the depth detection and allowing more velocity profiling pings to occur per ensemble. VP1 turns on the depth detection with one vertical ping prior to the profiling pings.

VR – Set Max Range

Purpose	Limit the range to search for a surface.
Format	VR*nnnn*
Range	*nnnn* = 0 to 1000 cm (32.8 ft)
Default	VR1000

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

Description This command applies an upper limit to the range the V-ADCP searches for the surface. VR values less than the maximum will reduce the time spent searching for a surface when the surface is not detected.

Expert Vertical Beam Commands

The following expert commands define the criteria used to set the Vertical Beam data.

```
VC 0 0  25 -------------- Detect mode (0-2), Use Press (0=no), Range Screen (%)
VD 111000000 ------------ Data Out {a;c;s;*;*;*;*;*;*}
VE 030 00003 ------------ Edge Detect Thres (cnts), Width (samples)
VG 090 00185 ------------ High and low RSSI threshold (cnts)
VP 001 ------------------ Number of Pings per Sample (0 or 1)
VS 001 ------------------ Set Number of Sub pings in a burst (1 - 25)
VT 0001 ----------------- Transmit Length (code elements)
VW 030 00016 ------------ W Filter Thres (cnts), Width (samples)
VX 0 -------------------- Xmit Power Duty Cycle (1/8, 1/4/ 3/4th)
V? ---------------------- Display #V-Command Menu
```

#VC – Detect Mode

Purpose 1. Controls the surface detection filter that is applied to average RSSI data.

2. Controls whether the pressure sensor will be used as a first guess in detecting the surface.

3. Controls the percent of range used in screening pings within a burst.

Format #VC *m p rrr*

Range *m* = 0 to 2
p = 0 or 1
rrr = 0 to 100 %

Default #VC 0 0 25

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

Description: See below.

If *m* = 0, the 'W' filter is used on average data. If *m* = 1, the leading edge filter is used on average data. If *m* = 2, the 'W' filter and then the leading edge filter is used on average data.

If *p* = 0, then the pressure sensor is not used. If *p* = 1, then the pressure sensor is used. Using the pressure sensor can reduce ping time and avoid false detection. Set the #VS command to 1 or 2 sub-pings for an improved ping rate if the pressure sensor is used.

The value set by the *rrr* digits determines the allowable difference of individual pings' range from the average range over a burst. The allowable difference is ±*rrr*, so the window is twice *rrr*. Screening the individual pings in this way is an effective means of avoiding false detection.

#VD – Data Out

Purpose Selects the vertical beam data types collected by the V-ADCP.

Format WD a;c;s;*;*;*;*;*;*

Range Firmware switches (see description)

Default VD 111000000

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

Description WD uses firmware switches to tell the V-ADCP the types of vertical beam data to collect. The V-ADCP always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the V-ADCP to collect that data type. The bits are described as follows:

a = Velocity	*d* = Reserved	*g* = Reserved
c = Correlation	e = Reserved	*h* = Reserved
s = Echo Intensity	*f* = Reserved	*I* = Reserved

Example WD 111 000 000 (default) tells the V-ADCP to collect velocity, correlation magnitude, and echo intensity.

1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
2. Spaces in the command line are allowed.

#VE – Leading Edge Detection Filter Parameters

Purpose Sets the leading edge filter detection threshold counts and filter width.

Format #VE *tt wwwww*

Range *tt* = 0 to 255 counts
wwwww = 0 to 65535 samples

Default #VE 030 00003

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

Description Only applies when the leading edge filter is selected by the #VC command. The filter calculates the difference between the current sample and the sample *wwwww* samples prior to the current sample. The maximum detected output of this filter must be greater than '*tt*' counts for successful detection.

#VG - High and Low RSSI Threshold

Purpose Sets the high and low RSSI thresholds.

Format #VG*nnn ttttt*

Range *nnn*= 0 to 255 counts

tttt=

Default VG 090 00185

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

Description The #VG command is used for the gain switch. For instance #VG 90 185 would set the RSSI Low Threshold to 90 and High threshold to 185. When the RSSI counts are less than 90, the V-ADCP sets the vertical beam to High-Gain mode. When the RSSI counts are greater than 185, the V-ADCP switches to Low-Gain mode.

#VP – Enable Vertical Beam Ping

Purpose Turn the vertical beam ping on or off.

Format VP*nn*

Range *nn* = 0 (turn vertical beam ping off) or 1 (turn vertical beam ping on)

Default VP1

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

Description This command enables or disables the vertical ping depth detection. VP0 turns off the depth detection and allowing more velocity profiling pings to occur per ensemble. VP1 turns on the depth detection with one vertical ping prior to the profiling pings.

#VS – Number of Sub Pings in Burst

Purpose Sets the number of sub pings in a burst.

Format #VS pp

Range pp = 0 to 25 pings

Default #VS 001

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

Description Set the pings per burst to one or two to improve ping time. Up to 16 pings is recommend to screen the data for false detects.

#VT – Transmit Length

Purpose Sets the transmit length in code elements.

Format #VT *tttt*

Range *tttt* = 0 to 9999 code elements

Default #VT 1

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

Description There are four cycles per code elements. The phase of all code elements are the same if '*tttt*' > 1.

#VW – W Filter Parameters

Purpose Sets the 'W' filter detection threshold counts and filter width.

Format #VW *tt wwwww*

Range *tt* = 0 to 255 counts, *wwwww* = 0 to 65535 samples

Default #VW 030 00016

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

Description Only applies when the 'W' filter is selected by the #VC command. The maximum detected output of this filter must be greater than '*tt*' counts for successful detection. The width of the filter is set by the *wwwww* parameter.

#VX – Transmit Power

Purpose Sets the transmit power (duty cycle control).

Format #VX *p*

Range *p* = 0 to 2

Default #VX 0

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

Description See table below.

Table 8: Vertical Beam Transmit Power

'p'	Transmit Duty Cycle
0	1/8
1	1/4
2	3/4

Water Profiling Commands

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

```
>W?
Available Commands:

WD 111100000 ------------ Data Out {v;c;a;p;s;*;*;*;*}
WF 0010 ----------------- Blanking Distance (cm)
WN 050 ------------------ Number of Cells [1-50]
WP 010 ------------------ Number of Ping Clusters [1-999]
WS 0006 ----------------- Cell Size (cm)
WV 0175 ----------------- Ambiguity Velocity (cm/s)
W? ---------------------- Display W-Command Menu
```

The WO command is not applicable to the V-ADCP and is not documented. The command will display if the user does W?.

Standard Water Profiling Commands

This section lists the most often used Water Profiling commands.

WD – Data Out

Purpose	Selects the data types collected by the V-ADCP.
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 V-ADCP the types of data to collect. The V-ADCP always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the V-ADCP to collect that data type. The bits are described as follows:

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

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

1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
2. Spaces in the command line are allowed.

WF – Blank after Transmit

Purpose	Moves the location of first 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	WF0010

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

Description WF positions the start of the first cell at some vertical distance from the transducer head. This allows the V-ADCP transmit circuits and any transducer ringing time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.

1. The distance to the middle of cell #1 is a function of blank after transmit (WF), cell size (WS), and speed of sound. The fixed leader data contains this distance.
2. Small WF values may show ringing/recovery problems in the first cells that cannot be screened by the V-ADCP.

WN – Number of Cells

Purpose	Sets the number of cells over which the V-ADCP collects data.
Format	WN*nnn*
Range	*nnn* = 001 to 50 cells
Default	WN020

Recommended Setting. Set as required by the application.

Description The velocity profiling range of the V-ADCP is set by the number of cells (WN) times the size of each cell (WS).

WP – Number of Ping Clusters per Ensemble

Purpose	Sets the number of ping clusters to average in each data ensemble.
Format	WP*nnnnn*
Range	*nnnnn* = 0 to 999 ping clusters
Default	WP00010

Recommended Setting. Set as required by the application.

Description WP sets the number of ping clusters to average in each ensemble before sending/recording the data. Each ping cluster lasts for a duration set by the TD command and will contain one surface track ping and a number of velocity pings (pings as fast as possible).

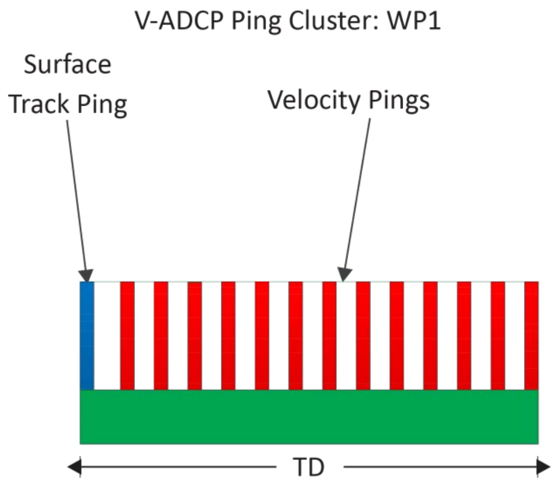

Figure 14. V-ADCP Ping Cluster

WS – Cell Size

Purpose Selects the size for a measurement cell.

Format WS*nnnn*

Range *nnnn* = 3 to 100 cm

Default WS006

Recommended Setting. Set as required by the application.

Description The V-ADCP collects data over a variable number of cells. WS sets the size of each cell in centimeters.

