WorkHorse Horizontal H-ADCP

Operation Manual

P/N 957-6212-00 (February 2024)

https://www.teledynemarine.com

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Revision History

February 2024

- Updated Returning Systems to the TRDI Factory, page 85 Brokerage address.

July 2023

- Updated website address.

February 2023

- Removed RTV from anode installation. Applying RTV to the anodes reduces their effectiveness which can lead to corrosion of the housing.
- Updated the EAR statement.

June 2022

- Added note that 967-6095 is the standard HADCP build.

April 2022

- 90Z-8000-00 replaced with 95Z-6007-00.

September 2021

- Corrected Vent Plug O-Ring P/N 97Z-6084-01 size from 3-094 to 3-904.

July 2021

- Added PD0 decoder link.
- Added using TRDI Toolz.
- Updated outline installation drawing 967-6095.
- Replaced Quick Start Card with a Deployment Guide and Getting Started sheet.

November 2018

- Replaced tonal with total, page 101.

June 2018

- Updated the Inventory List with the 90Z-8000-00 combined CD. Systems may ship with individual CDs or one combined CD.
- Added Testing the Sensors
- Added the BIT output for PD8.
- Added Vent Plug information.
- Added using the cable clips.
- Removed references to SurfaceView.
- Updated outline installation drawings.
- Updated Replacing the CPU Lithium Battery.
- Updated the EX command figure for H-ADCP Coordinate Transformation.

May 2015

- Combined Quick Start Guide into the Operation Manual.
- Created new H-ADCP setup card.
- Added corrections for ICN 126 antifouling paint.
- Added corrections for ICN 127 Force Cold Start.
- Added corrections for ICN 130 End Cap Removal.
- Added corrections for ICN 145 I/O Connector Lubricant.
- Added corrections for ICN 153 Converting ADC channels.
- Updated the installation instructions.
- Updated the maintenance procedures and parts location drawings.
- Updated the specifications and outline installation drawings.

- Updated Commands and Output Data Format to firmware version 11.11.
- Updated styles and fonts.

December 2008

- General update to the manual. – Removed add oil to pressure sensor.
- Added more to installation section.
- Incorporated the following corrections: ICN095, ICN106, and ICN114 (oil).

October 2007

- Initial release.

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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Client Services Administration – rdicsadmin@teledyne.com

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

Self-Service Customer Portal

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

Teledyne Marine Software Portal

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

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

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

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

CONVENTIONS USED IN THIS MANUAL

Conventions used in the WorkHorse Horizontal Acoustic Doppler Current Profiler (H-ADCP) Operation Manual have been established to help learn how to use the system quickly and easily.

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

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

```
[BREAK Wakeup A]
WorkHorse Horizontal Broadband ADCP Version 11.xx
Teledyne RD Instruments (c) 1996-2004
All Rights Reserved.
>
```

There are four visual aids to help:

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 H-ADCP).

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

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

NOTES

Chapter 1

AT A GLANCE

In this chapter:

System Overview

The H-ADCP transducer assembly contains the end-cap, housing, transducer ceramics, and electronics. The standard acoustic frequencies are 600 and 300 kHz. See the Outline Installation Drawings for dimensions and weights.

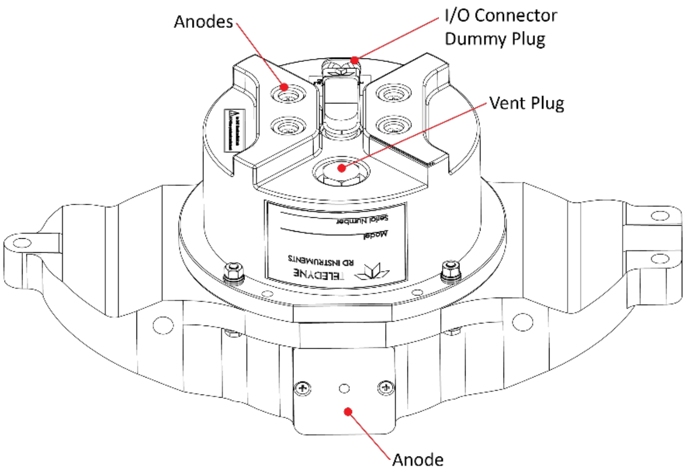
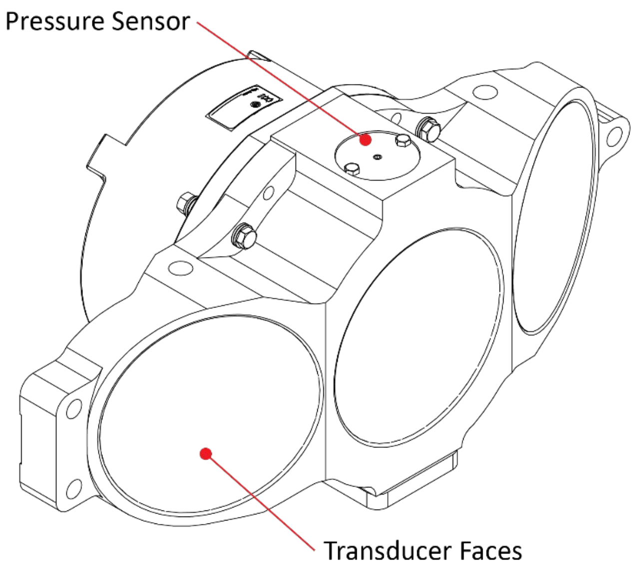
Picture	Description
	The Input/Output (I/O) cable connects the H-ADCP to the computer and external power supply. When the cable is not connected, use the dummy plug to protect the connector. The standard H-ADCP housing allows deployment depths to 200 meters. Anodes provide protection against corrosion. Use the Vent Plug to vent the system before opening the housing. Loosen the port ½ turn and listen for airflow; if none, then open another ½ turn and listen again for airflow. Repeat until the Vent Plug is fully removed. This will ensure no internal pressure is present when removing the housing.
	The optional pressure sensor (standard 200 Bar) measures water pressure (depth). The orange urethane faces cover the transducer ceramics. Never set the transducer on a hard surface. The urethane faces may be damaged. The H-ADCP electronics and transducer ceramics are mounted to the transducer head.

Figure 1. 300/600 kHz H-ADCP Overview

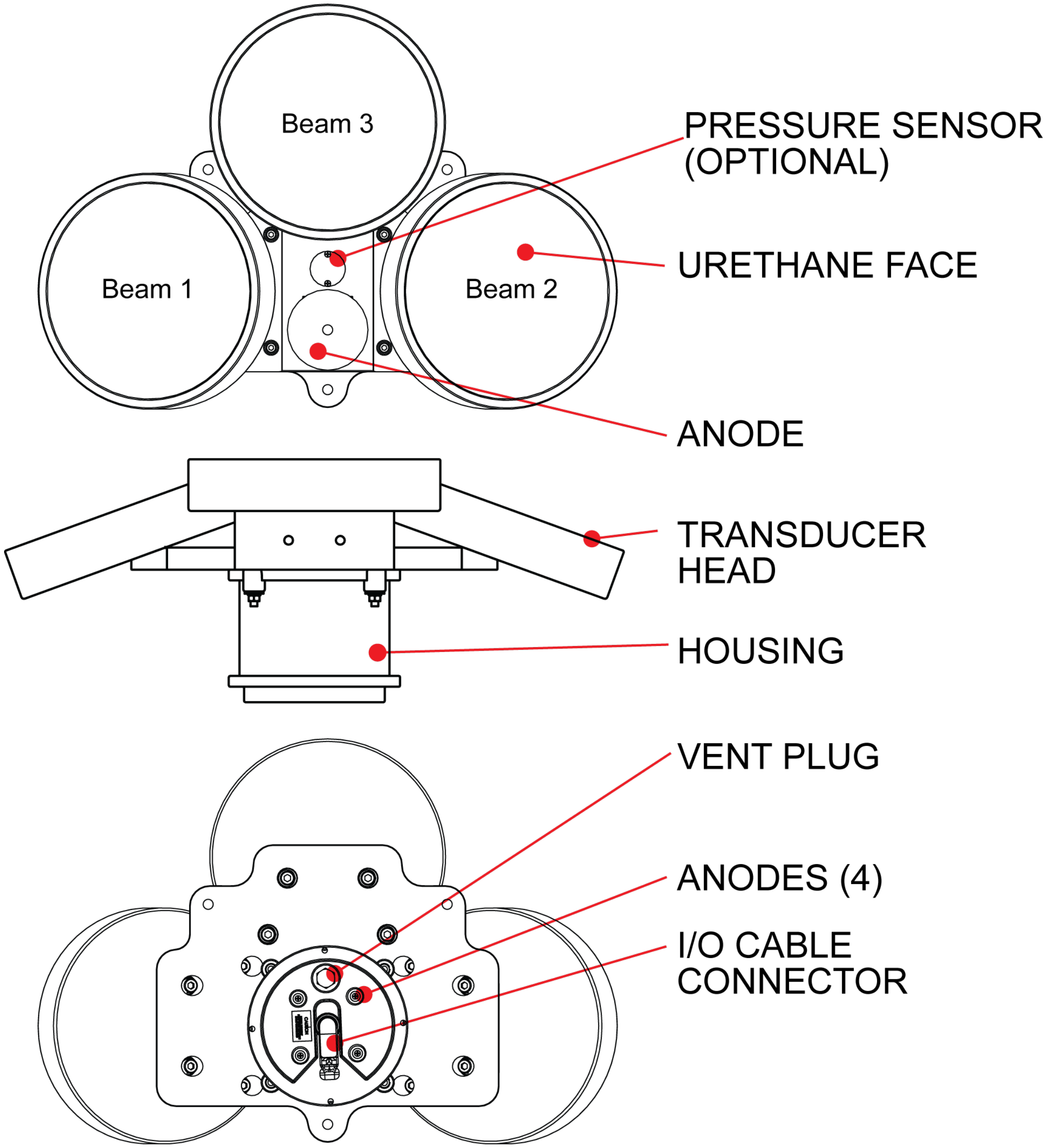


Figure 2. 300 kHz NB H-ADCP Overview

Inventory List

Included with the H-ADCP system:

Part Number	Name	Description
HADCP-I	H-ADCP 600 kHz H-ADCP 300 kHz H-ADCP 300 kHz Narrow Beam	The H-ADCP system includes the transducer and dummy plug. When unpacking, use care to prevent physical damage to the transducer face and connector. Use a soft pad to protect the transducer.
	H-ADCP Accessories Kit	Contains the I/O cable, shipping case, software, and documentation listed below.

Included with the H-ADCP Accessories Kit:

Part Number	Name	Description
73B-3030-005	I/O cable	The I/O cable is used for serial communications.
737-3008-025	Extension Cable	25-meter extension cable
717-3014-00 PO3-6	AC Power Adapter Power cord	AC power adapter provides 48 VDC
737-3010-00	RS232/RS422 Converter	If you ordered RS-422 communications, a RS-232 to RS-422 adapter will be added.
MRDI1004 305D0550-4	Shipping case	Shipping case with custom foam cutouts.
95Z-6007-00	Download instructions	This sheet has instructions for downloading the software and manuals.
	TRDI Toolz Software	Utility and testing software package that can be used to test the H-ADCP.
	WavesMon Software (optional) WavesView Software (optional)	Waves is a feature upgrade for 300 kHz NB H-ADCPs. *WavesMon* is the directional wave measurement package for the H-ADCP. Use *WavesView* to view wave data. It is an enormously useful tool for turning waves data into waves information.
957-6294-00	H-ADCP Getting Started sheet	A printed reference showing H-ADCP connection.
957-6293-00	H-ADCP Deployment Guide	A printed guide showing setup thru deployment.
757K6085-00	Mounting Kit (optional)	Optional mounting kit for 300/600 kHz H-HADCPs
757K6073-00 757K6071-00	Tools and Spare Parts kit	See Tools and Spare Parts for a list of parts included in these kits.

Computer Considerations

TRDI designed the H-ADCP to use a Windows® compatible computer. The computer controls the H-ADCP and displays its data, usually through our *WavesMon* program.

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

Minimum computer hardware requirements:

- Windows 10®, Windows 8.1®, Windows 7®, Desktop, Laptop, or Netbook computer
- Screen resolution above 1024x768
- Mouse or another pointing device
- One Serial Port

The computer configuration varies depending of the number of communication ports and the external data refresh rate. Serial communications require a lot of processor resources, and the minimum requirements can vary. A good quality video card is required to operate *WavesMon*. TRDI software does not use graphic card 3D functions; however, video memory is needed to display all graphics.

However, with experience we can recommend that:

- If you are using more than two communication ports, you should not use a Celeron processor.
- Intel Pentium III or higher processors work best to operate the H-ADCP and give access to the display and keyboard without losing ensembles.

Power Overview

H-ADCP requires +20 to 50 VDC to operate. The AC Adapter runs on any standard AC power and supplies +48 VDC to run the H-ADCP.

Transmitted power increases or decreases depending on the input voltage (within the voltage range of 20 to 50 VDC).

> The transmitted power is decreased approximately 1 DB if the input voltage drops from 42 VDC to 33 VDC. For a 300 kHz H-ADCP, each DB will result in a decrease in range of one default depth cell.

Power on Cycle

The power supply must be able to handle the inrush current as well. Inrush current is the current required to fully charge up the capacitors when power is applied to the H-ADCP. The capacitors provide a store of energy for use during transmit. The inrush current is as high as 3 Amps rms. The H-ADCP will draw this amperage until its capacitors are fully charged.

If the power supply limits the current or the power drop on the cable is significant, then the power on cycle will take longer. It can take up to one minute. You do not want the power to shut down during the inrush current draw, as this may not allow the H-ADCP electronics to start.

AC Power Adapter

The AC power adapter is designed to maintain a 400-ma supply under the H-ADCP's inrush current. The adapters are 75-Watt supplies, with 48 VDC, 1.5-amp output. They will not fall back to 0 amps, 0 volts under a load. Customer provided power supplies might shut themselves down under such a load; when that occurs, the H-ADCP will not wakeup.

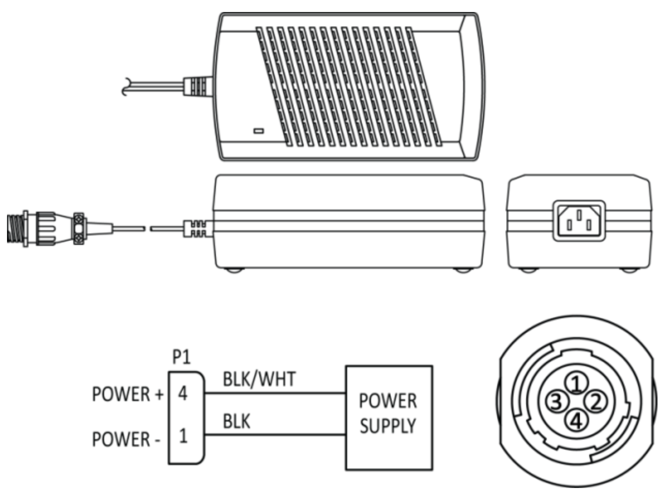
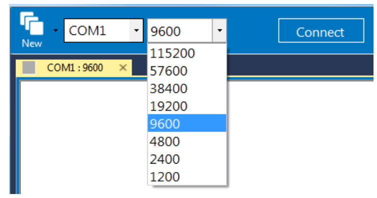


Figure 3. AC Power Adapter

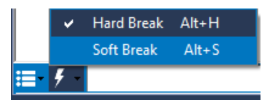
Setting up the H-ADCP System

Use this section to connect the H-ADCP to a computer and establish communications. Install the *RDI Tools* software to communicate with the H-ADCP.



To establish communications with the H-ADCP:

1. Connect the system and apply power.
2. Start the *TRDI Toolz* software.
3. Select **New Serial Connection**.
4. Enter the ADCP's communication settings. Select the **COM Port** the serial cable is connected to and set the **Baud Rate** from the drop-down lists. If you are unsure of the ADCP's baud rate, use **Tools**, **Find ADCP**. *TRDI Toolz* will try different baud rates until it connects to the ADCP.
5. Click the **Connect** button. Once connected, the button will change to **Disconnect**.
6. Click the **Break** () button. From the **Break** button drop down menu, select **Hard Break**. The wakeup banner will display in the terminal window.



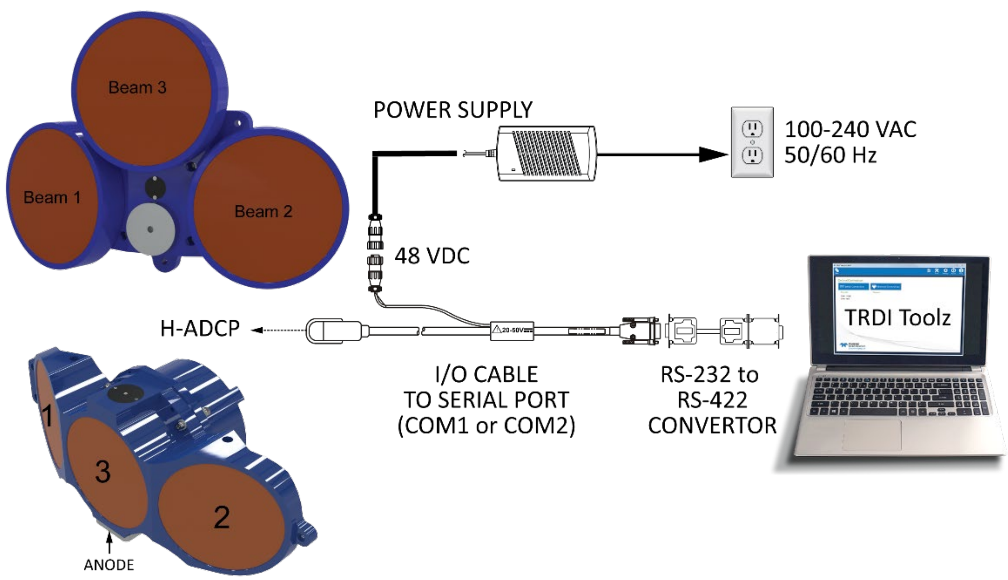


Figure 4. H-ADCP Connections

Testing the H-ADCP

These tests check that the H-ADCP can communicate with the computer and runs the H-ADCP Pre-Deployment tests.

```
>cr1
[Parameters set to FACTORY defaults]
>ck
[Parameters saved as USER defaults]
```

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

At the ">" prompt in the communication window, enter **CK** then press the Enter key. This will save the factory default setting as the default power up condition.

```
>ps0
  Instrument S/N:  3192
       Frequency:  307200 HZ
   Configuration:  3 BEAM, HORIZONTAL
      Beam Angle:  25 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  UP
       Sensor(s):  HEADING  TILT 1  TILT 2  DEPTH  TEMPERATURE
PRESSURE
Pressure Sens Coefficients: (c3,c2,c1,offset) 0.00,0.00,0.01,-1.15

Temp Sens Offset:  -0.22 degrees C

    CPU Firmware:  11.07 [0]
   Boot Code Ver:  Required:  1.13   Actual:  1.13
    DEMOD #1 Ver:  ad48, Type:  1f
    DEMOD #2 Ver:  ad48, Type:  1f
    PWRTIMG  Ver:  85d3, Type:   6

Board Serial Number Data:
   D1  00 00 00 E6 FD 28  09 PIO727-3013-04X
   B4  00 00 00 E7 09 74  09 REC727-1015-04X
   34  00 00 00 E6 F8 29  09 CPU727-2000-00H
   A9  00 00 02 C9 37 69  09 DSP727-2001-04F
>
```

At the ">" prompt in the communication window, enter **PS0** then press the Enter key. This will display the H-ADCP system configuration data.

```
>pa

PRE-DEPLOYMENT TESTS

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

At the ">" prompt in the communication window, enter the direct command **PA** then press the Enter key. This will run the H-ADCP Pre-Deployment tests.

```
>Pt3

Correlation Magnitude: Narrow Bandwidth

               Lag  Bm1  Bm2  Bm3
                 0  255  255  255
                 1  144  144  146
                 2   70   71   73
                 3   37   33   35
                 4   24   18   18
                 5   13   12    8
                 6    6    5    2
                 7    3    2    1

  High Gain RSSI:    71   67   74
   Low Gain RSSI:    16   16   18

  SIN Duty Cycle:    49   52   49
  COS Duty Cycle:    48   50   48

Receive Test Results = $000 ... PASS
>
```

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

Testing the Sensors

Confirm that the tilts and heading output are correct.

```
Press any key to quit sensor display ...
Heading   Pitch    Roll    Up/Down   Attitude Temp   Ambient Temp  Pressure
301.01°  -7.42°  -0.73°     Down       24.35°C         22.97°C       0.0 kPa
300.87°  -7.60°  -0.95°     Down       24.36°C         22.97°C       0.0 kPa
```

At the ">" prompt in the communication window, enter **PC2** then press the Enter key.

Rotate the system and verify the Heading is reasonable.

Pitch and Roll the system and verify positive and negative readings.

The PC2 heading shows the raw (magnetic north) heading only. The EB command (Heading Bias) is not applied.

Orientation	Pitch +	Roll +	Heading Reasonableness
Downward	Beam 3 Tilted Upward	Beam 2 Higher than Beam 1	Clockwise rotation is increasing heading Validate accuracy at 0, 90, 180 degrees

When an H-ADCP is orientated properly and horizontal, PC2 Up/Down will state it is orientated downward.

The 300 kHz NB H-ADCP should only be rotated/tilted by holding onto the transducer mounting plate. Do not rotate/tilt by holding onto the housing, end-cap, or beams. The system weight can cause serious damage to the H-ADCP or personnel lifting the unit.

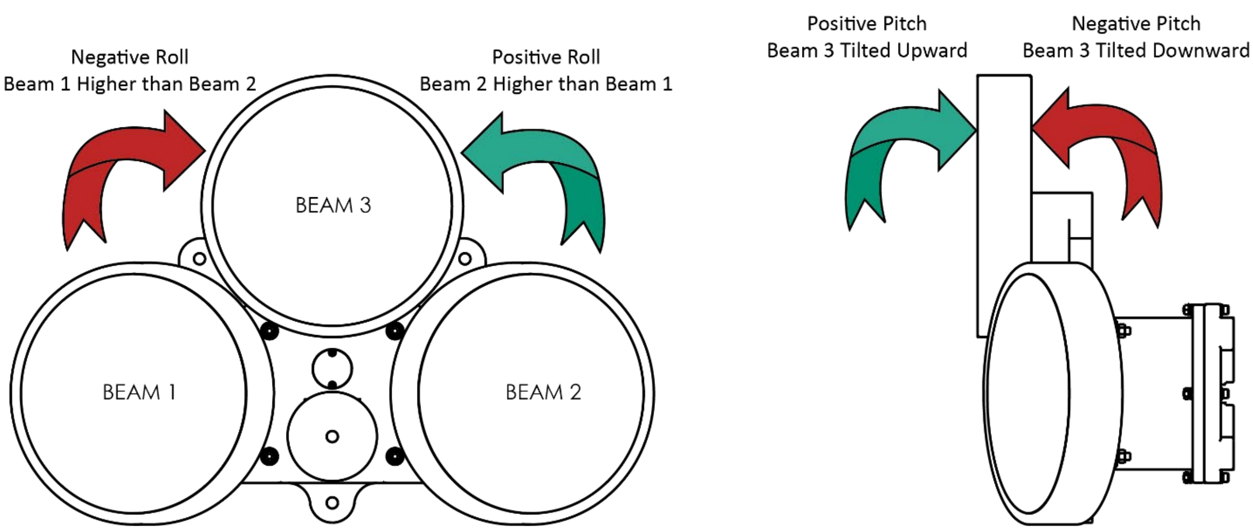


Figure 5. H-ADCP Pitch and Roll

Changing the Baud Rate in the H-ADCPs

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

```
[BREAK Wakeup B]
WorkHorse Horizontal Broadband ADCP Version 11.10
Teledyne RD Instruments (c) 1996-2009
All Rights Reserved.
>cr1
[Parameters set to FACTORY defaults]
```

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

Start the *TRDI Toolz* program and establish communications with the H-ADCP.

Click the **Break** ( ) button.

At the ">" prompt in the communication window, type **CR1** then press the Enter key. This will set the H-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)
>
```

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

Exit *TRDI Toolz*.

The H-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 *TRDI Toolz* so the communication port is available for use with other programs.

Caring for the H-ADCP System

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

General Handling Guidelines

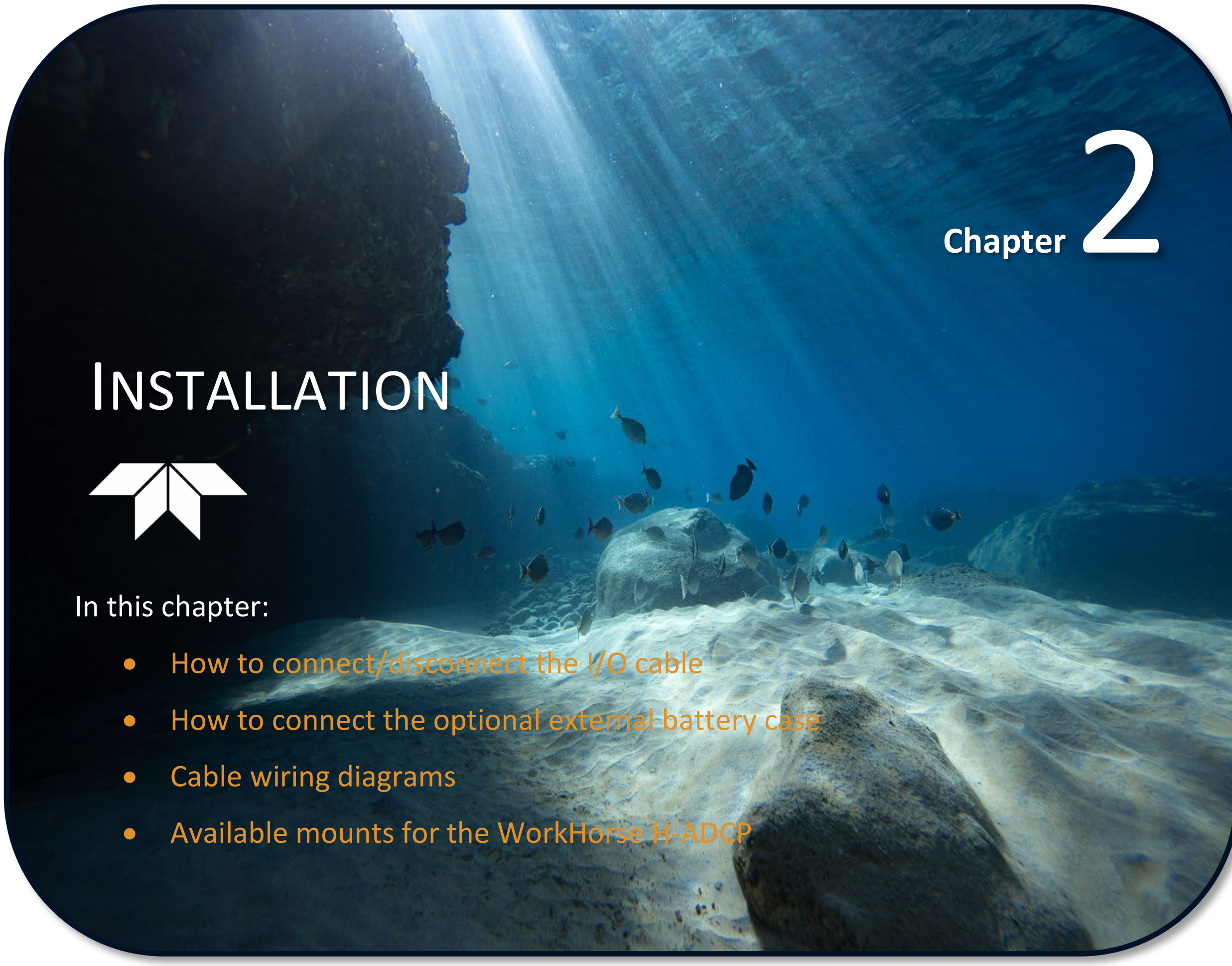
- Never set the transducer on a hard or rough surface. **The urethane faces may be damaged.**
- Always remove the retaining strap on the underwater-connect cable and dummy plug when disconnecting them. **Failure to do so will break the retainer strap.**
- Do not apply any upward force on the end-cap connector as the I/O cable is being disconnected. **Stressing the connector may cause the H-ADCP to flood.** Read the Installation section for details on disconnecting the I/O cable.
- Do not expose the transducer faces to prolonged sunlight. **The urethane faces may develop cracks.** Cover the transducer faces on the H-ADCP if it will be exposed to sunlight.
- Do not expose the I/O connector to prolonged sunlight. **The plastic may become brittle.** Cover the connector on the H-ADCP if it will be exposed to sunlight.
- Do not store the H-ADCP in temperatures over 60 degrees C. **The urethane faces may be damaged.**
- Vent the system before opening by loosening the hardware on the housing. **If the H-ADCP flooded, there may be gas under pressure inside the housing.**
- Do not scratch or damage the O-ring surfaces or grooves. **If scratches or damage exists, they may provide a leakage path and cause the H-ADCP to flood.** Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support an H-ADCP by the external I/O cable. **The connector or cable will break.**
- The 300 kHz NB H-ADCP should only be lifted by holding onto the transducer mounting plate. Do not lift by holding onto the housing, end-cap, or beams. **The system weight can cause serious damage to the H-ADCP or personnel lifting the unit.** Use the Outline Installation Drawings to locate the transducer mounting plate.

Assembly Guidelines

- Read the Maintenance section for details on H-ADCP re-assembly. Make sure the housing assembly O-ring stays in the groove when you re-assemble the H-ADCP. Tighten the hardware as specified. **Loose, missing, stripped hardware, or a damaged O-ring can cause the H-ADCP transducer to flood.**
- Use silicone lubricant (included in the spare parts kit) on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone from the metal portions of the pins. **Regular lubrication is required: Apply silicone lubricant prior to each connection.**
- Do not connect or disconnect the I/O cable with power applied. When you connect the cable with power applied, you may see a small spark. **The connector pins may become pitted and worn.**
- The **H-ADCP** I/O cable may be connected while slightly wet; do not connect under water.

Deployment Guidelines

- Read the WavesMon Software User's Guides. **This guide has tutorials to help you learn how to collect data with the H-ADCP.**
- Align the compass whenever any ferrous metals are relocated inside or around the H-ADCP housing. **Ferro-magnetic materials affect the compass.**
- The AC power adapter is not designed to withstand water. **Use caution when using on decks in wet conditions.**
- Avoid using ferro-magnetic materials in the mounting fixtures or near the H-ADCP. **Ferro-magnetic materials affect the compass.**
- Your H-ADCP transducer housing and mounting plate is made of aluminum. **Do not connect other metal to the H-ADCP. Other metals may cause corrosion damage. Use isolating bushings when mounting the H-ADCP to a metal structure.** Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it at the installation site.
- Sacrificial anodes are fitted to the H-ADCP to prevent corrosion (see Zinc Anode Inspection and Replacement). Standard anode protection will typically protect the parts that may corrode. However, **you should plan regular inspections of the mounting hardware for signs of corrosion**. TRDI disposes many corroded hardware sets during inspections.
- Inspect the paint on the end-cap, housing, and transducer assemblies for corrosion, scratches, cracks, abrasions, paint blisters, exposed metal (silver-colored aluminum), exposed anodize (black or dark green), and exposed primer (yellow). **Be critical in your judgment; the useful life of the H-ADCP depends on it.** See Protective Coating Inspection and Repair for details.



Chapter 2

INSTALLATION

In this chapter:

- How to connect/disconnect the I/O cable
- How to connect the optional external battery case
- Cable wiring diagrams
- Available mounts for the WorkHorse H-ADCP

I/O Cable and Dummy Plug

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

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

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

a) The connector or connector pins can crack.

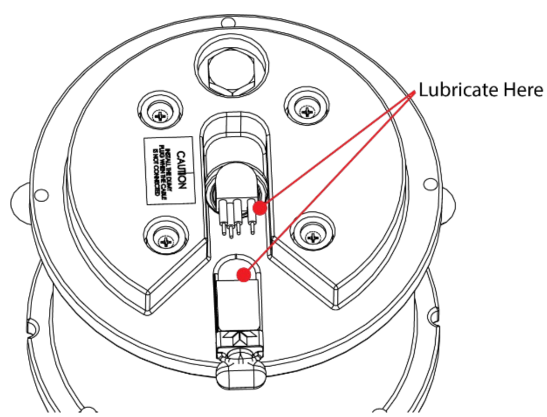
b) The O-ring on the bottom of the connector can be damaged.

c) The molded urethane on the connector may separate from the brass insert.

If the connector is damaged in any of these ways, your H-ADCP will flood.

To disconnect the cable:

1. Release the retaining strap by pulling it over the connector.
2. Grasp the cable/dummy plug close to the housing.
3. Pull the cable/dummy plug straight away from the housing. Avoid side-to-side rocking motions as much as possible. Do not apply any upward force on the connector as it is being disconnected.



To connect the cable:

1. Check all pins for signs of corrosion (greenish oxidation, black deposits, or pitting).
2. Use light amounts of silicone lubricant (included in the spare parts kit) on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone from the metal portions of the pins. **Regular lubrication is required**: Apply silicone lubricant prior to each connection.

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

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

As a result of any damage to the neoprene rubber, corrosion may occur on current carrying pins.

3. Gently push the cable straight in toward the connector. Do not apply any upward force on the connector as it is being connected.
4. Roll the retaining strap over the connector.

Using the Cable Clips

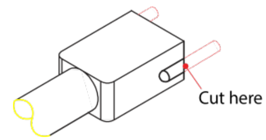
New dummy plugs and cables no longer use a molded retaining strap.

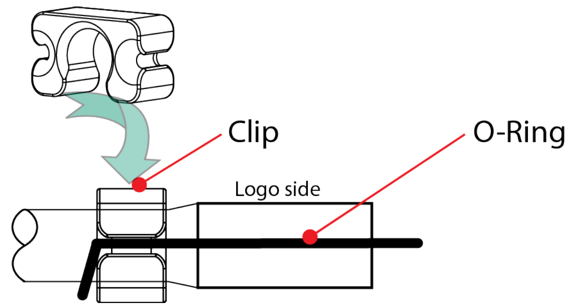
To use the cable clips:

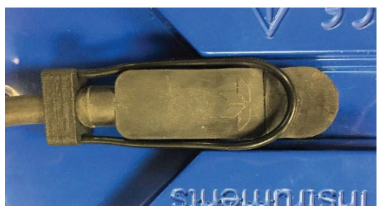
1. Remove the broken retaining strap if needed.
2. Snap the clip onto the cable or dummy plug.

- Black clip & 2-137 O-ring = cables
- White clip & 2-130 O-ring = dummy plugs

3. Route the O-ring through the clip. Connect the cable/dummy plug and then stretch O-ring over connector.







Routing Cables

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

Route this cable so:

- It does not have kinks or sharp bends.
- Protect the cables with hose if zip-ties are used to secure them to structures (see Figure 6).
- The cable can easily be replaced it if it fails.
- The cable connector is not spliced. The wet-end connector is 3.0cm (1.18 inches) long, 2.54cm (1.00 inches) wide, 1.27cm (0.5 inches) high. Model# Impulse LPMIL-7-FS.

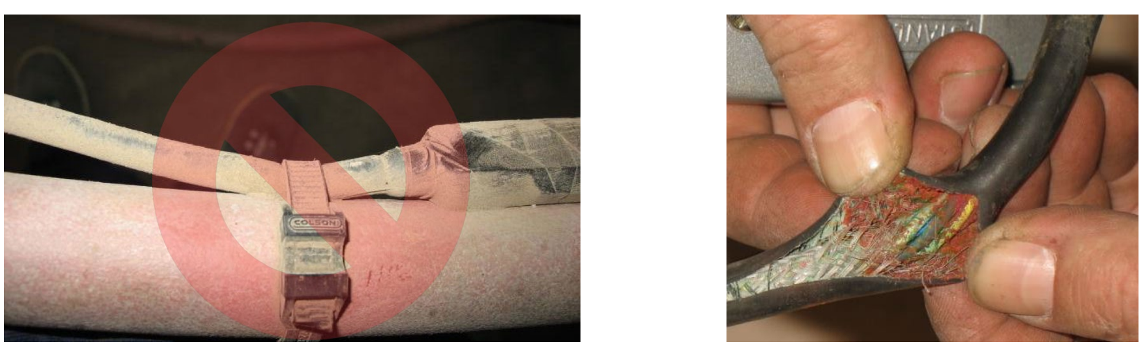


Figure 6. Do not use Zip-Ties Directly on Cables

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

Cable Wiring Diagrams

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

Where shown, the color code is for reference only; your cable may be different.

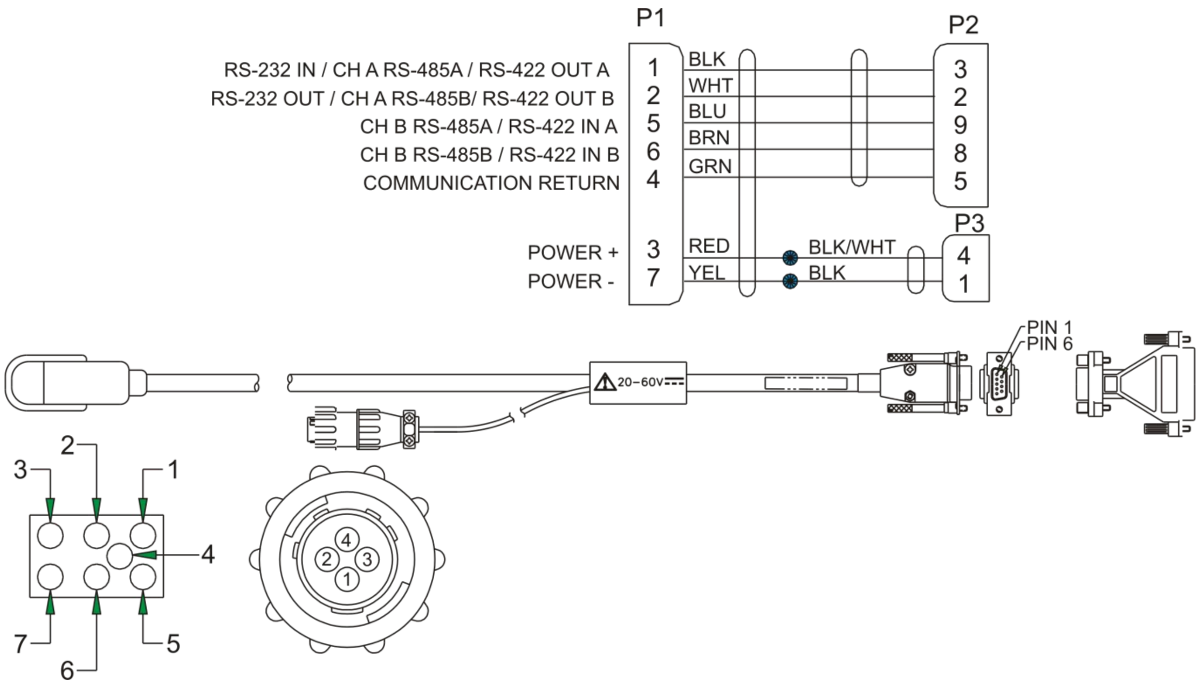


Figure 7. I/O Cable Wiring

Where shown, IN refers to signals going into the H-ADCP and OUT refers to signals coming out of the H-ADCP.