WV – Ambiguity Velocity

Purpose Sets the radial ambiguity velocity.

Format WV*nnn*

Range *nnn* = 000 to 999 cm/s

Default WV175

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

Description The WV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam when operating in water mode 1 (WM1). WV is set based on the maximum velocity the V-ADCP is expected to measure. Use the table below to set the WV value.

Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur. TRDI recommends that the WV command not be set below 100cm/s.

Table 9. Recommended WV Setting

Maximum apparent velocity relative to V-ADCP	WV setting
5 m/s	WV175 (default setting)
6 m/s	WV210
7 m/s	WV245
8 m/s	WV280
9 m/s	WV315
10 m/s	WV350
15 m/s	WV525
20 m/s	WV700

This table does not include any factor of safety against ambiguity errors due to the single-ping standard deviation, vertical or transverse velocity components, or instrument misalignment. A safety factor ranging between 1.1 and 2.0 is recommended. Larger safety factors should be used with smaller bin sizes, lower WV settings, lower water temperatures, and higher vertical or transverse velocity components.

NOTES

Chapter 7

PD0 OUTPUT DATA FORMAT

In this chapter, you will learn:

- PDO output data format
- PD19 output data format
- PD23 output data format

This section shows the output data format of the V-ADCP. V-ADCP 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). 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 V-ADCP Ensemble).

The following description is for the standard PD0 V-ADCP output data format. Figure 16 through Figure 25 shows the ASCII and binary data formats for the V-ADCP PD0 mode. Table 11 through Table 24 defines each field in the output data structure.

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

The V-ADCP by default is set to collect velocity, correlation data, echo intensity, and percent good data. The data, preceded by ID code 7F7F, contains header data (explained in Table 11). The fixed and variable leader data is preceded by ID codes 0000 and 0080, (explained in Table 12 and Table 13). The V-ADCP always collects Header and Leader data. The table below shows some of the most common IDs.

Table 10: Data ID Codes

ID	LSB	MSB	Description
0x7F7F	7F	7F	Header
0x0000	00	00	Fixed Leader
0x0080	80	00	Variable Leader
0x0100	00	01	Velocity Profile Data
0x0102	02	01	Streamwise Velocity Data
0x0200	00	02	Correlation Profile Data
0x0300	00	03	Echo Intensity Profile Data
0x0400	00	04	Percent Good Profile Data
0x0500	00	05	Status Profile Data
0x4000	00	40	Surface Track Status
0x4001	01	40	Surface Track Commands
0x4002	02	40	Surface Track Amplitude

The V-ADCP always sends the Least Significant Byte (LSB) first.

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (58 BYTES)
	VARIABLE LEADER DATA (60 BYTES)
WD-command	**STREAMWISE VELOCITY** (4 BYTES + nBeams * 12 BYTES + nBeams * 4 BYTES PER RANGE CELL)
	VELOCITY (2 BYTES + 8 BYTES PER RANGE CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER RANGE CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER RANGE CELL)
	PERCENT GOOD (2 BYTES)
VD-command VP-command	**SURFACE TRACK AMPLITUDE** (16+7*NPing-1BYTE)
	SURFACE TRACK COMMANDS (28 BYTES)
	SURFACE TRACK STATUS (46 BYTES)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 15. PD0 Standard Output Data Buffer Format

Some data outputs are in bytes per range cell. For example a 3 beam V-ADCP, if the WN-command (number of range cells) = 30, and the following data are selected for output, the required data buffer storage space is 1248 bytes per ensemble.

```
WD-COMMAND = WD 111 100 000 (default), WP-COMMAND = 10 (default)
VD-COMMAND = VD 111 000 000 (default), VP-COMMAND = 2 (default)
     22  BYTES OF HEADER DATA (6 + [2x Number Of 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)
    400  BYTES OF STREAMWISE VELOCITY DATA (4 + 3 x 12 + 3 x 4 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)
     22  BYTES OF VERTICAL BEAM AMPLITUDE DATA (16 + 7*1 - 1)
     28  BYTES OF VERTICAL BEAM COMMANDS DATA
     46  BYTES OF VERTICAL BEAM STATUS DATA
      2  BYTES OF RESERVED FOR TRDI USE (FIXED)
      2  BYTES OF CHECKSUM DATA (FIXED)
   1248  BYTES OF DATA PER ENSEMBLE
```

Header Data Format

BYTE	BIT POSITIONS 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 11 for a description of the fields.

Figure 16. Binary Header Data Format

This data is always output in this format.

Header information is the first item sent by the V-ADCP to the output buffer. The V-ADCP always sends the Least Significant Byte (LSB) first.

Table 11: 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 V-ADCP).
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 25).
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 V-ADCP 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 V-ADCP 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 4n+9 to 4n+12	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 V-ADCP will store information for data type #3 through data type #n. Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Types #3-n begin (first byte of ensemble is Binary Byte) #1).

Fixed Leader Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	FIXED LEADER ID = 0000								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	RESERVED								
8									
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS {WN}								
11	PINGS PER ENSEMBLE {WP}								LSB
12									MSB
13	RANGE CELL LENGTH {WS}								LSB
14									MSB
15	BLANK AFTER TRANSMIT {WF}								LSB
16									MSB
17	RESERVED								
18	LOW CORR THRESH {WC}								
19	NO. CODE REPS								
20	RESERVED								
21	ERROR VELOCITY MAXIMUM {WE}								LSB
22									MSB
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS {TP}								
26	COORDINATE TRANSFORM {EX}								
27	RESERVED								
28									

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
29 30	RESERVED								
31	SENSOR SOURCE {EZ}								
32	SENSORS AVAILABLE								
33 34	BIN 1 DISTANCE								
35 36 37 38	RESERVED								
39	FALSE TARGET THRESH {WA}								
40	RESERVED								
41 42	TRANSMIT LAG DISTANCE								LSB MSB
43 ↓ 50	CPU BOARD SERIAL NUMBER								MSB ↓ LSB
51	SYSTEM BANDWIDTH {WB}								LSB
52 53 54	RESERVED								
55 ↓ 58	V-ADCP SERIAL NUMBER								LSB ↓ MSB

See Table 12 for a description of the fields

Figure 17. Fixed Leader Data Format

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

Table 12: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word 0000 (00 00h). LSB is sent first.
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 V-ADCP 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 - - - - - 1 1 0 38-kHz SYSTEM - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - RESERVED - - 0 1 - - - - RESERVED - - 1 0 - - - - RESERVED - 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 25E BEAM ANGLE 0 0 1 0 - - - - 2-BEAM + VERT. STAGE 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 - 16	7-8	Reserved	Reserved
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The V-ADCP uses two beams to calculate horizontal velocity and one vertical beam to calculate stage.
19,20	10	WN / Number of Cells	Contains the number of range cells over which the V-ADCP collects data (WN-command). Scaling: LSD = 1 range cell; Range = 1 to 128 range cells

Table 12: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP-command). If WP = 0, the V-ADCP does not collect the WD water-profile data. Note: The V-ADCP 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 / Range cell Length	Contains the length of one range cell (WS-command). 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 V-ADCP to allow the transmit circuits time to recover before the receive cycle begins (WF-command). Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Reserved	Reserved
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-command). 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	Reserved	Reserved
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 V-ADCP flags all four beams of the affected bin as bad. 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 V-ADCP automatically extends the ensemble interval (set by TE) if (WP x TP > TE).

51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX-command). These firmware switches indicate how the V-ADCP collected data.
			`xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES)`
			`xxx01xxx = INSTRUMENT COORDINATES`
			`xxx10xxx = RESERVED`
			`xxx11xxx = RESERVED`
			`xxxxx1xx = TILTS (PITCH AND ROLL) USED IN TRANSFORMATION`
			`xxxxxx1x = RESERVED`
			`xxxxxxx1 = BIN MAPPING USED`

53-60	27-30	Reserved	Reserved

Table 12: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description

61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ-command). These firmware switches indicate the following.
			`FIELD       DESCRIPTION`
			`1xxxxxx = CALCULATES EC (SPEED OF SOUND) FROM ED, ES, AND ET`
			`x1xxxxx = USES ED FROM DEPTH SENSOR`
			`xx1xxxx = USES EH FROM TRANSDUCER HEADING SENSOR`
			`xxx1xxx = USES EP FROM TRANSDUCER PITCH SENSOR`
			`xxxx1xx = USES ER FROM TRANSDUCER ROLL SENSOR`
			`xxxxx1x = USES ES (SALINITY) FROM CONDUCTIVITY SENSOR`
			`xxxxxx1 = USES ET FROM TRANSDUCER TEMPERATURE SENSOR`
			NOTE: If the field = 0, or if the sensor is not available, the V-ADCP uses the manual command setting. If the field = 1, the V-ADCP uses the reading from the internal 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 range cell (bin). This distance is a function of range cell length (WS), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-76	35-38	Reserved	Reserved
77,78	39	WA / False Target Threshold	Contains the threshold value used to reject data received from a false target, usually fish (WA-command). Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
79,80	40	Reserved	Reserved
81-84	41,42	LagD / Transmit lag distance	This field contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters
85-100	43-50	CPU Board Serial Number	Contains the serial number of the CPU board. The CPU Board Serial number is stored in Big Endian (MSB sent first).
101-102	51	WB / System Bandwidth	Contains the WB-command setting. Range = 0 to 1
103-108	52-54	Reserved	Reserved.
109-116	55-58	Serial #	V-ADCP serial number.

Variable Leader Data Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
1	VARIABLE LEADER ID = 0080	LSB 80h
2		MSB 00h
3	ENSEMBLE NUMBER	LSB
4		MSB
5	RTC YEAR {TS}	
6	RTC MONTH {TS}	
7	RTC DAY {TS}	
8	RTC HOUR {TS}	
9	RTC MINUTE {TS}	
10	RTC SECOND {TS}	
11	RTC HUNDREDTHS {TS}	
12	ENSEMBLE # MSB	
13	BIT RESULT	LSB
14		MSB
15	SPEED OF SOUND {EC}	LSB
16		MSB
17	DEPTH OF TRANSDUCER {ED}	LSB
18		MSB
19	RESERVED	LSB
20		MSB
21		LSB
22		MSB
23		LSB
24		MSB
25	SALINITY {ES}	LSB
26		MSB
27	TEMPERATURE {ET}	LSB
28		MSB
29	MPT MINUTES	
30	MPT SECONDS	
31	MPT HUNDREDTHS	

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0
32	RESERVED							
33	PITCH STD							
34	ROLL STD							
35	Reserved							
36	ADC1 - Battery Voltage							
37–40	Reserved ↓							
41	ADC6 - Battery Voltage x 1000 / 157							
42–53 ↓ 60	RESERVED ↓							

See Table 13 for a description of the fields.

Figure 18. Variable Leader Data Format

Variable Leader data refers to the dynamic V-ADCP data (from clocks/sensors) that change with each ping. The V-ADCP always sends Variable Leader data as output data (LSBs first).

Table 13: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VID / Variable Leader ID	Stores the Variable Leader identification word 0080 (80 00h). LSB is sent first.

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	5	RTC Year	These fields contain the time from the V-ADCP's real-time clock (RTC) that the current data ensemble began. The TS-command (Set Real-Time Clock) initially sets the clock. The V-ADCP does account for leap years.
11,12	6	RTC Month	
13,14	7	RTC Day	
15,16	8	RTC Hour	
17,18	9	RTC Minute	
19,22	10	RTC Second	
21,22	11	RTC Hundredths	
23-24	12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3,4) "rolls over." This allows ensembles up to 16,777,215. See Ensemble Number field above.

25-28	13,14	BIT / BIT Result	This field contains the results of the V-ADCP's Built-in Test function. A zero code indicates a successful BIT result (see Table 14). The BIT code will not repeat if the error occurs more than once.
			`BYTE 14          BYTE 13`
			`# of errors    BIT error code`

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

Table 13: Variable Leader Data Format

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-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters -1 = Unknown (Hex FFFF)
37-48	19- 24	Reserved	
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt -1 = Unknown (Hex FFFF)
53-56	27,28	ET / Temperature	Contains the temperature of the water at the transducer head (ET-command). This value may be a manual setting or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees C.
57,58	29	MPT minutes	Sleep time: This field contains the total time that the V-ADCP slept during the previous ensemble.
59,60	30	MPT seconds	
61,62	31	MPT hundredths	
63 - 68	32-34	Reserved	
69-70	35	ADC Channel 0	These fields contain the outputs of the Analog-to-Digital Converter (ADC). Here is the description for each channel: CHANNEL DESCRIPTION 0 Reserved 1 Battery Voltage 2 Reserved 3 Reserved 4 Reserved 5 Reserved 6 Battery Voltage x 1000 / 157 7 Reserved Note that the ADC values may be "noisy" from sample-to-sample, but are useful for detecting long-term trends.
71-72	36	ADC Channel 1	
73-74	37	ADC Channel 2	
75-76	38	ADC Channel 3	
77-78	39	ADC Channel 4	
79-80	40	ADC Channel 5	
80-81	41	ADC Channel 6	
82-83	42	ADC Channel 7	
84-120	43-60	Reserved	

How to Determine the Battery Voltage

For information on how to decode the PD0 format, see Rules for the Data Format PD0. Once the PD0 format is decoded, read the corresponding byte in the Variable Leader.

- The voltage output is located in byte 36 (ADC1).
- If you want the voltage in a better resolution, use byte 41 (ADC6) and multiply it by 157.

Another way to decode the PD0 format is to use *BBconv* (included with RDI tools). Shown below is a decoder file for use with *BBconv*. For information on how to use decoder files, see the RDI Tools User's Guide.

```
;  Binary Fixed & Variable Leader Decode File
0080,35,1          ; Not used
0080,36,1          ; Battery Voltage
0080,37,1          ; Not used
0080,38,1          ; Not used
0080,39,1          ; Not used
0080,40,1          ; Not used
0080,41,1          ; Battery Voltage x 1000 / 157
$L
```

Table 14: Built In Test Error Codes

Code (hex)	Name	Description
22	Temperature Sensor Fail	If the temperature sensor is not available or is not configured properly this code is set. The transducer must be connected to the electronics when the BREAK is sent or the temperature sensor will be flagged as unavailable for the duration of the deployment.
23	Pressure Sensor Fail	If the primary depth sensor is the pressure sensor and it is not available this code is set. If the Expander board returns a pressure sensor failure message this code is set.
30	UART Stuck	When ensemble data is ready for output and the UART interrupt can't be cleared this code is set.
31	UART Tx timeout	When a new ensemble is ready to be output and the previous ensemble is still in queue after an unreasonable amount of time this code is set.
32	UART IRQ Stuck	If in the interrupt handler loop for more than 30000 consecutive loops this code is set.
33	UART Buffer Stuck	If the output buffer is full and a character is waiting more than 100 msec to be added to that buffer this code is set.
35	UART No Clear	If the system is waiting to go to sleep and the UART interrupt doesn't clear after 20 msec this code is set.
37	UART Sleep Timeout	If the system does not have enough time to sleep due to data output this code is set.
40	VB No Detect	If the Vertical Beam is unable to detect the surface in the DWADFM or V-ADCP modes this code is set.
50	RTC Battery Low	If the Real Time Clock reports a low battery condition this code is set.
51	RTC Time Not Set	If the time was lost due to power and the user has not set the time using the TS command this code is set.
60	Recorder Pointers Lost	If RAM based pointers to the next recorder write location are lost, due to power or a firmware down load, this code is set.
61	Recorder Erase Error	The system is unable to erase the Loop/Slate recorder Flash memory.
62	Recorder Data Read Time-Out	While attempting to read a page of data from the Flash memory a time-out occurred.
63	Recorder Data Write Time-Out	While attempting to write a page of data to the Flash memory a time-out occurred.
64	Recorder Page Erase Time-Out	While attempting to erase a page of Flash memory a time-out occurred.

Table 14: Built In Test Error Codes

Code (hex)	Name	Description
65	Recorder Erase Status Error	The Flash memory control register returned an error indication after an erase took place.
66	Recorder Slate Full	The recorder is in the Slate mode and the recorder is full
71	Beam 1 Bad	While processing Beam 1 velocities one or more bins were flagged bad.
72	Beam 2 Bad	While processing Beam 2 velocities one or more bins were flagged bad.
73	Beam 3 Bad	While processing Beam 3 velocities one or more bins were flagged bad.
76	Vertical Beam Failure	In the SW mode the vertical beam percent good was less than 50%.
77	Vertical Beam Marginal	In the SW mode the vertical beam percent good was less than 70%.
78	Flow Shape Fail-ure	A comparison between the actual measured velocities and the HRW model had a value greater than 0.1 (0 = perfect fit)
79	Flow Shape Marginal	A comparison between the actual measured velocities and the HRW model had a value greater than 0.1 (0.0 = perfect fit)
7A	Unable to Cal-culate Dis-charge (Q)	The system could not calculate Q due to too few velocity bins (need at least 6 good ones) or a depth estimate was unavailable.
7B	Temperature Sensor Failure	Over at least the last four sample periods the temperature sensor did not return a valid temperature.
90	I/O Expander Board Failure	The system was unable to establish communication with I/O Expander board via the SPI bus.
91	Interlock Open	The I/O Expander board detected a failure in the external connector interlock pins.

Velocity Data Format

BYTE	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID = 0100								LSB 00h
2									MSB 01h
3	RANGE CELL #1, VELOCITY 1								LSB
4									MSB
5	RANGE CELL #1, VELOCITY 2								LSB
6									MSB
7	RANGE CELL #1, VELOCITY 3								LSB
8									MSB
9	RESERVED								
10									
11	RANGE CELL #2, VELOCITY 1								LSB
12									MSB
13	RANGE CELL #2, VELOCITY 2								LSB
14									MSB
15	RANGE CELL #2, VELOCITY 3								LSB
16									MSB
17	RESERVED								
18									
↓	(SEQUENCE CONTINUES FOR UP TO 50 CELLS)								↓
395	RANGE CELL #50, VELOCITY 1								LSB
396									MSB
397	RANGE CELL #50, VELOCITY 2								LSB
398									MSB
399	RANGE CELL #50, VELOCITY 2								LSB
400									MSB
401	RESERVED								
402									

See Table 15 for description of fields

Figure 19. Velocity Data Format

The number of range cells is set by the WN-command.