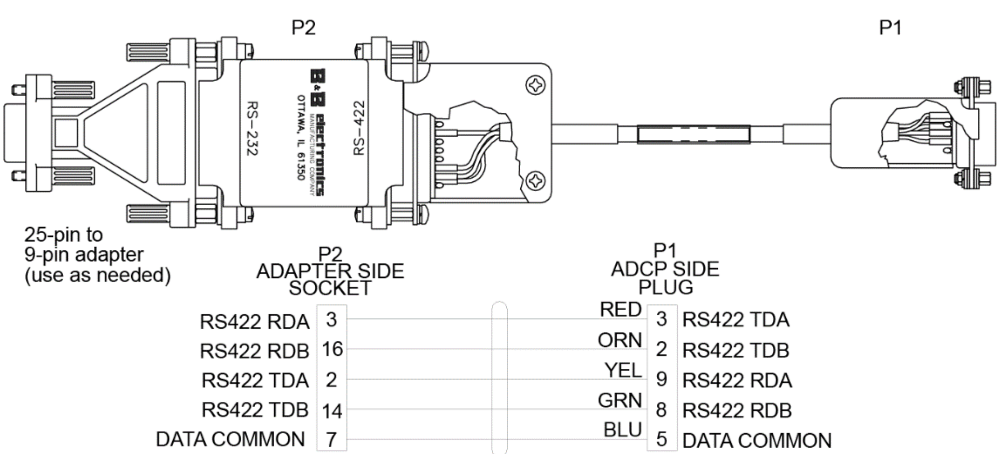


Figure 8. RS232-to-RS422 Converter Wiring (25-Pin to 9-Pin)

Installation

The H-ADCP must be rigidly mounted to a structure, such as a large vessel, solid wall, pier, or pile. The mounting structure must be firm, stable, without settlement or displacement over time. To gain the maximum profiling range at a site, TRDI recommends the H-ADCP be mounted near the middle of the water depth at the mounting structure location. For a site with a significant seasonal change of water level, the H-ADCP may need to be mounted at different elevations according to seasonal water level change. In deep water TRDI recommends the H-ADCP be mounted 5 to 20 meters below the surface.

Proper transducer mounting is critical to system performance. There are a few basic variations for H-ADCP system installation:

1. Fixed mounted
2. Rail system that allows the H-ADCP to be moved up and down for maintenance
3. Dual taught wire system lowered via a winch
4. Free hanging from a spreader bar lowered over the side of the platform from a winch

The two preferred methods are fixed mounted or via the dual taught wire method to eliminate any heading, roll or pitch movement. Changes in transducer orientation will cause errors in water velocity measurements. Fixed mounted and rail system mounted H-ADCPs result in optimal system performance, along with ease of maintenance when using a rail system.

Consideration should be taken into account when mounting to a platform with Dynamic Positioning as there can be turbulent flow around the transducer, causing flow noise that will reduce system range performance.

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

Use isolating bushings when mounting the H-ADCP to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it at the installation site.

Cathodic Disbondment and Galvanic Corrosion

Cathodic disbondment is the loss of adhesion between a cathodic coating and its metal substrate due to the corrosion reaction that take place in the interface of coatings. Disbondment of coating occurs when coatings in a cathodic protection system interact either chemically or physically, ultimately causing corrosion beneath the coat.

Cathodic Protection is a technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell. A simple method of cathodic protection connects the H-ADCP's metal housing to a more easily corroded "sacrificial metal" anode. The sacrificial metal then corrodes instead of the protected metal.

The anode only provides cathodic protection as long as it is present and connected to the H-ADCP housing; **check the anode condition** **on a regular basis**.

Figure 9. Cathodic Protection and Anodes

Dissimilar metals and alloys have different electrode potentials, and when two or more come into contact in an electrolyte, one metal acts as anode and the other as cathode. The electro-potential difference between the dissimilar metals is the driving force for an accelerated attack on the anode member of the galvanic couple.

Galvanic corrosion will contribute to accelerated corrosion of parts of the H-ADCP system. **When mounting the H-ADCP aluminum housing to other metals, always use isolation washers**.

Figure 10. Galvanic Corrosion

H-ADCP Orientation

The H-ADCP must be mounted with its transducer orientation in the horizontal direction. That is, the three transducers, which are for water velocity measurement, must be looking horizontally (also called side-looking). The pressure sensor, which is for water depth measurement, must be looking up towards the water surface.

X-Axis - Pitch is measured around the X-axis and should be set to zero.

Y-Axis - Roll is measured around the Y- axis and should be set to zero.

Pressure Sensor – The pressure sensor must be facing up towards the water surface (for the 300 kHz NB H-ADCP, it is facing the beams – Beam 3 should be upward).

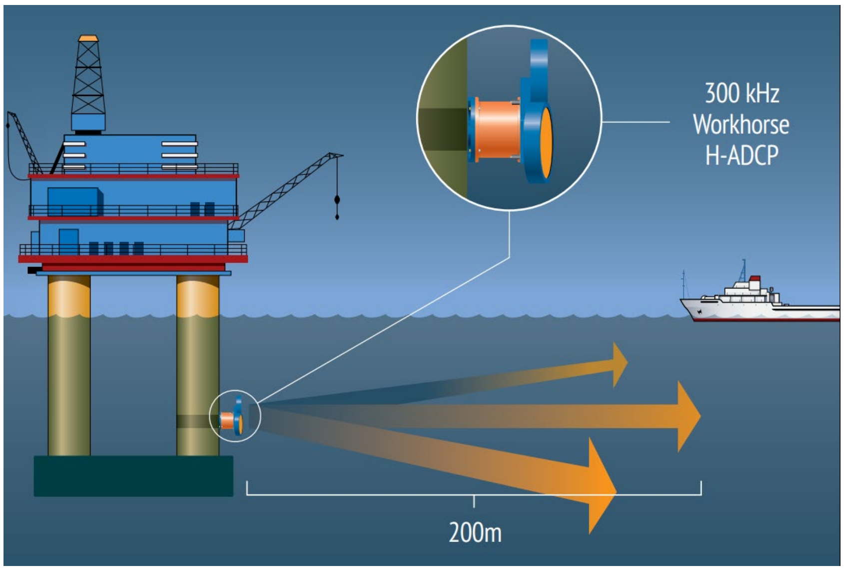


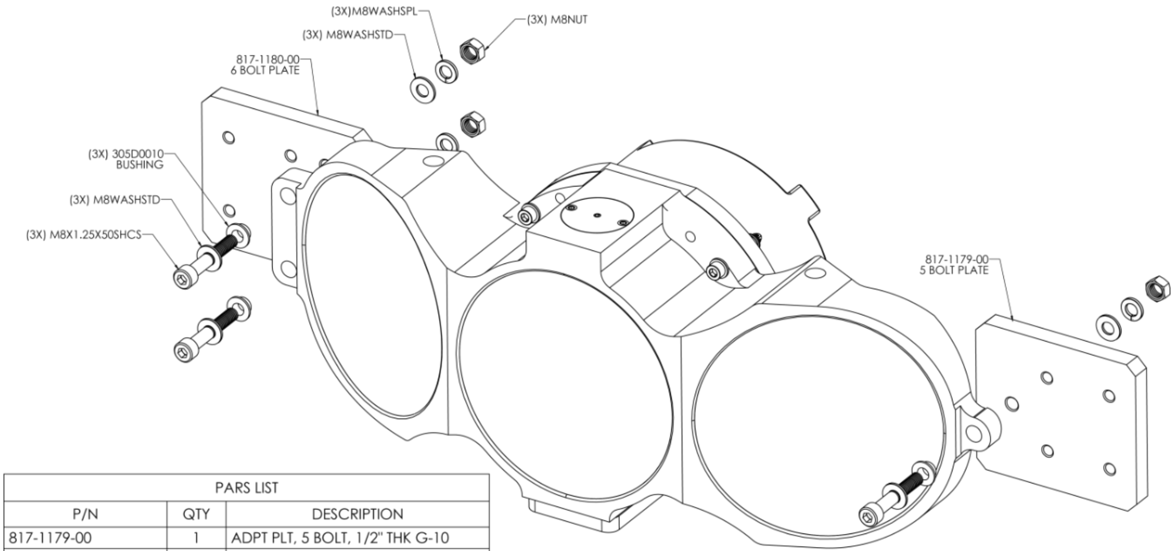
Figure 11. Installing the H-ADCP

Attaching the H-ADCP to a Structure

- Attach the H-ADCP to a rigid structure, solid wall, pier, or pile. The mounting structure must be firm, stable, without settlement or displacement over time.
- Double-check all the connections, seals, and bolts. Connect the I/O cable and make sure that the strain relief is attached to the cable. Make sure that the I/O cable is routed so that it is not subject to becoming entangled or snagged.
- Bolt the H-ADCP to the structure using isolating bushings when mounting the H-ADCP to a metal structure.

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

Use isolating bushings when mounting the H-ADCP to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it at the installation site.



PARS LIST		
P/N	QTY	DESCRIPTION
817-1179-00	1	ADPT PLT, 5 BOLT, 1/2" THK G-10
817-1180-00	1	ADPT PLT, 6 BOLT, 1/2" THK G-10
305D0010	3	BUSHING, BLACK DELRIN
M8X1.25X50SHCS	3	M8 SCREW
M8WASHSTD	6	WASHER, M8, STANDARD
M8 WASHSPL	3	WASHER, M8, SPLIT LOCK
M8NUT	3	NUT, M8

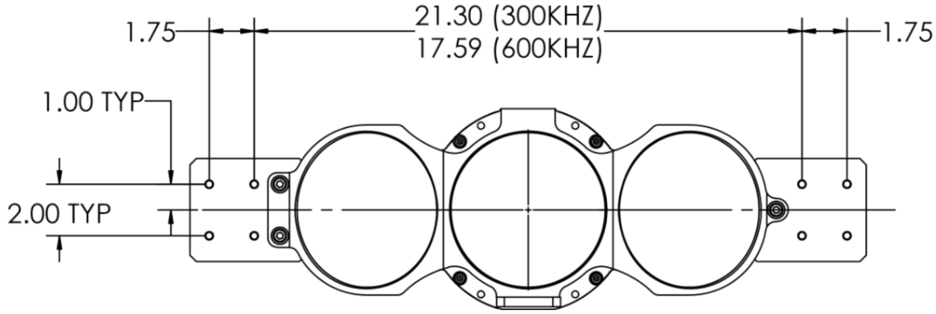


Figure 12. Optional Mounting Kit (P/N 757K6085-00)

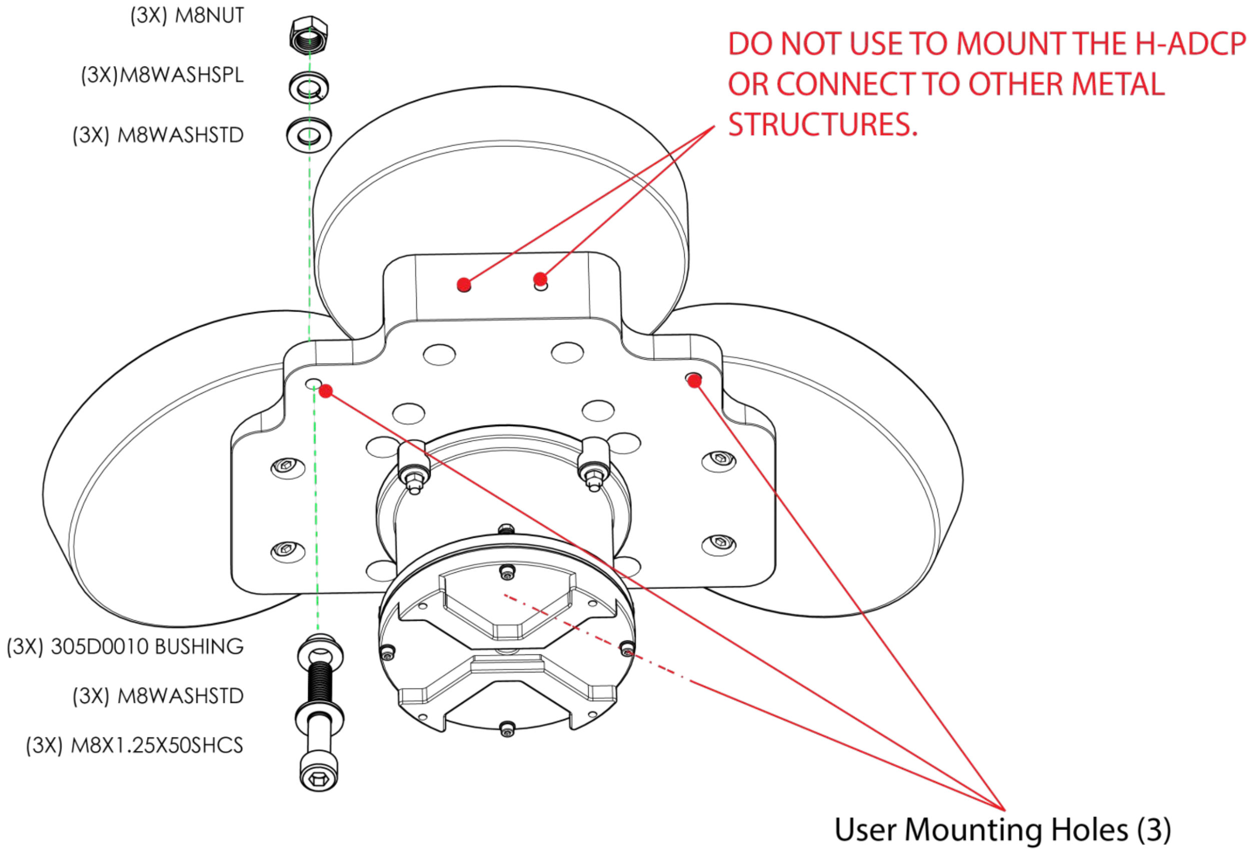


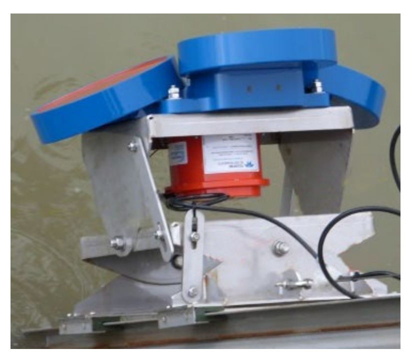
Figure 13. 300 kHz NB H-ADCP Mounting Holes

The two M12 tapped holes on the top edge of the mounting plate are used to help handle the system during production of the H-ADCP.

Do not use these holes to mount the H-ADCP or connect any other metal structures to the H-ADCP. This can lead to **Galvanic Corrosion** and destruction of the H-ADCP.

Poor Mount

H-ADCP mount is using the two M5 tapped holes to connect to a metal structure.



Good Mount

H-ADCP mount uses the three user mounting holes with isolation bushings. Does not use the two M5 tapped holes.

Photos by Drs. P.E. Meijer / CEO Aqua Vision

H-ADCP Wave System Installation Checklist

Waves is a feature upgrade for 300 kHz NB H-ADCPs (see Feature Upgrades).

For information on how to use the Waves commands, see the WavesMon User's Guide.

✓ **System Orientation**

1. **Deploy the system pointed into the wave direction as much as possible.** If the system is in the shadow of the platform it may be challenging to profile outside of it.
2. **Waves from the side are acceptable, but not ideal**. Waves from the side can be measured; however, the smallest measurable wave specification is different. Waves straight on might be measurable at 20 cm height, whereas waves from the side may need to be a minimum of 1.5m height.

✓ **Obstructions**

1. **Avoid obstructions in the beams.** Obstructions in the beams (fish, hardware, boats, thruster wash), may challenge the measurement. If the ADCP can get good profiles, it can produce both waves and currents results.
   - To avoid **fish** problems near the platform, choose range cells that are distant from the platform.
   - To avoid a **fixed obstruction**, choose range cells that are short of the obstruction.
   - Obstructing the beams close to the system makes collecting data impossible.
   - The **bottom is a fixed obstruction** and one must choose range cells that are short of it if deployed in shallow water.
   - The system is resilient to striking the **surface** at a grazing angle.
   - A very large sea state will create wave troughs that block the beams if the deployment depth is too shallow.

✓ **Know Your Heading**

1. **Confirm that the ADCP heading is valid** (not simply pointing at the nearest large piece of steel.)
   - If the instrument heading is not correct, a fixed heading can be entered into the software if the platform heading is relatively fixed.
   - If the instrument heading is not correct and the platform can rotate to any orientation, then an externally measured heading must be applied.

✓ **Tilts (constant angle not dynamics)**

1. The **ideal tilt is angled slightly upward (2 to 5 degrees pitch).**
2. A **level** deployment is **acceptable**.
3. **Use Caution if pitched slightly down:** this can place the measurement at great depth making it impossible to measure small or higher frequency waves.
4. **Pitch that is greater than 15 degrees is not recommended:** this scenario has not been tested.

5. The roll should be **zero** for **best measurements**. Roll less than 10 degrees is acceptable. **Use Caution if roll is greater than 10 degrees:** if cells in the right beam are too deep and cells in the left beam are too shallow the measurement may be compromised.

✓ **Deployment Depth**

1. The **ideal deployment depth** is approximately **10m submergence angled slightly upward (2 to 5 degrees pitch)** so that range cells at 100m are at about 3- to 5-meters submergence.
2. A large sea state will create wave troughs that block the beams if the deployment depth is too shallow: 6-meter waves will be a problem for a 3-meter deployment depth.
3. A very deep deployment depth will limit the wave frequencies and wave height that can be measured.
4. If a deep deployment is unavoidable, a greater tilt can be used but should not exceed about 15 degrees.
5. See Table 1, page 3 for the upper cutoff frequency.

✓ **Motion (dynamics)**

The best data is collected with the H-ADCP fixed in position: In many installations, such as when hanging over the side of a FPSO or Oil Platform, the H-ADCP will have motion as the vessel moves. This motion is typically coupled to the actual wave activity (and the vessel motion because of that): the result is that the quality of the H-ADCP waves measurement will be reduced. The default thresholds in *WavesMon* are set conservatively to avoid the biases from these motions. What follows are the motion limits that this conservative approach will work. Note that these motions assume that accelerations are minimal, and the system moves slowly to the tilts and yaw angles indicated. You must make sure that your system will not move with high acceleration or tilts and yaw angles greater than what is specified below.

1. A fixed mounted system will perform better than a moving one. The system must pitch, roll, and yaw with the waves **less than ± 10 degrees.** The performance with frequency and minimum wave height has been de-rated for these kinds of dynamics.
2. **Pitch is the most damaging** of the types of motion. Pitch causes the depth of the range cells to move up and down in partially correlated fashion with the waves. The consequence of dynamic pitching is that the highest usable frequency will be reduced (0.2 Hz rather than 0.5Hz at 10m deployment depth).
3. **Roll** is less of a problem than pitch but still de-rates the performance.
4. **Yaw** at wave frequencies causes the directional distribution to be smeared but is not a serious problem to wave parameters. If the system is rotating (>45 degrees in 17 minutes) then expect the wave direction to be biased accordingly.

✓ **Platform Influence**

1. Floating platforms like drill ships will influence waves near the platform.
    - Long period waves will move the platform (heave): the pressure sensor cannot be used as a reference because it will not see the long period waves.
    - Shorter period waves will reflect off the platform causing wave energy at these frequencies to be exaggerated.
    - **It is best to select range cells that are distant from the platform (60-100m)** because the platform will reflect high frequency waves and move with low frequency waves. The H-ADCP can accurately measure both long and short waves, in the vicinity and far away from the platform. Other instrumentation (such as pressure sensor, or surface tracker) attached to the platform, will not be able to accurately measure the waves because the platform partially moves with the longer period waves and reflects shorter period waves. Because the H-ADCP can profile a range of cells

distant from the platform and because it exclusively measures the horizontal component of the waves, the H-ADCP can resolve the real wave environment.

- **Set the small wave screening frequency to 0.03 Hz if the platform is heaving with the waves.** This keeps the processing from using the pressure sensor data at wave band frequencies since we know the pressure sensor is not accurate if it moves with the waves.

✓ **Highest Usable Frequency**

1. If for any reason, wave direction, wave height, or wave period seems unrealistic, try setting the upper cutoff frequency to a more conservative setting (lower frequency).

Table 1: Horizontal Waves Upper Cutoff Frequency

Depth (meters)	8 Meter Bins		4 Meter Bins	
	Frequency	Period	Frequency	Period
5	0.35	2.86	0.32	3.13
10	0.22	4.55	0.195	5.13
20	0.13	7.69	0.12	8.33
40	0.086	11.63	0.078	12.82

✓ **Default Settings**

1. 2Hz data is essential. Set the Baud Rate to ensure that data transfer can keep up with moving whole ensembles at 2Hz.
2. Collect data in **Broadband** mode.
3. Choose **8-meter bins:** 4 meters will work, but 8-meter bins are quieter.
4. Unless the platform rotation rate is significant, collect 4096 samples per burst continuously. If the rotation is important, then collect 2048.
5. The upper cutoff frequency default is 0.2Hz (5 second period waves). While we can often outperform this, it is a setting that will work across a wide range of deployment conditions and environments.
6. You must collect data using **Beam Coordinates** to calculate waves data.

Testing the Installed H-ADCP

Once the H-ADCP is mounted in the water, it's time to communicate with it and make adjustments. *TRDI Toolz* will be used to adjust the pitch and roll settings.

To test the setup:

1. Start *TRDI Toolz*.
2. Send the PC2 command.

```
Press any key to quit sensor display ...
Heading    Pitch     Roll    Up/Down    Attitude Temp    Ambient Temp   Pressure
180.01°  -0.42°  -0.13°     Down         24.35°C         22.97°C         0.0 kPa
180.87°  -0.60°  -0.15°     Down         24.36°C         22.97°C         0.0 kPa
```

> The PC2 heading shows the raw (magnetic north) heading only. The EB command (Heading Bias) is not applied.

Pitch and Roll Adjustment

The PC2 command indicates the pitch and roll angles of the H-ADCP.

Adjust the mount until the roll is zero. The H-ADCP rolls about the Y-axis. The roll must be zero.

Adjust the mount until the pitch is zero. The H-ADCP pitches about the X-axis.

> A slight upward or downward pitch may be required to avoid beam interference from the bottom or surface.

Orientation	Pitch +	Roll +
Downward	Beam 3 Tilted Upward	Beam 2 Higher than Beam 1

> When an H-ADCP is orientated properly and horizontal, PC2 Up/Down will state it is orientated downward (see **Figure 5**, page 9).

Periodic Maintenance

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

Objects deployed within about 100 meters (328 feet) of the surface are subject to the buildup of organic sea life (biofouling). Soft-bodied organisms usually cause no problems, but hard barnacle shells can cut through the urethane transducer face causing transducer failure and leakage into the H-ADCP (see Figure 14).

Figure 14. Barnacle Damage to a Urethane Face

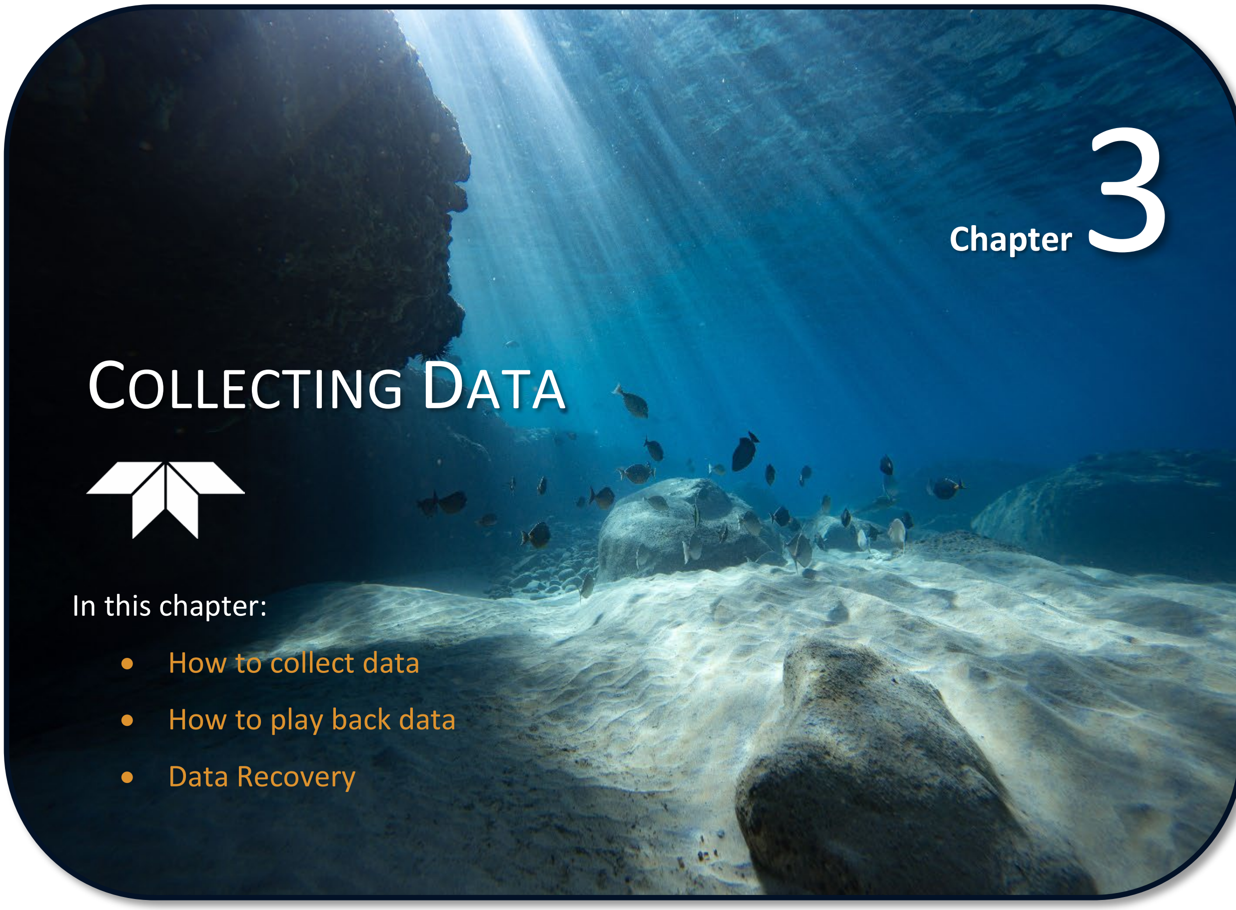
The following options can help reduce biofouling:

- The best-known way to control biofouling is cleaning the H-ADCP transducer faces often. However, in many cases this is not possible.
- Coat the entire H-ADCP with antifouling paint. Make sure that the paint is applied in an even coat over the transducer faces.

Your H-ADCP transducer housing and mounting plate is made of aluminum that is protected by sacrificial anodes and a hard anodize coat and paint. Do not connect other metal to the H-ADCP. **Other metals may cause corrosion damage (see Cathodic Disbondment and Galvanic Corrosion)**.

Use isolating bushings when mounting the H-ADCP to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it at the installation site.

Sacrificial anodes are fitted to the H-ADCP to prevent corrosion (see Zinc Anode Inspection and Replacement). Standard anode protection will typically protect the parts that may corrode. However, **you should plan regular inspections of the mounting hardware for signs of corrosion**. TRDI disposes many corroded hardware sets during inspections.



Chapter 3

COLLECTING DATA

In this chapter:

- How to collect data
- How to play back data
- Data Recovery

Data Collection

For information on collecting and playing back data using *WavesMon*, see the WavesMon User's Guide.

Data Recovery

The following section describes all the options available for recovering the data from an H-ADCP recorder card.

Recover the Entire Recorder using TRDI Toolz

To recover data:

1. Click **Tools**, **Download Data**.
2. *TRDI Toolz* uses the RY command to recover the data. The RY command uploads the entire contents of the recorder via the serial interface to a host computer using the standard YMODEM protocol for binary file transfer. The data is transferred to the host and stored as binary files.

Recover a Single File Using Direct Commands

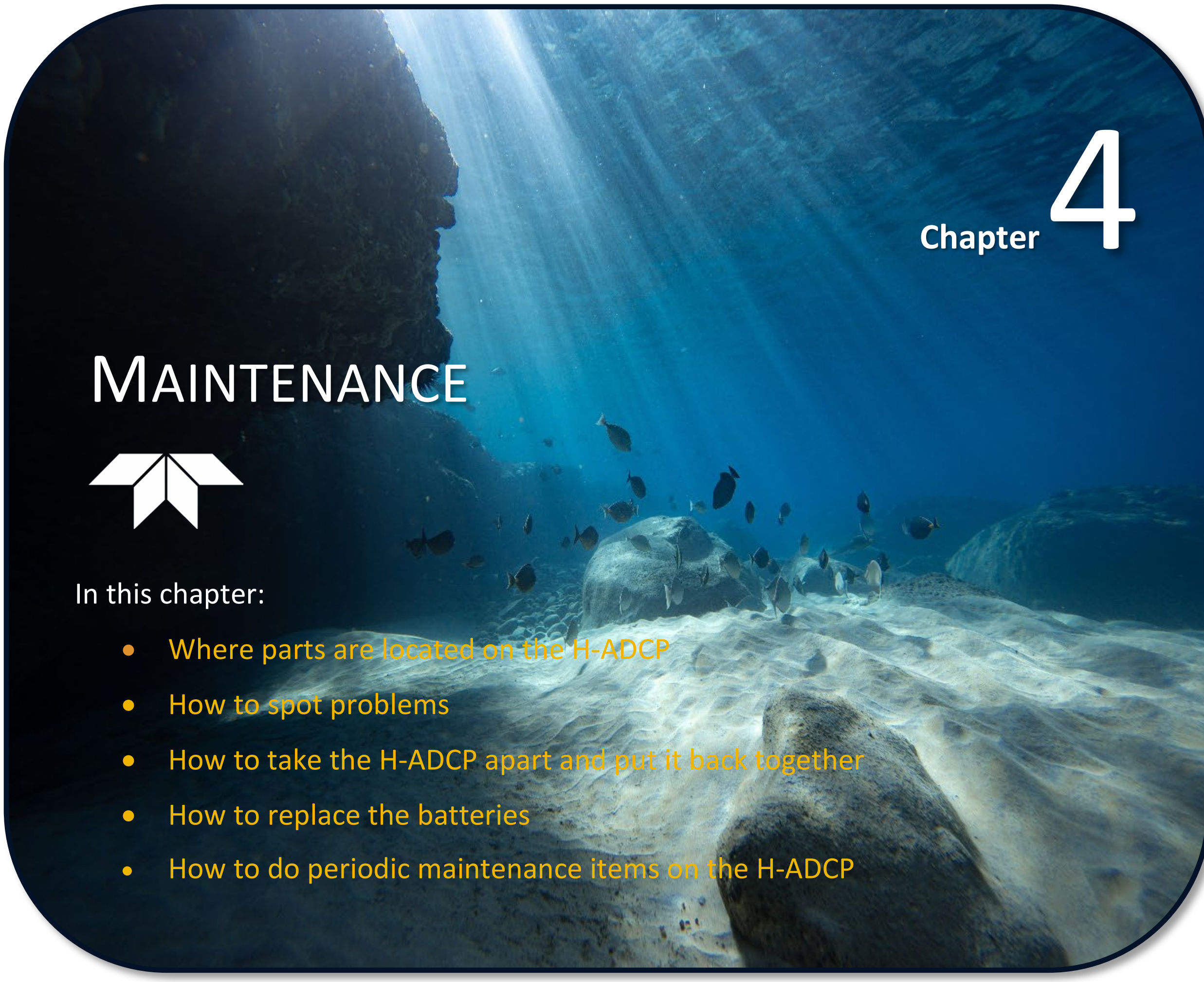
Another option is to use direct commands to recover a single data file from the H-ADCP recorder. The following command sequence should be used. Note it is assumed the user has applied power to the H-ADCP and has setup the communications cable and baud rate properly with a host computer using *TRDI Toolz*.

Step	Command/Action	Description

1	Send Break	This is a >100ms transition signal sent to the H-ADCP to wake it up. The response will be to receive the H-ADCP wake-up banner followed by a prompt ">". Example:
		`[BREAK Wakeup A]`
		`WorkHorse Broadband ADCP Version 16.30`
		`RD Instruments (c) 1996-2008`
		`All rights reserved.`
		`>`

2	CR1	This places the H-ADCP in factory default mode. The H-ADCP will respond confirming that it has been reset to factory defaults and outputting a prompt. Example:
		`>cr1`
		`[Parameters set to FACTORY defaults]`
		`>`

3	RR	The H-ADCP will display the recorder's contents.
4	RY##	The RY command will start the Y-Modem protocol routine. The ## selects the file number you wish to recover. Find your file in the H-ADCP recorder contents display. Ignoring the volume name, FORMAT, and DIR listings at the top of the directory, as well as data files containing 0 bytes, count down from the top (first non-zero) data file to your file. If you see that your file is the fifth file in the recorder, use RY05. Once you send the RY## command you will be prompted to select your recording directory path to save the recorder data. When you click OK, the download will begin. When your file is downloaded, the TRDI Toolz program will display "Recovery Complete".
5	Repeat step 4 to recover another data file, or exit	The Y-Modem when complete will stop. You can recover another file or turn off power to the H-ADCP (and exit *TRDI Toolz* if you are done using this program).



Chapter 4

MAINTENANCE

In this chapter:

- Where parts are located on the H-ADCP
- How to spot problems
- How to take the H-ADCP apart and put it back together
- How to replace the batteries
- How to do periodic maintenance items on the H-ADCP

Parts Location Drawings

This section is a visual overview of the inside and outside parts of the H-ADCP. Use the following figures to identify the parts used on your system.

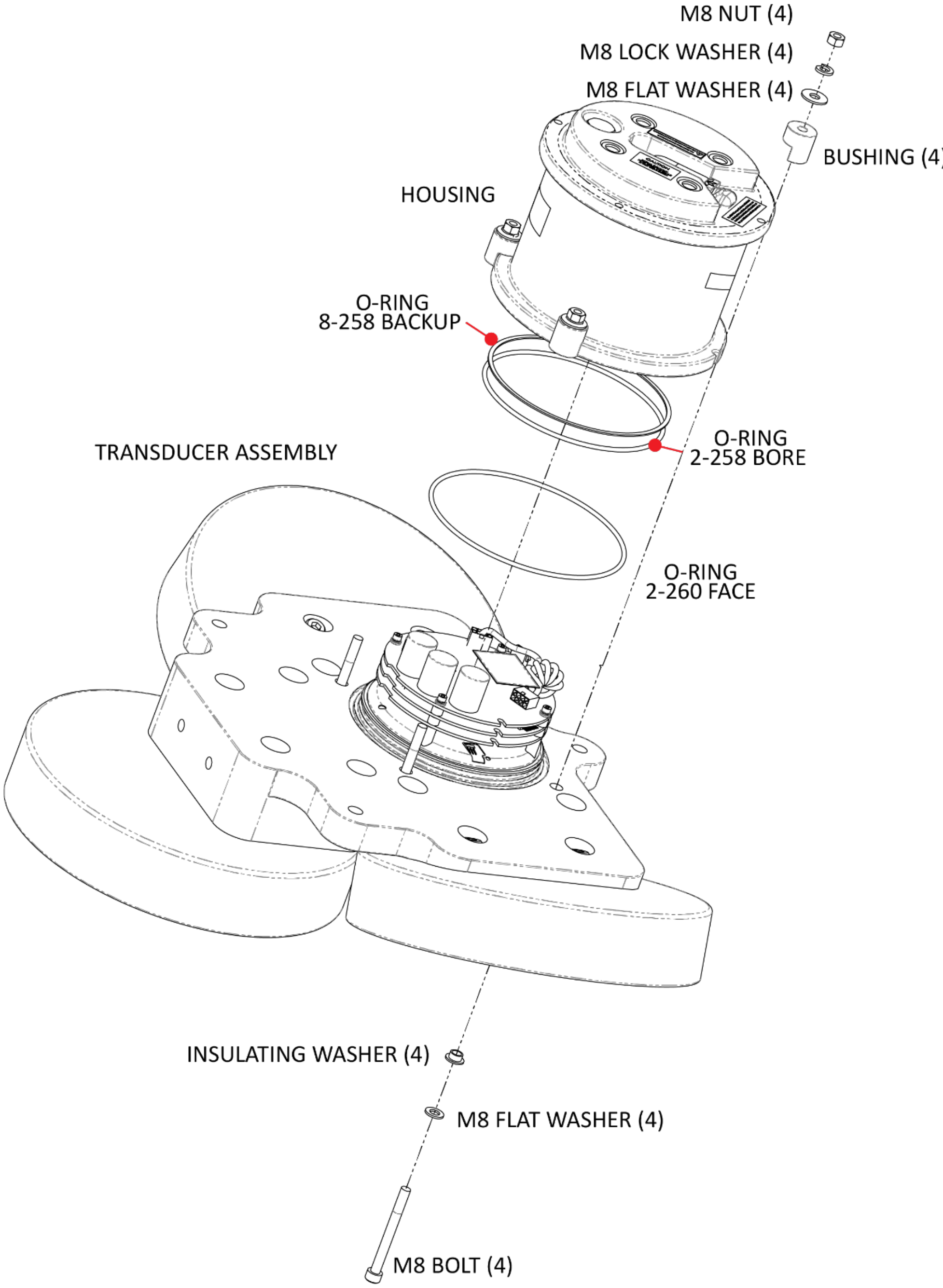


Figure 15. 300 kHz NB Assembly – One Piece Housing

See outline installation drawing 967-6095. This is the standard built system.

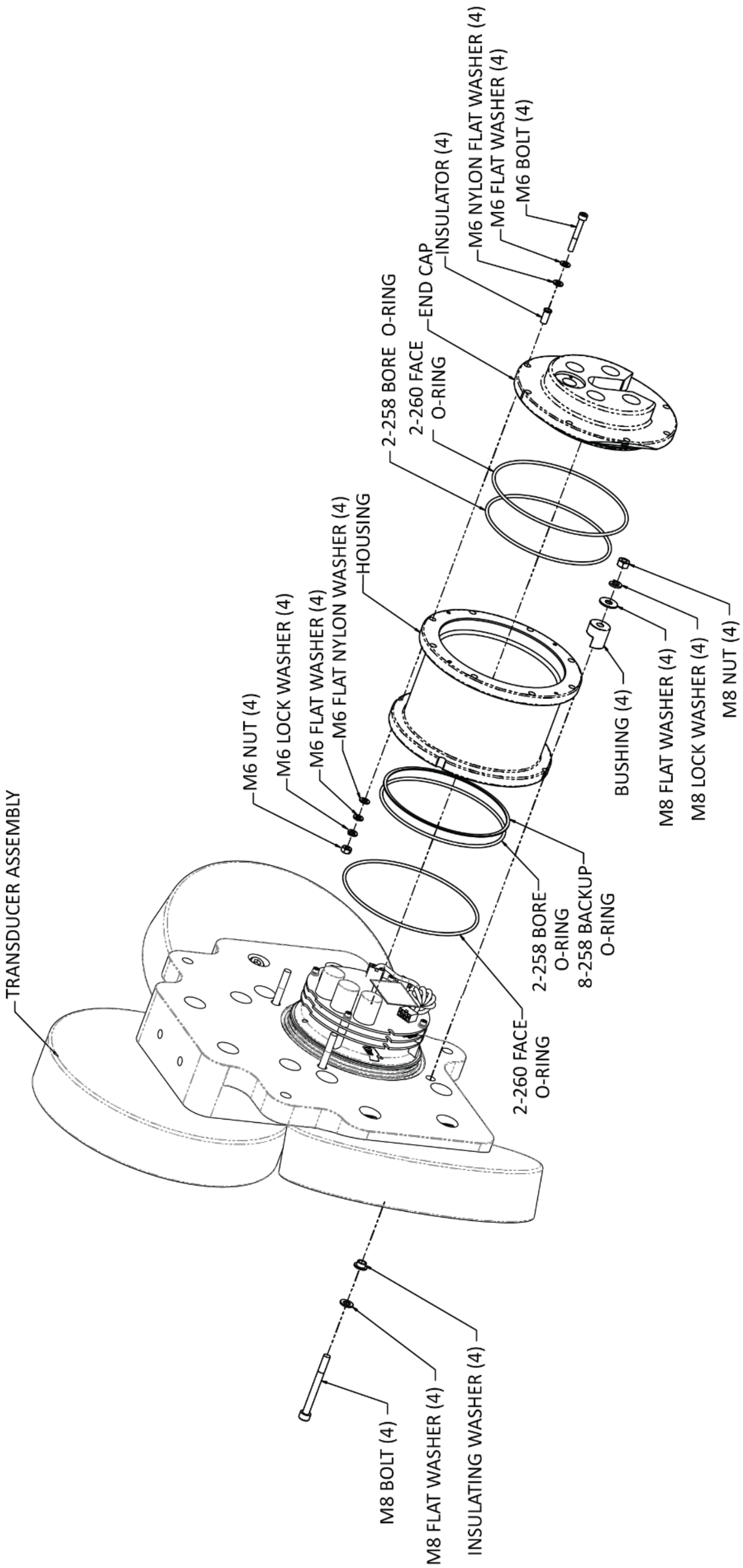


Figure 16. 300 kHz NB Assembly – Two Piece Housing

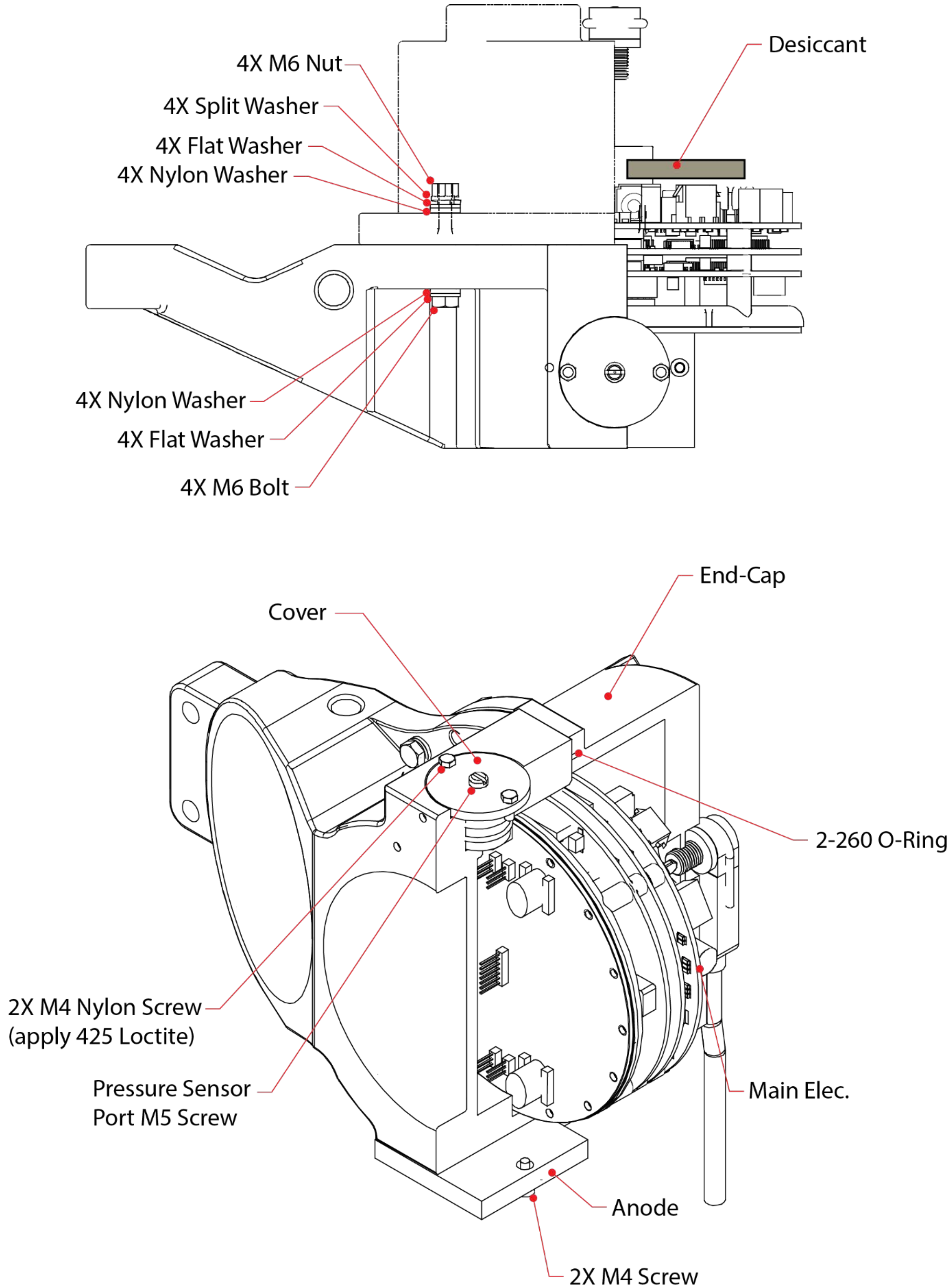


Figure 17. 300/600 kHz H-ADCP Assembly

Maintenance Schedule

To ensure that you continue to receive optimal results from your Teledyne RD Instruments product(s), TRDI recommends that every H-ADCP be returned to our factory for an inspection every two to three years. We'll provide your unit with a thorough multi-point inspection, and let you know if any refurbishment services are required to properly maintain the unit. To learn more about this service, please contact field service.

Calibration Items

Use the following calibration schedule:

Item	TRDI Recommended Period
Transducer Beam Angle	TRDI recommends returning the H-ADCP every two to three years for verification of velocity accuracy
Pitch & Roll (Tilt)	
Temperature (Factory)	TRDI recommends returning the H-ADCP every two to three years for Factory calibration
Pressure Sensor (Factory)	
Heading (Field Pre-Deploy)	Field Compass Calibration (AF) performed prior to each deployment (see Compass Calibration)
Heading (Field Post-Deploy)	Field Compass Verification (AX) performed post each deployment (see Compass Calibration Verification)

Pressure sensor and compass drift effects will accumulate over time. TRDI recommends a factory calibration be done every two to three years. The longer you wait between factory calibrations, the more error (due to drift) you can expect to have.

For example, the pressure sensor has an initial accuracy spec of ±0.25%, and a long-term drift spec of ±0.11%. Most of the 0.11% drift will occur in the first 12 months of operation. The fluxgate compasses accumulate an error of approximately 1% over a year.

Maintenance Items

Inspect the H-ADCP to spot problems:

Item	TRDI Recommended Period
Transducer Beams	The urethane coating is important to H-ADCP watertight integrity. Many users are not familiar with the early signs of urethane failure. The primary damage to the urethane is from bio-fouling and long exposure to the water and sun. Damage occurs on the surface of the urethane and at the edge where the urethane bonds to the cups. Mishandling, chemicals, abrasive cleaners and excessive depth pressures can also damage the transducer ceramics or urethane coating. Before each deployment, check the urethane coating on the transducer faces for dents, chipping, peeling, urethane shrinkage, hairline cracks and damage that may affect watertight integrity or transducer operation (see Figure 18). Based on experience, TRDI knows that most systems need to have the urethane inspected after three to five years of field use; shorter periods may be required depending on marine growth.
O-rings	O-rings should be replaced whenever the system is opened and BEFORE they are showing any signs of wear and tear. Replace the end-cap O-ring each time the end-cap is removed. All O-rings should be replaced every one to two years maximum.
Housing and End Cap	Inspect for damage and replace as needed before each deployment. Inspect the paint on the end-cap, housing, and transducer assemblies for corrosion, scratches, cracks, abrasions, paint blisters, exposed metal (silver-colored aluminum), exposed anodize (black or dark green), and exposed primer (yellow). **Be critical in your judgment; the useful life of the H-ADCP depends on it.** See Protective Coating Inspection and Repair for details.

Item	TRDI Recommended Period
Hardware (bolts, etc.)	Check all bolts, washers and split washers for signs of corrosion before each deployment. TRDI recommends replacement after every deployment or every year whichever is longer. Damaged hardware should never be used.
Zinc Anodes	Inspect the anodes before each deployment for wear around the mounting bolts. Cover bolts with silicone sealant prior to deployment. Replace anodes whenever the mounting bolt is in less than 75% in contact with the bolt. Replace all anodes one to two years maximum.
Cables and Connectors	Check the end-cap I/O connector for cracks or bent pins (see Figure 19) before each deployment. Replace the end-cap I/O connector every five years as a normal maintenance item (see Table 4 to order parts). Check the cable connectors for cracks or bent pins. Inspect the full length of the cable for cuts, nicks in the insulation, and exposed conductors before each deployment. Check the Deck Box (Mariner) connectors on the rear panel for cracks or bent pins. Repair of the Deck Box connectors should only be done by TRDI.
CPU Lithium Coin-Cell Battery	TRDI recommends replacing the lithium coin-cell battery every five years.

Figure 18. Transducer View

Figure 19. End-Cap View

Spare Parts

Periodic maintenance helps maintain the H-ADCP so it is ready for a deployment. Use the following tables to order replacement parts.

Table 2: H-ADCP 300 Narrow Beam ADCP Spare Parts (P/N 757K6071-00)

Part Number	Description	Where Used
5020	Silicone Lubricant, 4-Pack	Inside Housing
97Z-6052-00	O-Ring, 2-260	
97Z-6050-00	O-Ring, 2-258	
97Z-6068-00	O-Ring, Backup, 8-258	
DES3	Desiccant, Sealed Bag	
M10COMBINATION	Wrench, 10MM COMB.	Used to attach housing to transducer.
M13COMBINATION	Wrench, 13MM COMB.	
7289A16	Key, Hex, 5M	
7289A17	Key, Hex, 6M	
305D0010	Bushing, Inst. housing	
810-4004-00	Bushing, Inst. housing	
M6WASHSPLTI	Washer, 6MM Split Lock	
M6WASHSTDTI	Washer, Flat, 12.5MM OD	
M6X1.0NUTTI	Nut, Hex, 10MM	
M6X1.0X45HHTI	Screw, Hex Head,	
M8WASHSPLTI	Washer, Split Lock,	
M8WASHSTDTI	Washer, Flat, 22.9MM OD	
M8X1.25NUTTI	Nut, Hex, 13MM	
M8X1.25X65HHTI	Screw, Hex Head, Full Threads Length	
817-1067-00	Screw, Pressure Sensor	Pressure Sensor

Table 3. H-ADCP 300 and 600 kHz ADCP Spares Parts (P/N 757K6073-00)

Part Number	Description	Where Used
97Z-6052-00	O-RING, 2-260, DURO 70, EPDM	Inside Housing
5020	Silicone lubricant, 4-pack	
DES2	Desiccant bag	
M10COMBINATIO	Wrench, 10mm Comb.	Used to attach housing to transducer.
7289A16	Key, Hex, 5M	
M6WASHNYLON	Washer, Flat, 6.4 ID 12.5 OD, Nylon	
M6WASHSPL	Washer, Split Lock SST316	
M6WASHSTD	Washer, Flat,12.5MMOD SST 316	
M6X1.0NUT	Nut, Hex, SST 316	
M6X1.0X45HH	Screw, Hex Head, SST 316	
206062-1	Clamp, Cable, Plastic Shell	AC power adapter
206430-2	Receptacle, 4 Pin, Free Hang	
66101-4	Socket, Crimp, 18-16AWG	
817-1067-00	Screw, Pressure Sensor	Pressure Sensor

Table 4. Replacement Kits

Part Number	Description	Where Used
757K6122-00	H-ADCP End-Cap Tools Kit	Replacing the End Cap Connector
757K6134-00 757K6144-00	End Cap Connector Replacement Kit (requires the H-ADCP End-Cap Tools Kit)	
810-4006-00	Anode, end-cap H-ADCP 300/600 kHz	Zinc Anode Inspection and Replacement
817-1086-00	Anode, housing H-ADCP 300/600 kHz (square)	
817-4118-00	Anode, housing H-ADCP 300 kHz Narrow Beam (round)	
757K6035-03	600 kHz Spare Boards Kit	Replacement spare boards kit
757K6108-00	300 kHz Spare Boards Kit	
757K6073-00 757K6063-00	H-ADCP 300/600 kHz Spare Parts Kit H-ADCP 300 kHz Narrow Beam Spare Parts Kit	Replacement spare parts kit
757K6042-00 757K6097-00	H-ADCP 300/600 kHz Close-up kit H-ADCP 300 kHz Narrow Beam Close-up kit	Includes needed hardware, O-rings, and desiccant to seal the H-ADCP.

Disassembly and Assembly Procedures

This section explains how to remove and replace the end-cap or transducer head to gain access to the H-ADCP's electronics, and internal recorder. Read all instructions before doing the required actions.

Housing Assembly Removal

Caution label on End-Cap

Wear safety glasses and keep head and body clear of the end-cap while opening.

Any system that was deployed may have pressure inside the housing.

H-ADCP systems use either a one-piece housing or a housing and end-cap assembly. When you need access to the electronics, TRDI recommends removing the housing assembly.

1. Remove all power to the H-ADCP.
2. Remove the I/O cable and place the dummy plug on the I/O cable connector (see I/O Cable and Dummy Plug).
3. Stand the H-ADCP on its transducer faces on a soft pad.

   Wear safety glasses and keep head and body clear of the transducer while opening.

   Any system that was deployed may have pressure inside the housing.

4. Inspect the transducer bolts for any signs of damage such as bending, stretched bolts, crushed or deformed bushings, etc. These signs may indicate that there is internal pressure inside the system.
5. To avoid any possible injury it is ALWAYS recommended to vent the system:

   If the system includes a Vent Plug, use the Vent Plug to vent the system before opening the housing. Loosen the port ½ turn and listen for airflow; if none, then open another ½ turn and listen again for airflow. Repeat until the Vent Plug is fully removed. This will ensure no internal pressure is present when removing the housing.

   If the system does not have a Vent Plug, loosen but do not remove the four transducer bolts to allow any internal pressure to be vented from the system. **Loosen the transducer bolts two turns each in a cross-pattern. Repeat until the face seal O-ring is not compressed and the system has the opportunity to vent.** If you note that the transducer moves as you loosen the bolts then this may indicate that internal pressure is present. Be sure to only loosen the bolts far enough to allow the system to vent.
6. Once all four bolts have been loosened and you are sure that there is no internal pressure, remove the bolts from the transducer.
7. Carefully lift the housing assembly straight up and away from the transducer until you can gain access to the connector jack on the common mode choke. Use care; the plastic mating surfaces scratch easily. Do not damage the mating surfaces.

   The cable attached to the end cap is only long enough to disconnect the internal I/O cable. There is NOT enough cable to set the transducer down next to the Housing Assembly.

8. Squeeze the sides of the internal I/O cable connector to release it from the common mode choke jack. Set the end-cap assembly aside. Set the transducer assembly (transducer face down) on a soft pad.
9. Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see O-ring Inspection and Replacement).
10. When you are ready to re-assemble the H-ADCP, see H-ADCP Re-assembly.

End-Cap Removal Procedures

Caution label on End-Cap

Wear safety glasses and keep head and body clear of the end-cap while opening.

Any system that was deployed may have pressure inside the housing.

When you need access to the electronics, TRDI recommends removing the housing assembly (see Housing Assembly Removal). Use Parts Location Drawings for parts identification.

The end-cap should only be removed if the O-rings or desiccant need to be replaced for periodic maintenance.

To remove the end-cap:

1. Dry the outside of the H-ADCP.
2. Disconnect the I/O cable and install the dummy plug.
3. Stand the H-ADCP on its transducer faces on a soft pad.
4. Inspect the housing and end cap bolts for any signs of damage such as bending, stretched bolts, crushed or deformed bushings, etc. These signs may indicate that there is internal pressure inside the system.
5. To avoid any possible injury, it is ALWAYS recommended to vent the system:

   If the system includes a Vent Plug, use the Vent Plug to vent the system before opening the housing. Loosen the port ½ turn and listen for airflow; if none, then open another ½ turn and listen again for airflow. Repeat until the Vent Plug is fully removed. This will ensure no internal pressure is present when removing the housing.

   If the system does not have a Vent Plug, loosen but do not remove the four transducer bolts to allow any internal pressure to be vented from the system. **Loosen the transducer bolts two turns each in a cross-pattern. Repeat until the face seal O-ring is not compressed and the system has the opportunity to vent.** If you note that the transducer moves as you loosen the bolts, then this may indicate that internal pressure is present. Be sure to only loosen the bolts far enough to allow the system to vent.
6. Once all four end-cap bolts have been loosened and you are sure that there is no internal pressure, remove the bolts from the end-cap.

   Make sure you save all hardware removed during this procedure for re-assembly.

7. Carefully pull the end-cap away from the housing until you can gain access to the connector jack on the common mode choke. Use care; the plastic mating surfaces scratch easily. Do not damage the mating surfaces.
8. Squeeze the sides of the internal I/O cable connector to release it from the common mode choke jack. Set the end-cap aside.
9. Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see O-ring Inspection and Replacement). Even small scratches can cause leakage around the O-ring seal.

H-ADCP Re-Assembly

To replace the end-cap and housing assembly, proceed as follows. Use Parts Location Drawings for parts identification.

1. Make sure all printed circuit boards, spacers, cables, and screws have been installed.
2. Install two fresh bags of desiccant just before closing the H-ADCP (see Desiccant Bags).

O-ring Inspection and Replacement

This section explains how to inspect/replace the H-ADCP O-rings. A successful deployment depends on the condition of two O-rings and their retaining grooves. See Parts Location Drawings for the locations of the following O-rings. Read all instructions before doing the required actions.

300 and 600 kHz H-ADCPs

- Transducer assembly, face, 2-260

300 kHz Narrow Beam Width H-ADCP

- Transducer assembly, face, 2-260
- Transducer assembly, bore, 2-258
- Transducer assembly, par-bak 8-258

The backup O-ring is installed on 300 kHz Narrow Beam Width systems in addition to the 2-258 bore O-ring on the transducer head assembly. Install the backup O-ring with the cupped side facing the 2-258 bore seal O-ring.

Systems with a 97Z-4000-00 Vent Plug

- 97Z-6084-00 O-RING, 2-015, .070DIAX .551 ID, EPDM, DURO 90A, VENT PLUG
- 97Z-6084-01 O-RING, 3-904, .072DIAX .351 ID, EPDM, DURO90A, VENT PLUG

TRDI strongly recommends replacing these O-rings whenever you disassemble the H-ADCP. Inspecting and replacing the O-rings should be the last maintenance task done before sealing the H-ADCP.

TRDI recommends you use new O-rings if you are preparing for a deployment.

To replace the O-Ring:

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

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

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

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

3. If a scratch is on the 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.

5. The backup O-ring (see Figure 20) is installed in addition to the 2-258 bore O-ring on the transducer head assembly for 300 kHz Narrow Beam Width systems only. Install the backup O-ring with the cupped side facing the 2-258 bore seal O-ring.
6. Lubricate and inspect the Vent Plug O-rings. Place the corner Vent Plug O-ring so that it rests on the bottom of the vent plug hole. Check the face Vent Plug O-ring is in the groove on the plug.
7. Install the Vent plug until "finger-tight."
8. Tighten the Vent Plug to the recommended torque value of 6.8 Newton-meters (60 pound-inches).

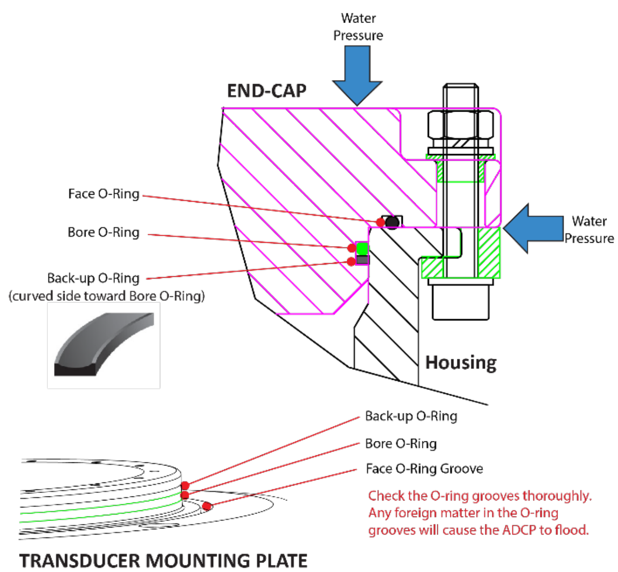


Figure 20. 300 kHz Narrow Beam Width Backup O-Ring Detail

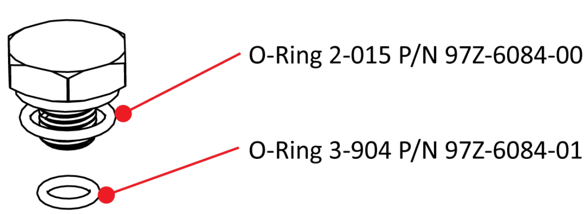


Figure 21. Vent Plug O-Rings

Tighten the Vent Plug to the recommended torque value of 6.8 Newton-meters (60 pound-inches).

Housing Assembly Replacement

To replace the housing assembly:

1. Stand the H-ADCP on its end-cap.
2. Inspect, clean, and lubricate the O-ring on the housing (see O-ring Inspection and Replacement). Apply a very thin coat of silicone lube on the O-ring.

TRDI recommends you use new O-rings if you are preparing for a deployment.

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

3. Connect the internal I/O connector to the plug on the common mode choke.
4. Gently lower the transducer head/electronics assembly into the housing, aligning the mating holes and the beam 3 number embossed on the transducer head with the beam 3 number embossed on the end-cap. When mating the housing with the transducer head flange try to apply equal pressure to all parts of the O-ring. Make sure the face O-ring remains in the retaining groove.

Check that no wires or any other object is pinched between the transducer head assembly and the housing. Use rubber bands to hold the wiring in place as necessary. If the O-ring is not in the groove or if a wire or other object is pinched, the H-ADCP will flood.

5. Examine the transducer assembly nuts, bolts, and washers (8-mm) for corrosion; replace if necessary. The Parts Location Drawings shows the assembly order of the transducer mounting hardware. All hardware items are needed to seal the H-ADCP properly.
6. Install all four sets of hardware until "finger tight."
7. Tighten the bolts in small increments in a "cross" pattern until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value of 9.6 Newton-meters (85 pound-inches). Do not deform the plastic bushings.

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

Do not over tighten the bolts that hold the transducer, housing, and end cap together. If you tighten too far, you can crack or break the plastic housing. On the other hand, leaving the bolts too loose can cause the system to flood. Tighten the hardware to the recommended torque value.

The recommended torque value for the transducer head 8-mm bolts is 9.6 Newton-meters (85 pound-inches).

End-Cap Replacement

To replace the end-cap:

1. Stand the H-ADCP on its transducer face on a soft pad.
2. Inspect, clean, and lubricate the O-ring on the housing (see O-ring Inspection and Replacement). Apply a very thin coat of silicone lube on the O-ring.

TRDI recommends you use new O-rings if you are preparing for a deployment.

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

3. Connect the internal I/O connector to the plug on the common mode choke.
4. Place the end-cap on the housing, aligning the mating holes and the beam 3 number embossed on the end-cap with the beam 3 number embossed on the transducer head. When mating the end-cap with the housing flange, try to apply equal pressure to all parts of the O-rings. Make sure the face O-ring remains in its retaining groove.

Check that no wires or any other object is pinched between the end-cap and the housing. Use rubber bands to hold the wiring in place as necessary. If the O-ring is not in the groove or if a wire or other object is pinched, the H-ADCP will flood.

5. Examine the end-cap assembly nuts, bolts, and washers (6-mm) for corrosion; replace if necessary. The Parts Location Drawings shows the assembly order of the end-cap mounting hardware. All the hardware items are needed to seal the H-ADCP properly.
6. Install all four sets of hardware until “finger-tight.”
7. Tighten the bolts in small increments in a “cross” pattern until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value of 5.6 Newton-meters (50 pound-inches).

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

Do not over tighten the bolts that hold the transducer, housing, and end cap together. If you tighten too far, you can crack or break the plastic housing. On the other hand, leaving the bolts too loose can cause the system to flood. Tighten the hardware to the recommended torque value.

The recommended torque value for the end-cap 6-mm bolts is 5.6 Newton-meters (50 pound-inches).

Periodic Maintenance Items

Replacing the Desiccant Bags

Desiccant bags are used to dehumidify the housing interior. The factory-supplied desiccant lasts a year at specified H-ADCP deployment depths and temperatures. Remember that desiccant rapidly absorbs moisture from normal room air.

The average dry weight of a new desiccant bag is 7.2 grams ((5%). The weight increases to 8.4 to 9 grams for a “used” desiccant bag. Used desiccant bags may be dried at 250° for 14 hours. As a minimum, replace the desiccant bags (Table 2, item 6) whenever you are preparing to deploy or store the H-ADCP for an extended time.

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

Do not puncture or tear the desiccant bag. Do not use desiccant bags that are torn or open.

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 when the O-rings are replaced. All O-rings should be replaced every one to two years maximum.

To replace the desiccant:

1. Remove the transducer head (see Housing Assembly Removal).
2. Remove the new desiccant bags from the airtight aluminum bag.
3. Remove the old desiccant bags and install two new ones. For Monitor and Mariner systems, place the desiccant bags (Table 2, item 6) between the PIO board and the end-cap. For Sentinel systems, place the desiccant under one of the rubber bands on the battery pack (see Parts Location Drawings).
4. Install the transducer head (see Housing Assembly Replacement).

Cleaning the Pressure Sensor Port

To read the water pressure, water must be able to flow through the copper screw on the pressure sensor. The tiny hole in the copper screw may at times be blocked.

The pressure sensor is optional. It may not be included on your system.

To clean the pressure sensor port:

1. Place the H-ADCP on its' end-cap. Use a soft pad to protect the H-ADCP.
2. Use a straight-slot screwdriver to remove the copper pressure sensor port screw.
3. Gently clean out the hole in the copper screw with a needle. If the hole becomes enlarged or the screw is corroded, replace the screw. A replacement copper screw is included in the spare parts kit (part number 817-1067-00).
4. Install the copper screw. Tighten the screw "finger tight" (2 in/lbs). Do not over tighten the screw or you may strip the threads on the plastic cover disc. If this happens, return the H-ADCP to TRDI for repair.

The pressure sensor is installed in an anodized aluminum cavity that includes a plastic protective cover to hold the copper screw. This cover is held into place with two M3 screws. The holes where the M3 screws are inserted in the pressure sensor housing are anodized aluminum.

TRDI knows from our experience that it is difficult to anodize sharp edges on threaded holes such as these. In marine and freshwater environments, poor anodizing on aluminum will lead to corrosion problems. **Always inspect for corrosion in this (and all) areas between deployments.**

The pressure sensor is filled with silicone oil. Never poke a needle or other object through the copper screw while the screw is installed over the pressure sensor. You will perforate the sensor, causing it to fail.

Do not attempt to clean the surface of the pressure sensor. The diaphragm is very thin and easy to damage.

If the pressure sensor surface looks corroded or is bowed outward, then contact TRDI for servicing. Do not attempt to remove the pressure sensor. It is not replaceable in the field.

Preventing Biofouling

This section explains how to prevent the buildup of organic sea life (biofouling) on the transducer faces. Objects deployed within about 100 meters (≈328 feet) of the surface are subject to biofouling, especially in warm water. This means H-ADCP systems are subject to biofouling. Soft-bodied organisms usually cause no problems, but barnacles can cut through the urethane transducer face causing failure to the transducer and leakage into the H-ADCP. Therefore, you should take steps to prevent biofouling during shallow water deployments.

The following options can help reduce biofouling:

- The best-known way to control biofouling is cleaning the H-ADCP transducer faces often. However, in many cases this is not possible.
- Coat the entire H-ADCP with antifouling paint. Make sure that the paint is applied in an even coat over the transducer faces and inductive modem (see Applying Antifouling Paints).

Antifouling Paints

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

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

Do not use antifouling paints that contain cuprous oxide on aluminum housings as it will cause galvanic corrosion.

Applying Antifouling Paints

The following tips are only general recommendations. Always follow the anti-fouling paint manufacturer's instructions on how to apply the anti-fouling paint.

TRDI recommends that any antifouling coating should be applied in as thin a layer as possible. It should be understood that applying a coating may reduce the measurement range of the H-ADCP (though it will not affect its accuracy in the measurable range).

As originally manufactured, the transducer faces have a smooth surface which makes it inhospitable for most biofouling to develop. Preserving this smooth surface is an effective way to prevent heavy biogrowth on the transducer faces. However, if an antifouling coating is desired on the transducer faces, then the faces must be lightly abraded to allow for the antifouling coating to adhere. **As a rule, the surface must be kept smooth unless an antifouling coating will be applied.**

1. Transducer Face Surface Preparation and painted housings - Lightly abrade the surface using Scotch Brite® to remove gloss. Thoroughly clean the areas to be painted with soapy water and dry.
2. Surface Application:
   - Mask as necessary. Do not paint over mounting hardware, anodes, pressure sensors, etc.
   - Apply an even, thin layer (0.1mm, 4mil per coat) of antifouling paint. If more than one coat is needed to reach the maximum thickness, allow each coat to dry for 16 hours.
   - When applying paint to the urethane faces, use extra caution to apply a smooth, thin coat of paint.

If the H-ADCP includes the optional pressure sensor, do not block the sensor port. The sensor port is a small hole in the center of the copper screw (see Pressure Sensor Maintenance). During anti-fouling paint application, tape-off the screw. Once the anti-fouling paint has cured, remove the tape.

This means that the sensor port is not fully protected from bio fouling. Even though the sensor port is surrounded by the antifouling paint, bio fouling may still build up on the copper screw and eventually clog the sensor port. However, most organisms do not seem to find the small amount of unpainted surface attractive. If it is logistically possible to periodically inspect/clean the pressure sensor port, it is highly recommended. This tradeoff situation must be analyzed for individual deployments. Unfortunately, the location of the deployment site usually dictates action in this regard.

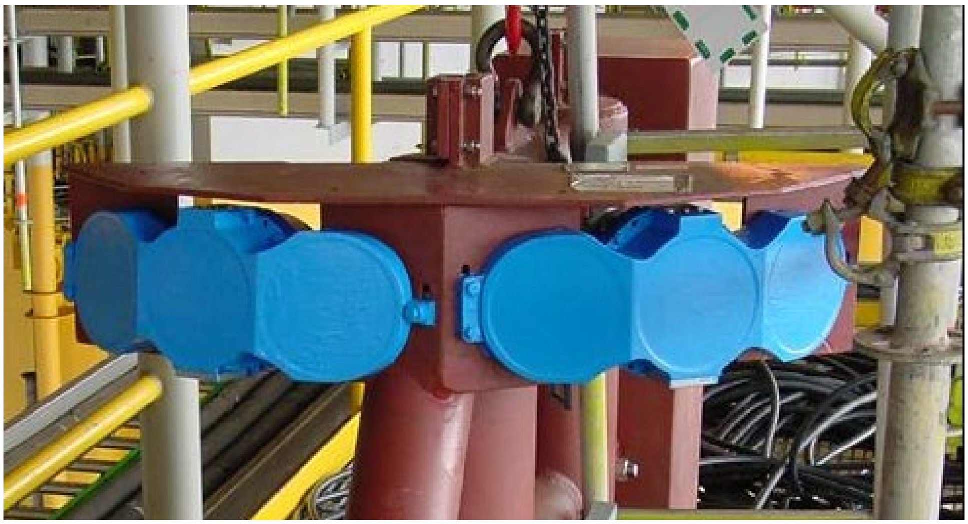


Figure 22. Antifouling Paint Applied to an H-ADCP

Removing Biofouling

To remove foreign matter and biofouling:

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

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

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

> If barnacles have entered more than 1.0 to 1.5 mm (0.06 in.) into the transducer face urethane, you should send the H-ADCP to TRDI for repair. If you do not think you can remove barnacles without damaging the transducer faces, contact TRDI.

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

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

Zinc Anode Inspection and Replacement

H-ADCP systems have five sacrificial zinc anodes. If the H-ADCP does not have exposed bare metal, properly installed anodes help protect the H-ADCP from corrosion while deployed.

Zinc Anode Inspection

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

To inspect the anodes:

- Inspect the anodes on the transducer assembly, housing and end-cap for corrosion and pitting. If most of an anode still exists, you may not want to replace it.
- If you have doubts about the condition of the anodes, remove and replace the anode.

Zinc Anode Electrical Continuity Check

Check electrical continuity using a digital multi-meter (DMM). Scratch the surface of the anode with the DMM probe to make good contact if the anode is oxidized. All measurements must be less than five ohms. If not, reinstall the affected anode.

Housing Anodes. Measure the resistance between all four anodes. Scratch the surface of the anode with the DMM probe to make good contact if the anode is oxidized. The resistance should be less than five ohms.

Transducer Anode. Remove the housing. Measure the resistance between the anode and any one of the four screws holding the PC boards to the transducer. The resistance should be less than five ohms.

Zinc Anode Replacement

To remove and replace the zinc anode/s:

1. Remove the screw.
2. The anode may stick to the H-ADCP. To break this bond, first place a block of wood on the edge of the anode to protect the housing anodizing and paint. Carefully strike the block to loosen the anode.
3. Clean the bonding area under the anode. Remove all foreign matter and corrosion.
4. Set a new anode in place and fasten with new screws.
5. Check the electrical continuity. If any measurement is greater than one ohm, reinstall the affected anode.

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

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

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

Calibrating the Compass

Compass calibration corrects for distortions in the earth's magnetic fields caused by permanent magnets or ferromagnetic materials near the H-ADCP. These magnetic field distortions, if left uncorrected, will create errors in the heading data from the H-ADCP. A compass calibration should be conducted at each measurement location, and whenever the mounting fixture or ancillary equipment are changed or rearranged. You should be aware of the following items:

- Ferromagnetic structures such as platform hull, bridges, or sheet piling in the measurement location may interfere with proper compass operation. **The compass calibration procedure can NOT correct for heading errors due to these types of structures.** If the H-ADCP is mounted next to a large ferrous material such as the hull of a platform, external heading data MUST be input to the system software running on a customer-supplied computer, from a customer-supplied heading device. Most commercially-available heading reference instruments will provide a digital (serial) NMEA $HDT or $HDG output suitable for use with H-ADCP software.
- A good compass calibration requires slow, smooth movement to allow the compass to collect data at each point.
- Calibrate the compass as close to the location that it will be deployed and as far away as possible from objects that have magnetic fields that could result in a poor calibration. **Common objects to avoid calibrating the compass near include steel reinforced concrete, buildings, and automobiles.**
- **Completing the calibration rotation(s) does not guarantee an acceptable compass error**. Compass error is based not only on the quantity of measurements made during the calibration but also the quality of the magnetic environment. Attempting to calibrate the compass in a poor environment, e.g., near fixed ferrous objects, will likely result in an unacceptable compass error regardless of how well the calibration is performed.
- The Single-tilt calibration is intended for applications where tilting the unit is not practical. This calibration is only applicable to the tilt orientation the unit is rotated about during the calibration.

Compass Background

The compass calibration algorithm collects magnetic field vector information for various measured headings during the calibration. Hard and soft iron effects rotating with the compass are made observable during the calibration by causing the local field to be perturbed as the compass is spun during the calibration. That is, each component of the hard and soft iron has to alternately increase the local field for some orientations and decrease for orientations 180 degrees (or 90 degrees for soft iron) from those orientations for the algorithm to "notice" it. Tilting and rotating the compass about the vertical axis is sufficient to do this.