The V-ADCP packs velocity data for each range cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The V-ADCP 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.

The setting of the EX-command (Coordinate Transformation) determines how the V-ADCP references the velocity data as shown below.

EX-CMD	COORD SYS	VEL 1	VEL 2	VEL 3
00xxx	BEAM	BEAM 1 radial	BEAM 2 radial	BEAM 3 radial
01xxx	INST	X horizontal	Y horizontal	Z vertical

Table 15: Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word 0100 (00 01h). LSB is sent first.
5-8	3,4	Range cell 1, Velocity 1	Stores velocity data for range cell #1, velocity 1. See above.
9-12	5,6	Range cell 1, Velocity 2	Stores velocity data for range cell #1, velocity 2. See above.
13-16	7,8	Range cell 1, Velocity 3	Stores velocity data for range cell #1, velocity 3. See above.
17-20	9,10	Reserved	Reserved
21-804	11-402	Cells 2 – 50 (if used)	These fields store the velocity data for range cells 2 through 50 (depending on the setting of the WN-command). These fields follow the same format as listed above for range cell 1.

Streamwise Velocity Data Format

(3 beam system shown)

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VELOCITY ID = 0102								LSB 02h
2									MSB 01h
3	Number of Beams								
4	Number of Bins								
5	X position of beam 1								LSB
6									MSB
7	X position of beam 2								LSB
8									MSB

BYTE	7/S	6	5	4	3	2	1	0	
9	X position of beam 3								LSB
10									MSB
11	Y position of beam 1								LSB
12									MSB
13	Y position of beam 2								LSB
14									MSB
15	Y position of beam 3								LSB
16									MSB
17	Z position of beam 1								LSB
18									MSB
19	Z position of beam 2								LSB
20									MSB
21	Z position of beam 3								LSB
22									MSB
23	dX position of beam 1								LSB
24									MSB
25	dX position of beam 2								LSB
26									MSB
27	dX position of beam 3								LSB
28									MSB
29	dY position of beam 1								LSB
30									MSB
31	dY position of beam 2								LSB
32									MSB
33	dY position of beam 3								LSB
34									MSB
35	dZ position of beam 1								LSB
36									MSB
37	dZ position of beam 2								LSB
38									MSB
39	dZ position of beam 3								LSB
40									MSB

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
41	RANGE CELL #1, VELOCITY 1								LSB
42									MSB
43	RANGE CELL #1, VELOCITY 2								LSB
44									MSB
45	RANGE CELL #1, VELOCITY 3								LSB
46									MSB
47	RANGE CELL #2, VELOCITY 1								LSB
48									MSB
49	RANGE CELL #2, VELOCITY 2								LSB
50									MSB
51	RANGE CELL #2, VELOCITY 3								LSB
52									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 50 CELLS)								↓
335	RANGE CELL #50, VELOCITY 1								LSB
336									MSB
337	RANGE CELL #50, VELOCITY 2								LSB
338									MSB
339	RANGE CELL #50, VELOCITY 3								LSB
340									MSB
341	RANGE CELL #1, Standard Deviation 1								LSB
342									MSB
343	RANGE CELL #1, Standard Deviation 2								LSB
344									MSB
345	RANGE CELL #1, Standard Deviation 3								LSB
346									MSB
347	RANGE CELL #2, Standard Deviation 1								LSB
348									MSB
349	RANGE CELL #2, Standard Deviation 2								LSB
350									MSB
351	RANGE CELL #2, Standard Deviation 3								LSB
352									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 50 CELLS)								↓

BYTE	7/S	6	5	4	3	2	1	0	
	BIT POSITIONS								
635	RANGE CELL #50, Standard Deviation 1								LSB
636									MSB
637	RANGE CELL #50, Standard Deviation 2								LSB
638									MSB
639	RANGE CELL #50, Standard Deviation 3								LSB
640									MSB

See Table 15 for description of fields

Figure 20. Streamwise Velocity Data Format

The number of range cells is set by the WN-command.

The V-ADCP packs velocity data for each range cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The V-ADCP 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. Streamwise velocity is along the Y axis of the transducer.

Table 16: Streamwise Velocity Data Format

Binary Byte	Field	Description
1,2	Velocity ID	Stores the velocity data identification word 0100 (00 01h). LSB is sent first.
3	Beams	3 in this example
4	Bins	10 in this example
5,6	Beam 1 X	Location of beam 1 bin 1 on the X axis of the transducer
7,8	Beam 2 X	Location of beam 2 bin 1 on the X axis of the transducer
9,10	Beam 3 X	Location of beam 3 bin 1 on the X axis of the transducer
11,12	Beam 1 Y	Location of beam 1 bin 1 on the Y axis of the transducer
13,14	Beam 2 Y	Location of beam 2 bin 1 on the Y axis of the transducer
15,16	Beam 3 Y	Location of beam 3 bin 1 on the Y axis of the transducer
17,18	Beam 1 Z	Location of beam 1 bin 1 on the Z axis of the transducer
19,20	Beam 2 Z	Location of beam 2 bin 1 on the Z axis of the transducer
21,22	Beam 3 Z.	Location of beam 3 bin 1 on the Z axis of the transducer
23,24	Beam 1 dX	Spacing between Beam 1 bins along the X axis of the transducer
25,26	Beam 2 dX	Spacing between Beam 2 bins along the X axis of the transducer
27,28	Beam 3 dX	Spacing between Beam 3 bins along the X axis of the transducer
29,30	Beam 1 dY	Spacing between Beam 1 bins along the Y axis of the transducer
31,32	Beam 2 dY	Spacing between Beam 2 bins along the Y axis of the transducer

Table 16: Streamwise Velocity Data Format

Binary Byte	Field	Description
33,34	Beam 3 dY	Spacing between Beam 3 bins along the Y axis of the transducer
35,36	Beam 1 dZ	Spacing between Beam 1 bins along the Z axis of the transducer
37,38	Beam 2 dZ	Spacing between Beam 2 bins along the Z axis of the transducer
39,40	Beam 3 dZ	Spacing between Beam 3 bins along the Z axis of the transducer
41,42	Range cell 1, Velocity 1	Stores velocity data for range cell #1, velocity 1. See above.
43,44	Range cell 1, Velocity 2	Stores velocity data for range cell #1, velocity 2. See above.
45,46	Range cell 1, Velocity 3	Stores velocity data for range cell #1, velocity 3. See above.
47-100	Cells 2 – 10 (if used)	These fields store the velocity data for range cells 2 through 10 (depending on the setting of the WN-command). These fields follow the same format as listed above for range cell 1.
101,102	Range cell 1, Standard Deviation 1	Stores standard deviation of the Streamwise velocity data for range cell #1, sw velocity 1. See above.
103,104	Range cell 1, Standard Deviation 2	Stores standard deviation of the Streamwise velocity data for range cell #1, sw velocity 2. See above.
105,106	Range cell 1, Standard Deviation 3	Stores standard deviation of the Streamwise velocity data for range cell #1, sw velocity 2. See above.
107-160	Cells 2 – 10 (if used)	These fields store the standard deviation data for range cells 2 through 10 (depending on the setting of the WN-command). These fields follow the same format as listed above for range cell 1.

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

BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB 00h
2	Correlation Magnitude = 0200, Echo Intensity = 0300, Echo Intensity = 0400								MSB 02 – 04h
3	RANGE CELL #1, FIELD #1								
4	RANGE CELL #1, FIELD #2								
5	RANGE CELL #1, FIELD #3								
6	RESERVED								
7	RANGE CELL #2, FIELD #1								
8	RANGE CELL #2, FIELD #2								
9	RANGE CELL #2, FIELD #3								
10	RESERVED								
↓	(SEQUENCE CONTINUES FOR UP TO 50 BINS)								↓
199	RANGE CELL #50, FIELD #1								
200	RANGE CELL #50, FIELD #2								
201	RANGE CELL #50, FIELD #3								
202	RESERVED								

See Table 17 through Table 19 for a description of the fields.

Figure 21. Binary Correlation Magnitude, Echo Intensity, and Percent-Good Data Format

The number of range cells is set by the WN-command.

Correlation magnitude data give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The V-ADCP 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. Correlation data is scaled for a nominal value of 128.

Table 17: Correlation Magnitude Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the correlation magnitude data identification word 0200 (00 02h). LSB is sent first.
3	Range cell 1, Field 1	Stores correlation magnitude data for range cell #1, beam #1. See above.
4	Range cell 1, Field 2	Stores correlation magnitude data for range cell #1, beam #2. See above.
5	Range cell 1, Field 3	Stores correlation magnitude data for range cell #1, beam #3. See above.
6	Reserved	Reserved
7 – 202	Cells 2 – 50 (if used)	These fields store correlation magnitude data for range cells 2 through 50 (depending on the WN-command) for all beams. These fields follow the same format as listed above for range cell 1.

The echo intensity scale factor is about 0.45 dB per V-ADCP count. The V-ADCP does not directly check for the validity of echo intensity data.