There are three compass calibrations to choose from; one only corrects for hard iron while the second corrects for both hard and soft iron characteristics for materials rotating with the H-ADCP. The third method provides calibration for a single tilt orientation. Hard iron effects are related to residual magnetic fields and cause single cycle errors while soft iron effects are related to magnetic permeability that distorts the earth's magnetic field and causes double cycle errors. In general, the hard iron calibration is recommended because the effect of hard iron dominates soft iron. If a large double cycle error exists, then use the combined hard and soft iron calibration.

Preparing for Calibration

To prepare for compass calibration:

1. Place the H-ADCP on a piece of strong cardboard on top of a smooth wooden (non-magnetic) table. If a wooden table is not available, place the H-ADCP on the floor as far away from metal objects as possible. Use the cardboard to rotate the H-ADCP during calibration—this way you will not scratch the H-ADCP. Place the H-ADCP in the same orientation as it will be deployed.
2. Connect the H-ADCP as shown in Setting up the H-ADCP System.
3. Start *TRDI Toolz*.

Compass Calibration Verification

Compass calibration verification is an automated built-in test that measures how well the compass is calibrated. The procedure measures compass parameters at every 5º of rotation for a full 360º rotation. When it has collected data for all required directions, the H-ADCP computes and displays the results.

> Verify the compass if any ferrous metals are relocated inside or around the H-ADCP housing. Calibrate the compass if the system has been moved to a new location (see Compass Calibration Procedure).

To verify the compass calibration:

1. Prepare the H-ADCP for calibration (see Preparing for Calibration).
2. Using *TRDI Toolz,* wake up the ADCP by pressing the button.
3. At the > prompt, type **AX** and press the **Return** key.
4. When prompted, rotate the H-ADCP slowly 360 degrees (approximately 5 degrees per second). Pay particular attention to the Overall Error. For example:

```
HEADING ERROR ESTIMATE FOR THE CURRENT COMPASS CALIBRATION:
   OVERALL ERROR:
      Peak Double + Single Cycle Error (should be < 5():   ( 1.55(
   DETAILED ERROR SUMMARY:
      Single Cycle Error:                                 ( 1.54(
      Double Cycle Error:                                 ( 0.07(
      Largest Double plus Single Cycle Error:             ( 1.61(
      RMS of 3rd Order and Higher + Random Error:         ( 0.31(
```

If the overall error is less than 2°, the compass does not require alignment. You can align the compass to reduce the overall error even more (if desired).

Compass Calibration

The built-in automated compass calibration procedure is similar to the alignment verification but requires three rotations instead of one. The H-ADCP uses the first two rotations to compute a new calibration matrix and the third to verify the calibration. It will not accept the new matrix unless the calibration was carried out properly, and it asks you to verify that you want to use the new calibration if it is not as good as the previous calibration. While you are turning the H-ADCP for the two calibration rotations, the H-ADCP checks the quality of the previous calibration and displays the results. It compares these results with the results of the third calibration rotation.

To calibrate the compass:

1. Prepare the H-ADCP for calibration (see Preparing for Calibration).
2. Using *TRDI Toolz,* wake up the ADCP by pressing the button.
3. At the > prompt, type **AF** and press the **Return** key. Choose option "a" or "b" to start the calibration procedure.

```
Field Calibration Procedure
Choose calibration method:
     a. Remove hard iron error (single cycle) only.
     b. Remove hard and soft iron error (single + double cycle).
     c. Calibration for a single tilt orientation (single + double cycle).
     d. Help.
     e. Quit.
```

In general, the hard iron calibration is recommended for Monitor and Mariner systems because the effect of hard iron dominates soft iron.

For Sentinel systems that have just replaced the battery, then use the combined hard and soft iron calibration. Changing the H-ADCP Sentinel batteries should only change the hard-iron signature of the H-ADCP but can induce both single and double cycle compass errors.

4. Tilt the H-ADCP (see Figure 23). Tilt an upward-looking H-ADCP with a block under one side of the end-cap. A 35-mm block will give you an 11-degree tilt. Check the on-screen instructions to see if the orientation is OK. Adjust as necessary.

The tilts must remain constant during the rotations. The transducer beam is the center point of the rotation.

5. When prompted, rotate the H-ADCP slowly 360 degrees (approximately 5 degrees per second).
6. The second rotation requires the H-ADCP to be tilted 15 degrees in another direction than from the first rotation (see Figure 23). Follow the on-screen instructions to orient the H-ADCP correctly. When prompted, rotate the H-ADCP slowly 360 degrees (approximately 5 degrees per second).
7. The third rotation requires the H-ADCP to be tilted 15 degrees in another direction than from the first and second rotations. Follow the on-screen instructions to orient the H-ADCP correctly.
8. If the calibration procedure is successful, it records the new calibration matrix to nonvolatile memory. The H-ADCP will not change its matrix unless the calibration is properly carried out.
9. If the calibration procedure is not successful, return your H-ADCP to the original factory calibration, by using the AR-command. Try using the AR-command if you have trouble calibrating your compass. In some circumstances, a defective compass calibration matrix can prevent proper calibration.

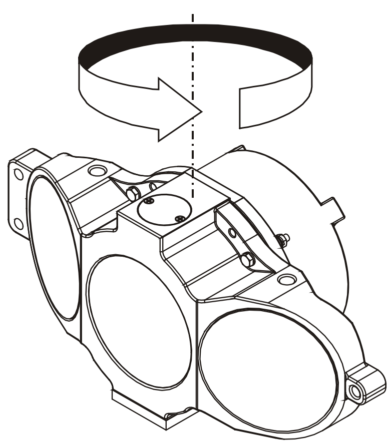


Figure 23. Compass Calibration

Installing Firmware Upgrades

Firmware upgrades can be downloaded from the Teledyne Marine software portal: https://tm-portal.force.com/TMsoftwareportal.

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

To install a firmware update:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the button.
3. Click **Tools**, **Firmware Update**.
4. Select the **.abs* update file.

Installing Feature Upgrades

The feature upgrade installation program is used to install Waves capabilities in an H-ADCP.

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

> Many feature upgrades require the latest firmware version to be installed in your H-ADCP. If you need to update the firmware, do this before installing the feature upgrade (see **Firmware Upgrades**).

To install a feature update:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the button.
3. Click **Tools**, **Activate Features**.
4. Select the **.Feature* update file.

> Contact your local sales representative if you are interested in upgrading your system.

Corrective Maintenance Items

Replacing Fuses

PIO Board. There is one fuse on the PIO Board (see Figure 24) that protects the H-ADCP from excessive incoming power. If this fuse continues to blow, check your input power before applying power again.

To replace the fuse:

1. Turn off the power.
2. Remove the transducer head (see Housing Assembly Removal).
3. The PIO board fuse is located next to the internal I/O connector. Use a small flat-blade screwdriver to open the fuse housing. Turn the end 180° (counter-clockwise) to open the fuse housing.
4. Gently pull the fuse housing out. Turn the housing to remove the fuse.
5. Check the fuse using an ohmmeter. Replace the fuse if necessary with the correct voltage and amperage fuse (Table 2 item 7).
6. Install the transducer head (see Housing Assembly Replacement).
7. Test the system (see Testing the H-ADCP).

Changing Communications Setting

A switch on the PIO board (see Figure 24) changes the communication settings between RS-232 and RS-422. Your computer and the H-ADCP must both be set to the same communication setting. Use the RS-232-to-RS-422 converter if the H-ADCP is using RS-422 communications and your computer only has an RS-232 COM port.

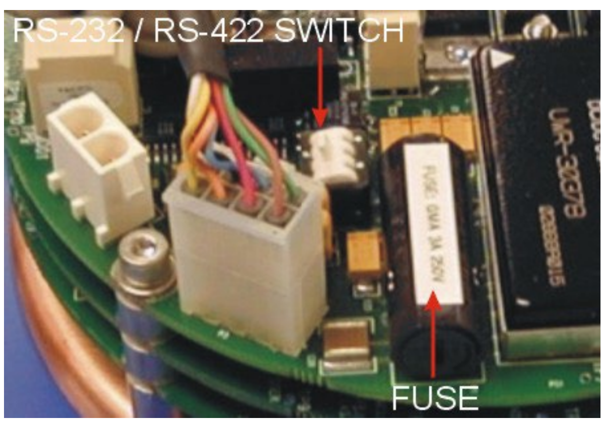


Figure 24. Communication Switch and Fuse

Protective Coating Inspection and Repair

TRDI uses paint on the housing for identification and corrosion protection. For more protection, the case and the transducer assembly are first anodized per MIL-A-8625, Type 3, Class 1 and sealed with sodium dichromate. Do not damage the surface coatings when handling the H-ADCP.

Inspect the end-cap, housing, and transducer assemblies for corrosion, scratches, cracks, abrasions, paint blisters, exposed metal (silver-colored aluminum), exposed anodize (black or dark green), and exposed primer (light blue or yellow for 6000 meter systems). **Be critical in your judgment; the useful life of the H-ADCP depends on it.**

The procedures contained in this section apply to our standard aluminum systems. For systems made of other materials, contact TRDI. Read all instructions before doing the required actions.

The chemicals used in the following steps can be hazardous to your health. Read all material safety data sheets and manufacturer's instructions before handling these chemicals.

If there is any damage to the paint near the edges of the urethane transducer cups or the I/O connector, DO NOT DEPLOY THE H-ADCP. Return the H-ADCP to TRDI for repair.

To repair or touch up the protective paint:

1. Remove all loose paint without damaging the anodizing. Clean and prepare the damaged area using a fine-grade abrasive cloth. Feather the edges of the paint near the damaged area. Try to have a smooth transition between the paint and the damaged area. Do not sand the anodized area. If there is damage to the anodizing, return the H-ADCP to TRDI for repair.
2. Clean the area with alcohol. Do not touch the area after cleaning.
3. Mix the epoxy primer Part A and Part B using a 1:1 mix. Paint one coat of epoxy primer (see note below). Allow the primer to dry thoroughly before continuing.
4. Mix the colored paint using two parts color and 1 part catalyst. Paint with one coat of colored paint (see note below).

The catalyst (hardener) will rapidly harden in air. Mix only the amount of paint you need and work quickly.

TRDI uses two-part epoxy type paint. This paint is manufactured by Sherwin –Williams Proline Paint Store, 2426 Main St., San Diego, CA, 92113-3613, Telephone: +1 (619) 231-2313.

Primer Manufacturer's part numbers:
F-158 for 6000 meter systems (part A and part B)
3061 for all other systems (part A and part B)

Colored paint Manufacturer's part numbers:
4800HS, Catalyst,
4800-19, Yellow
4800-28, Orange
4800-01, Snow White
4800-25, Bright Blue

Contact the paint manufacturer for preparation and application procedures for this and other paints. Contacting this company is done with the knowledge that Teledyne RD Instruments is not recommending them, but only offering this as a source for the paint.

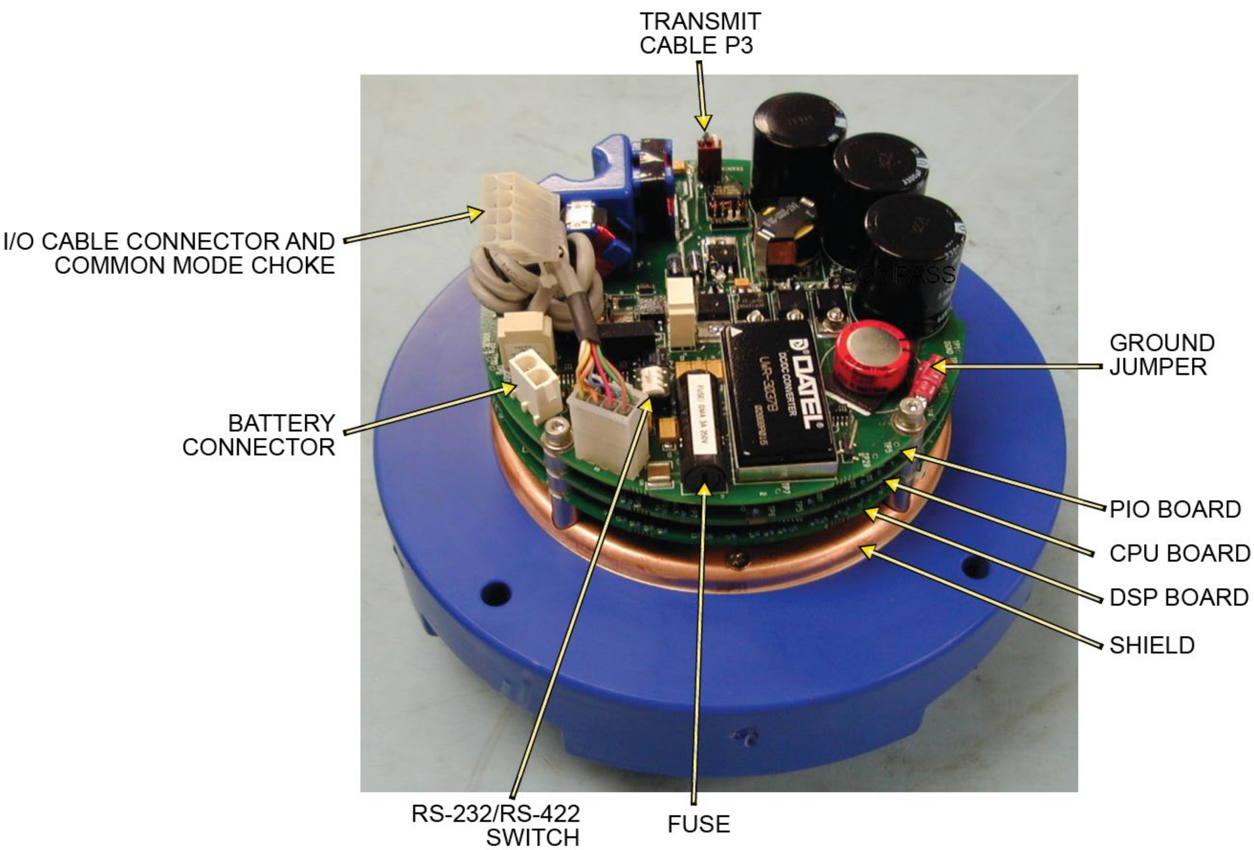
Installing the Spare Boards Kit

The Spare Boards Kit has been set up so that you will replace all three of the H-ADCP boards at once. This is done so that you do not have to risk damaging the individual boards while swapping in individual boards. The heading, pitch, and roll sensors have all been calibrated (the temperature sensor is an independent calibration and not changed by these new boards). Once you have replaced the original boards, place them back in the Spare Board Kit box and contact Teledyne RD Instruments Customer Service Department so that you can return them for repair.

Before handling either the Spare Board Kit or the original Board Set, always wear an earth-grounding static protection strap. The electronics in the H-ADCP are very sensitive to static discharge. Static discharge can cause damage that will not be seen immediately and will result in early failure of electronic components.

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

The Spare Boards Set will allow your system to perform to the same velocity specifications as your original set. However, there is an offset error in the compass that can be as great as ±1.5 degrees. This error CANNOT be removed by doing the Field Calibration procedure (AF command) even though you MUST do this as part of the installation. The additional ±1.5 degrees can only be removed by TRDI at the factory. In most cases, the total compass error will still be within our original specification of ±5.0 degrees. The only way to be sure that you have smaller errors than this specification is to perform your own local compass verification and correct any errors you find during post processing of the data.



Remove the Original Set of Boards

To remove the original boards:

1. Remove the housing assembly from the transducer. Use Housing Assembly Removal for instructions.
2. With your earth-ground static protection strap on, use a 3mm Allen wrench, to remove the four bolts that secure the three original H-ADCP boards to the Transducer assembly.
3. Note the orientation of the transmit cable connector as it is plugged into the PIO board and to the Receiver board (see Figure 25).

   This cable must be removed and it has a very tight fit. To remove this cable, lift straight up on the three boards and tilt slightly (no more than 2 cm) toward the cable. This should allow you enough slack to unplug the cable from the PIO board. If this is not possible you may unplug the cable from the Receiver board. Be sure to note its orientation before unplugging.

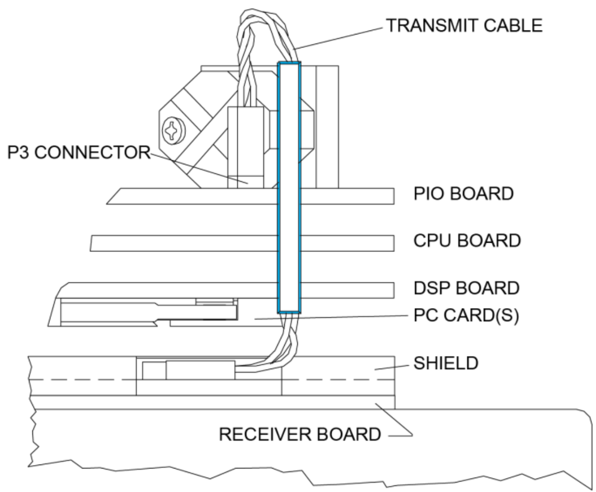


Figure 25. Transmit Cable

4. Once the transmit cable has been disconnected you may now remove the top three boards as a set by lifting the set straight up.

   These top three boards are connected to each other via connectors and will remain as one piece (see Figure 26). The DSP board connects to the Receiver board through a 26-pin header. The 26-pin header is a series of male pins. The 26-pin header may or may not stay connected to the DSP board when you remove the top three boards. If you see that there are male pins sticking out of the DSP board when you finish removing the board set then the header has remained attached to the DSP board. If this happens remove it and place it into the Receiver board. To remove it, gently rock it back and forth while pulling it away from the DSP board. Once removed, align it with the connector on the Receiver board and press it into place.

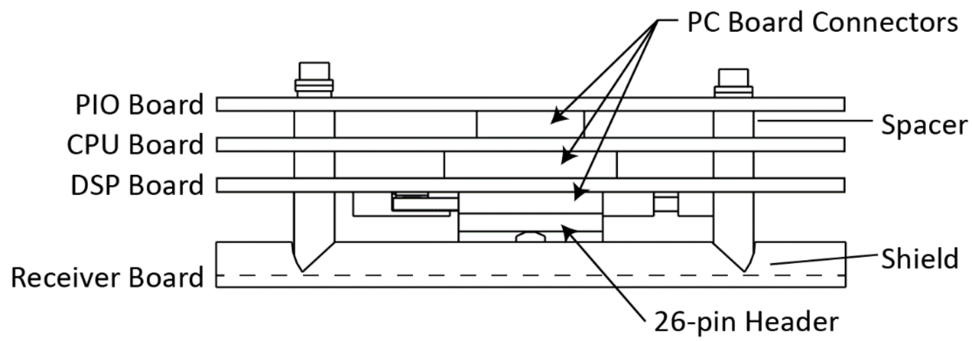


Figure 26. PC Board Connectors

5. Remove all PCMCIA card(s) from the original set of boards. These PCMCIA cards will be used again once you install your Spare Boards Set. The Spare Board set does NOT contain a PCMCIA card(s). The PCMCIA card(s) are located on the bottom of the DSP board. To remove the PCMCIA card(s) press the button(s) on the side of the PCMCIA card slot. As you press this button the PCMCIA card will slide out. You will have to pull the card(s) out the rest of the way once the button is depressed all the way in.
6. Set the original board set to the side for now.

Installing the Spare Board Kit

To install the spare boards kit:

1. With your earth-ground static protection strap on, remove the Spare Board Kit from the anti-static bag.
2. Using a 3 mm Allen wrench and a 7mm wrench remove the nuts from the bolts that secure the Spare Boards together. You will be using these bolts to secure the spare set in your system. DO NOT change the position of any of the bolts. The bolt containing the felt washers and ground jumper must remain in the same position (see Figure 27).

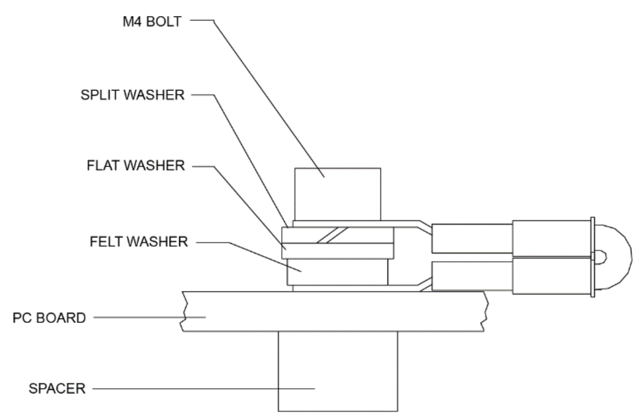


Figure 27. Ground Jumper

3. Place the nuts (just removed) on the four bolts of your original set of boards and place them into the anti-static bag. You will use the new set of bolts included in the Spare Board kit to secure them to the Transducer assembly.
4. Install all PCMCIA cards removed in Remove the Original Set of Boards step 5 into the PCMCIA card slots. The PCMCIA card is keyed and will only connect when it has been aligned correctly and slid all the way in. The PCMCIA card is installed with the label side pointing away from the DSP board.

5. Connect the Spare Board set to the Receiver board. Align the Spare Board set to the 26-pin header connected to the Receiver board. As you connect the Spare Board set, connect the transmit cable you removed in Remove the Original Set of Boards step 3. Be sure to connect the cable in the same orientation as was installed on the original board set.

   To test that the transmit cable is connected properly, start *TRDI Toolz* and run the PT4 test. The test failure example shown below is what you would see for a missing or improperly attached transmit cable.

```
[BREAK Wakeup A]
H-ADCP Broadband H-ADCP Version 16.21
Teledyne RD Instruments (c) 1996-2002
All Rights Reserved.
>pt4

IXMT    =      0.0 Amps rms  [Data= 0h]
VXMT    =     19.3 Volts rms [Data=4ch]
   Z    =    999.9 Ohms
Transmit Test Results = $C0 ... FAIL
>
```

6. Insert the four new bolts and tighten to 4 Newton-pounds.
7. Install the Transducer into the Pressure Case. See H-ADCP Re-assembly for instructions.

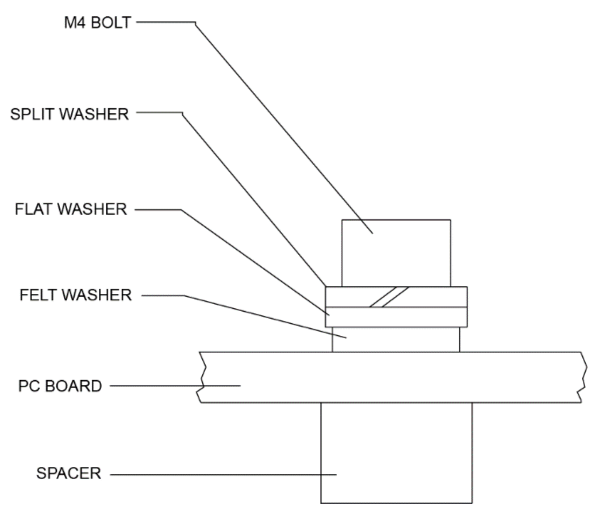


Figure 28. Mounting Hardware

Installing the Beam Cosine Matrix

The beam cosine matrix table corrects small transducer beam misalignment angles that occur during manufacturing. This file will be emailed.

To install the beam cosine matrix:

1. Connect your H-ADCP as you would normally and apply power.
2. Start *TRDI Toolz* and confirm that the H-ADCP is communicating normally and which communication port you are using (COM 1 or COM 2).
3. Copy the Beam Cosine Matrix file onto the computer.
4. Run the script file *xxxx BEAM COSINE MATRIX.rds* (where xxxx is your system serial number).

   Your Beam Cosine Matrix table will automatically be updated in your H-ADCP. You can view the contents of this file to confirm that the data entered during the &V portion matches the contents in the PS3 results under the label Q14.

Installing the Pressure Sensor Coefficients

If the H-ADCP included a pressure sensor, the pressure sensor coefficients must be loaded. This file will be emailed.

To install the pressure sensor coefficients:

1. Connect your H-ADCP as you would normally and apply power.
2. Start *TRDI Toolz* and confirm that the H-ADCP is communicating normally and which communication port you are using (COM 1 or COM 2).
3. Copy the file onto the computer.
4. Run *xxxxx PRESSURE SENSOR COEFFICIENTS.rds* (where xxxx is your system serial number) to install the pressure sensor coefficients appropriate to the system.

   The Pressure coefficients will automatically be updated in your H-ADCP. You can verify the pressure sensor coefficients loaded by viewing the PS0 results.

Testing the System after Board Replacement

To test the system after replacing any board(s):

1. Install the Transducer in the Pressure Case.
2. Connect the cable and power as you normally do and test the H-ADCP as shown in Testing the H-ADCP. All PA tests should pass when run in water and the PC tests should pass with the H-ADCP out of water.
3. Perform a field calibration of the compass. Use Compass Calibration for instructions on running the AF command. Remember that there will be up to 1.5 degrees of offset error in the compass measurement. This error is not removed by the field calibration.

You have completed the H-ADCP Spare Board Installation. The original boards can be returned to TRDI for repair. Please contact the Teledyne RD Instruments Customer Service Department for return shipping instructions and repair costs (see Technical Support).

If the H-ADCP included optional feature upgrades, these features must be re-installed. See Installing Feature Upgrades for instructions

Replacing the End Cap Connector

This section explains how to replace the 7-pin end-cap connector on a H-ADCP or external battery.

Some older H-ADCP end-caps may have the connector brass lock nut glued into place. If this is the case for your end-cap assembly, TRDI recommends that you purchase a new end cap assembly.

Equipment Provided

The H-ADCP End-Cap Tools Kit (P/N 757K6122-00) includes the following:

- Socket, lock nut removal
- Extracting wrench
- Plug, dummy, modified

The End Cap Replacement Kit P/N 757K6123-00 (200 and 500 meter systems), 757K6125-00 (6000 meter systems), and 757K6149-00 (H-ADCP External Battery case) includes the following:

- 7-pin end-cap connector with cable and 2-014 O-ring
- Isolation bushing and 2-017 O-ring (metal end-caps only)
- Connector, header, 8-pin Molex or 2-pin as needed
- Fuses and fuse holders, wire, shrink tube (External Battery kit only)
- Nut, brass
- End-cap O-ring(s)
- Desiccant
- Silicon lubricant, 4-pack
- Loctite® 242
- Cord, lacing, black

Customer Supplied Additional Equipment

- Soft pad (ESD Safe) to rest H-ADCP on while dissembling and reassembly
- Socket wrench handle
- Torque Wrench (35 Inch/pound / 4 N-M)
- Multi-Meter

Removing the End-Cap Connector

To remove the end-cap connector:

1. Remove the end-cap from the housing.
2. Insert the modified dummy plug into the connector.

Figure 29. Modified Dummy Plug

3. Place the Extracting Wrench over the connector and dummy plug. The wrench will fit into the End Cap slot.

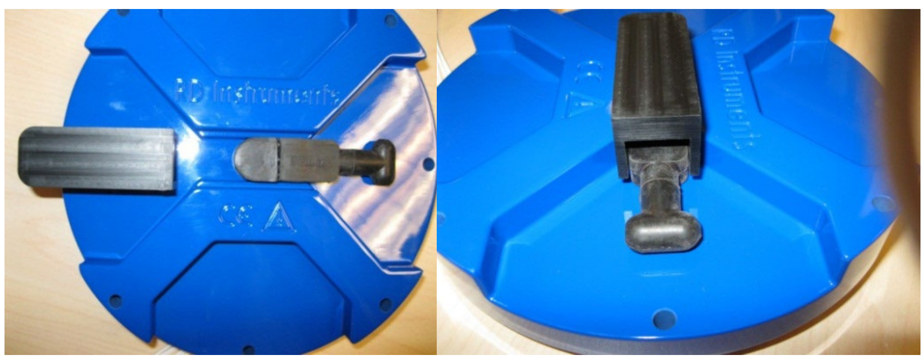


Figure 30. Extracting Wrench

4. Flip the end-cap assembly over and insert the socket onto the lock nut. Slide the cable wires into the socket's clearance slot.

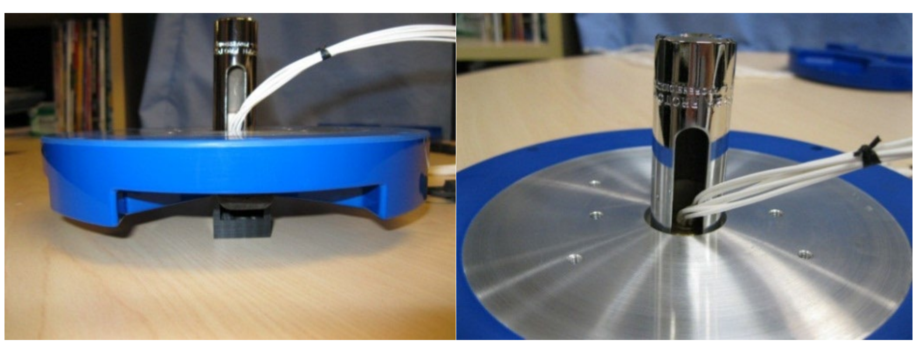


Figure 31. Lock Nut Removal Socket

5. Attach a ratchet wrench to the socket and remove the lock nut.

Figure 32. Removing the Connector

6. Remove the Molex 8-pin header connector by cutting the wires approximately 3-inches from the connector. Remove the connector from the end-cap.

> USE CAUTION – do not score or scratch the O-ring seal bore.

7. Remove all the tools and clean the end-cap thoroughly with Flux-Off® cleaner (or similar product). The O-ring pocket must be free of dirt, burrs and divots.

> Replace the end cap if any burrs or divots are found. These could provide a leakage path into the H-ADCP housing.

Installing the New End-Cap Connector

To install the new connector:

1. Clean the connector threads with Flux-Off® cleaner (or similar product).
2. Apply a **light** coat of silicon lubricant onto the O-rings (P/N 2-014 and 2-017).

> Do not over lube the O-rings.

3. Systems with a metal end-cap use an isolation bushing and 2-017 O-ring between the end-cap and the 7-pin connector. Press the new bushing and O-ring onto the end-cap as shown in Figure 33.

> Carefully check metal end-caps for signs of corrosion such as white deposits. If corrosion caused part of the end-cap to be visibly damaged, do not redeploy your system. Send it back to TRDI for inspection.

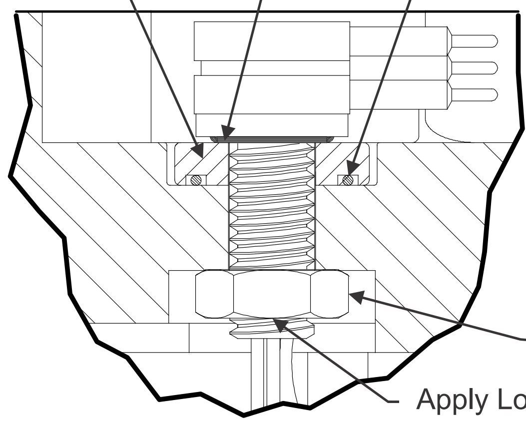


Figure 33. End-Cap Connector with Isolation Bushing

The isolation bushing and 2-017 O-ring are required for metal end-caps only.

4. Install the O-ring onto the face seal groove located at the bottom of the threads on the connector.

Do not scratch or mar the O-ring surface as you feed it over the threads of the connector.

5. Install the modified dummy plug. Pay attention to the pin orientation. **Do not bend the pins**.
6. Apply one drop of Loctite® 242 on the top starting threads of the connector.
7. Install the connector into the end cap by feeding the 7 wires and pins through the end-cap from the outside face (see Figure 29. Modified Dummy Plug).

The connector pins should point away from beam 3.

8. Push the connector down so that it fully bottoms out in the O-ring pocket.

Do not score or scratch the bore or the O-ring pocket sealing face.

9. Feed the brass nut through the wires and pins and hand tighten onto the connector threads.
10. Place the Extracting Wrench over the connector and dummy plug. The wrench will fit into the End Cap slot between the 2 rails (see Figure 30. Extracting Wrench).
11. Flip the End-Cap assembly over and insert the slotted socket onto the lock nut. Fit the cable wires into the socket's clearance slot (see Figure 31. Lock Nut Removal Socket).
12. Attach a torque ratchet wrench to the socket and tighten the nut to 35 in/lbs., (4 NM). **Make sure that the connector is aligned straight and is parallel to the rails**.
13. Remove the assembly tools and the dummy plug.
14. Follow the wiring schematic in order to assemble the Molex 8-pin header connector or external battery case wiring (see Wiring Diagrams). Insert the pins into the connector. As the pin is pushed into the connector, the tabs on the pin will lock it into place.

Use the old cut-off Molex connector as a reference in addition to the schematic diagram when installing the new Molex connector. Each wire should have a corresponding J1 pin number tag.

15. After all the pins for the connector are installed, use a multi-meter to confirm that the connector has been wired properly by performing an end-to-end continuity check.
16. Use the black lacing cord to bind the connector wires together. The lacing is applied by wrapping it around the wire bundle approximately four times and then tying it securely with a square knot. Each wrap on the wire bundle should be spaced approximately 3-inches apart. This will prevent the wires from "bird caging" out and getting caught between the end-cap and pressure case O-ring.

Wiring Diagrams

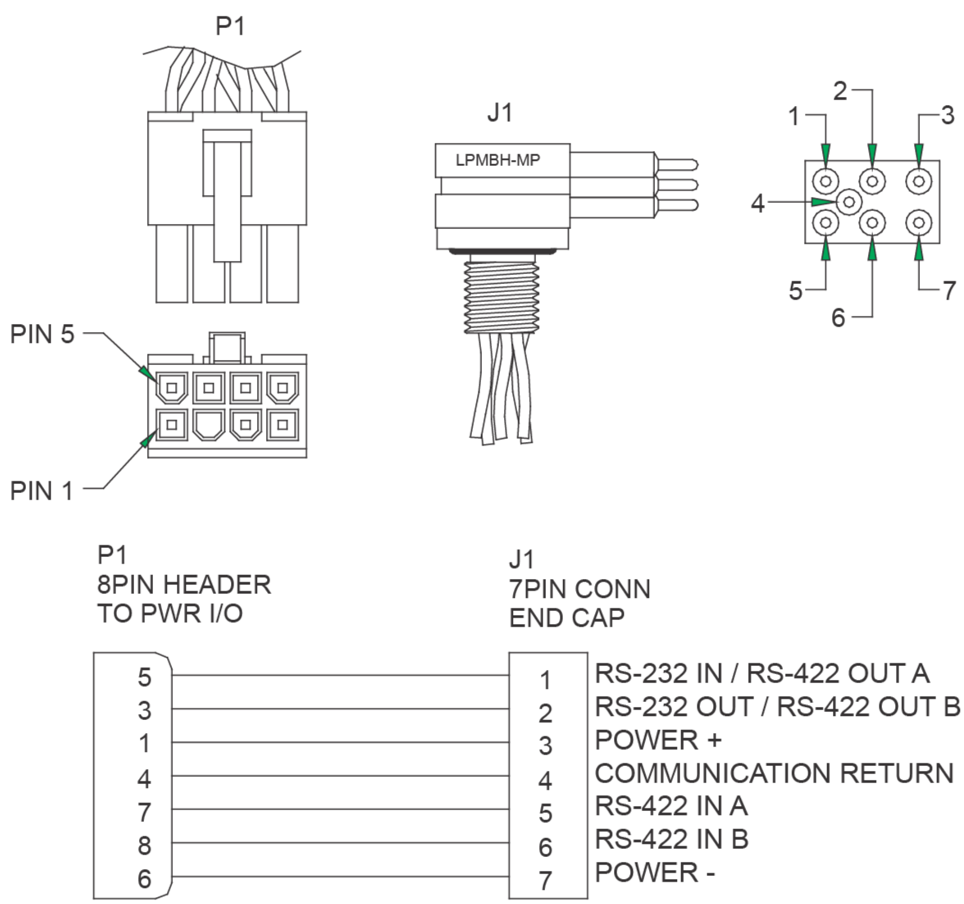


Figure 34. End-Cap Connector Wiring – H-ADCP

Replacing the CPU Lithium Battery

This section explains how to replace the rechargeable lithium coin-cell battery in a H-ADCP system. The battery is located on the CPU board just below the PIO board transmit capacitors. The battery will recharge itself as soon as power is applied to the ADCP. Over time, the battery loses the ability to recharge and the voltage capacity drops. Therefore, **TRDI recommends replacing the battery every five years**.

> The battery keeps the Real-Time Clock (RTC) running in case power is removed temporarily. The RTC drifts independently from the battery voltage by approximately 12 minutes/year. Clock drift does NOT indicate problems with the battery.

Equipment Required

- ESD safe workspace
- Soft pad (ESD Safe) to rest WorkHorse on while dissembling and reassembly
- Anti-static ground strap
- Hex wrenches
- O-rings and desiccant for ADCP
- Soldering iron
- Digital multi-meter
- Lithium battery VL2330

To check for a failing lithium battery:

1. Charge the lithium battery by powering the system using external power and use *TRDI Toolz* to send the PC2 command to prevent the ADCP from sleeping. Let the system run for three hours.
2. Send the TS command and set the clock.
3. Remove all power to the system and wait at least 6 hours (two days is recommended). If you don't want to wait several days, open the housing. On the PIO board short TP10 (GND) to TP11 (VDD2) for 10 seconds using a jumper wire. Remove the jumper.
4. Power up the system and send the TS? command to verify the system time. If the time has reset to January 1, 2000 or is significantly incorrect, then you should verify the lithium battery voltage.

Testing the Lithium Battery Voltage

To verify that the lithium battery voltage:

1. Charge the battery by powering the system using external power and send the PC2 command to prevent the ADCP from sleeping. Let the system run for three hours.
2. Remove all power from the ADCP. Remove the housing assembly.

> Wait a few minutes after turning the power off before removing the electronics stack. This allows the transmit capacitors on the PIO board time to discharge.

3. Attach an earth-grounded wrist strap.

> Before handling any of the WorkHorse boards, you must be sure that you always wear an earth-grounding static protection strap. The electronics in the WorkHorse are very sensitive to electro-static discharge (ESD). ESD can cause damage that will not be seen immediately and will result in early failure of electronic components.

4. Remove the CPU board from the main electronic stack (see Installing the Spare Boards Kit).
5. Measure the voltage on the CPU board between TP17 (BAT+) and the small pin on the battery located on the back side of the CPU board (GND) (see Figure 35).

6. The voltage should hold stable at approximately 2 to 3 VDC for several hours at least, but for best results it should hold at 3 VDC for several days.
7. If the voltage is not holding for more than a week, then the battery may be defective. Before continuing, review your options:
    - Replace the Lithium battery yourself.
    - If you are uncomfortable with replacing the battery, please contact TRDI Customer Service Administration to schedule a replacement of the battery or request a Return Merchandise Authorization (RMA).

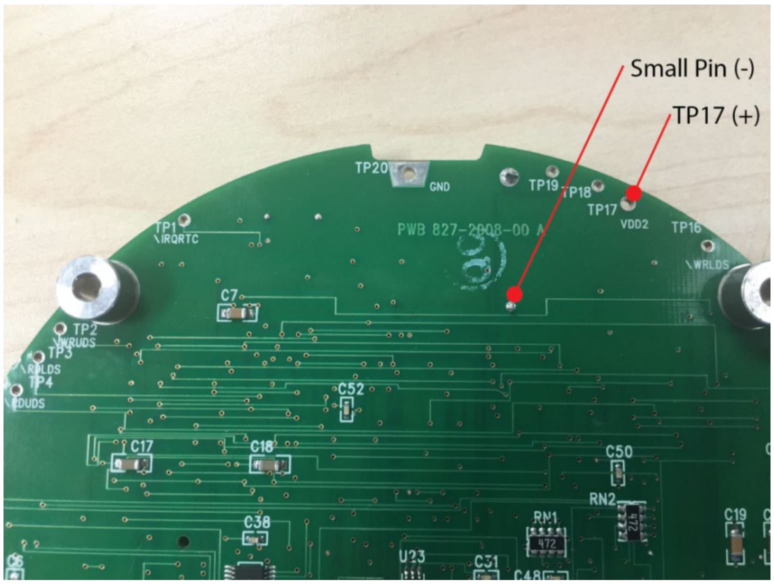


Figure 35. Lithium Battery Test Points on the CPU Board

Replacing the Lithium Battery

To replace the battery:

1. While wearing an earth-grounded wrist strap, locate the lithium battery B1 (on the top side of the CPU board).
2. De-solder the two associated pins for B1 which are located on the underside of the CPU board.
3. Install the new battery assembly (VL2330). Please note the battery pins; the battery can only be installed one way.

Figure 36. Lithium Battery

4. Verify the voltage holds stable at approximately 3 VDC (see Testing the Lithium Battery Voltage, step 2).
5. Replace the housing assembly. Make sure to use new O-rings and desiccant.

NOTES

Chapter 5

TROUBLESHOOTING

In this chapter:

Considering the complexity of the H-ADCP, TRDI has provided as much information as practical for field repair; *fault location to the component level is beyond the scope of these instructions*. The provided information assumes that faults are isolated with a large degree of certainty to a Least Replaceable Assembly (LRA) level only. The time to repair the system will be minimized if an entire replacement unit is available in the field. If time to repair is of essence, Teledyne RD Instruments strongly advises the availability of the listed LRAs.

Table 5: List of Least Replaceable Assemblies

LRA	Description
H-ADCP	The entire H-ADCP; includes the electronics, housing, transducer ceramic assemblies, and end-cap.
I/O Cable	Connects the H-ADCP with the Computer.
End-Cap	Includes the end-cap, connector, and internal I/O cable.
H-ADCP electronics	The spare boards kit Includes the PIO, CPU, and DSP boards.
PC Card	Replaceable PC recorder card.

Since these Least Replaceable Assemblies are manufactured in different configurations, please contact Teledyne RD Instruments (see Technical Support for contact information) to obtain the correct part number for your specific system configuration. Please provide the serial number of the H-ADCP when contacting Teledyne RD Instruments about a replacement assembly. If you want to replace the I/O Cable only, then please provide the cable length.

Equipment Required

Special test equipment is not needed for trouble shooting and fault isolation. The required equipment is listed in Table 6. Any equipment satisfying the critical specification listed may be used.

Table 6: Required Test Equipment

Required Test Equipment	Critical Specification
DMM	Resolution: 3 ½ digit DC-Voltage Range: 200 mV, 2V, 20 V, 200V DC-Voltage Accuracy: ± 1% AC-Voltage Range: 200 V, 450 V AC-Voltage Accuracy: ± 2% Resistance Range: 200, 2 k, 20 k, 200 k, 20 MOhm Res.-Accuracy: ± 2% @ 200 Ohm to 200 kOhm Res.-Accuracy: ± 5% @ 20 Mohm Capacitance Range: 20 nF, 2 uF, 20 uF Capacitance Accuracy: ± 5%
Serial Data EIA Break-Out Box such as from International Data Sciences, Inc. 475 Jefferson Boulevard Warwick, RI 02886-1317 USA.	Model 60 or similar is recommended as it eases the troubleshooting of RS-232 communication problems significantly. Other manufacturers or models may be substituted.

The EIA Break-out Panel is not necessary, but eases RS-232 communication problems troubleshooting significantly.

Basic Steps in Troubleshooting

The first step in troubleshooting is determining what type of failure is occurring. There are four types of failures:

- Communication failure
- Built-In test failure
- Beam failure
- Sensor failure

Communication failures can be the hardest problem to solve as the problem can be in any part of the system (i.e. the computer, H-ADCP, cable, or power). The symptoms include having the system not respond, or not responding in a recognizable manner (for example "garbled" text).

Built-In test failures will appear when the system diagnostics are run. Use *WinSC* or *TRDI Toolz* to identify the failing test.

Beam failures can be identified when collecting data or during the user-interactive performance tests.

Sensor failures can also be identified when collecting data or during the user-interactive performance tests. The sensor may send incorrect data, or not be identified by the system.

Troubleshooting the H-ADCP

Although the H-ADCP is designed for maximum reliability, it is possible for a fault to occur. This section explains how to troubleshoot and fault isolate problems to the Least Replaceable Assembly level (see Table 5). Before troubleshooting, review the procedures, figures, and tables in this guide. Also, read the System Overview to understand how the H-ADCP processes data.

⚠ Under all circumstances, follow the safety rules listed in the Troubleshooting Safety.

Troubleshooting Safety

Follow all safety rules while troubleshooting:

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

⚠ Complete the ground path. The power cord and the outlet used must have functional grounds. Before power is supplied to the H-ADCP, the protective earth terminal of the instrument must be connected to the protective conductor of the power cord. The power plug must only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.

⚠ Any interruption of the earthing (grounding) conductor, inside or outside the instrument, or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.

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

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

Measurements described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Do not attempt to open or service the power supply.

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

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

Troubleshooting a Communication Failure

H-ADCPs communicate by means of two serial communication channels. The user can choose between RS-232 and RS-422 classes of serial interfaces with a switch on the PIO board in the H-ADCP.

To successfully communicate, both the host computer and the H-ADCP must communicate using the same class of serial interface. Standard serial interfaces in IBM compatible computers are also RS-232.

If you have just received your H-ADCP from TRDI, the standard configuration is RS-232 for Sentinels and RS-422 for Monitors and Mariners.

If you are using a high baud rate and/or a long I/O cable (greater than 50 meters) connected to a Sentinel H-ADCP, RS-232 may not work. Switch to RS-422 and try to wake up the H-ADCP again.

Most communication problems are associated with incorrect cabling (i.e. the serial cable is connected to the wrong port) or data protocols (i.e. the wrong baud rate is set between the H-ADCP and computer).

Incorrect Wakeup Message

When you send a break and the wakeup message is not readable (garbled), this may indicate a communications mismatch or lost boot code.

- Sending a break causes “garbage” to appear on the screen. The “garbage” text may keep scrolling. This happens when the computer is using RS-232 and the H-ADCP is set for RS-422 or vice-versa. Check the RS-232/RS-422 switch on the PIO board (see Communications Setting).

- Sending a break causes "garbage" to appear on the screen. You can hear the H-ADCP "beep" when the break is sent. The "garbage" text does not keep scrolling. Check that the H-ADCP and computer are both using the same baud rate. See the CB-command in the H-ADCP Command and Output Data Format guide.
- If the H-ADCP gives a steady "beep" when power is applied, the ">" prompt appears on the screen, and an "X" appears when additional breaks are sent, this may indicate that the boot code has been lost. This can happen if you abort while downloading new firmware. Try downloading the firmware again.

No Wakeup Message

When you send a Break and do not see the wakeup message, you need to isolate the problem to a computer fault, power, cable failure, or an H-ADCP problem.

Check the following items:

1. Connect the H-ADCP to a computer as shown in Setting up the H-ADCP System. Check that all cable connections are tight.
2. Is the H-ADCP AC power adapter working? Is the input voltage to the AC power adapter between 100 to 240 VAC? Is the output level 48 VDC?
3. If the H-ADCP is running from a battery, check that the battery voltage is above 30 VDC. H-ADCPs will work at 20 VDC with at least 400 milli amps; however, both lithium and alkaline battery packs with voltages below 30 VDC are at or near their end of life, and are approaching uselessness.
4. Is the computer hooked up properly? Does it have power?
5. Make sure that your computer and the *TRDI Toolz* programs are set up to use the communication port the serial cable is connected to on the computer.
6. In the case where the H-ADCP is only able to accept a SOFT BREAK due to telemetry components that will not "pass" a HARD BREAK to the H-ADCP and where you can cycle power, TRDI recommends that you consider removing power for one week. Re-apply power after a week and the H-ADCP should wake up.

> The H-ADCP automatically stores the last set of commands used in RAM. Removing power for one week allows the RAM to lose its backup power. When power is re-applied, the H-ADCP will then do a 'cold start' (see H-ADCP Checks).
>
> This is something that can be done without recovering the instrument. It assumes power can be cycled without recovering the H-ADCP and the H-ADCP is still functioning. The cost benefits of waiting a week needs to be weighed against the cost of divers recovering the H-ADCP.

Check the Power

The following test can be done with a voltmeter to check the power. Check the power going into the H-ADCP by measuring the voltage on the end of the cable that connects to the H-ADCP at Pins 3 and 7 (GND) (see H-ADCP Cables). The voltage should be +48 VDC (using the standard AC adapter). If not, check the voltage at the other end of the cable and the AC adapter.

Check the I/O Cable

This test will check the communication between the computer and H-ADCP.

To check the cable:

1. Disconnect both ends of the cable and measure the continuity using a DMM (see H-ADCP Cables for the wiring diagram). Correct any problems found.
2. Reconnect the I/O cable to host computer.
3. Load *TRDI Toolz* on your computer. Select the proper communications port (see the RDI Tools User's Guide for help on using *TRDI Toolz*).
4. For RS-232 communications, short pins 1 and 2 together on the female 7-pin connector that was plugged into the H-ADCP (see H-ADCP Cables). If you are using RS-422, connect a jumper between pin 2 to pin 6 and another jumper between pins 1 to pin 5 of the underwater connector at the H-ADCP end of the cable.
5. Type any characters on the keyboard. The keys you type should be echoed on the screen. If you see characters, but not correctly (garbage), the cable may be too long for the baud rate. Try a lower baud rate. If this works disconnect the jumper on pins 1 and 2 and then push any keys on the keyboard. You should NOT see anything you type.
6. If the keys are echoed correctly on the screen, the computer and the communication cable are good. Re-connect the I/O cable to the H-ADCP. The above loop-back test does not show if transmit and receive pairs are interchanged. Thus, it is important that you check the wiring diagrams provided in H-ADCP Cables.

A loop-back test does not show if transmit and receive wires or pairs are interchanged, even though characters may be displayed correctly.

7. If the keys are echoed correctly on the screen, the computer and the communication cable are most likely good. Re-connect the serial cable to the Deck Box. If the H-ADCP still does not wakeup, there could still be a problem with the Deck Box or H-ADCP.

H-ADCP Checks

Once you have eliminated possible problems with the power, I/O cable, communications settings, and the computer, that leaves the H-ADCP as the source of the problem. The following checks may help in some situations.

To Cold Start the H-ADCP:

1. Remove the housing to gain access to the PC boards.
2. Remove *all* power to the H-ADCP.

Disconnect the power cables P1 and P2 on the PIO board to ensure that NO POWER is applied to the H-ADCP during the next step.

3. Short TP10 to TP11 on the PIO board for 10 seconds.
4. Remove the jumper.
5. Connect the computer and connect power to the H-ADCP. Send a break to the H-ADCP. This should start the H-ADCP in the "cold start" mode.

To check the fuse:

Check the fuse on the PIO board is not blown (see Fuse Replacement for fuse replacement procedures).

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

Check for Boot Code Error:

If the H-ADCP gives a steady "beep" when power is applied, the ">" prompt appears on the screen, and a "X" appears when additional breaks are sent, this may indicate that the boot code has been lost. This can happen if you abort while downloading new firmware. Try downloading the firmware again.

Troubleshooting a Built-In Test Failure

The built-in diagnostic tests check the major H-ADCP modules and signal paths. The spare boards kit may be used to repair some failures. This kit includes:

- Spare Boards including PIO board, CPU board, and DSP board. These boards are held together with the standard M4 screw assembly and kept inside a protective anti-static bag.
- A disk containing your original beam cosine matrix table
- Tools for installation

The Spare Boards kit is not included with the system. You can order the kit by contacting Teledyne RD Instruments Customer Service department (see How to Contact Teledyne RD Instruments and Table 4, page 36).

See **Installing the Spare Boards Kit** for instructions.

When to use the Spare Boards Kit

Use this Kit whenever you have any of the following problems:

- Cannot communicate to the H-ADCP and you have ensured that the serial port on the computer, H-ADCP Cable, Deck Box (Mariner only), and H-ADCP RS-232 to RS-422 converter (if applicable) are all working properly.
- Your H-ADCP fails any of the following PA tests at any time:

CPU Tests:

- RTC
- RAM
- ROM

DSP Tests:

- Timing RAM
- Demod RAM
- Demod REG
- FIFOs

System Tests:

- XILINK Interrupts
- Receive Loop Back Test

- Your H-ADCP fails any of the following PA tests provided the items indicated by {} have been checked:

  Recorder Tests:

  Any recorder test fails {provided that the PCMCIA card(s) have been checked for proper installation, operation and they are DOS formatted; we STRONGLY recommend checking PCMCIA cards in a computer before replacing the boards}

  System Tests:

  Transmit {if the H-ADCP fails when it is in water and air bubbles have been rubbed from the faces}

  Sensor Tests:

  H/W Operation {if the H-ADCP fails when it is NOT sitting/resting on its side, or located near a large magnetic field like a motor in a boat}

The spare boards kit will not correct any of the following failures:

- A damaged beam or its urethane surface
- Damage to the transducer beam connections below the copper shield
- If it passes all PA tests and yet the data is all marked as bad
- Fails the following PA test:

  System Tests:

  Wide Bandwidth {bandwidth tests may fail due to external interference}

  Narrow Bandwidth {bandwidth tests may fail due to external interference}

  RSSI Filter

  Transmit

Table 7: Pre-deployment Test (PA) Possible Cause of Failures

PA Test Name	Possible Cause of Failure
Pre-Deployment Tests CPU Tests: RTC RAM ROM	CPU board failed
Recorder Tests: PC Card #0 Card Detect Communication DOS Structure Sector Test (short) PC Card #1 Card Detect Communication DOS Structure Sector Test (short)	PC card not plugged in PC card failed DSP board failed
DSP Tests: Timing RAM Demod RAM Demod REG FIFOs	DSP board failed
System Tests: XILINX Interrupts	DSP or CPU board failed
Receive Loop-Back	DSP or CPU board failed
Wide Bandwidth Narrow Bandwidth RSSI Filter	Not in water External interference DSP or Receiver board failed
Transmit	Not in water or PIO board failed
Sensor Tests: H/W Operation	PIO board failed Receiver board failed Pressure sensor failed H-ADCP laying on its' side

Troubleshooting a Beam Failure

The PC1 test is designed to measure the relative noise in the environment and then have you apply more noise by rubbing the ceramics with your hand. Sometimes your hand does not generate enough noise for the system to detect. This could be due to the environment you are in or for other reasons. A simple, safe, and easy to find material that works very well as a replacement to your hand is packaging material (a.k.a. bubble wrap). Using this instead of your hand will very likely provide enough relative frictional difference for the system to pass.

If the PC1 test fails, your system may still be okay. In this case deploy the H-ADCP into a bucket or container of water (preferably at least 0.5 meters deep). Record some data using *TRDI Toolz* and the log file (**F3** key), or record data straight to the recorder card if your H-ADCP has one. Then look at the data using the *WinADCP* program and make sure that the echo amplitude counts in the 1st depth cell for all beams is between 128 and 192. If they are not, contact Field Service for further troubleshooting tips.

If the beam continuity test still fails and/or the echo amplitude indicates a problem, a bad DSP board, Receiver board, PIO board, or a bad beam may cause the failure. If replacing the DSP and PIO board (included with the spare boards kit) does not fix the problem, the H-ADCP must be returned to TRDI for repair.

```
>PC1

BEAM CONTINUITY TEST

When prompted to do so, vigorously rub the selected
beam's face.

If a beam does not PASS the test, send any character to
the H-ADCP to automatically select the next beam.

Collecting Statistical Data...
  41  46  45  43  41  46  45  43  41  46  45  42  41  46  44  42

Rub Beam 1 = PASS |   NOTE - Possible cause of failure
Rub Beam 2 = PASS |          DSP Board
Rub Beam 3 = PASS |          Receiver Board
                  |          PIO Board
>                 |          Beam
```

This test must be performed with the H-ADCP out of water and preferably dry.

Troubleshooting a Sensor Failure

If the PA test fails the sensor test, run PC2 to isolate the problem. The ambient temperature sensor is mounted on the receiver board. This sensor is imbedded in the transducer head, and is used for water temperature reading. The attitude temperature sensor is located on the PIO board under the compass. The H-ADCP will use the attitude temperature if the ambient temperature sensor fails.

If one of the temperature sensors fails, the PC2 test will show both sensors at the same value.

```
>PC2
Press any key to quit sensor display ...

Heading   Pitch    Roll   Up/Down    Attitude Temp   Ambient Temp   Pressure
301.01°  -7.42°  -0.73°    Up          24.35°C        22.97°C         0.0 kPa
300.87°  -7.60°  -0.95°    Up          24.36°C        22.97°C         0.0 kPa
300.95°  -7.60°  -0.99°    Up          24.37°C        22.97°C         0.0 kPa
300.71°  -7.61°  -0.96°    Up          24.37°C        22.98°C         0.0 kPa
300.69°  -7.61°  -0.96°    Up          24.35°C        22.98°C         0.0 kPa
300.76°  -7.60°  -0.98°    Up          24.38°C        22.97°C         0.0 kPa
>
```

If the temperature sensor is bad, the data can still be collected with no effects to accuracy or quality. Contact TRDI about scheduling a repair of the temperature sensor at your convenience.

When an H-ADCP is orientated properly and horizontal, PC2 Up/Down will state it is orientated downward. If the H-ADCP is laying on its transducer faces, it will state Up.

Fault Log

To determine why a sensor failed, view the fault log. To view the fault log, start *TRDI Toolz*. Press the **End** key to wake up the H-ADCP. Type the following commands: **CR1**, **PA**, **FD**, **FC**. The fault log will be displayed by the FD command and is cleared by the FC command.

```
[BREAK Wakeup A]

H-ADCP Broadband H-ADCP Version x.xx
Teledyne RD Instruments (c) 1996-1997
All rights reserved.
[BREAK Wakeup A]
>CR1
>PA
|          (PA test results (not shown))
|
>FD
Total Unique Faults   =     2
Overflow Count        =     0
Time of first fault:    97/11/05,11:01:57.70
Time of last fault:     97/11/05,11:01:57.70

Fault Log:
Entry #  0 Code=0a08h  Count=    1  Delta=    0 Time=97/11/05,11:01:57.70
 Parameter = 00000000h
  Tilt axis X over range.
Entry #  1 Code=0a16h  Count=    1  Delta=    0 Time=97/11/05,11:01:57.70
 Parameter = 00000000h
  Tilt Y axis ADC under range.
End of fault log.
>FC
```

System Overview

This section presents a functional description of H-ADCP operation using block diagrams.

Operating Modes

The H-ADCP has two modes of operation: *command mode*, and *ping mode* (also referred to as "Deployment Saver" Mode). Depending on what mode the H-ADCP is in; it will go either to sleep, or to resume pinging.

Command Mode

Whenever you wake up your H-ADCP, power dissipation increases from less than 1 mW to around 2.2 W. If you leave the H-ADCP in command mode without sending a command for more than 5 minutes, the H-ADCP automatically goes to sleep. This protects you from inadvertently depleting batteries.

- If the H-ADCP receives a BREAK, it will go to the command prompt and wait for a command. The H-ADCP will wait at the command prompt for five minutes. If no commands have been sent, it will go to sleep (also called "Battery Saver" mode).
- If you press the reset switch (located on the CPU board), the H-ADCP will go to sleep.
- If the H-ADCP receives a CS-command, it will go into the ping mode and begin pinging. If a TF-command (Time of First Ping) was sent prior to the CS-command, then the H-ADCP will go to sleep until the TF time occurs.
- If the H-ADCP does a COLD wakeup (i.e. an unknown state), it will go to the command prompt.
- If the H-ADCP is asleep for approximately nine hours, it wakes up to charge the capacitor used to maintain RAM. Once the capacitor is charged (this only takes a few seconds), the H-ADCP goes back to sleep.

Ping Mode

After you send commands to the H-ADCP that tells it to start collecting data, the H-ADCP goes into deployment saver mode. If power is somehow removed and later restored, the H-ADCP simply picks up where it left off and continues to collect data using the same set up.

- If the H-ADCP receives a BREAK, it will go to the command prompt, but stays in the ping mode. If a valid command is received, the H-ADCP will switch to the command mode. If no valid command is received, a warning will be displayed after four minutes, indicating that the system will self-deploy. After a total of five minutes with no input, the H-ADCP will resume pinging.
- If you press the reset switch, and an alarm is currently set for the next ping, the H-ADCP will go to sleep. If no alarm is set, the system will start a new deployment and starts pinging immediately unless a TF-command had been set after the last BREAK. In this case, the H-ADCP will go to sleep until the TF time occurs.
- If the H-ADCP does a COLD wakeup, the system will start a new deployment and starts pinging immediately unless a TF-command had been set after the last BREAK. In this case, the H-ADCP will go to sleep until the TF time occurs if the TF time is valid (i.e., not in the past).
- If the H-ADCP is asleep for approximately nine hours, it wakes up to charge the capacitor used to maintain RAM. Once the capacitor is charged, if a valid alarm is set for the next ping time, the H-ADCP goes back to sleep and waits for the alarm. If no alarm is set, the H-ADCP will resume pinging immediately, or wait for the TF time (if valid), and then start pinging.

Overview of Normal H-ADCP Operation

Refer to Figure 37 through Figure 39. The following events occur during a typical data collection cycle.

1. The user or a controlling software program sends data collection parameters to the H-ADCP. The user/program then sends a CS-command to start the data collection cycle. The firmware program stored in the CPU microprocessor takes control of H-ADCP operation based on the commands received through the serial I/O cable.

   Figure 37 shows a flow chart of the wake-up logic used by the H-ADCP. The H-ADCP determines what to do based on where the wake-up came from (a Break, CS-command, battery saver timer, or watchdog timer was detected).

2. On the PIO Board, the POWER REGULATOR circuit sends a transmit command to the POWER AMPLIFIER circuit. This tells the H-ADCP to start acoustic transmissions (pinging) on all TRANSDUCERS.
3. The TRANSDUCERS receive echoes from the backscatter. The RECEIVER board amplifies and translates the echoes into a base-band frequency.
4. The CPU board processes the received echoes.
5. After echo reception, the H-ADCP injects a self-test signal into the RECEIVER board and processes the signal as normal data for test purposes.
6. The THERMISTOR measures water temperature at the transducer head and sends it to the CPU via the DSP Board.
7. The PIO Board sends pitch and roll from the TILT SENSOR and H-ADCP heading from the COMPASS to the DSP Board. The DSP Board digitizes this information and sends it to the CPU for processing.
8. The CPU repeats steps “b” through “g” for a user-defined number of pings. The CPU averages the data from each ping to produce an ensemble data set.
9. At the end of the ensemble (sampling) interval, the CPU sends the collected data to the serial I/O connector or PCMCIA recorder.

Functional Description of Operation

The following paragraphs describe how the H-ADCP operates and interacts with its modules. Refer to Figure 37 through Figure 39 throughout this description.

Input Power

The H-ADCP Monitor/Sentinel requires a DC supply between 20 volts and 50 volts. Either an external DC power supply or internal battery packs can provide this power. Figure 38 shows the DC voltage power distribution path.

Board Descriptions

PIO Board.

- Receives the filtered/internal power.
- Uses a diode “OR” gate to determine which power source to use (external or internal). With both sources connected, the OR gate selects the “higher” voltage for H-ADCP use.
- Limits the in-rush of current to the H-ADCP and provides over- and negative-voltage protection. Either condition will blow a protective fuse. However, damage could occur to other circuits before the fuse blows. Please ensure you apply only voltages within the specified range (+20 to +50 VDC).

- Converts the operating power supply (filtered/isolated 20 to 50 VDC) in a DC-to-DC converter to the +5 VDC (Vcc) used to power all other H-ADCP circuits.
- Uses the Power Amplifier circuit on the PIO board to generate the high-amplitude pulse AC signal that drives the sonar transducers. The Power Amplifier sends the drive signal to the Receiver Board.
- RS-232/RS-422 switch.

CPU Board.

- Real time clock.
- Generates most of the timing and logic signals used by the H-ADCP.

DSP Board.

- Contains the PCMCIA recorder slots.
- Analog to Digital converter.
- Digitizes information from sensors and sends sensor information to the CPU.

Receiver Board.

- Tuning functions
- Receiver functions
- Temperature sensor
- Interface for pressure sensor

Sensors

This section describes the standard H-ADCP sensors. The PIO and DSP boards control the environmental sensors and contain unit-specific data. Sensors include:

Temperature Sensor (Thermistor) - Used to measure the water temperature. The system uses this data to calculate the speed of sound. This sensor is embedded in the transducer head and is not field replaceable.

Up/Down Sensor - Determines whether the transducer head is facing up or down. This sensor is located on the PIO board.

Compass - Determines the Beam 3 heading angle of the H-ADCP using a flux-gate compass. This sensor is located on the PIO board. The flux-gate measured earth magnetic field vector together with the tilt sensor pitch and roll information is used to determine the heading. Since the tilt sensor data is only valid when the H-ADCP is ±20° from vertical, the heading information is also limited to this range.

Attitude Sensor - Determines the tilt angles of the H-ADCP. This sensor is located on the PIO board. The attitude sensor uses a pitch and roll liquid-filled sensor. This sensor is functional to an angle of ±20° from vertical.

Pressure Sensor (optional) - Measures pressure at the H-ADCP transducer. This sensor is embedded in the transducer head and is not field replaceable.

The CPU microprocessor controls a multiplexed analog-to-digital converter to accept analog data from the sensors. Digital data are taken in directly. The pressure sensor incorporates a Wheatstone Bridge strain gage to measure the water pressure at the transducer faces. Depth is calculated from pressure, with water density adjusted by the salinity (ES) setting.

Calibration data for the sensors, a beam-angle correction matrix, and unit identification parameters (frequency, serial number, firmware version, etc.) are stored in ROM.

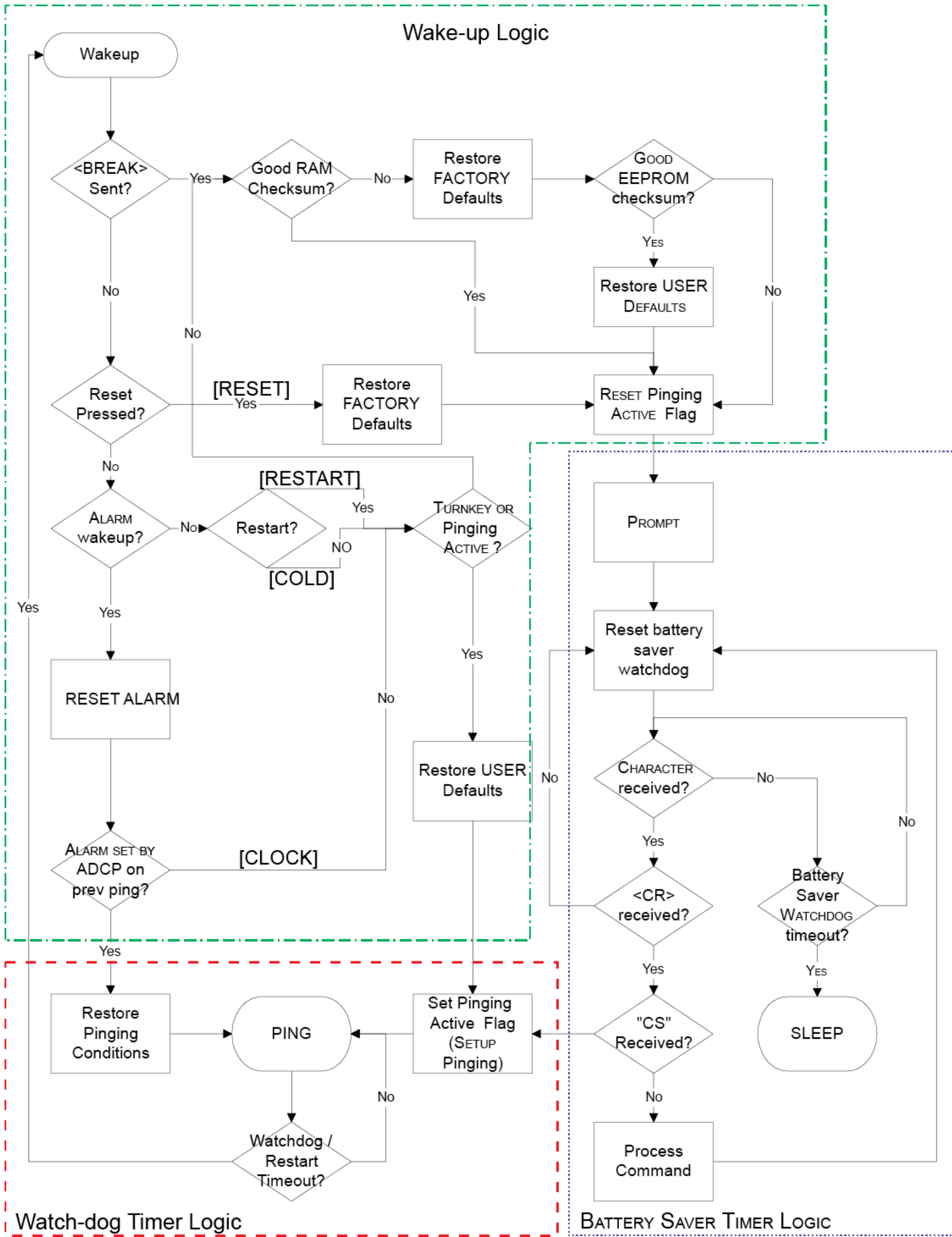


Figure 37. H-ADCP Wake-up and Timer Logic

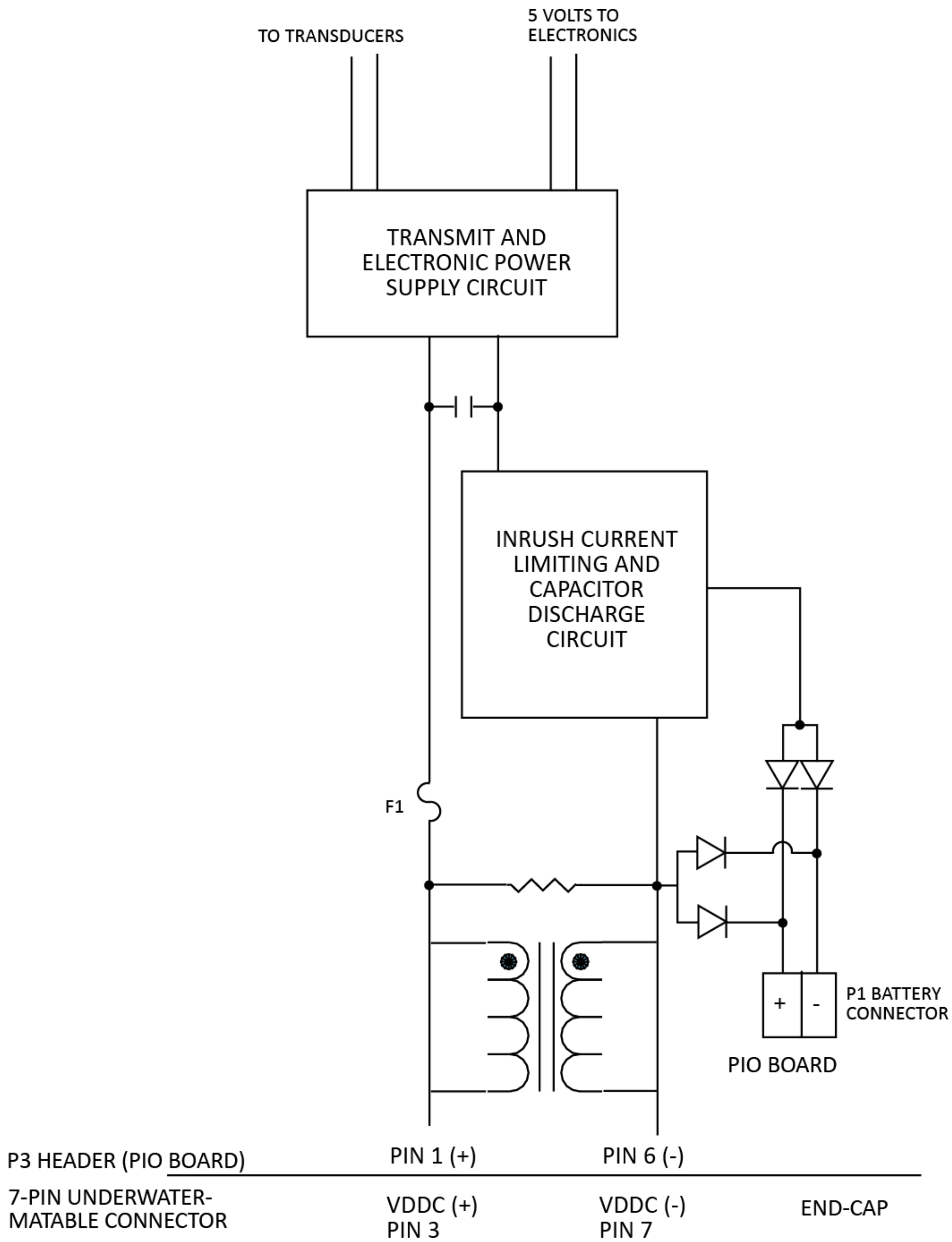


Figure 38. DC Power Path

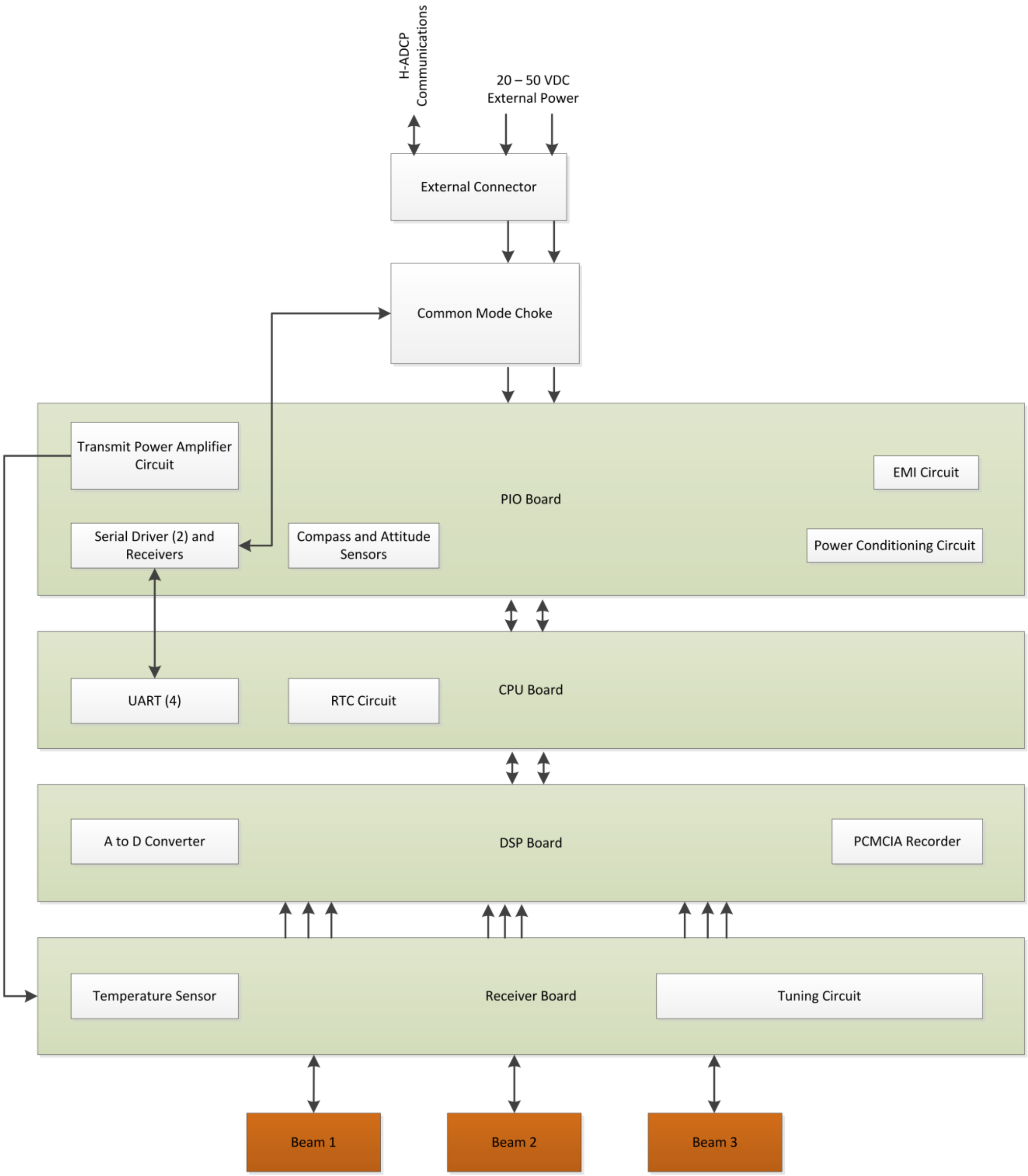


Figure 39. H-ADCP Block Diagram

Chapter 6

RETURNING SYSTEMS TO TRDI FOR SERVICE

In this chapter:

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

Shipping the H-ADCP

This section explains how to ship the H-ADCP.