Table 18: Echo Intensity Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the echo intensity data identification word 0300 (00 03h). LSB is sent first.
3	Range cell 1, Field 1	Stores echo intensity data for range cell #1, beam #1. See above.
4	Range cell 1, Field 2	Stores echo intensity data for range cell #1, beam #2. See above.
5	Range cell 1, Field 3	Stores echo intensity data for range cell #1, beam #3. See above.
6	Reserved	Reserved
7 – 202	Cells 2 – 50 (if used)	These fields store echo intensity data for range cells 2 through 50 (depending on the WN-command) for all beams. These fields follow the same format as listed above for range 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 range cell of the velocity profile. The setting of the EX-command (Coordinate Transformation) determines how the V-ADCP references percent-good data as shown below.

EX-Command	Coord. Sys	Velocity 1	Velocity 2	Velocity 3	Velocity 4
		Percentage Of Good Pings For:			
00xxx	Beam	BEAM 1	BEAM 2	BEAM 3	RESERVED
		Percentage Of:			
01xxx	Inst	% Solution Available in Bin	Reserved	% No Solution Available in Bin	Reserved

At the start of the velocity profile, the backscatter echo strength is typically high on both beams. Under this condition, the V-ADCP uses all three beams to calculate the horizontal and vertical velocities. As the echo returns from far away range cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the V-ADCP to reject some of its range cell data (low correlation magnitude value). This causes the V-ADCP to stop calculating velocities. As an example, let us assume range cell 10 has returned the following percent-good data.

```
FIELD #1 = 10, FIELD #2 = 20, FIELD #3 = 90, FIELD #4 = x
```

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 10 for each beam based on the Low Correlation Threshold (WC-command). Here, beam 1=10%, beam 2 = 20%, and beam 3=90%. These are not typical nor desired percentages. Typically, you would want the three beams to be about equal and greater than 25%.

On the other hand, if velocities were collected in INSTRUMENT coordinates and bin 10 returned the following percent-good, the results would be interpreted differently.

```
FIELD #1 = 55, FIELD #2 = x, FIELD #3 = 45, FIELD #4 = x
```

FIELD 1 - Percentage of Good Solutions - Shows percentage of successful velocity calculations involving all three beams (55%).

FIELD 2 - Reserved - Not used in the V-ADCP.

FIELD 3 - Percentage of No Solution - 45% of the velocity data were rejected because there was insufficient information (less than 3 good beams velocity Data) to attempt a transformation.

FIELD 4 - Reserved - Not used in the V-ADCP.

Table 19: Percent-Good Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the percent-good data identification word 0400 (00 04h). LSB is sent first.
3	Range cell 1, Field 1	Stores percent-good data for range cell #1, field 1. See above.
4	Range cell 1, Field 2	Stores percent-good data for range cell #1, field 2. See above.
5	Range cell 1, Field 3	Stores percent-good data for range cell #1, field 3. See above.
6	Range cell 1, Field 4	Stores percent-good data for range cell #1, field 4. See above.
7-202	Range cell 2 – 50 (if used)	These fields store percent-good data for range cells 2 through 50 (depending on the WN-command), following the same format as listed above for range cell 1.

Surface Track Status Output

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	Vertical Beam Status ID = 4000								LSB 00h
2									MSB 40h
3	Depth (Corrected Surface Track)								
4									
5									
6									
7	Depth (Uncorrected Surface Track)								
8									
9									
10									
11	Evaluation Amplitude								
12	Amplitude at the Surface								
13	%Good of Surface Track								
14	STD Surface Track								
15									
16									
17									
18	Min Surface Track								
19									
20									
21									
22	Max Surface Track								
23									
24									
25									
26	Pressure Depth Correction								
27									
28									
29									

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0
30	Depth (Uncorrected Pressure)							
31								
32								
33								
34	Percent Good of Depth based on Pressure							
35	STD of Depth based on Corrected Pressure							
36								
37								
38								
39	Min of Depth based on Corrected Pressure							
40								
41								
42								
43	Max of Depth based on Corrected Pressure							
44								
45								
46								

Figure 22. Surface Track Status Output

For Evaluation Amplitude, Amplitude at the Surface, Standard Deviation, Max Surface Track and Min Surface Track the following applies: If number of bursts per ensemble is 1, then this is based on the good pings in the ensemble. If the number of bursts per ensemble is greater than 1, then this is based on the output from each burst which could be from individual pings or from average RSSI data.

Table 20: Surface Track Status Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_STATUS_ID / Vertical Beam Status ID	Stores the Vertical Beam Status ID word 4000 (00 40h). LSB is sent first.
5-12	3-6	Depth (Corrected Surface Track)	Depth based on surface track output with corrections applied. Units: 0.1mm
13-20	7-10	Depth (Uncorrected Surface Track)	Depth based on raw surface track output. Units: 0.1mm
21,22	11	Evaluation Amplitude	Maximum detection filter evaluation amplitude. Units: Counts
23,24	12	Amplitude at the Surface	Signal amplitude at Surface. Units: Counts
25,26	13	%Good of Surface Track	Percentage of surface track pings in an ensemble burst that are marked good based on signal strength and a comparison with burst average depth (see VC command). Units: %
27-34	14-17	STD Surface Track	Standard deviation of good depths from corrected surface track pings. Units: 0.1mm
35-42	18-21	Min Surface Track	Minimum depth of good corrected surface track. Units: 0.1mm pings
43-50	22-25	Max Surface Track	Maximum depth of good corrected surface track pings Units: 0.1mm
51-58	26-29	Pressure Depth Correction	Last good difference between pressure depth and vertical beam depth ensemble outputs. Units: 0.1mm
59-66	30-33	Depth (Uncorrected Pressure)	Depth based on raw pressure output. Units: 0.1mm
67,68	34	%Good of Depth based on Pressure	Percentage of corrected pressure measurements good in the ensemble. Units: %
69-76	35-38	STD of Depth based on Corrected Pressure	Standard deviation of good depths based on corrected pressure measurements in the ensemble. Units: 0.1mm
77-84	39-42	Min of Depth based on Corrected Pressure	Minimum depth of corrected pressure measurements in the ensemble. Units: 0.1mm
85-92	43-46	Max of Depth based on Corrected Pressure	Maximum depth of corrected pressure measurements in the ensemble. Units: 0.1mm

Surface Track Amplitude Output

BYTE	7	6	5	4	3	2	1	0	
1	Vertical Beam Amp ID = 4002								LSB 02h
2									MSB 40h
3	Pings in Burst (NPing)								
4	Bin Location of Surface (Avg.)								
5									
6	Filter Evaluation Amp (Avg.)								
7	Amplitude at Surface (Avg.)								
8	W Filter Bin Location of Surface (Avg.)								
9									
10	W Filter Evaluation Amp (Avg.)								
11	W Filter Amplitude at Surface (Avg.)								
12	Leading Edge Filter Bin Location of Surface (Avg.)								
13									
14	Leading Edge Filter Evaluation Amp (Avg.)								
15	Leading Edge Amplitude at Surface (Avg.)								
16 to 16+2*NPing-1	W Filter Bin Location (Individual Pings)								
16+2*NPing to 16+5*NPing-1	W Filter Evaluation Amplitude (Individual Pings)								
16+5*NPing to 16+6*NPing-1	W Filter Amplitude (Individual Pings)								
16+6*NPing to 16+7*NPing-1	Status of Individual Pings								

Figure 23. Surface Track Amplitude Output

The data in this structure is from the last burst in an ensemble.

Table 21: Surface Track Amplitude Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_AMP_ID / Vertical Beam Amp ID	Stores the Vertical Beam Amplitude ID word 4002 (02 40h). LSB is sent first.

Hex Digit	Binary Byte	Field	Description
5,6	3	Pings in Burst (NPing)	Number of surface track pings in an ensemble burst
7-10	4,5	Bin Location of Surface (Avg)	Final bin location of the surface based on either averaged RSSI data or averages of detected bin locations from single pings. Units: Samples
11,12	6	Filter Evaluation Amp (Avg)	Final filter evaluation amplitude based on either averaged RSSI data or averages of evaluation amplitudes from single pings. Units: Counts
13,14	7	Amplitude at Surface (Avg)	Final amplitude based on either averaged RSSI data or averages of amplitudes from single pings. Units: Counts
15-18	8,9	W Filter Bin Location of Surface (Avg)	W filter bin location of the surface from averaged RSSI data. Units: Samples
19,20	10	W Filter Evaluation Amp (Avg)	Evaluation amplitude output of the W Filter where the filter detects the surface using averaged RSSI data. Units: Counts
21,22	11	W Filter Amplitude at Surface (Avg)	RSSI amplitude at the bin location where the W filter detects the surface using averaged RSSI data. Units: Counts
23-26	12,13	Leading Edge Filter Bin Location of Surface (Avg)	Leading edge filter bin location of the surface from averaged RSSI data. Units: Samples
27,28	14	Leading Edge Filter Evaluation Amp (Avg)	Evaluation amplitude output of the leading edge filter where the filter detects the surface using averaged RSSI data. Units: Counts
29,30	15	Leading Edge Amplitude at Surface (Avg)	Leading edge amplitude at the bin location where the Filter detects the surface using averaged RSSI data. Units: Counts
31 to 31+4*NPing	16 to 16+2*NPing-1	W Filter Bin Location (Individual Pings)	W filter bin location where the filter detects the surface for individual pings in the ensemble burst. Units: Samples
31+4*NPing+1 to 31+6*NPing	16+2*NPing to 16+5*NPing-1	W Filter Evaluation Amplitude (Individual Pings)	W filter evaluation amplitude where the filter detects the surface for individual pings in the ensemble burst. Units: Counts
31+6*NPing-1 to 31+8*NPing	16+5*NPing to 16+6*NPing-1	W Filter Amplitude (Individual Pings)	W filter amplitude where the filter detects the surface for individual pings in the ensemble burst.
31+8*NPing-1 to 31+10*NPing	16+6*NPing to 16+7*NPing-1	Status of Individual Pings	Final status of each ping after data quality checks.