Remove all customer-applied coatings or provide certification that the coating is nontoxic if you are shipping a H-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 H-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 H-ADCP.

If you need to ship the H-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 H-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 H-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:

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

Step 4 - Urgent shipments

Send the following information by telephone to TRDI.

Attention: Customer Service Administration

Phone: +1 (858) 842-2700

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

Returning Systems to TRDI Europe Factory

When shipping the system to TRDI Europe, the following instructions will help ensure the H-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:

- 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 Telephone to TRDI

Attention: Sales Administration

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

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

Notes

Chapter 7

SPECIFICATIONS

In this chapter:

A brief review of H-ADCP operation may help you understand the specifications listed in this section.

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

The H-ADCP emits an acoustic pulse called a PING. Scatterers that float ambiently with the water currents reflect some of the energy from the ping back to the H-ADCP. The H-ADCP uses the return signal to calculate a velocity. The energy in this signal is the *echo intensity*. Echo intensity is sometimes used to determine information about the scatterers.

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

The H-ADCP does not measure velocity at a single point; it measures velocities throughout the water column. The H-ADCP measures velocities from its transducer head to a specified range and divides this range into uniform segments called *depth cells* (or *bins*). The collection of depth cells yields a *profile*. The H-ADCP produces two profiles, one for velocity, and one for echo intensity.

The H-ADCP calculates velocity data relative to the H-ADCP. The velocity data has both speed and direction information. The H-ADCP can get absolute direction information from a heading sensor.

The following tables list the specifications for the H-ADCP. About the specifications:

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

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

Table 8: Water Profiling Specifications

Cell Size[1] Horizontal Resolution	H-ADCP 300 300kHz nominal (LR mode[2]) 148m (187m)				H-ADCP 600 600kHz nominal (LR mode[2]) 60m (75m)				H-ADCP-N 300 300kHz nominal (LR mode[2]) 178m (221m)			
	Range (m)		Std Dev (cm/s)		Range (m)		Std Dev (cm/s)		Range (m)		Std Dev (cm/s)	
	Nominal	Long	Nominal	Long	Nominal	Long	Nominal	Long	Nominal	Long	Nominal	Long
0.5m					41	54	11.03	23.14				
1.0m	99	134	10.97	23.01	45	59	5.66	11.87	126	164	13.55	28.44
2.0m	108	145	5.62	11.74	49	64	2.89	6.05	136	176	6.94	14.51
4.0m	120	158	2.87	6.02	54	70	1.36	2.83	149	190	3.55	7.44
8.0m	134	173	1.36	2.89	60	75	0.6	1.22	163	205	1.73	3.68
16.0m	148	187	0.6	1.32					178	221	0.77	1.65
Aspect Ratio Limitation	12/1 (range/total depth)				12/1 (range/total depth)				19/1 (range/total depth)			

1. User's choice of cell size is not limited to the typical values specified.
2. Range, which depends on cell size, is specified here for narrow bandwidth mode at 5°C, typical ocean backscatter, and nominal 48VDC input power. Default configuration is LR mode (WB=1).

Table 9: Specifications

Profile Parameter		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	Velocity accuracy	±0.5% ±5mm/sec	±0.25% ±2.5mm/sec	±0.5% ±5mm/sec
	Velocity resolution	0.1cm/s	0.1cm/s	0.1cm/s
	Velocity range	±5m/s (default), ±20m/s (max)	±5m/s (default), ±20m/s (max)	±5m/s (default), ±20m/s (max)
	No. of depth cells	1-128	1-128	1-128
	Error velocity data rejection	Yes; required on a single-ping basis to screen errors from passing vessels		

Transducer and Hardware		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	Beam width	2.1°	1.3°	1.1°
	Beam angle	25°	25°	20°

System Weight		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	In Air	16kg	14kg	72.1kg
	In Water	10kg	8.6kg	56.2kg

Environmental		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	Standard depth rating	200 meters		
	Operating temperature	-5° to 45°C		
	Storage temperature	-30° to 60°C		

Power		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	DC Input	20 to 50 VDC external power supply		
	Transmit	60W @ 48V (600kHz), 190W @ 48V (300kHz)		

Communications		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	Serial port	Selectable by switch for RS-232 or RS-422. ASCII or binary output at 1200 to 115,200 baud.		
	Optional Internal memory	Optional memory card. Two PCMCIA memory card slots are available. The maximum memory for each slot is 2GB, with the total memory capacity not to exceed 4GB.		

Sensors		H-ADCP 300	H-ADCP 600	H-ADCP-N 300
	Temperature	Range -5° to 45° C, Precision ±0.4° C, Resolution 0.01°		
	Compass (1)	Type flux gate, Accuracy ±2°, Precision ± 0.50, Resolution 0.01°, Max tilt ± 15°		
	Optional Pressure Sensor (2)	Short-term uncertainty ±0.1%, Max. drift ±0.25%		

1. @ 60° magnetic dip angle, 0.5G total field. Includes built-in field calibration procedure. Compass uncertainty is for tilts less than 15°.
2. A 50m pressure sensor is standard. 100m and 200m are available if required.

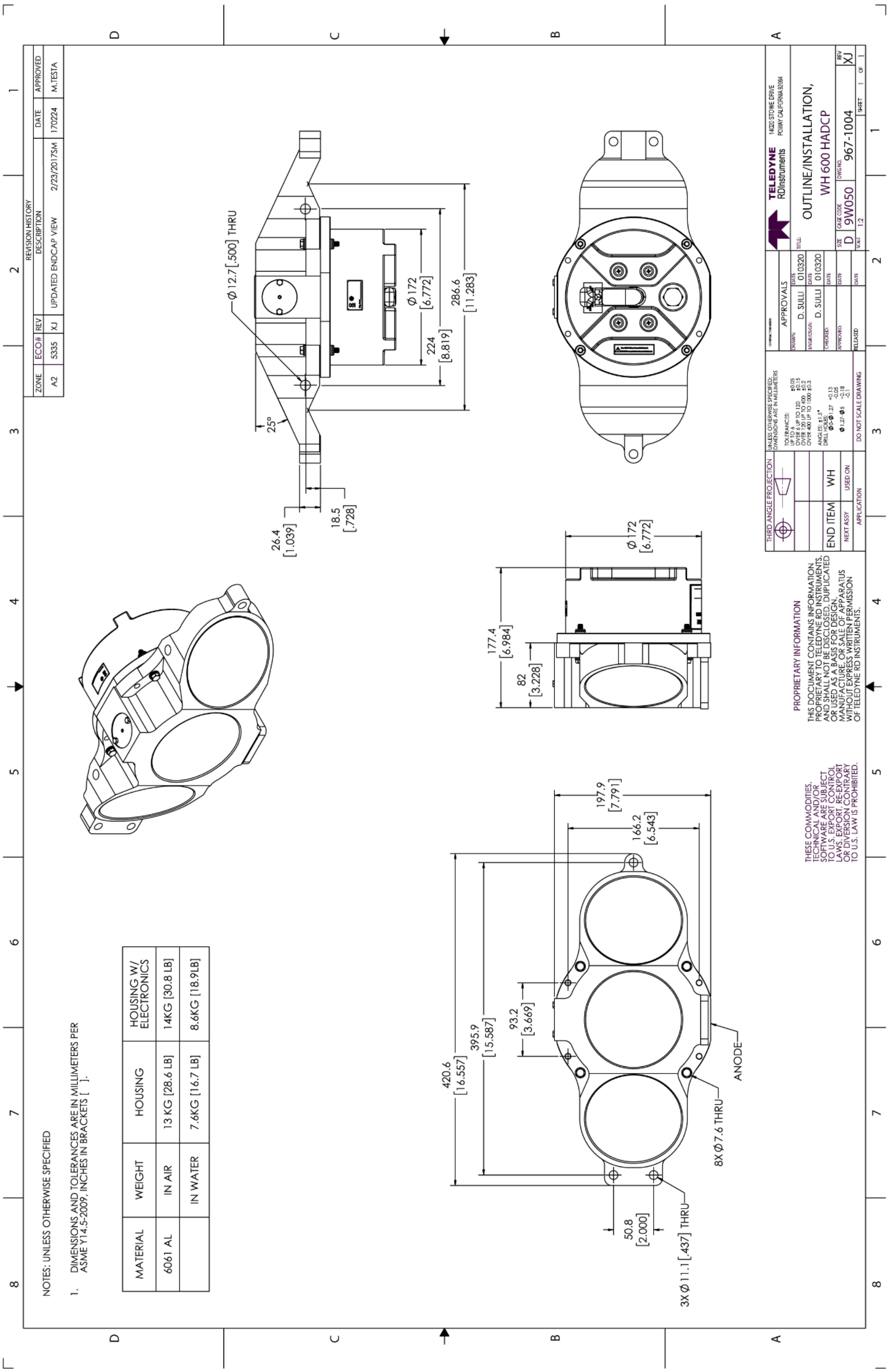
Outline Installation Drawings

The following drawings show the H-ADCP dimensions and weights.

Table 10: Outline Installation Drawings

Description	Drawing #
600 kHz H-ADCP	967-1004
300 kHz H-ADCP	967-1015
300 kHz Narrow Beam Width H-ADCP (early prototype builds)	967-6043
300 kHz Narrow Beam Width H-ADCP (one-piece housing). This is the standard built system.	967-6095
300 kHz Narrow Beam Width H-ADCP (two-piece housing – no longer manufactured)	967-6096

Outline Installation Drawings are subject to change without notice. Verify you have the latest version of the drawing by contacting TRDI before building mounts or other hardware.


REVISION HISTORY
ZONE | ECO# | REV | DESCRIPTION | DATE | APPROVED
A2 | 5335 | XJ | UPDATED ENDCAP VIEW | 2/23/2017SM | 170224 | M.TESTA
Ø 12.7 [.500] THRU
Ø 172 [6.772]
224 [8.819]
286.6 [11.283]
25°
26.4 [1.039]
18.5 [.728]
Ø 172 [6.772]
177.4 [6.984]
82 [3.228]
197.9 [7.791]
166.2 [6.543]
420.6 [16.557]
395.9 [15.587]
93.2 [3.669]
ANODE
8X Ø 7.6 THRU
50.8 [2.000]
3X Ø 11.1 [.437] THRU
NOTES: UNLESS OTHERWISE SPECIFIED
1. DIMENSIONS AND TOLERANCES ARE IN MILLIMETERS PER ASME Y14.5-2009, INCHES IN BRACKETS [ ].
MATERIAL | WEIGHT | HOUSING | HOUSING W/ ELECTRONICS
6061 AL | IN AIR | 13 KG [28.6 LB] | 14KG [30.8 LB]
IN WATER | 7.6KG [16.7 LB] | 8.6KG [18.9LB]
TELEDYNE RD Instruments
14020 STOWE DRIVE POWAY CALIFORNIA 92064
OUTLINE/INSTALLATION, WH 600 HADCP
SIZE D CAGE CODE 9W050 DWG NO 967-1004 REV XJ
SCALE 1:2 SHEET 1 OF 1
APPROVALS
DRAWN D. SULLI 010320
ENGR/DESIGN D. SULLI 010320
THIRD ANGLE PROJECTION
END ITEM WH
NEXT ASSY USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY INFORMATION
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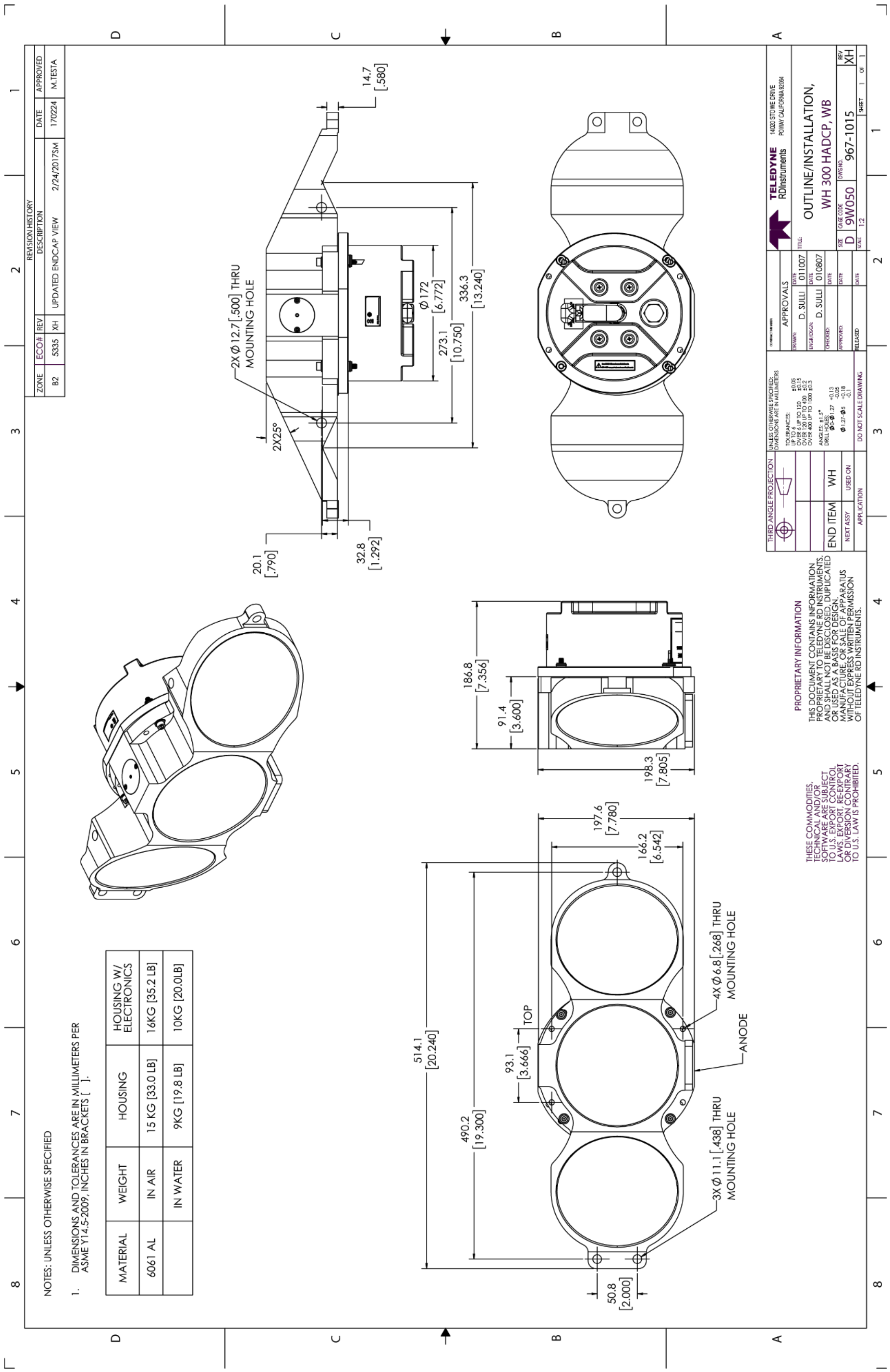
REVISION HISTORY
ZONE REV DESCRIPTION DATE APPROVED
B2 5335 XH UPDATED ENDCAP VIEW 2/24/2017SM 170224 M.TESTA
14.7 [.580]
2X Ø 12.7 [.500] THRU MOUNTING HOLE
Ø172 [6.772]
273.1 [10.750]
336.3 [13.240]
2X25°
20.1 [.790]
32.8 [1.292]
186.8 [7.356]
91.4 [3.600]
198.3 [7.805]
197.6 [7.780]
166.2 [6.542]
514.1 [20.240]
490.2 [19.300]
93.1 [3.666]
TOP
4X Ø 6.8 [.268] THRU MOUNTING HOLE
ANODE
3X Ø 11.1 [.438] THRU MOUNTING HOLE
50.8 [2.000]
NOTES: UNLESS OTHERWISE SPECIFIED
1. DIMENSIONS AND TOLERANCES ARE IN MILLIMETERS PER ASME Y14.5-2009, INCHES IN BRACKETS [ ].
MATERIAL | WEIGHT | HOUSING | HOUSING W/ ELECTRONICS
6061 AL | IN AIR | 15 KG [33.0 LB] | 16KG [35.2 LB]
 | IN WATER | 9KG [19.8 LB] | 10KG [20.0LB]
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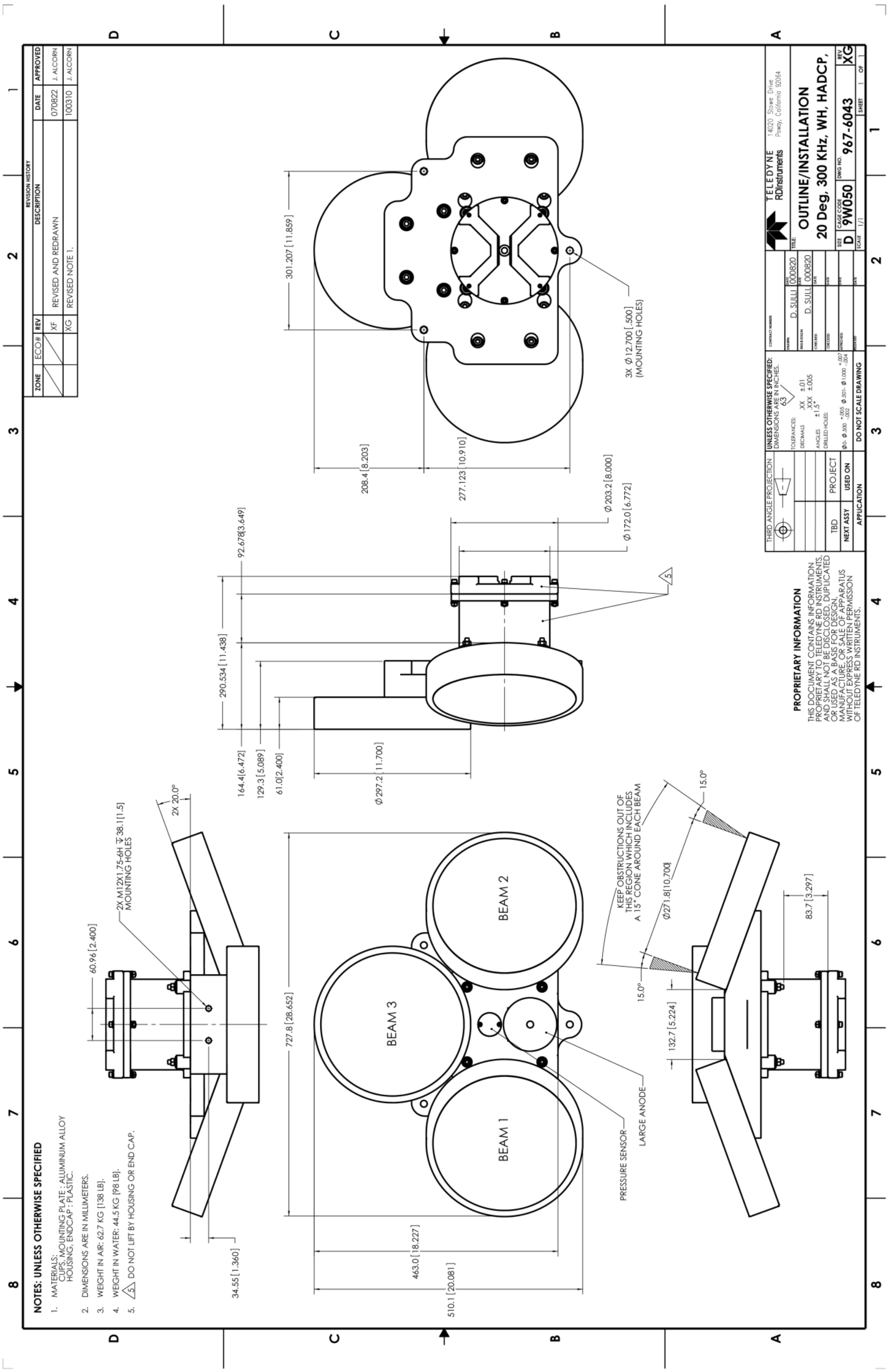
THIRD ANGLE PROJECTION
END ITEM
WH
DO NOT SCALE DRAWING
APPROVALS
D. SULLI 011007
D. SULLI 010807
TELEDYNE RD Instruments
14020 STOWE DRIVE POWAY CALIFORNIA 92064
OUTLINE/INSTALLATION, WH 300 HADCP, WB
D 9W050 967-1015 XH
SCALE 1:2


NOTES: UNLESS OTHERWISE SPECIFIED
1. MATERIALS: CUPS, MOUNTING PLATE : ALUMINUM ALLOY HOUSING, ENDCAP : PLASTIC.
2. DIMENSIONS ARE IN MILLIMETERS.
3. WEIGHT IN AIR: 62.7 KG [138 LB].
4. WEIGHT IN WATER: 44.5 KG [98 LB].
5. DO NOT LIFT BY HOUSING OR END CAP.
BEAM 1
BEAM 2
BEAM 3
PRESSURE SENSOR
LARGE ANODE
KEEP OBSTRUCTIONS OUT OF THIS REGION WHICH INCLUDES A 15° CONE AROUND EACH BEAM
2X M12X1.75-6H ↧ 38.1 [1.5] MOUNTING HOLES
3X Ø 12.700 [.500] (MOUNTING HOLES)
2X 20.0°
15.0°
Ø271.8 [10.700]
83.7 [3.297]
132.7 [5.224]
60.96 [2.400]
34.55 [1.360]
463.0 [18.227]
510.1 [20.081]
727.8 [28.652]
Ø 297.2 [11.700]
164.4 [6.472]
129.3 [5.089]
61.0 [2.400]
290.534 [11.438]
92.678 [3.649]
Ø 203.2 [8.000]
Ø 172.0 [6.772]
208.4 [8.203]
277.123 [10.910]
301.207 [11.859]
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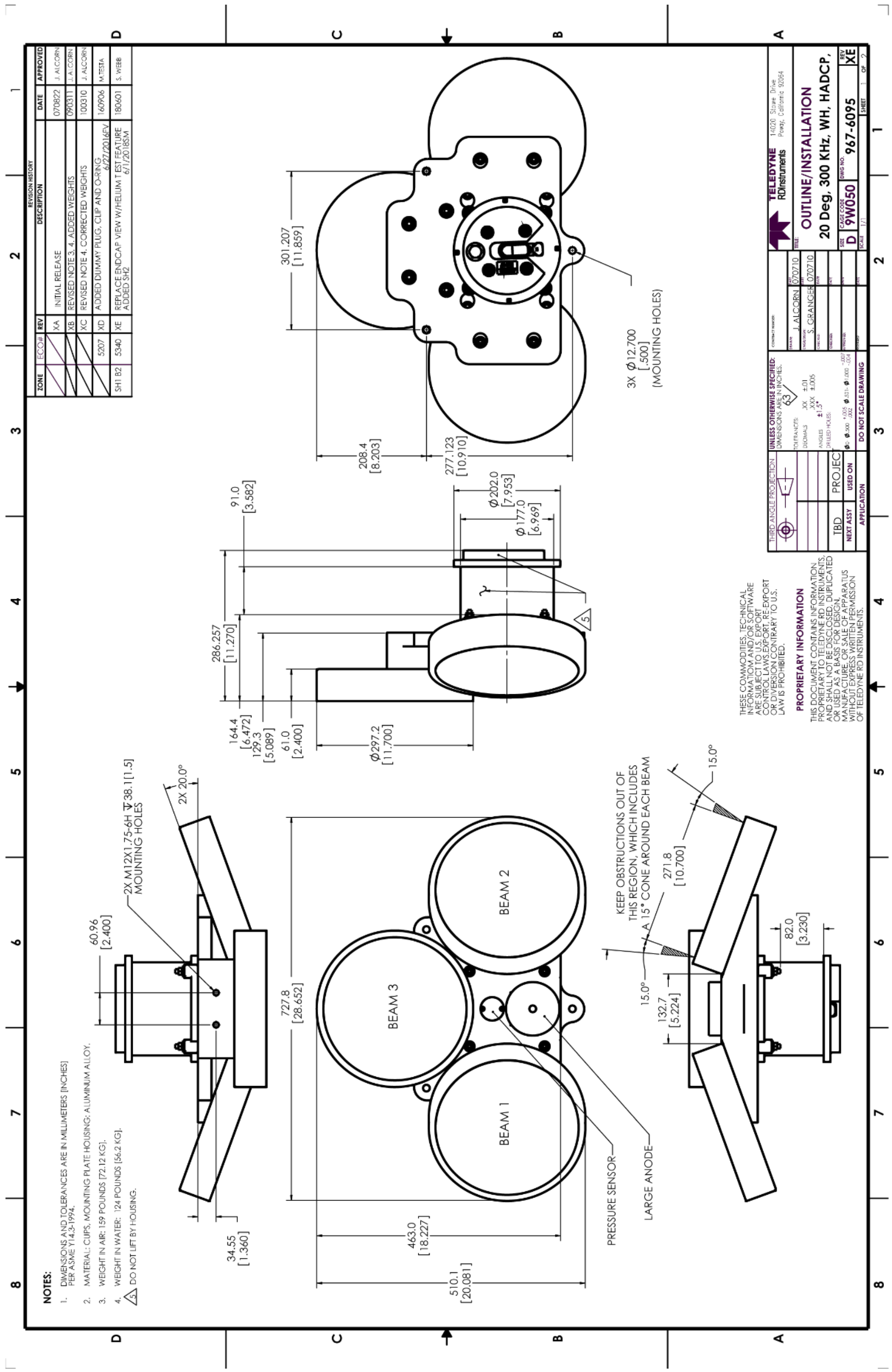
REVISION HISTORY
XF REVISED AND REDRAWN 070822 J. ALCORN
XG REVISED NOTE 1. 100310 J. ALCORN
TELEDYNE RD Instruments
14020 Stowe Drive Poway, California 92064
OUTLINE/INSTALLATION
20 Deg, 300 KHz, WH, HADCP,
D 9W050 967-6043 XG
DO NOT SCALE DRAWING


NOTES:
1. DIMENSIONS AND TOLERANCES ARE IN MILLIMETERS [INCHES] PER ASME Y14.5-1994.
2. MATERIAL: CLIPS, MOUNTING PLATE HOUSING: ALUMINUM ALLOY.
3. WEIGHT IN AIR: 159 POUNDS [72.12 KG].
4. WEIGHT IN WATER: 124 POUNDS [56.2 KG].
5. DO NOT LIFT BY HOUSING.
BEAM 1
BEAM 2
BEAM 3
PRESSURE SENSOR
LARGE ANODE
KEEP OBSTRUCTIONS OUT OF THIS REGION, WHICH INCLUDES A 15° CONE AROUND EACH BEAM
2X M12X1.75-6H 38.1[1.5] MOUNTING HOLES
3X Ø12.700 [.500] (MOUNTING HOLES)
2X 20.0°
15.0°
REVISION HISTORY
INITIAL RELEASE
REVISED NOTE 3, 4, ADDED WEIGHTS
REVISED NOTE 4, CORRECTED WEIGHTS
ADDED DUMMY PLUG, CLIP AND O-RING
REPLACE ENDCAP VIEW W/HELIUM TEST FEATURE ADDED SH2
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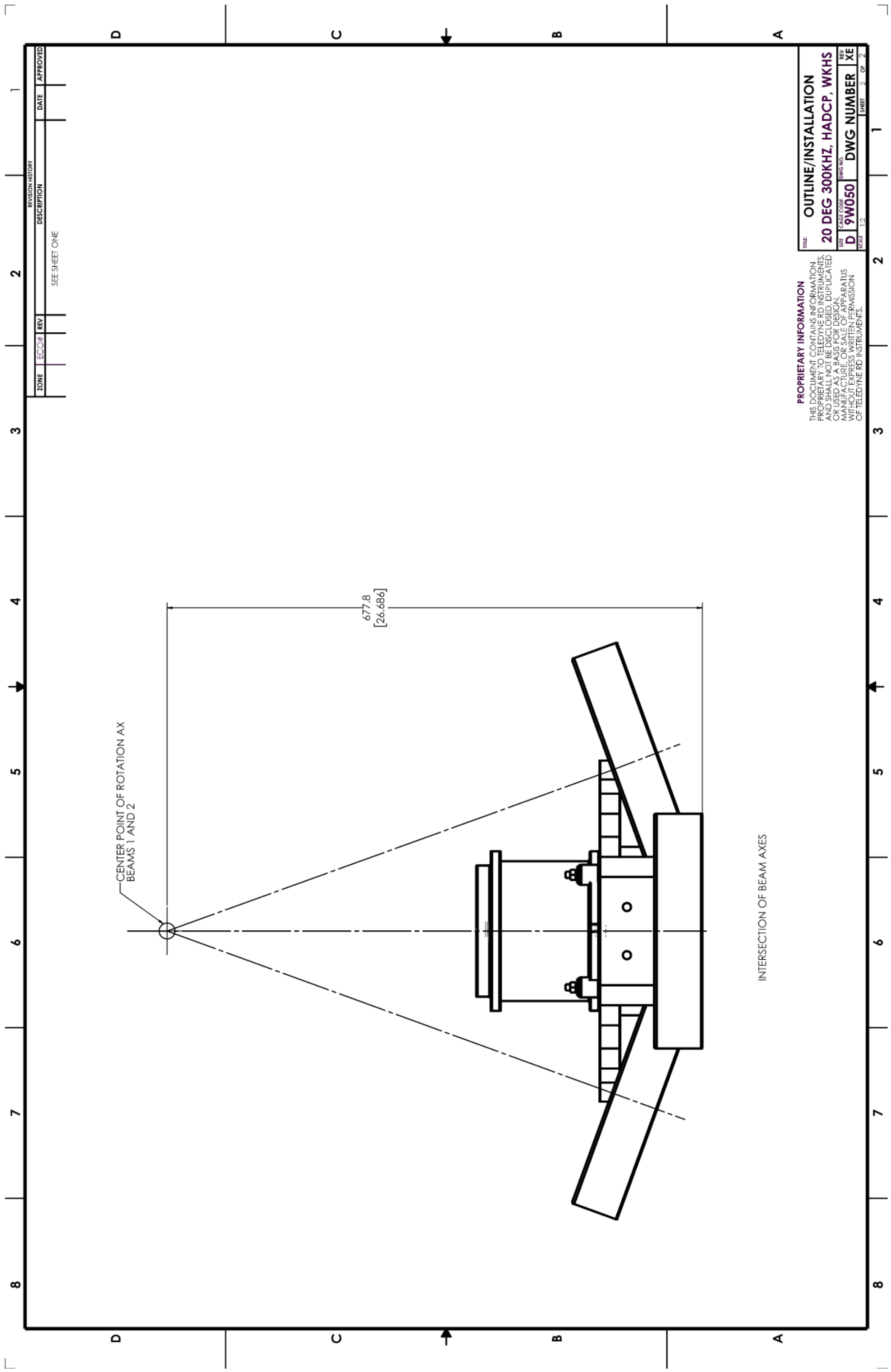
TELEDYNE RDInstruments
14020 Stowe Drive Poway, California 92064
OUTLINE/INSTALLATION
20 Deg, 300 KHz, WH, HADCP,
D 9W050 967-6095 XE
DO NOT SCALE DRAWING


REVISION HISTORY
ZONE
ECO#
REV
DESCRIPTION
DATE
APPROVED
SEE SHEET ONE
677.8
[26.686]
CENTER POINT OF ROTATION AX
BEAMS 1 AND 2
INTERSECTION OF BEAM AXES
PROPRIETARY INFORMATION
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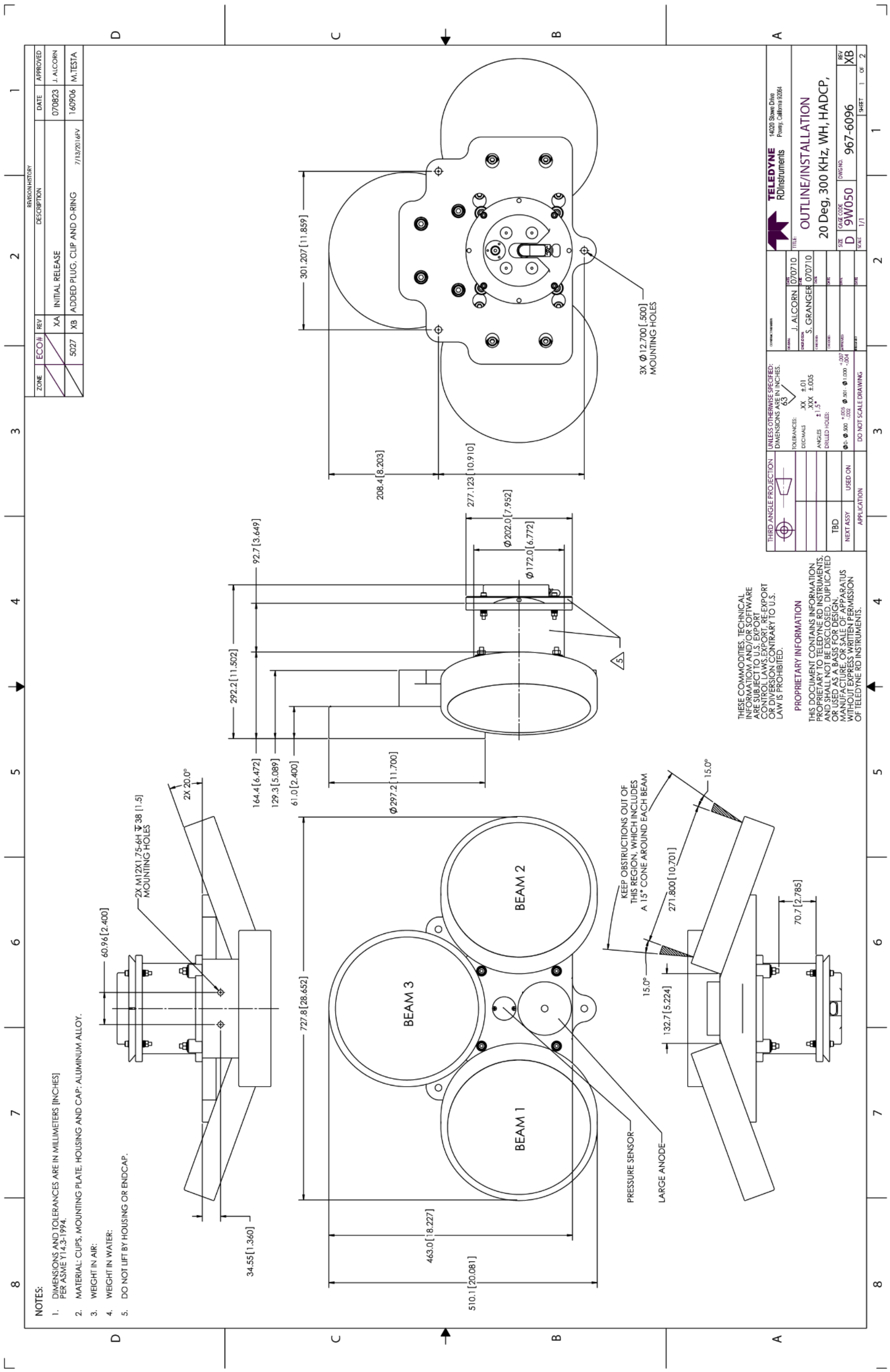
TITLE:
OUTLINE/INSTALLATION
20 DEG 300KHZ, HADCP, WKHS
SIZE
D
CAGE CODE
9W050
DWG NO.
DWG NUMBER
REV
XE
SCALE
1:2
SHEET 2 OF 2


REVISION HISTORY
ZONE | ECO# | REV | DESCRIPTION | DATE | APPROVED
XA | INITIAL RELEASE | 070823 | J. ALCORN
5027 | XB | ADDED PLUG, CLIP AND O-RING | 160906 | M.TESTA
301.207 [11.859]
3X Ø12.700 [.500] MOUNTING HOLES
208.4 [8.203]
277.123 [10.910]
Ø202.0 [7.952]
Ø172.0 [6.772]
92.7 [3.649]
292.2 [11.502]
164.4 [6.472]
129.3 [5.089]
61.0 [2.400]
Ø297.2 [11.700]
2X 20.0°
2X M12X1.75-6H ↧38 [1.5] MOUNTING HOLES
60.96 [2.400]
727.8 [28.652]
BEAM 1
BEAM 2
BEAM 3
PRESSURE SENSOR
LARGE ANODE
KEEP OBSTRUCTIONS OUT OF THIS REGION, WHICH INCLUDES A 15° CONE AROUND EACH BEAM
15.0°
271.800 [10.701]
132.7 [5.224]
70.7 [2.785]
34.55 [1.360]
463.0 [18.227]
510.1 [20.081]
NOTES:
1. DIMENSIONS AND TOLERANCES ARE IN MILLIMETERS [INCHES] PER ASME Y14.3-1994.
2. MATERIAL: CUPS, MOUNTING PLATE, HOUSING AND CAP: ALUMINUM ALLOY.
3. WEIGHT IN AIR:
4. WEIGHT IN WATER:
5. DO NOT LIFT BY HOUSING OR ENDCAP.
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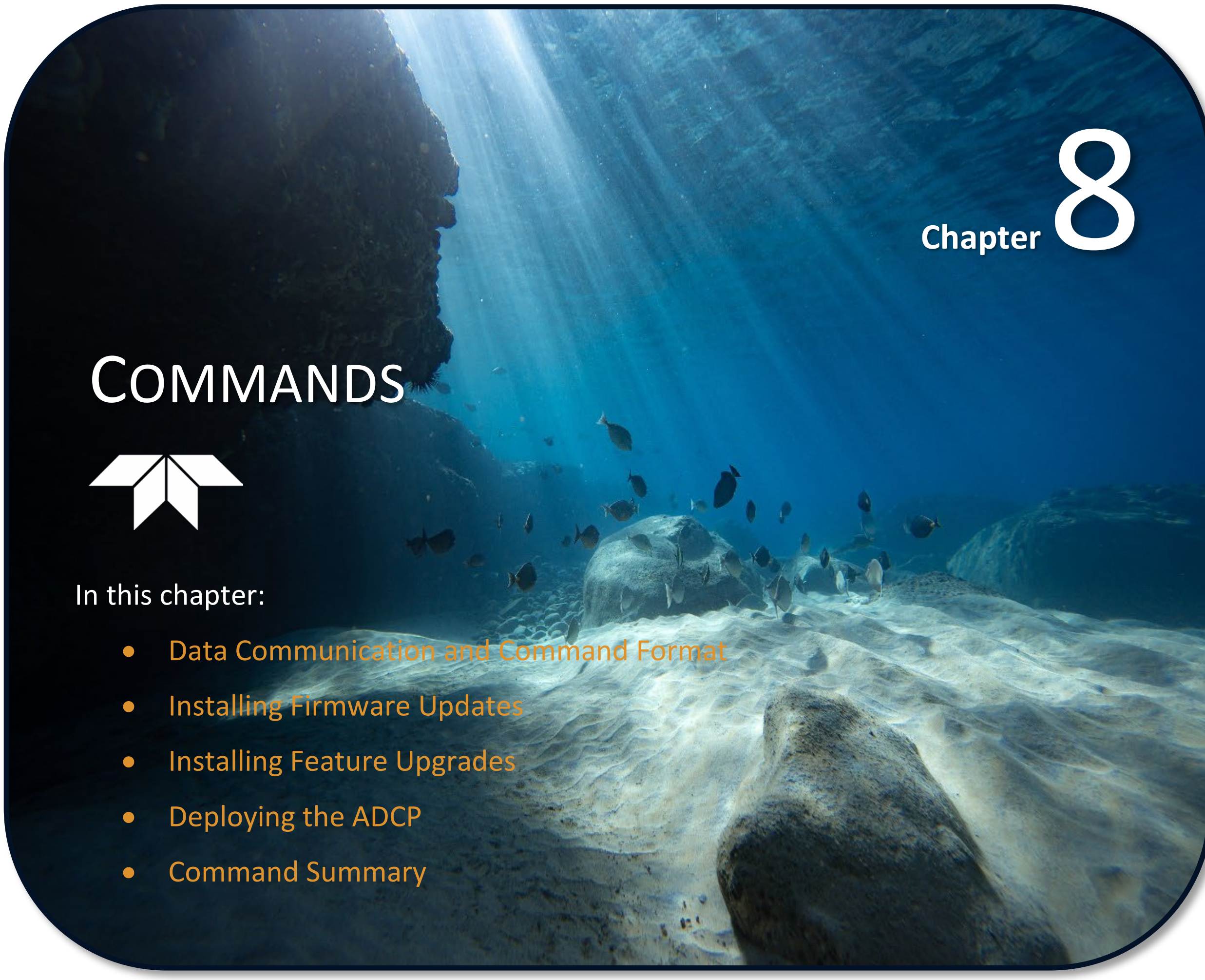
OUTLINE/INSTALLATION
20 Deg, 300 KHz, WH, HADCP,
SIZE D
CAGE CODE 9W050
DWG NO. 967-6096
REV XB
SCALE 1/1
SHEET 1 OF 2



Chapter 8

COMMANDS

In this chapter:

This section defines the commands used by the H-ADCPs. These commands (T) let you set up and control the H-ADCP without using an external software program such as our *WinH-ADCP* or *WavesMon*, programs. However, we recommend you use our software to control the H-ADCP because entering commands directly from a terminal can be difficult. *Make sure you read and understand* Using Direct Commands to Deploy your H-ADCP *before deploying your H-ADCP*. Most H-ADCP settings use factory-set values (Table 13). If you change these values without thought, you could ruin your deployment. *Be sure you know what effect each command has before using it*. Call TRDI if you do not understand the function of any command.

Using *WinH-ADCP* / *WavesMon* for real-time deployments to develop the command file will ensure that the H-ADCP is set up correctly. The commands shown in Table 12 directly affect the range of the H-ADCP and the standard deviation (accuracy) of the data.

These commands apply to H-ADCP firmware version 11.10.

Data Communication and Command Format

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

Immediately after you apply power to the H-ADCP, it enters the STANDBY mode. Send a BREAK signal using *TRDI Toolz* by pressing the **End** key to put the H-ADCP in command mode. When the H-ADCP receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The H-ADCP is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
[BREAK Wakeup A]
WorkHorse Horizontal Broadband H-ADCP Version 11.xx
RD Instruments (c) 1996-2009
All Rights Reserved.
>
```

If you use a terminal/program other than *TRDI Toolz*, the BREAK length (up to down transition) must last at least 300 ms.

Command Input Processing

Input commands set H-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,

```
>WP1<CR> [Your input]
```

Leading zeros are not required. Sending WP00001 and WP1 set the number of pings to 1.

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

```
>WP1<CR>      [Your original input]
>             [H-ADCP response to a valid, no-output command]
```

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

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

After correctly entering all the commands for your application, you would send the CS-command to put the H-ADCP into the ping mode and begin the data collection cycle.

Data Output Processing

After the H-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 (see TE – Time per Ensemble). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, and status data.

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

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

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

Using Direct Commands to Deploy

TRDI recommends that you use our software programs *WinH-ADCP* as your primary method of deployment. If this is not possible in your deployment then we **strongly recommend** that the commands shown in Table 11 be the **minimum** commands you send to the instrument.

TRDI does not recommend the use of direct commands as your primary way of deploying H-ADCPs as any incorrect command setting can have severe consequences to your data collection.

Table 11: ADCP Minimum Required Commands for Deployments

Command	Description
CR1	This command will set your H-ADCP to a known factory default setting and must be your first command
	Special commands here –after CR1 command and before any other commands
CFxxxxx	This command will set your H-ADCP collection mode; binary, recorder, etc.
EAxxxxx	This command will set your magnetic compass offset for true north
EDxxx	This command will set your H-ADCP depth
ESxx	This command will set your H-ADCP’s expected salinity

Command	Description
CR1	This command will set your H-ADCP to a known factory default setting and must be your first command
EXxxxxx	This command will set your H-ADCP's coordinate system; earth, beam, etc.
EZxxxxxxx	This command will set what sensors will be used by your H-ADCP; heading, pitch, roll, temp, etc.
WBx	This command will set the water profile bandwidth between wide (0) and narrow (1)
WNxx	This command will set the number of depth cells to collect
WPxx	This command will set the number of pings to average
WSxxxx	This command will set the depth cell size to use
TExxxxxxxx	This command will set the time between ensembles
TPxxxxxx	This command will set the time between pings
CK	This command will save your setup to the internal RAM and must be your second to last command
CS	This command will start your deployment and must be your last command

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

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

Command Summary

Table 12 gives a summary of the H-ADCP input commands, their format, and a brief description of the parameters they control. Table 13 lists the factory default command settings.

This table shows all commands including optional feature upgrades and expert commands. To see the expert commands, you must first send the command EXPERTON. Some commands may not be available for your H-ADCP.

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

Table 12: H-ADCP Input Command Summary

Command	Description
?	Shows command menu (deploy or system)
<BREAK> End	Interrupts or wakes up H-ADCP and loads last settings used
EXPERTON	Turns expert mode on. All commands will be listed
EXPERTOFF	Turns expert mode off.
OL	List features/special firmware upgrades that are installed
AC	Output calibration data
AD	Display factory calibration
AF	Field calibrate compass to remove hard iron error
AR	Return to factory calibration
AX	Examine compass performance
AZ	Zero pressure sensor
BA*nnn*	Evaluation amplitude minimum (1 to 255 counts)
BB*nnnn*	High Bandwidth Maximum Depth (dm)
BC*nnn*	Correlation Magnitude minimum (0 to 255 counts)

Table 12: H-ADCP Input Command Summary

Command	Description
BE*nnnn*	Error velocity maximum (0 to 9999 mm/s)
BF*nnnn*	Depth guess (1 to 65535 dm, 0 = automatic)
BGss,dd,nnnnn	
BHccc,sss,lll,mmm	
BI*nnn*	Gain switch depth (0 to 999 meters)
BK*n*	Water-mass Layer Mode (0-Off, 1-On, 2-Lost, 3-No BT)
BL*mmm,nnnn,ffff*	Water mass layer parameters: Min Size (dm), Near (dm), Far (dm)
BM*n*	Bottom track mode (5 = Default, 4 = Default minus Coherent)
BP*nnn*	Bottom Track Pings per Ensemble
BR*n*	Resolution (0 = 4%, 1 = 2%, 2 = 1%)
BS	Clear distance traveled
BX*nnnn*	Maximum Tracking Depth (40 to 65535 dm)
BZ*nnn*	Coherent ambiguity velocity (cm/s radial)
CB*nnn*	Serial port control (baud rate/parity/stop bits)
CF*nnnn*	Flow control
CK	Keep parameters as user defaults
CLn	Sleep between Pings (0 = No, 1 = Yes)
CM*n*	Not used.
CN*n*	Save NVRAM to recorder (0 = On, 1 = Off)
CP*n*	Polled mode (0 = Off, 1 = On)
CQ*nnn*	Transmit power (0 = Low, 1 to 255 = High)
CR*n*	Retrieve parameters (0 = User, 1 = Factory)
CS or **Tab**	Start pinging
CY*n*	Clear error status word (0 = Clear, 1 = Display)
CZ	Power down H-ADCP
DB*x,y,z*	RS-485 port control
DS	Load speed of sound with SVSS sample
DWx	Current ID on RS-485 bus (0 to 31)
DX	Set SVSS to raw mode
DY	Set SVSS to real mode
DZ	Get single scan from SVSS
EA±*nnnn*	Heading alignment (-179.99 to 180.00 degrees)
EB±*nnnn*	Heading bias (-179.99 to 180.00 degrees)
EC*nnnn*	Speed of Sound (1400 to 1600 m/s)
ED*nnnn*	Transducer Depth (0 to 65535 dm)
EH*nnnn*	Heading (000.00 to 359.99 degrees)
EP±*nnnn*	Pitch (-60.00 to +60.00 degrees)
ER±*nnnn*	Roll (-60.00 to +60.00 degrees)
ES*nn*	Salinity (0 to 40)
ET±*nnnn*	Temperature (-5.00 to +40.00 degrees C)
EX*nnnn*	Coordinate Transformation (Xform:Type; Tilts; 3Bm; Map)
EZ*nnnnnn*	Sensor Source (C;D;H;P;R;S;T)
FC	Clear Fault Log
FD	Display Fault Log
HA*nnn*	Waves false target threshold (fish rejection)
HB*nn*	Number of automatically choosen bins (20 Max)
HD*nnn nnn nnn*	Waves selected data (Vel;Pres;Surf ;; ;;)
HF*nnnnn*	Waves Flow Control (Res;Res;Res;Ser;Rec)
HP*nnnn*	Number of pings per record
HRhh:mm:ss.ff	Time between wave bursts (hh:mm:ss.ff)
HS*nnn,nnn,nnn,nnn,nnn*	Bins selected for directional wave data recording
HThh:mm:ss.ff	Time between wave pings (hh:mm:ss.ff)
HV*nnn,nnn,nnn,nnn,nnn*	Bins selected for velocity spectrum data recording
PA	Pre-deployment tests
PC1	Beam Continuity Built-in test
PC2	Display Heading, Pitch, Roll, and Orientation Built-in test
PD*nn*	Data stream select (0-6,8,14)

Table 12: H-ADCP Input Command Summary

Command	Description
PM	Distance measurement facility
PS0	Display System Configuration
PS3	Display Instrument Transformation Matrix
PT*nnn*	Built-In test (0 to 200)
RA	Number of deployments
RB	Recorder built-in test
RE ErAsE	Erase recorder
RF	Recorder free space (Bytes)
RN	Set deployment name
RR	Show recorder file directory
RS	Recorder free space (Megabytes)
RY	Upload recorder files
SAxyz	Synchronize before/after ping/ensemble
SBx	Enable Channel B Breaks (1 = YES , 0 = NO)
SI*nnnn*	Synchronization interval (0 to 65535 s)
SM*n*	RDS3 mode select (0 = Off, 1 = Master, 2 = Slave)
SS*x*	RDS3 sleep mode (0 = No Sleep, 1 = Sleep)
ST*n*	Slave timeout (0 to 10800 seconds)
SW*n*	Synchronization delay (0m to 65535 (1/10 milliseconds))
TBhh:mm:ss.ff	Time per burst
TC*nnnn*	Ensemble per burst (0 to 65535)
TEhh:mm:ss.ff	Time per ensemble (hours:minutes:seconds.100th of seconds)
TFyy/mm/dd, hh:mm:ss	Time of first ping (year/month/day, hours:minutes:seconds)
TGccyy/mm/dd, hh:mm:ss	Time of first ping (Y2k compatible) (century year/month/day, hours:minutes:seconds)
TPmm:ss.ff	Time between pings (minutes:seconds.100th of seconds)
TSyy/mm/dd, hh:mm:ss	Set real-time clock (year/month/day, hours:minutes:seconds)
TTccyy/mm/dd, hh:mm:ss	Set real-time clock (Y2k compatible) (century year /month/day, hours:minutes:seconds)
WA*nnn*	False target threshold maximum (0 to 255 counts)
WB*n*	Mode 1 Bandwidth Control (0 = Wide, 1 = Narrow)
WC*nnn*	Low correlation threshold (0 to 255 counts)
WD*nnn nnn nnn*	Data Out (Vel;Cor;Amp PG;St;P0 P1;P2;P3)
WE*nnnn*	Error correlation threshold (0 to 5000 mm/s)
WF*nnnn*	Blank after transmit (0 to 9999 cm)
WI*n*	Clip data past bottom (0 = Off, 1 = On)
WJ*n*	Receiver gain select (0 = Low, 1 = High)
WL*sss,eee*	Water reference layer
WN*nnn*	Number of depth cells (1 to 128)
WP*nnnn*	Pings per ensemble (0 to 16384)
WQ*n*	Sample ambient sound (0 = Off, 1 = On)
WS*nnnn* [min, max]	Depth cell size, 20 to 800 (300kHz), 10 to 800 (600kHz)
WT*nnnn*	Transmit length (0 to 3200 cm)
WU*n*	Ping weight (0 = Box, 1 = Triangle)
WV*nnn*	Ambiguity velocity (002 to 480 cm/s radial)
WW*nnn*	Mode 1 Pings before Mode 4 Re-acquire
WY*n,nnn*	WM 1: Bandwidth (0=WB, 1=NB), Amb. Vel.(cm/s)

Table 13: H-ADCP Factory Defaults

Command	300 kHz	600 kHz
BA	30	30
BB	320	160
BC	220	220
BE	1000	1000
BF	0	0
BI	20	10
BK	0	0
BL	160,320,480	80,160,240
BM	5	5
BP	0	0
BR	1	1
BX	350	150
BZ	4	4
CB	411	411
CF	11110	11110
CL	1	1
CM	0	0
CN	1	1
CP	0	0
CQ	255	255
DB	611	611
DW	0	0
EA	+0	+0
EB	+0	+0
EC	1500	1500
ED	0	0
EH	0	0
EP	+0	+0
ER	+0	+0
ES	0	0
ET	+2500	+2500
EX	01110	01110
EZ	1111101	1111101
HA	255	255
HB	5	5
HD	111 000 000	111 000 000
HF	00000	00000
HP	0	0
HR	01:00:00.00	01:00:00.00
HS	001,010,021,022,023	001,010,021,022,023
HT	00:00:00.50	00:00:00.50
HV	001,010,021,022,023	001,010,021,022,023
PD	0	0
SA	001	001
SB	1	1
SI	0	0
SM	0	0
SS	0	0
ST	0	0
SW	0	0

Table 13: H-ADCP Factory Defaults

Command	300 kHz	600 kHz
TB	00:00:00.00	00:00:00.00
TC	0	0
TE	00:00:00.00	00:00:00.00
TP	00:01.00	00:00.20
WA	255	255
WB	1	1
WC	64	64
WD	111 100 000	111 100 000
WE	1500	1500
WF	175	100
WI	0	0
WJ	1	1
WL	0,5	0,5
WN	30	30
WP	30	30
WQ	0	0
WS	800 [20,1600]	400 [10,800]
WT	0	0
WU	0	0
WV	185	185
WW	4	4
WY	1,185	1,185

The highlighted commands have frequency dependent defaults.

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

? – Help Menus

Purpose	Lists the major help groups.
Format	*x*? (see description)
Description	Entering ? by itself displays all command groups. To display help for one command group, enter *x*?, where *x* is the command group you wish to view. When the H-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 WP-command setting enter WP?.
Examples	See below.

```
[BREAK Wakeup A]

WorkHorse Broadband H-ADCP Version 16.xx
Teledyne RD Instruments (c) 1996-2005
All Rights reserved.
>?
Available Menus:
DEPLOY? ------------------ Deployment Commands
SYSTEM? ------------------ System Control, Data Recovery and Testing Commands

Available Commands:

C? ----------------------- CONTROL Commands
E? ----------------------- ENVIRONMENTAL SENSORS Commands
P? ----------------------- PERFORMANCE Commands
S? ----------------------- RDS^3 SYNCHRONIZATION Commands
T? ----------------------- TIMING Commands
W? ----------------------- WATER PROFILING Commands
R? ----------------------- RECORDER Commands
A? ----------------------- SENSOR/COMPASS Commands
O? ----------------------- FEATURE Commands
D? ----------------------- APPLIED MICROSYSTEMS Commands
?? ----------------------- DISPLAY Quick Menus
>
```

Break

Purpose Interrupts H-ADCP without erasing present settings.

Format <BREAK>

Recommended Setting. Use as needed.

Description A BREAK signal interrupts H-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 H-ADCP in the DATA I/O mode. The BREAK command does not erase any settings or data. Using *TRDI Toolz*, pressing the **End** key sends a BREAK.

Example <BREAK>

```
[BREAK Wakeup A]
WorkHorse Broadband H-ADCP Version 11.xx
Teledyne RD Instruments (c) 1996-2015
All Rights reserved.
>?
```

When you send a break the text inside the brackets '[…]' of the first line of the Wakeup Messages indicates the H-ADCP's communication configuration:

- **[BREAK Wakeup A]** => H-ADCP is set to send/receive RS232 communication through the serial lines of the I/O cable
- **[BREAK Wakeup B]** => H-ADCP is set to send/receive RS432 communication through the serial lines of the I/O cable.
- **[BREAK Wakeup AB]** => RS232/422 switch on the top of the PIO board in the H-ADCP is in between two positions, but neither RS232 nor RS422. It can also mean that the H-ADCP received a trigger pulse while in command mode.
- **[ALARM Wakeup A]** => When you send a break, if the input voltage has a low voltage reading you will get the following message:

```
[ALARM Wakeup A]
WorkHorse Broadband H-ADCP Version 11.xx
Teledyne RD Instruments (c) 1996-2015
All Rights Reserved.
>
```

If this message appears after a break, it is advised not to deploy the H-ADCP since TRDI cannot guarantee the unit will perform to the performance specifications.

Software Breaks - The H-ADCP will use the "= = =" string instead of a break. Soft breaks work when the CL command is 1 or 0. When CL is 1, while you are in command mode the system will not sleep at timeout; it will either start pinging or stay in the command mode depending upon what was happening before the soft break. The system will only sleep if CL is 1 and it is between pings while deployed (not in command mode), or if a CZ command is sent while in command mode.

Expert Mode

Purpose Turns on or off the expert mode.

Format expertoff, experton

Recommended Setting. Use as needed.

Description When the Expert Off command is used, it limits the amount of commands displayed on the help menu. When the expert mode is turned off, all commands are still available (to ensure software compatibility) but do not display. The Expert On command shows all of the available commands in the help menu.

Examples See below.

```
expertoff
Expert Mode is Off
>
experton
Expert Mode is On
>
```

OL - Features

Purpose Lists special firmware upgrades that are installed.

Format OL

Recommended Setting. Use as needed.

Description Lists special features that are installed. See Feature Upgrades for information on how to install additional capability in your H-ADCP.

Examples See below.

```
>ol                                FEATURES
---------------------------------------------------------------------
Feature                                                     Installed
---------------------------------------------------------------------
Bottom Track                                                    Yes
Water Profile                                                   Yes
High Resolution Water Modes                                      No
Lowered ADCP                                                     No
Waves Gauge Acquisition                                          No
See your technical manual or contact TRDI for information on how to
install additional capability in your H-ADCP.
```

Compass Commands

The compass calibration algorithm corrects for distortions caused by ferrous material near the H-ADCP to give you an accurate measurement.

Available Compass Commands

This section lists the available compass commands.

```
>a?
Available Commands:

AC ----------------------- Output Active Fluxgate & Tilt Calibration Data
AD ----------------------- Display Calibration Data
AF ----------------------- Field Calibrate to remove Hard and/or Soft Iron Error
AR ----------------------- Restore Factory Fluxgate Calibration data:
                              make factory the active calibration data
AX ----------------------- Examine Compass Performance
AZ   0.000000 ------------ Zero pressure reading
A? ----------------------- Display Public Sensor Commands

>
```

Compass Command Descriptions

AC – Output Active Calibration Data

Purpose Outputs active fluxgate and tilt calibration data.

Format AC

Recommended Setting. Use as needed.

Description The AC command is identical to the AD command except that the AC command doesn't prompt the user for Factory or Active Calibration data; it assumes active. The AC Command doesn't prompt the user to "press any key to continue…" when the screen is full.

Example See below

```
>ac

              ACTIVE FLUXGATE CALIBRATION MATRICES in NVRAM
               Calibration date and time: 4/6/2000  11:00:29
                             S inverse
          +                                                   +
     Bx   ¦   2.8071e-01 -2.8343e-01 -3.8045e-02  1.1574e-02 ¦
     By   ¦   8.6383e-04  1.8275e-03 -3.8555e-01  2.9522e-03 ¦
     Bz   ¦  -1.3365e-01 -1.2769e-01  4.9614e-03 -2.2870e-01 ¦
     Err  ¦   3.5561e-01  3.3613e-01 -6.3830e-04 -3.9550e-01 ¦
          +                                                   +
                             Coil Offset
                         +                +
                         ¦   3.4253e+04   ¦
                         ¦   3.5362e+04   ¦
                         ¦   3.5650e+04   ¦
                         ¦   3.3749e+04   ¦
                         +                +
                             Electrical Null
                              +       +
                              ¦ 34575 ¦
                              +       +
                    TILT CALIBRATION MATRICES in NVRAM
                Calibration date and time: 4/6/2000  10:58:42
              Average Temperature During Calibration was   26.6 °C

                   Up                              Down
```

```
        +                        +    +                        +
Roll    ¦  -3.2219e-07  -1.1456e-05 ¦    ¦  4.2529e-07   1.6306e-05 ¦
Pitch   ¦  -1.1477e-05   8.4276e-08 ¦    ¦ -1.6188e-05   1.9917e-07 ¦
        +                        +    +                        +

        +                        +    +                        +
Offset  ¦   3.2400e+04   3.2470e+04 ¦    ¦  3.0128e+04   3.2002e+04 ¦
        +                        +    +                        +

                          +       +
                   Null   ¦ 33336 ¦
                          +       +
```

AD – Display Factory or Active Calibration Data

Purpose Displays factory calibration or active calibration data.

Format AD

Recommended Setting. Use as needed.

Description Displays factory calibration or active calibration data.

Example >AD

```
Display factory calibration data or active calibration data [f or a]?a

              ACTIVE FLUXGATE CALIBRATION MATRICES in FLASH
               Calibration date and time: 3/8/1996  09:53:42
                             S inverse
          |                                                  |
     Bx   |   2.9102e-01  2.6325e-01  2.1267e-02  4.0145e-01 |
     By   |   2.7342e-01  2.5335e-01 -4.8691e-02 -3.9508e-01 |
     Bz   |  -1.8192e-01  2.0180e-01  2.3319e-01 -2.7045e-02 |

     Err  |   3.9761e-01 -3.9925e-01  6.4865e-01 -6.0795e-02 |
          |                                                  |
                             Coil Offset
                         |                 |
                         |   3.5076e+04    |
                         |   3.3277e+04    |
                         |   3.2996e+04    |
                         |   3.3953e+04    |
                         |                 |
                             Electrical Null

                              |       |
                              | 33901 |
                              |       |   press any key to continue...

                    TILT CALIBRATION MATRICES in FLASH
              Calibration date and time: 12/28/1995  08:13:29
             Average Temperature During Calibration was   23.4° C

                  Up                              Down

        |                            |     |                            |

Roll    |  -2.1990e-05  -2.8379e-05 |     |   2.6648e-05   3.4953e-05 |
Pitch   |  -2.9185e-05   2.2630e-05 |     |  -3.5895e-05   2.8521e-05 |
        |                            |     |                            |

        |                            |     |                            |
Offset  |   3.1747e+04   3.0144e+04 |     |   3.0434e+04   3.2971e+04 |
        |                            |     |                            |

                             |       |

                      Null   | 33408 |
                             |       |
```

AF – Field Calibrate Compass

Purpose Calibrates the compass to remove hard and soft iron effects.

Format AF

Recommended Setting. Use as needed.

Description The built-in automated compass calibration procedures are similar to the alignment verification, but requires three rotations instead of one. The H-ADCP uses the first two rotations to compute a new calibration matrix and the third to verify the calibration. It will not accept the new matrix unless the calibration was carried out properly, and it asks you to verify that you want to use the new calibration if it is not as good as the previous calibration. While you are turning the H-ADCP for the two calibration rotations, the H-ADCP checks the quality of the previous calibration and displays the results. It compares these results with the results of the third calibration rotation.

There are two compass calibrations to choose from; one only corrects for hard iron while the other corrects for both hard and soft iron characteristics for materials rotating with the H-ADCP. Hard iron effects are related to residual magnetic fields and cause single cycle errors while soft iron effects are related to magnetic permeability that distorts the earth's magnetic field and causes double cycle errors. In general, the hard iron calibration is recommended because the effect of hard iron dominates soft iron. If a large double cycle error exists, then use the combined hard and soft iron calibration.

For details on compass alignment, see Compass Calibration.

AR – Return to Factory Calibration

Purpose Returns to the factory calibration matrix.

Format AR

Recommended Setting. Use as needed. TRDI strongly recommends sending the AR command (compass restore) before the AF (field calibrate) command. This is done to prevent corruption of the calibration matrix due to a previous incomplete compass calibration.

Description If the calibration procedure is not successful (AF-command), return your H-ADCP to the original factory calibration, by using the AR-command. Try using the AR-command if you have trouble calibrating your compass. In some circumstances, a defective compass calibration matrix can prevent proper calibration.

AX – Examine Compass Calibration

Purpose Used to verify the compass calibration.

Format AX

Recommended Setting. Use as needed.

Description Compass calibration verification is an automated built-in test that measures how well the compass is calibrated. The procedure measures compass parameters at every 5° of rotation for a full 360° rotation. When it has collected data for all required directions, the H-ADCP computes and displays the results. Pay particular attention to the Overall Error.

Example >AX

```
---------------------------------------------------------------------------
                    TRDI Compass Error Estimating Algorithm

   Press any key to start taking data after the instrument is setup.
   Rotate the unit in a plane until all data samples are acquired...
   rotate less than 5°/sec. Press Q to quit.

 N        NE        E         SE        S         SW        W         NW        N
 ^                  ^                   ^                   ^                   ^
 *************************************************************************
Accumulating data ...
Calculating compass performance ...

                          >>> Total error:   1.5° <<<

Press D for details or any other key to continue...

HEADING ERROR ESTIMATE FOR THE CURRENT COMPASS CALIBRATION:

   OVERALL ERROR:
      Peak Double + Single Cycle Error (should be < 5°):  ± 1.55°

   DETAILED ERROR SUMMARY:
      Single Cycle Error:                                ± 1.54°
      Double Cycle Error:                                ± 0.07°
      Largest Double plus Single Cycle Error:            ± 1.61°
      RMS of 3rd Order and Higher + Random Error:        ± 0.31°

      Orientation:    Down
      Average Pitch: -19.29°        Pitch Standard Dev:     0.28°
      Average Roll:   -0.59°        Roll Standard Dev:      0.31°

Successfully evaluated compass performance for the current compass calibration.
Press any key to continue...
```

AZ – Zero Pressure Sensor

Purpose Zeros the pressure sensor.

Format AZ

Recommended Setting. Use as needed.

Description This command zeros the pressure sensor at the specific location where the H-ADCP will be used.

If the pressure sensor is not installed, using the AZ command will generate the following error.

```
Err: No pressure sensor detected
```

Bottom Track Commands

The H-ADCP uses these commands for "range" to boundary applications. For example, the HADCP is swept at various tilt angles. The goal is to directly measure the x-sectional area and maximum depth in the middle of the channel.

The H-ADCP is NOT designed for moving vessel Bottom Track applications. The default setting BP0 turns off Bottom Tracking.

Available Bottom Track Commands

This section lists the most often used Bottom Track commands.

```
>b?
BA = 030 ----------------- Evaluation Amplitude Min (1-255)
BB = 0060 ---------------- High Bandwidth Maximum Depth (dm)
BC = 220 ----------------- Correlation Magnitude Min (0-255)
BE = 1000 ---------------- Max Error Velocity (mm/s)
BF = 00000 --------------- Depth Guess (0=Auto, 1-65535 = dm)
BG = 80,20,00030 --------- BM6 Shal Xmt (%), Deep Xmt (%), Deep (dm)
BH = 190,010,004,040 ----- BM6 Thresh(cnt), S Amb(cm/s), L Amb(cm/s), MinAmb
BI = 005 ----------------- Gain Switch Depth (0-999 meters)
BK = 0 ------------------- Layer Mode (0-Off Only, Disabled)
BL = 040,0060,0100 ------- Layer:  Min Size (dm), Near (dm), Far (dm)
BM = 5 ------------------- Mode (4 wo/PP, 5 w/PP)
BP = 000 ----------------- Pings per Ensemble
BR = 0 ------------------- Resolution (0 = 4%, 1 = 2%, 2 = 1%)
BS ----------------------- Clear Distance Traveled
BX = 00040 --------------- Maximum Depth (40-65535 dm)
BZ = 004 ----------------- Coherent Ambiguity Velocity (cm/s radial)
>
```

Bottom Track Command Descriptions

BA - Evaluation Amplitude Minimum

Purpose	Sets the minimum value for valid bottom detection.
Format	BA*nnn*
Range	*nnn* = 1 to 255 counts
Default	BA30

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

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

BB – High Bandwidth Maximum Depth

Purpose This command lets the user define the depth at which the H-ADCP switches between 25% and 50% bandwidth.

Format BB*nnnn*

Range *nnnn* = 0 to 9999 dm

Default B320 (300 kHz), BB160 (600 kHz)

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

Description This command lets the user define the depth at which the H-ADCP switches between 25% and 50% bandwidth. A setting of zero disables 50% bandwidth. A setting of 9999 disables 25% bandwidth.

BC - Correlation Magnitude Minimum

Purpose Sets minimum correlation magnitude for valid velocity data.

Format BC*nnn*

Range *nnn* = 0 to 255 counts

Default BC220

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

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

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

BE - Error Velocity Maximum

Purpose Sets maximum error velocity for good bottom-track data.

Format BE*nnnn*

Range *nnnn* = 0 to 9999 mm/s

Default BE1000

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

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

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

BF - Depth Guess

Purpose Sets a "best-guess" of expected bottom range for internal calculations.

Format BF*nnnnn*

Range *nnnnn* = 1 to 65535 dm (0 = automatic)

Default BF0

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

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

If improperly set, the H-ADCP may not bottom-track at all if the bottom range varies from the input range.

BI - Gain Switch Depth

Purpose Selects the maximum vertical distance from the transducer to the bottom at which the H-ADCP operates at low gain.

Format BI*nnn*

Range *nnn* = 0 to 999 meters

Default BI20 (300 kHz), BI10 (600 kHz),

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

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

BK – Water-Mass Layer Mode

Purpose Selects the ping frequency of the water-mass layer ping

Format BK*n*

Range *n* = 0

Default BK0

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

Description BK selects how often the H-ADCP performs a water-mass layer ping while bottom tracking. The number of water-mass layer pings per ensemble is dependent on the BP-command (bottom pings per ensemble) and this command setting. Use the BL-command to set the location of the water-mass layer.

Table 14: Water-Mass Reference-Layer Modes

Command	Description
BK0	Disables the water-mass layer ping.
BK1	N/A
BK2	N/A
BK3	N/A

BL - Water-Mass Layer Parameters

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

Format BL*mmm*,*nnnn*,*ffff*

Range *mmm* = Minimum Layer Size (0 to 999 decimeters) [meters x 10]
nnnn = Near Layer Boundary (0 to 9999 decimeters) [meters x 10]
ffff = Far Layer Boundary (0 to 9999 decimeters) [meters x 10]

Default BL160,320,480 (300 kHz), BL80,160,240 (600 kHz)

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

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

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

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

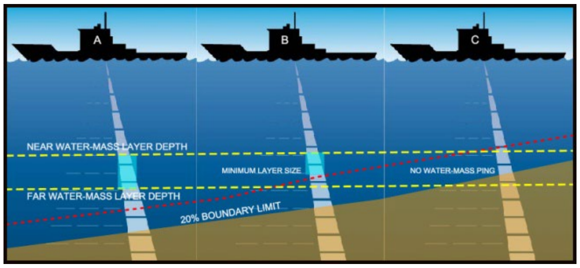


Figure 40. Water-Mass Layer Processing

BM - Bottom Track Mode

Purpose Sets the Bottom Track mode.

Format BM*n*

Range *n* = 4, 5, (see description)

Default BM5

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

Description See below

Bottom Track Mode 4

Bottom Track Mode 4 uses the correlation side-peak position to resolve velocity ambiguities. It lengthens the lag at a predetermined depth to improve variance.

Bottom Track Mode 5

Bottom Track Mode 5 is similar to Bottom Track Mode 4, but has a lower variance in shallow water by a factor of up to four. In very shallow water at slow speeds, the variance is lower by a factor of up to 100. Bottom Track Mode 5 also has a slightly slower ping rate than Bottom Track Mode 4.

Bottom Mode 5 (default setting) will shift to Bottom Mode 4 if the conditions warrant.

The H-ADCP limits searching for the bottom to the value set by the BX-command (max bottom tracking altitude) + 0.5 transmit length. This allows a faster ping rate when the bottom altitude is close to the BX-command setting.

Table 15: BM4/BM5 Minimum Tracking Depths

Frequency (kHz)	BM4/BM5 Minimum Tracking Depths (m)
300	1.5
600	1.0

BP – Bottom-Track Pings per Ensemble

Purpose Sets the number of bottom-track pings to average together in each data ensemble.

Format BP*nnn*

Range *nnn* = 0 to 999 pings

Default BP0

In firmware versions 11.06 and earlier, the default is BP1.

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

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

The H-ADCP interleaves bottom-track pings with water-track pings (see TP – Time Between Pings). If BP = zero, the H-ADCP does not collect bottom-track data. The H-ADCP automatically extends the ensemble interval (TE) if BP x TP > TE.

BR - Resolution

Purpose Sets the vertical depth resolution.

Format BRn

Range n = 0 to 2 (see description)

Default BR1

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

Description BR sets the vertical depth resolution as a percentage of the overall range detected; the lower the resolution, the finer the depth reading. With BR0 set, if you had a depth of 100 meters, then the depth would read 100 meters until you passed 104 meters. If you had BR2 set, then it would change when you reached 101 meters. Setting a higher resolution (e.g. 1%) results in longer ping times.

BR0 = 4% BR1 = 2% BR2 = 1%

Resolution Setting Limitations:

1. Minimum RSSI Bin Size – The RSSI sampling interval cannot be smaller than the minimum RSSI bin size (for example, 5 cm for a 1200 kHz system). This means that you get the resolution that you command in % or 5 cm (for the above example) - whichever is larger. The minimum RSSI bin sizes vary with system frequency according to the following table:

Frequency	Min RSSI Bin Size
300	18 cm
600	9 cm

2. BM5 Low Altitude Minimum RSSI Bin Size -- This limitation affects only Bottom Mode 5 operation below the following altitudes:

- 300 kHz -- 10 meters -- the resolution becomes 16 cm
- 600 kHz -- 5 meters -- the resolution becomes 8 cm

BS - Clear Distance Traveled

Purpose	Clears internal distance traveled accumulators.
Format	BS

Recommended Setting. Use as needed.

Description	Distance traveled is calculated and output in DVL output formats (PD5 and PD6). The accumulator is zeroed on <BREAK> or by using this command in the manual ensemble cycling mode.

BX – Maximum Tracking Depth

Purpose	Sets the maximum tracking depth in bottom-track mode.
Format	BX*nnnn*
Range	*nnnn* = 10 to 65535 decimeters (meters x 10)
Default	BX350 (300 kHz), BX150 (600 kHz)

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

Description	The BX-command sets the maximum tracking depth used by the H-ADCP during bottom tracking. This prevents the H-ADCP from searching too long and too deep for the bottom, allowing a faster ping rate when the H-ADCP loses track of the bottom. If the bottom-track water reference layer is in use (BK > 0), BX must be greater than the Far Layer Boundary (BLmmm,*nnnn*,ffff), or the H-ADCP sends Error Code 012.
Example	If you know the maximum depth in the deployment area is 20 meters (200 decimeters), set BX to a value slightly larger than 200 dm, say 210 dm, instead of the default 350 dm for a 300 kHz H-ADCP. Now if the H-ADCP loses track of the bottom, it will stop searching for the bottom at 210-dm (21 m) rather than spend time searching down to 350-dm (35 m).

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

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

BZ - Coherent Ambiguity Velocity

Purpose Sets the Bottom-Track Mode 5 ambiguity velocity.

Format BZ*nnn*

Range *nnn* = 2 to 160 cm/s radial

Default BZ4

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

Description The BZ-command selects the ambiguity velocity used by the bottom-track ping in shallow water when bottom-track Mode 5 is in use.

Control System Commands

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

Available Control System Commands

This section lists the available Control System commands.