Surface Track Commands Output

BYTE	7	6	5	4	3	2	1	0	
1	Vertical Beam Commands ID = 4001								LSB 01h
2									MSB 40h
3	VM_Blank								
4									
5	VM_Pings								
6									
7	VM_BW								
8	VM_DetectMode								
9	VM_PressScreen								
10	VM_RangeScreen								
11	VM_EdgeDetectThres								
12	VM_EdgeDetectDelta								
13									
14	VM_RcvrGain								
15	VM_OffsetTenthsMM								
16									
17	VM_ScalePPM								
18									
19	VM_MaxRange								
20									
21	VM_MaxRange								
22									
23	VM_XmtLength								
24									
25	VM_WThreshold								
26	VM_WWidth								
27									
28	VM_XmitPwr								

Table 22: Surface Track Commands Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_CMD_ID / Vertical Beam Commands ID	Stores the Vertical Beam Commands ID word 4001 (01 40h). LSB is sent first.
5-8	3,4	VM_Blank	See VF command.
9-12	5,6	VM_Pings	See VP command.
13,14	7	VM_BW	See #VB command.
15,16	8	VM_DetectMode	See #VC command.
17,18	9	VM_PressScreen	See #VC command.
19,20	10	VM_RangeScreen	See #VC command.
21,22	11	VM_EdgeDetectThres	See #VE command.
23-26	12,13	VM_EdgeDetectDelta	See #VE command.
27,28	14	VM_RcvrGain	See #VJ command.
29-32	15,16	VM_OffsetTenthsMM	See #VO command.
33-36	17,18	VM_ScalePPM	See #VO command.
27-40	19,20	VM_MaxRange	See #VR command.
41-44	21,22	VM_SubPings	See #VS command.
45-48	23,24	VM_XmtLength	See #VT command.
49,50	25	VM_WThreshold	See #VW command.
51-54	26,27	VM_WWidth	See #VW command.
55,56	28	VM_XmitPwr	See #VX command.

For information on the #V_ commands, see Expert Vertical Beam Commands.

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 24. Binary Reserved BIT Data Format

Table 23: 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).

Binary Checksum Data Format

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

Figure 25. Binary Checksum Data Format

Table 24: Checksum Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum Data	This field contains a modulo 65535 checksum. The V-ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum.

Rules for the Data Format PD0

Use the following information to help write your own software:

1. 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 25: Common Data Format IDs

ID	LSB	MSB	Description
0x7F7F	7F	7F	Header
0x0000	00	00	Fixed Leader
0x0080	80	00	Variable Leader
0x0100	00	01	Velocity Profile Data
0x0200	00	02	Correlation Profile Data
0x0300	00	03	Echo Intensity Profile Data
0x0400	00	04	Percent Good Profile Data
0x0500	00	05	Status Profile Data

The V-ADCP always sends the Least Significant Byte (LSB) first.

2. Once a data type has been given an ID number and the format of that data has been published TRDI considers 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 3.
3. 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-xx are now specified by changes added in support to the V-ADCP. If additional sensor data is to be added to the variable leader data, than it must be added to the end of the data string (bytes 54-x as an example).

Note that new firmware versions may cause a change in the number of bytes and this implies that if byte-counting, requires altering your code at every change. This is not the case when using the data type IDs and offsets to navigate through the data. New variables are added at the end of a data type before the checksum. The offsets will dynamically change to reflect the change, allowing you to get to the same desired data every time.

4. 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.
5. The header data will include the number of data types in the files and the offset to each ID number for each data type.
6. The total number of the bytes in an ensemble minus the 2-byte checksum will be included in the header.

Decoding Sequence for PD0 Data

To decode PD0 data:

1. Locate the header data by locating the header ID number (in the case of PD0 profile data that will be 7F7F).
2. Confirm that you have the correct header ID by:
    a. Locating the total number of bytes (located in the header data) in the ensemble. This will be your offset to the next ensemble.
    b. 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.
    c. Read the 2-byte checksum word at the end of the ensemble, located by using the checksum offset in the header (determined in step 2-a) and compare this checksum word to the value calculated in step 2-b.
    d. 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 1 and search for the next header ID number occurrence.
3. Locate the number of data types (located in the header data).
4. Locate the offset to each data type (located in the header data).
5. 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.
6. Once the proper ID type has been located, use this manual to understand what each byte represents in that particular data type.

V-ADCP PD19 Output Data Format

PD19 output data format outputs ASCII data on the serial port and records PD0 data internally, if recording is enabled. The output of PD19 is a comma delimited format similar to a NEMA format. A typical output would appear as:

```
PRDIQ, 12, 432456.123, 2.45, 234.45, 0.65, 345.33, 15.12, 2.56, -0.32, 0
```

In order from left to right, the fields are described in Table 26.

Table 26: PD19 Output Data Format

Field	Description
Header	"PRDIQ" which is the unique identifier that the following data is in PD19 ASCII format
High Volume	The first numeric field is always an integer which represents the millions portion of accumulated volume.
Low Volume	The second data field is the lower part of the total volume. So, in the above output, the total volume is 12432456.123. The volume has been split into two separate fields because many devices like RTUs or PLCs can only accept values up to 999999.999 in a single field.
Stage	The water surface elevation (reference to a local datum) based on the vertical acoustic beam measurement.
Flow rate	The computed flow using the mean velocity and area computed from the channel geometry.
Mean velocity	Channel mean velocity calculated from the built-in Index-velocity model.
Area	Area computed from stage and the channel geometry.
Temperature	Temperature from the internal sensors of the V-ADCP
Pitch	Pitch from the internal sensors of the V-ADCP
Roll	Roll from the internal sensors of the V-ADCP
Fault Count	The number of successive readings for which either vertical range to surface or more than 50% of velocity cells are no valid. This will count up to the value set in IF. Until this value is reached, the last good velocity or stage data will be used to compute the other quantities.

V-ADCP PD23 Output Data Format

Table 27. PD23 Output Data Format

Field	Description
Header	PRDIQ23 is the unique identifier that the following data is in PD23 ASCII format
Date & time	Ensemble date and time. Date format =YY/MM/DD, Time format = hh:mn:ss
Q High Volume	The first numeric field is always an integer which represents the millions portion of accumulated volume. For example, if the total volume is 12432456.12, the value of the Q High Volume will be +1. Format = x
Q Low Volume	The second data field is the lower part of the total volume. So, in the above example, the Q Low Volume is 2432456.12. The volume has been split into two separate fields because many devices like RTUs or PLCs can only accept values up to 999999.99 in a single field. Format = x.xx
Fault Count	The number of successive readings for which either vertical range to surface or more than 50% of velocity cells are no valid. This will count up to the value set in the IF command (see IF - Flag Counter). Until this value is reached, the last good velocity or stage data will be used to compute the other quantities. Format = x
StageA	The water surface elevation (reference to a local datum) based on the vertical acoustic beam measurement. Format = x.xxx
StageP	Not used in the V-ADCP.
Flow rate	The computed flow using the mean velocity and area computed from the channel geometry. Format = x.xx
Mean velocity	Channel mean velocity calculated from the built-in Index-velocity model. Format = x.xxx
Area	Area computed from stage and the channel geometry. Format = x.xx
Temperature	Temperature from the internal sensors of the V-ADCP. Format = x.xx
Pitch	Pitch from the internal sensors of the V-ADCP
Roll	Roll from the internal sensors of the V-ADCP
Battery Voltage	The voltage of the V-ADCP. Format = x.x

Here is an example of PD23 output:

```
PRDIQ23,08/03/18,12:56:09,+0,566.22,0,1.279,,3.21,0.506,6.35,17.62,,,12.7
PRDIQ23,08/03/18,12:56:43,+0,675.37,0,1.280,,3.24,0.509,6.36,17.63,,,12.7
```

When there is invalid info to be displayed, the data field is blank as shown in red.
The field for StageA will be empty (,,) if the vertical beam goes bad.

Chapter 8

SPECIFICATIONS

In this chapter, you will learn:

- Specifications
- Outline Installation Drawings

Table 28: Velocity Profiling (Broadband)

Item	Specification
Number of cells	3 to 150
Min. cell size	3 cm
Max. cell size	10 cm
Max. profiling range	5.0 m
Min. Blanking distance	3 cm
Velocity range	±5 m/s default, ±20 m/s maximum
Accuracy:	±0.5% ± 0.2cm/s
Resolution	1 mm/s
Max. data output rate	1 Hz

Maximum profiling range depends on temperature, salinity, and solids concentration.

Table 29: Acoustic Transducer Specifications

Item	Specification
Velocity measurement:	Frequency: 2.4 mHz Geometry: Three beams Beam angle: 20°, ±25° Beam width: 0.95°
Water level measurement:	Frequency: 600 kHz Range: 0.1-10 m Accuracy: ± 0.25%±3 mm Resolution: 0.1 mm

Table 30: Temperature Sensor Specifications

Item	Specification
Range:	-5º to 45ºC
Accuracy:	±0.5ºC
Resolution:	0.01º C

Table 31: Environmental Specifications

Item	Specification
Communication:	RS-232 Baud rate: 1200 - 115,200 bps
Internal memory:	4 Mb
External power:	10-28 VDC
Internal battery:	18 VDC Alkaline battery, 570 Wh
Maximum current:	1 A
Power consumption:	0.11w @ 10% duty cycle
Housing:	Cast polyurethane weight: 5.2kg (with internal battery)
Dimension:	Housing Length 340mm; width 180mm; depth 140mm Transducer Length 202mm; width 92mm; depth 39mm
Operation temperature:	-5° to 40°C
Storage temperature:	-25° to 60°C
Vibration:	Meet IEC 60721-3-2 standard

Outline Installation Drawings

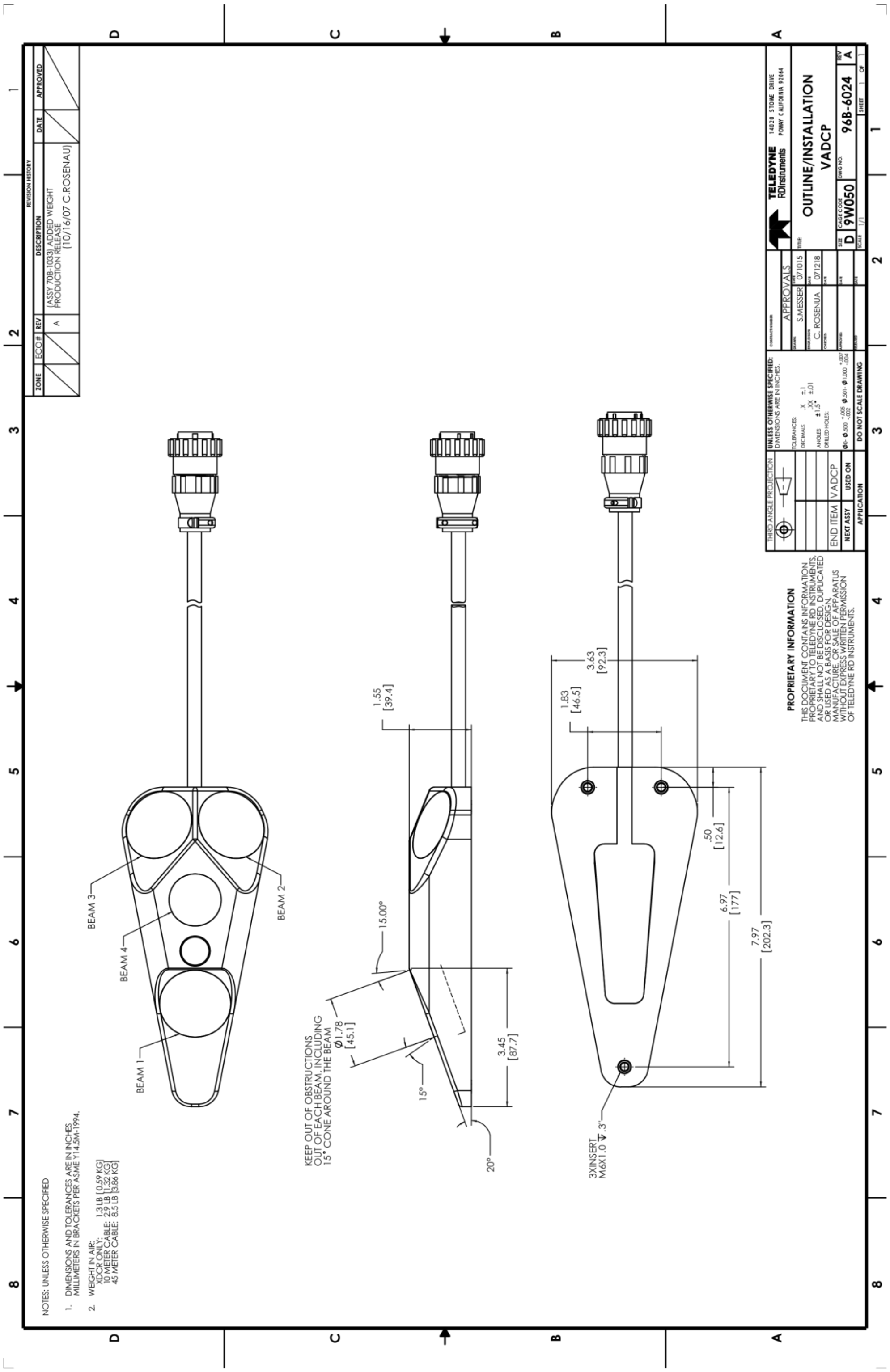

Figure 26. Outline Installation Drawing 96B-6024

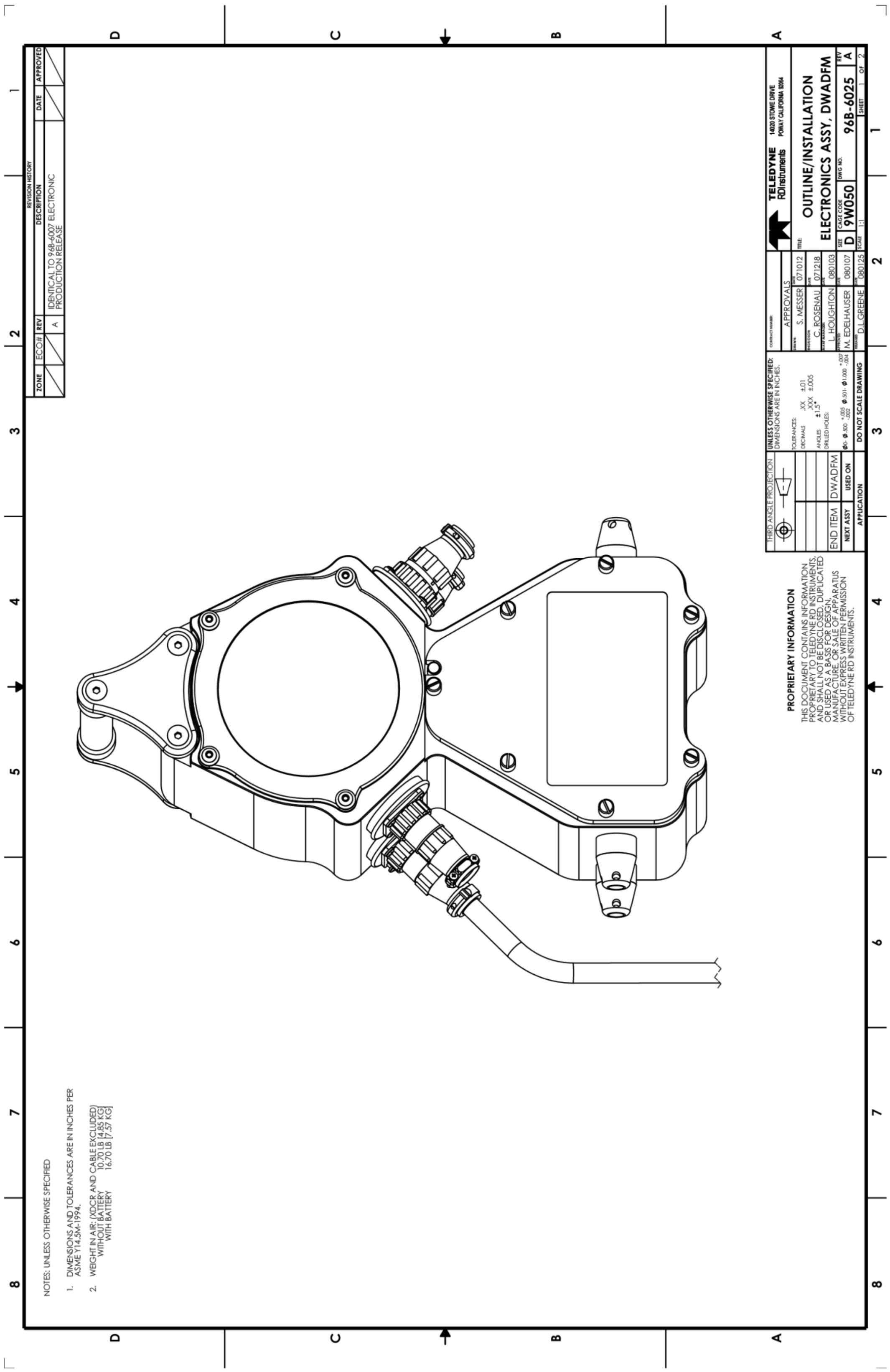

Figure 27. Outline Installation Drawing 96B-6025 Sheet 1

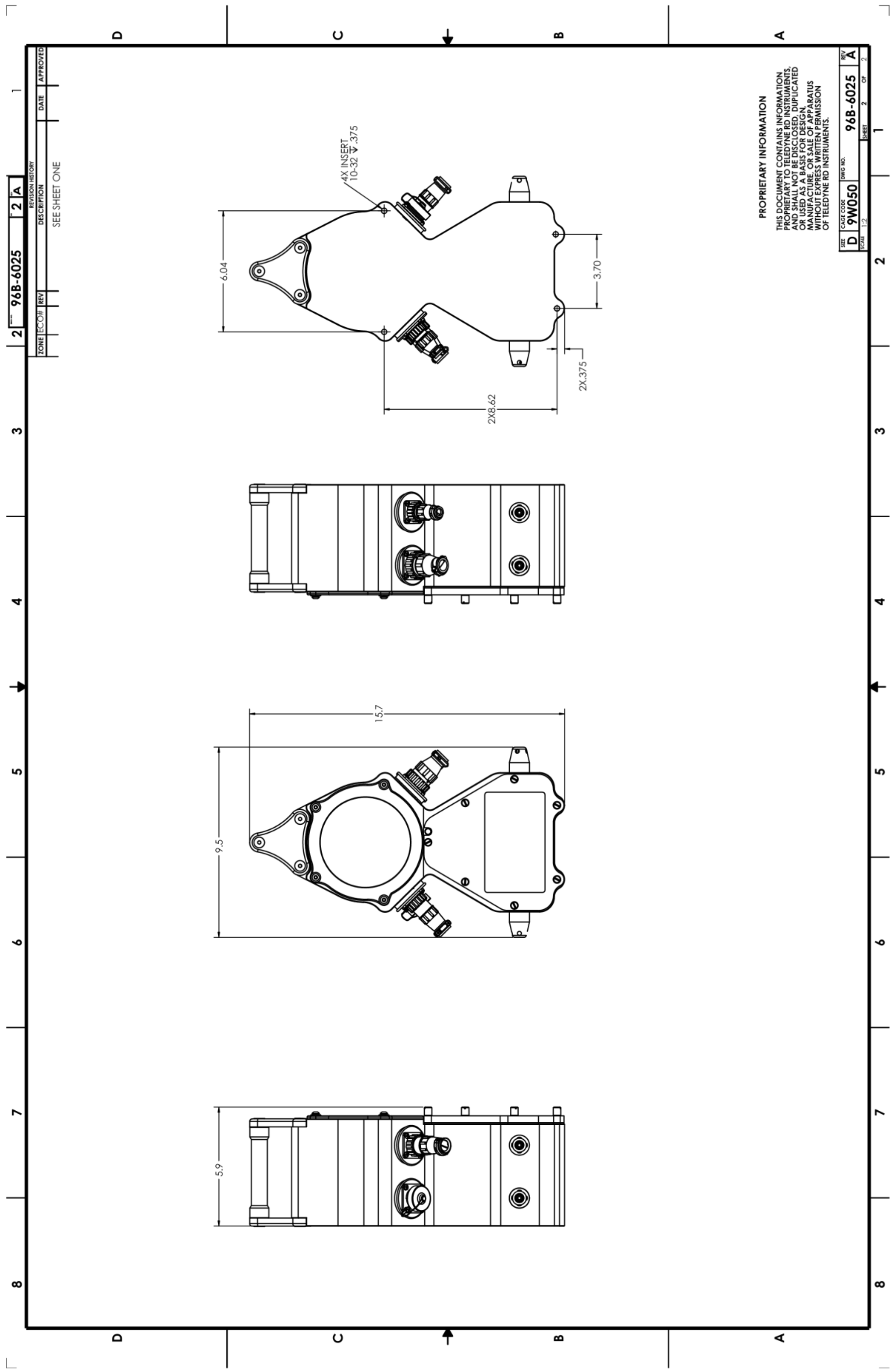

Figure 28. Outline Installation Drawing 96B-6025 Sheet 2

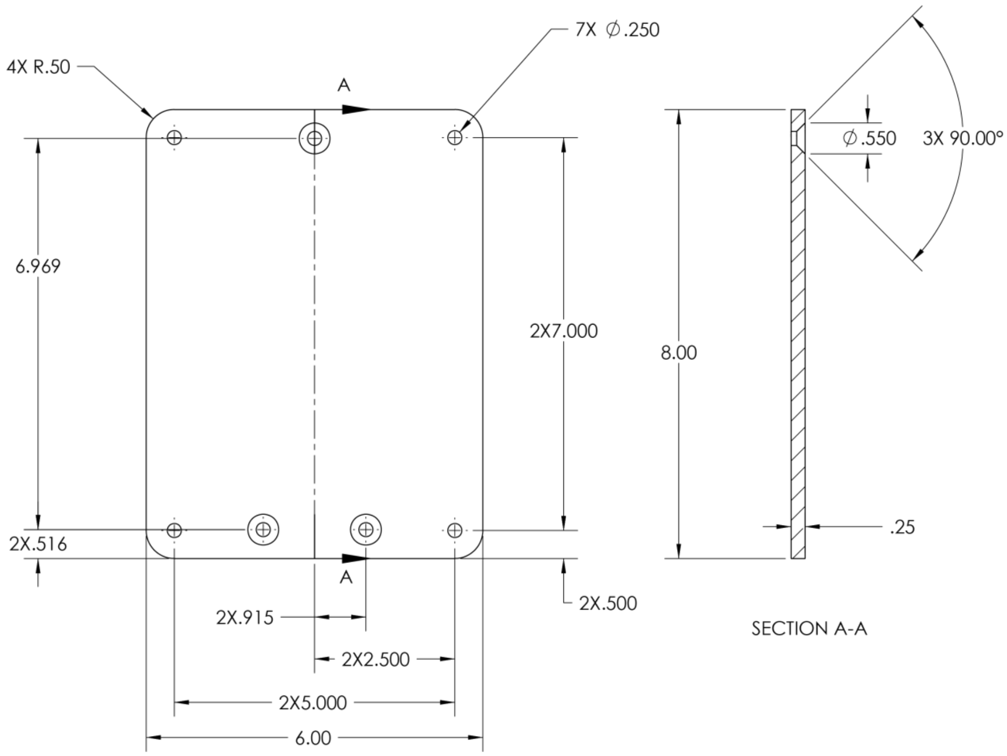

Figure 29. Sensor Mounting Plate Dimensions

NOTES

Appendix A

NOTICE OF COMPLIANCE

In this chapter, you will learn:

- Point 1
- Point 2
- Point 3
- Point 4
- Point 5

Date of Manufacture

China RoHS requires that all Electrical and Electronic Products are marked with a Date of Manufacture. This is the starting point for the Environmental Friendly Use Period, described below.

Environmental Friendly Use Period (EFUP)

Per SJ/T 11364-2006 – Product Marking, the EFUP is defined as the time in years in which hazardous/toxic substances within Electrical and Electronic Products (EIP) will not, under normal operating conditions, leak out of the Product, or the Product will not change in such a way as to cause severe environmental pollution, injury to health, or great damage to property. TRDI has determined the Environmental Friendly Use Period shall be Ten (10) years.

The purpose of the marking is to assist in determining the restricted substance content, recyclability, and environmental protection use period of our covered products, as required in Chinese law, and does not reflect in any way the safety, quality, or warranty associated with these TRDI products.

Some homogenous substance within the EIP contains toxic or hazardous substances or elements above the requirements listed in SJ/T 11363-2006. These substances are identified in Table 1 on page 2.

WEEE

The mark shown to the left is in compliance with the Waste Electrical and Electronic Equipment Directive 2002/96/EC (WEEE).

This symbol indicates the requirement NOT to dispose the equipment as unsorted municipal waste, but use the return and collection systems according to local law or return to one of the TRDI facilities below.

Teledyne RD Instruments USA
14020 Stowe Drive
Poway, California 92064

Teledyne RD Instruments Europe
2A Les Nertieres
5 Avenue Hector Pintus
06610 La Gaude, France

Teledyne RD Technologies
1206 Holiday Inn Business Building
899 Dongfang Road, Pu Dong
Shanghai 20122
China

CE

This product complies with the Electromagnetic Compatibility Directive 89/336/EEC, 92/31/EEC. The following Standards were used to verify compliance with the directives: EN 61326(1997), A1(1998), A2(2001) – Class "A" Radiated Emissions.

Material Disclosure Table

In accordance with SJ/T 11364-2006, the following table disclosing toxic or hazardous substances contained in the product is provided.

Table 32. Toxic or Hazardous Substances and Elements Contained in Product

零件项目(名称) Component Name	有毒有害物质或元素 Toxic or Hazardous Substances and Elements					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr^{6+})	多溴联苯 Polybrominated Biphenyls (PBB)	多溴二苯醚 Polybrominated Diphenyl Ethers (PBDE)
换能器配件 Transducer Assy.	X	O	O	O	O	O
机体装配 Housing Assy.	X	O	O	O	O	O
接收机电路板 Receiver PCB	X	O	O	O	O	O
数据处理器电路板 DSP PCB	X	O	O	O	O	O
输入输出口电路板 PIO PCB	X	O	O	O	O	O
外部接口电路板 I/O PCB	X	O	O	O	O	O
通讯接口板 Personality Module	X	O	O	O	O	O
外接电缆 External Cables	X	O	O	O	O	O
专用装运箱和泡沫塑料垫 Shipping Case w/Foam	O	O	O	O	O	O

O: 表示该有毒或有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。

O: Indicates that the toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit required in SJ/T 11363-2006.

X: 表示该有毒或有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。

X: Indicates that the toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T 11363-2006.

NOTES