```
>c?
CB = 611 ----------------- Serial Port Control (Baud [6=38400]; Par; Stop)
CF = 11110 --------------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CG = 0 ------------------- Swap Beams 1 & 2 (0 = Disable, 1 = Enable)
CK ----------------------- Keep Parameters as USER Defaults
CL = 1 ------------------- Sleep Enable (0 = Disable, 1 = Enable)
CM = 0 ------------------- RS-232 Sync Master (0 = OFF, 1 = ON)
CN = 1 ------------------- Save NVRAM to recorder (0 = ON, 1 = OFF)
CP = 0 ------------------- PolledMode (1=ON, 0=OFF;  BREAK resets)
CQ = 255 ----------------- Xmt Power (0=Low, 255=High)
CR # --------------------- Retrieve Parameters (0 = USER, 1 = FACTORY)
CS ----------------------- Go (Start Pinging)
CY # --------------------- Error Status Word (0=Clear, 1=Display)
CZ ----------------------- Power Down Instrument
>
```

Control System Command Descriptions

CB - Serial Port Control

Purpose Sets the RS-232/422 serial port communications parameters (Baud Rate/Parity/Stop Bits).

Format CB*nnn*

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

Default CB411

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

Description The H-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 H-ADCP responds with a ">" prompt. You may now change the external device's communication parameters to match the H-ADCP parameters before sending another command. See Changing the Baud Rate in the H-ADCPs for instructions on how to change the Baud rate using *TRDI Toolz*.

Table 16: Serial Port Control

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

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

CF - Flow Control

Purpose	Sets various H-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 H-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 recorder (if installed).

Table 17: 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 H-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 Data Recorder – Records data ensembles on the recorder (if installed).
CFxxxx0	Disable Data Recorder – No data ensembles are recorded on the recorder.
Example	CF01010 selects manual ensemble cycling, automatic ping cycling, Hex-ASCII data output, enables serial output, and disables data recording.

Not all data formats can be recorded. Carefully review the output data format before setting the CF command to set the Serial Output and if the data recorder is on or off.

CG – Swap Beams 1 & 2

Purpose: Swaps data for beams 1 & 2 when the H-ADCP is installed inverted.

Format CG*n*

Range *n* = 0 (Disable), 1 (Enable)

Default CG0

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

Description If CG is set to one, data for beams 1 & 2 are swapped (for inverted installations).

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 H-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 (see CR – Retrieve Parameters).

Always use the CK command in your configuration file (see Using Direct Commands to Deploy your H-ADCP). The H-ADCP automatically stores the last set of commands used in RAM (volatile memory). The user can store the configuration into non-volatile memory by sending a CK command. Note that the H-ADCP will restart in the previous configuration even if it was not saved with a CK command as long as the volatile memory's internal battery is not discharged. This can happen after several months without any power applied to the H-ADCP (Note that this battery will recharge as soon as power is reapplied). If the H-ADCP is stopped by removing the power while pinging, it will restart pinging and output data next time power is applied.

CL – Sleep Enable

Purpose Determines whether the H-ADCP will attempt to conserve power by sleeping between pings.

Format CL*n*

Range *n* = 0 to 1 (Sleep Between Pings (0 = No, 1 = Yes)

Default CL1

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

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

When CL is 1, while you are in command mode the system will not sleep at timeout; it will either start pinging or stay in the command mode depending upon what was happening before the soft break. The system will only sleep if CL is 1 and it is between pings while deployed (not in command mode), or if a CZ command is sent while in command mode.

CM - Master

Purpose Deprecated.

CN - Save NVRAM to Recorder

Purpose: Saves the contents of NVRAM to the recorder at the end of a deployment.

Format CN*n*

Range *n* = 0 (On), 1 (Off)

Default CN1

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

Description The CN command allows the contents of the NVRAM (approx. 8k bytes) to be written to the recorder as part of the deployment record. This can be useful for troubleshooting purposes.

CP – Polled Mode

Purpose: Allows the H-ADCP to be polled for data.

Format CP*n*

Range *n* = 0 (Off), 1 (On)

Default CP0

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

Description The CP command allows an H-ADCP to be polled for data. Setting the CP command to CP1 places the H-ADCP into a mode where it doesn't sleep. Instead, the H-ADCP stays awake between pings listening for certain commands (and drawing more power). Polled mode is only recommended for deployments where shore power can be provided. The commands the H-ADCP responds to while in polled mode are shown in Table 18.

The polled mode requires sufficient time between pings to listen for the polling commands. Setting the TP command to 1 second normally gives the H-ADCP enough time for polling (see TP – Time Between Pings).

In the polled mode (CP1), enough time must be allowed in the ensemble cycle (TE or TP commands) to allow the system to check for serial input. If both TE and TP are set to zero for the maximum ping rate, the system will not recognize any keyboard input with the exception of a <break>.

The output of the polled mode is on demand. If the H-ADCP is in the middle of an ensemble when the command arrives, it will send out the last completed ensemble, even as it continues to collect data for the current ensemble. Note that the polled mode does not output data until at least one ensemble has been completed.

Table 18: Polled Mode Commands

Command	Description
!	Execute a Break reset
+	Increment internal clock by 1 second
-	Decrement internal clock by 1 second
D	Dump the last ensemble
E	Print the current ensemble number
T	Print the current time

The commands are not echoed and they don't need to be followed by a CR/LF pair. These commands are only available when CP = 1.

Enabling polled mode disables the battery saver feature. Do not enable this mode when running from batteries.

CQ – Transmit Power

Purpose Allows the transmit power to be adjusted.

Format CQ*nnn*

Range *nnn* = 0, or 1 to 255 (0 = Low, 1 to 255 = High)

Default CQ255

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

Description Allows the transmit power to be set high or low.

This command only affects 75 kHz Long Ranger systems.

Although other frequency H-ADCPs allow the CQ command to be set to values other than the default, the CQ command has no effect and is not supported by *PlanADCP*.

CR – Retrieve Parameters

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

Format CR*n*

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

Recommended Setting. Use as needed.

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

Table 19: 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).

CR keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the H-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. Use Waves to create the command file. The CS command will be added to the end of the command file or sent by the software.

Description Use CS (or the **Tab** key) to tell the H-ADCP to start pinging its transducers and collecting data as programmed by the other commands. If the TF command is set (time of first ping), the H-ADCP waits until it reaches the TF time before beginning the data collection cycle.

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

2. If you try to record data (CFxxxx1), and the recorder is full, the H-ADCP will *not* start pinging and will return a *RECORDER NOT READY* message.

3. The ADCP will keep pinging after the recorder is full only if serial output is turned on (CFxxx1x). If the serial output is off, than the ADCP will shut down when the recorder is full, on the assumption that there is no sense in using up the battery if the data is not going anywhere.

CY - Clear Error Status Word

Purpose Clears the Error Status Word (ESW) stored in EEPROM on the CPU. The ESW is updated whenever an error occurs.

Format CY*n*

Range *n* = 0 (Clear), 1 (Display)

Format Use the CY1 command to display the ESW value or CY0 to clear the ESW.

Recommended Setting. Use as needed.

Description CY1 displays the active ESW value, which is a 32-bit value displayed in Hex ASCII.

Table 20: Error Status Word

ESW	Description
0x00000001	Bus Error Exception occurred.
0x00000002	Address Error Exception occurred.
0x00000004	Illegal Inst Exception occurred.
0x00000008	Zero Divide Exception occurred.
0x00000010	Emulator Exception occurred.
0x00000020	Unassigned Exception occurred.
0x00000040	Watchdog restart occurred.
0x00000080	Screen Save power down occurred.
0x00000100	Currently pinging.
0x00000200	Unused
0x00000400	Unused
0x00000800	Unused
0x00001000	Unused
0x00002000	Unused
0x00004000	Cold wakeup occurred.
0x00008000	Unknown wakeup occurred.
0x00010000	Clock read failure occurred.
0x00020000	Unexpected Alarm.
0x00040000	Clock jump forward.
0x00080000	Clock jump backward.
0x00100000	Unused
0x00200000	Unused
0x00400000	Unused
0x00800000	Unused
0x01000000	Unused
0x02000000	Unused
0x04000000	Unused
0x08000000	Power Fail (Unrecorded)
0x10000000	Spurious level 4 interrupt (DSP).
0x20000000	Spurious level 5 interrupt (UART).
0x40000000	Spurious level 6 interrupt (CLOCK).
0x80000000	Level 7 interrupt occurred.

In the command mode, the Error Status Word (ESW) codes can be cleared through the CY-command. In ping mode, the ESW is cleared (set to zero) between each ensemble. The values are logically OR'ed. For example, if an illegal instruction (xxx4) and a divide by zero error (xxx8) occurred since the last time the ESW was cleared, a value of "xxxC" would appear as the ESW.

ESW code 0x0000100 can only be seen if the CY-command is issued between CS-commands in the manual ping mode. This flag is used to determine if on wakeup, whether the H-ADCP was pinging or not previous to the present power up. A CS-command sets this bit; a <BREAK> resets the bit. This results in the following consequences:

a) A deployment must be ended with a <BREAK>. If the H-ADCP is pinging, and power is lost, when power is restored, the H-ADCP will continue to ping.

b) If the H-ADCP is in the command mode when power is lost, when power is restored, it will wake up in the command mode. If a timeout occurs, the H-ADCP will power down automatically.

In ping mode, the ESW is cleared (set to zero) between each ensemble. The ESW is written to the ensemble (see Variable Leader Data Format).

CZ – Power Down H-ADCP

Purpose Tells the H-ADCP to power down.

Format CZ

Recommended Setting. Use as needed.

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

Example See below

```
>cz

Powering Down
```

1. When powered down using the CZ-command, the H-ADCP still draws up to 30μa, but wakes up periodically (every 8 to 12 hours) for a few seconds to maintain RAM.

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 H-ADCP will draw up to 50 milli-amps of current. *A new battery will be discharged in a few days*.

3. Performance and testing commands (i.e. AF, PA, PT, RB, and RY) override the battery saver functions. For example, using the RY-command to recover data from the H-ADCP while on battery power will disable the automatic power saver mode. If a CZ-command is not used after all data has been recovered, the H-ADCP will remain in the command mode. TRDI recommends disconnecting the batteries and using the AC power adapter while testing or recovering data.

Environmental Commands

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

Available Environmental Commands

This section lists the available Environmental commands.

```
>e?
EA = +00000 -------------- Heading Alignment (1/100 deg)
EB = +00000 -------------- Heading Bias (1/100 deg)
EC = 1500 ---------------- Speed Of Sound (m/s)
ED = 00000 --------------- Transducer Depth (0 - 65535 dm)
EH = 00000 --------------- Heading (1/100 deg)
EP = +0000 --------------- Tilt 1 Sensor (1/100 deg)
ER = +0000 --------------- Tilt 2 Sensor (1/100 deg)
ES = 00 ------------------ Salinity (0-40 pp thousand)
ET = +2500 --------------- Temperature (1/100 deg Celsius)
EX = 11111 --------------- Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1111101 ------------- Sensor Source (C;D;H;P;R;S;T)
>
```

Environmental Command Descriptions

EA - Heading Alignment

Purpose Corrects for physical misalignment between Beam 3 and the heading reference.

Format EA±*nnnnn*

Range ±*nnnnn* = -17999 to 18000 (-179.99 to 180.00 degrees)

Default EA+00000

Recommended Setting. EA is typically set to zero (default), since Beam 3 is used as the heading reference for stationary deployment.

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

Example The H-ADCP is mounted in place on a moving ship. Beam 3 has been rotated 45 clockwise (+45) from the ship's centerline. Use the EA command to tell the H-ADCP where beam 3 is in relation to the ship's centerline. To convert +45 to an EA-command value, multiply the desired alignment angle in degrees by 100:

```
EA = +45.00 × 100 = +4500 = EA+4500
```

EB - Heading Bias

Purpose Corrects for electrical/magnetic bias between the H-ADCP heading value and the heading reference.

Format EB±*nnnnn*

Range ±*nnnnn* = -17999 to 18000 (-179.99 to 180.00 degrees)

Default EB+00000

Recommended Setting. Use EB to counteract the effects of magnetic declination at the deployment site. Set using *WavesMon*.

Description EB is the heading angle that counteracts the electrical bias or magnetic declination between the H-ADCP and the heading source. Use the EA-command to correct for physical heading misalignment between the H-ADCP and a vessel's centerline.

Examples A bottom-mounted H-ADCP is receiving heading from its internal compass. A navigation map for the deployment area shows a declination of 10°10'W 1995 (9'E/year). This means the magnetic offset in the year 2001 at this location is (- (10+10/60) + (9/60*6)) = -9.26666 degrees. Set the EB command value to EB-926.

EC - Speed of Sound

Purpose Sets the speed of sound value used for H-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 H-ADCP to scale velocity data, depth cell size, and range to the bottom. The H-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 H-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 H-ADCP transducer depth.

Format ED*nnnnn*

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

Default ED00000

Recommended Setting. Use the EZ-command.

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

Note	If the EZ *Transducer Depth* field = 1, the H-ADCP overrides the manually set ED value and uses depth from the internal pressure sensor. If a pressure sensor is not available, the H-ADCP uses the manual ED setting.

EH - Heading

Purpose	Sets the H-ADCP heading angle.
Format	EH*nnnnn*
Range	*nnnnn* = 0 to 35999 (000.00 to 359.99 degrees)
Default	EH00000

Recommended Setting. Use the EZ-command.

Description	EH sets the H-ADCP heading angle of beam 3. When mounted on a stationary platform, the H-ADCP assumes beam 3 points north (0).
Example	Convert heading values of 34 and 3.5 to EH-command values.

```
EH = 34.00 × 100 = 3400 = EH03400
EH =  3.50 × 100 =  350 = EH00350
```

If the EZ Heading field = one, the H-ADCP overrides the manually set EH value and uses heading from the transducer's internal sensor. If the sensor is not available, the H-ADCP uses the manual EH setting.

EP - Pitch (Tilt 1)

Purpose	Sets the H-ADCP pitch (tilt 1) angle.
Format	EP±*nnnn*
Range	±*nnnn* = -6000 to 6000 (-60.00 to +60.00 degrees)
Default	EP+0000

Recommended Setting. Use the EZ-command.

Description	EP sets the H-ADCP pitch (tilt 1) angle.
Example	Convert pitch values of +14 and -3.5 to EP-command values.

```
EP = 14.00 × 100 = 1400 = EP01400 (+ is understood)
EP = -3.50 × 100 = -350 = EP-00350
```

If the EZ Pitch field = 1, the H-ADCP overrides the manually set EP value and uses pitch from the transducer's internal tilt sensor. If the sensor is not available, the H-ADCP uses the manual EP setting.

ER - Roll (Tilt 2)

Purpose Sets the H-ADCP roll (tilt 2) angle.

Format ER±*nnnn*

Range ±*nnnn* = -6000 to 6000 (-60.00 to +60.00 degrees)

Default ER+0000

Recommended Setting. Use the EZ-command.

Description ER sets the H-ADCP roll (tilt 2) angle.

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

```
ER = 14.00 × 100 = 1400 = ER1400 (+ is understood)
ER = -3.50 × 100 = -350 = ER-0350
```

If the EZ Roll field = one, the H-ADCP overrides the manually set ER value and uses roll from the transducer's internal tilt sensor. If the sensor is not available, the H-ADCP uses the manual ER setting.

ES – Salinity

Purpose Sets the water's salinity value.

Format ES*nn*

Range *nn* = 0 to 40

Default ES0

Recommended Setting. Set using *WavesMon*. The default setting for this command is recommended for most applications.

Description ES sets the water's salinity value. The H-ADCP uses ES in its speed of sound calculations. The H-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* = -500 to 4000 (-5.00 C to +40.00 C)

Default ET2500

Recommended Setting. Use the EZ-command.

Description ET sets the temperature value of the water. The H-ADCP uses ET in its speed of sound calculations (see the primer). The H-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 H-ADCP overrides the manually set ET value and uses temperature from the transducer's temperature sensor. If the sensor is not available, the H-ADCP uses the manual ET setting.

EX – Coordinate Transformation

Purpose Sets the coordinate transformation processing flags.

Format EX*xxptb*

Range *xx* = Transformation
p = Pitch and Roll
t = 2 beam solutions
b = Bin mapping (not used)

Default EX11110

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 21: Coordinate Transformation Processing Flags

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

1. For ship and earth-coordinate transformations to work properly, you must set the Heading Alignment (EA) and Heading Bias (EB) correctly. You also must ensure that the tilt and heading sensors are active (EZ).

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

3. Each H-ADCP uses its own beam calibration matrix to correct data for beam pointing errors (e.g., if the beams erroneously point toward 21 degrees instead of 20 degrees). Correction is applied when the data are converted from beam coordinates to earth coordinates. If you output beam-coordinate data, you will need to apply the beam corrections yourself if you want the best possible data or use the *Waves* software.

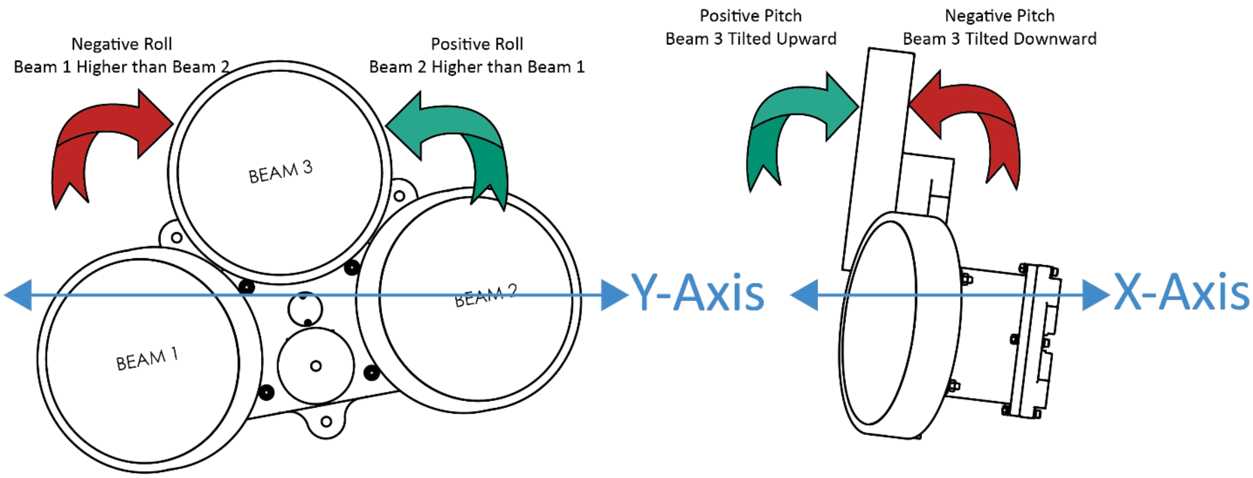


Figure 41. H-ADCP Coordinate Transformation

X – Axis - Pitch (Tilt 1) is measured around the X-axis.

Y- Axis - Roll (Tilt 2) is measured around the Y- axis.

EZ - Sensor Source

Purpose Selects the source of environmental sensor data.

Format EZ*cdhprst*

Default EZ1111101

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 H-ADCP to use data from a manual setting or from an associated sensor. When a switch value is non-zero, the H-ADCP overrides the manual E-command setting and uses data from the appropriate sensor. If no sensor is available, the H-ADCP defaults to the manual E-command setting. The following table shows how to interpret the sensor source switch settings.

Table 22: Sensor Source Switch Settings

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

Example EZ1111101 means calculate speed of sound from readings, use pressure sensor, transducer heading, internal tilt sensors, and transducer temperature.

Fault Log Commands

The H-ADCP uses the following commands to aid in troubleshooting and testing.

Available Fault Log Commands

This section lists the most often used Fault Log commands.

```
>f?
Available Commands:

FC ----------------------- Clear Fault Log
FD ----------------------- Display Fault Log
FX ----------------------- Toggle the Fault Log debug flag
F? ----------------------- Display Fault Log Commands

>
```

Fault Log Command Descriptions

FC – Clear Fault Log

Purpose Clears the fault log.

Format FC

Recommended Setting. Use as needed.

Description Use this command to clear the fault log of all previous entries.

FD – Display Fault Log

Purpose Displays the fault log.

Format FD

Recommended Setting. Use as needed.

Description Displaying the fault log will list why a built-in test failed. This may aid in troubleshooting.

Example >FD

```
Total Unique Faults   =     2
Overflow Count        =     0
Time of first fault:    97/11/05,11:01:57.70
Time of last fault:     97/11/05,11:01:57.70

Fault Log:
Entry #   0 Code=0a08h  Count=    1  Delta=    0 Time=97/11/05,11:01:57.70
 Parameter = 00000000h
  Tilt axis X over range.
Entry #   1 Code=0a16h  Count=    1  Delta=    0 Time=97/11/05,11:01:57.70
 Parameter = 00000000h
  Tilt Y axis ADC under range.
End of fault log.
```

Performance and Testing Commands

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

Available Performance and Testing Commands

This section lists the available Performance and Testing commands.

```
>p?
PA ----------------------- Pre-Deployment Tests
PC ### ------------------- Built In Tests, PC 0 = Help
PD = 00 ------------------ Data Stream Select (0-6,8,14)
PM ----------------------- Distance Measure Facility
PS # --------------------- Show Sys Parms (0=Xdcr,1=FLdr,2=VLdr,3=Mat,4=Seq)
PT ### ------------------- Built In Tests, PT 0 = Help
>
```

Performance and Testing Command Descriptions

PA – Pre-deployment Tests

Purpose Sends/displays results of a series of H-ADCP system diagnostic tests.

Format PA

Recommended Setting. Use as needed.

Description These diagnostic tests check the major H-ADCP modules and signal paths. We recommend you run this command before a deployment. These tests check the following boards/paths.

- CPU - CPU RAM and real-time clock.
- Recorder - verifies recorder operation.
- DSP - RAM, registers, and DSP-to-CPU Communications.
- System Tests - A test signal is routed through the DSP and back to the CPU. This checks the main electronics processor path.
- Receive Path - quiescent RSSI levels are checked for [20 < RSSI < 60 counts] and the RSSI filters are checked for proper time constants.
- Transmit Path - checks transmit voltage, current, and impedance.
- Sensors - verifies sensor operation.

Example see below

```
>PA
PRE-DEPLOYMENT TESTS
CPU TESTS:
  RTC......................................PASS
  RAM......................................PASS
  ROM......................................PASS
RECORDER TESTS:
  PC Card #0...............................DETECTED
    Card Detect............................PASS
    Communication..........................PASS
    DOS Structure..........................PASS
    Sector Test (short)....................PASS
  PC Card #1...............................DETECTED
    Card Detect............................PASS
    Communication..........................PASS
    DOS Structure..........................PASS
    Sector Test (short)....................PASS
DSP TESTS:
```

```
  Timing RAM...............................PASS
  Demod  RAM...............................PASS
  Demod  REG...............................PASS
  FIFOs....................................PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Receive Loop-Back........................PASS
  Wide Bandwidth...........................PASS
  Narrow Bandwidth.........................PASS
  RSSI Filter..............................PASS
  Transmit.................................PASS
SENSOR TESTS:
  H/W Operation............................PASS
```

Wide Bandwidth and Narrow Bandwidth may fail if transducer is not in water. H/W Operation test will fail if the transducer is on its side.

PC – User-Interactive Built-In Tests

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

Format PC*nnn*

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

Recommended Setting. Use as needed.

Description These diagnostic tests check beam continuity and sensor data. Both tests require user interaction (see examples).

Examples See below.

PC0 – Help Menu

Sending PC0 displays the help menu.

```
User Interactive, Built In Tests
--------------------------------
PC0 = Help
PC1 = Beam Continuity
PC2 = Sensor Data
```

PC1 – Beam Continuity

Sending PC1 tests the beam continuity by measuring the quiescent Receiver Signal Strength Indicator (RSSI) levels. There must be a change of more than 30 counts when the transducer face is rubbed.

The PC1 test is designed to measure relative noise in the environment and then have you apply more noise by rubbing the ceramics with your hand. Sometimes your hand does not generate enough noise for the system to detect. This could be due to the environment you are in or for other reasons. A simple, safe, and easy to find material that works better than rubbing with your hand is packaging material (a.k.a. bubble wrap). Using this instead of your hand will very likely provide enough relative frictional difference for the system to pass.

If it doesn't, your system still might be okay. In this case deploy the H-ADCP into a bucket or container of water (preferably at least 0.5 meters deep) and record some data using *TRDI Toolz* and the log file (**F3** key), or you can record data straight to the recorder card if your H-ADCP has one. You can than look at the data in our *WinADCP* program and make sure that the echo amplitude counts in the 1st depth cell for all beams is between 128 and 192. If they are not, contact Field Service for further troubleshooting tips.

```
BEAM CONTINUITY TEST
When prompted to do so, vigorously rub the selected
beam's face.
If a beam does not PASS the test, send any character to
the H-ADCP to automatically select the next beam.

Collecting Statistical Data...
  52  48  50  43
Rub Beam 1 = PASS
Rub Beam 2 = PASS
Rub Beam 3 = PASS
Rub Beam 4 = PASS
```

This test must be run while the H-ADCP is in air.

PC2 – Display Heading, Pitch, Roll, and Orientation

Sending PC2 displays heading, pitch angle, roll angle, up/down orientation and attitude temperature in a repeating loop at approximately 0.5-sec update rate. Press any key to exit this command and return to the command prompt.

```
Press any key to quit sensor display ...
Heading   Pitch    Roll   Up/Down    Attitude Temp   Ambient Temp  Pressure
301.01°  -7.42°  -0.73°     Down        24.35°C        22.97°C        0.0 kPa
300.87°  -7.60°  -0.95°     Down        24.36°C        22.97°C        0.0 kPa
300.95°  -7.60°  -0.99°     Down        24.37°C        22.97°C        0.0 kPa
300.71°  -7.61°  -0.96°     Down        24.37°C        22.98°C        0.0 kPa
300.69°  -7.61°  -0.96°     Down        24.35°C        22.98°C        0.0 kPa
300.76°  -7.60°  -0.98°     Down        24.38°C        22.97°C        0.0 kPa
```

The PC2 heading shows the raw (magnetic north) heading only. The EB command (Heading Bias) is not applied.

When an H-ADCP is orientated properly and horizontal, PC2 Up/Down will state it is orientated downward. If the H-ADCP is laying on its transducer faces, it will state Up.

PD - Data Stream Select

Purpose: Selects the type of ensemble output data structure.

Format: PDn

Range: n = 0 to 18 (see description)

Default: PD0

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

Description: PD selects the normal output data structure, a special application data structure, or a fixed data set for transmission/display as the data ensemble (see Table 23).

Table 23: Data Stream Selections

Format	Description
PD0	Sends The real water-current data set
PD1	Sends a TRDI-defined data set that always uses the same data (except for parts of the leader data). This data set is useful during user-software development.
PD2	Not used.
PD3	Sends Paramax-DVL ensemble output data structure.
PD4	Sends CSS-DVL output data structure (without sensor and made-good data).
PD5	Sends CSS-DVL output data structure (with sensor and made-good data).
PD6	Sends a special DVL ASCII data stream
PD7	Not used
PD8	Sends ensemble data as formatted ASCII text. A new-line character terminates each line. Two new-line characters terminate an ensemble.
PD14	Send the H-ADCP Condensed 2D Output Format
PD16	NMEA format without the leading '$'
PD18	PD18 is the same Output Data Format as PD16, but with the leading '$' necessary to fully comply with the NMEA format.

Not all data formats can be recorded. Carefully review the output data format before setting the CF command to set where data is sent and if the recorder is on or off.

All of TRDI's software supports PD0 formatted data only.

The table above gives a brief overall description of the data format output. For details on the actual data output please see Output Data Format.

PM - Distance Measurement Facility

Purpose Lets you measure distance over the bottom.

Format PM

Recommended Setting. For TRDI use only.

Description PM lets you use the H-ADCP to measure distances over the bottom using a dumb terminal.

PS – Display System Parameters

Purpose Sends/displays H-ADCP system configuration data.

Format PS*n*

Range *n* = 0, 3 (see description)

Recommended Setting. Use as needed.

Description See below.

PS0 – System Configuration

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

```
>ps0
  Instrument S/N:  0
       Frequency:  307200 HZ
   Configuration:  4 BEAM, JANUS
     Match Layer:  10
      Beam Angle:  20 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  DOWN
       Sensor(s):  HEADING  TILT 1  TILT 2  DEPTH  TEMPERATURE  PRESSURE
Pressure Sens Coefficients:
              c3 = +0.000000E+00
              c2 = +0.000000E+00
              c1 = -2.500000E-03
          Offset = +0.000000E+00

Temp Sens Offset:  -0.20 degrees C

    CPU Firmware:  16.xx
   Boot Code Ver:  Required:  1.13   Actual:  1.13
    DEMOD #1 Ver:  ad48, Type:  1f
    DEMOD #2 Ver:  ad48, Type:  1f
    PWRTIMG  Ver:  85d3, Type:   6
Board Serial Number Data:
   08  00 00 02 C9 20 A7  09 CPU727-2000-00H
   4D  00 00 00 D4 97 37  09 PIO727-3000-03C
>
```

PS3 – Instrument Transformation Matrix

PS3 sends information about the transducer beams. The H-ADCP uses this information in its coordinate-transformation calculations; for example, the output may look like this:

```
ps3
Beam Width:   3.7 degrees

Beam     Elevation     Azimuth
  1         -70.14      269.72
  2         -70.10       89.72
  3         -69.99        0.28
  4         -70.01      180.28

Beam Directional Matrix (Down):
  0.3399    0.0017    0.9405    0.2414
 -0.3405   -0.0017    0.9403    0.2410
 -0.0017   -0.3424    0.9396   -0.2411
  0.0017    0.3420    0.9398   -0.2415

Instrument Transformation Matrix (Down):    Q14:
  1.4691   -1.4705    0.0078   -0.0067       24069  -24092     127    -109
 -0.0068    0.0078   -1.4618    1.4606        -111     127  -23950   23930
  0.2663    0.2657    0.2657    0.2661        4363    4354    4353    4359
  1.0367    1.0350   -1.0359   -1.0374       16985   16957  -16972  -16996
Beam Angle Corrections Are Loaded.
>
```

If the H-ADCP needs beam angle corrections, a TRDI calibrated beam angle matrix is loaded into the instrument. This is done when the instrument is manufactured. For more details, see the H-ADCP Coordinate Transformation booklet (available for download at https://www.teledynemarine.com/support/RDI/technical-manuals).

The output may look like this for an H-ADCP.

```
Beam Width:   3.7 degrees

Instrument Transformation Matrix (Down):    Q14:
 -1.1831    1.1831    0.0000    0.0000      -19384   19384       0       0
 -0.3430   -0.3430   -0.3784    0.0000       -5619   -5619   -6199       0
  0.0000    0.0000    0.0000    0.0000           0       0       0       0
```

```
  0.7278    0.7278   -1.3192    0.0000       11924   11924  -21613       0
Beam Angle Corrections Are Loaded.
>
```

The error velocity for an H-ADCP is equal to the difference between the Y velocities of beams one and two and the Y velocity of beam three (Error = V1*E1 + V2*E2 + V3*E3).

PT - Built-In Tests

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

Format PT*nnn*

Range *nnn* = 0 to 200 (PT0 = Help menu)

Recommended Setting. Use as needed.

Description These diagnostic tests check the major H-ADCP modules and signal paths. Most of the tests give their final results in the format;

```
xxxxxxxxxx TEST RESULTS = $hhhh ... rrrr
```

Where

xxxxxxxxxx	= Module or path being tested
$hhhh	= Hexadecimal result code ($0 = PASS; see individual tests for description of bit results)
rrrr	= Overall test result (“PASS” or “FAIL”)

PT Test Results Error Codes

To find what bits are set when an error occurs, use the following tables.

Table 24: Error Code Hex to Binary Conversion

Hex Digit	Binary	Hex Digit	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

To convert error code $32CF (note: the dollar sign “$” signifies hexi-decimal), convert 32CF to binary. Error code $32CF has the following bits set: 13, 12, 9, 7, 6, 3, 2, 1, 0.

Hex Digit $	3				2				C				F			
Binary	0	0	**1**	**1**	0	0	**1**	0	**1**	**1**	0	0	**1**	**1**	**1**	**1**
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

PT0 - Help

Displays the test menu (shown below). As implied by the NOTE, adding 100 to the test number repeats the test continually until the H-ADCP receives a <BREAK>. Sending PT200 runs all tests. PT300 runs all tests continually until the H-ADCP receives a <BREAK>.

```
>PT0
Built In Tests
----------------
```

```
PT0 = Help
PT1 = NA
PT2 = Ancillary System Data
PT3 = Receive Path
PT4 = Transmit Path
PT5 = Electronics Wrap Around
PT6 = Receive Bandwidth
PT7 = RSSI Bandwidth
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT2 - Ancillary System Data

This test displays the values for ambient and attitude temperature and the contamination sensor (TRDI use only). The ambient temperature is measured on the receiver board. This sensor is imbedded in the transducer head, and is used for water temperature reading. The attitude temperature is measured on the PIO board under the compass. If one of the sensors fails, the PC2 test will show both sensors at the same value. The H-ADCP will use the attitude temperature if the ambient temperature sensor fails. A reading ≥+55° may indicate a shorted sensor, and a reading ≥-32° may indicate an open sensor.

```
>PT2
  Ambient  Temperature =    21.10 Degrees C
  Attitude Temperature =    21.39 Degrees C
  Internal Moisture    = 8D50h
```

PT3 - Receive Path

This test displays receive path characteristics. The test result is given as eight nibbles (1 nibble = 4 bits). Each nibble represents the result for a particular beam (most significant nibble = beam 1, least significant nibble = beam 8) (H-ADCPs utilize the four most significant nibbles). In this example, we only describe which bit is set for beam 2 for a given failure type. This test has three parts.

- ***Part 1*** - The H-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 H-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.
- ***Part 3*** - The H-ADCP displays the demodulator DAC values.

```
>PT3

Correlation Magnitude: Wide Bandwidth

               Lag  Bm1  Bm2  Bm3  Bm4
                 0  255  255  255  255
                 1  169  175  167  179
                 2   49   55   54   58
                 3   26   20   19    8
                 4   20   17   24   29
                 5   14   13   14   23
                 6    8    4   13    8
                 7    6    1   10    1

  High Gain RSSI:    43   41   40   42
   Low Gain RSSI:    19   19   17   18

  SIN Duty Cycle:    52   50   52   51
  COS Duty Cycle:    49   50   51   51
```

```
Receive Test Results = $0000 .... PASS
```

PT3 failure description - You can determine beam failure results ($>0, see PT Test Results Error Codes) by the individual bit settings:

Table 25: PT3 Failure

Bit #	PT3 Failure Description
0	Low Correlation – Correlation at lag 1 is <70% (130 counts).
1	High Correlation - A correlation at lag 7 or above is >63 counts.
2	High Noise Floor - Noise floor for high gain is >59.
3	Low Differential Gain – Noise floor difference between high and low gains is less than 5 dB (10 counts).

The H-ADCP should be in non-moving water during this test to get valid test results.

A functional H-ADCP may fail high correlation or high noise floor when this test is run in air due to interference. This test should be run in the deployed environment to achieve good results.

PT4 - Transmit Path

This test displays transmit path characteristics. During the test, the H-ADCP pings and measures the resulting transmit current and voltage. For example:

```
>PT4
IXMT    =      2.0 Amps rms
VXMT    =     74.0 Volts rms
   Z    =     37.6 Ohms
Transmit Test Results = $0 ... PASS
```

The H-ADCP should be in non-moving water during this test to get valid test results.

PT4 failure description - You can determine failure results ($>0 see PT Test Results Error Codes) by the individual bit settings:

Table 26: PT4 Failure

Bit #	PT4 Failure Description
0	ADC TIMEOUT ERROR - The DSP Board ADC was not ready for reading when the CPU was ready to read the ADC.
1	TRANSMIT TIMEOUT - The DSP Board never indicated completion of transmission.
2	SAMPLE TIMEOUT - The DSP Board never indicated completion of sampling.
3	LCA REGISTERS CORRUPTED - The DSP Board timing registers lost their value after pinging.
4	OVER-CURRENT SHUTDOWN
5	OVER-TEMPERATURE SHUTDOWN
6	INCORRECT TRANSDUCER IMPEDANCE - Impedance (Vxmt / Ixmt) was too high (>200Ω) or too low (<20Ω).
7	LOW TRANSMIT VOLTS AND/OR CURRENT - Transmit voltage was too low (Vxmt <10V) and/or transmit current too low (Ixmt <0.1A).

The H-ADCP should be in non-moving water during this test to get valid test results.

The test failure example shown below is what you would see for a missing or improperly attached transmit cable (see Troubleshooting a Built-In Test Failure).

```
>pt4

IXMT    =      0.0 Amps rms  [Data= 0h]
VXMT    =     19.3 Volts rms [Data=4ch]
   Z    =    999.9 Ohms
Transmit Test Results = $C0 ... FAIL
>
```

PT5 - Electronics Wrap Around

The PT5 test is not a valid test and will be removed in a future firmware release.

This test sets up the H-ADCP in a test configuration in which the test output lines from the DSP Board timing generator are routed directly to the Receiver board. The receiver then processes this signal. The test output signal sends a certain correlation pattern when processed. The ideal pattern is as follows.

```
  0   0   0   0
  0   0   0   0
  0   0   0   0
  0   0   0   0
255 255 255 255
  0   0   0   0
  0   0   0   0
255 255 255 255
  0   0   0   0
  0   0   0   0
  0   0   0   0
255 255 255 255
```

Acceptable deviations from this pattern are due to deviations in sampling bandwidth and demodulator low-pass filter bandwidth variations. For example:

```
>PT5
13  13  13  13
13  13  13  13
13  13  13  13
0   0   0   0
255 255 255 255
13  13  13  13
0   0   0   0
255 255 255 255
13  13  13  13
13  13  13  13
0   0   0   0
255 255 255 255
Electronics Test Results = $0000
```

PT6 - Receive Bandwidth

This test measure the receive bandwidth of the system. The bandwidth varies with system frequency and the WB command setting.

```
>PT6
Receive Bandwidth:
    Sample       bw     bw     bw     bw     bw
      rate   expect    Bm1    Bm2    Bm3    Bm4
       307      120     91     93     88     88 Khz
   results             PASS   PASS   PASS   PASS
```

The H-ADCP should be in non-moving water during this test to get valid test results.

Table 27: PT6 Receive Bandwidth Nominal Values

Bandwidth setting	WB command	300 kHz	600 kHz
Broad	0	79	200
Narrow	1	14	40

Beam fails if <50% or >125% of nominal value.

PT7 - RSSI Bandwidth

This test checks the RSSI filter circuits are working. Values listed are the indicated RSSI sampled at 1-ms intervals after a "listen" ping.

```
>PT7
RSSI Time Constant:

RSSI Filter Strobe 1 =   38400 Hz
  time    Bm1    Bm2    Bm3    Bm4
  msec   cnts   cnts   cnts   cnts
     1      6      6      7      8
     2     11     12     14     15
     3     15     16     19     20
     4     20     21     23     25
     5     23     24     27     28
     6     26     27     30     31
     7     28     29     32     33
     8     30     31     34     35
     9     32     33     36     37
    10     34     35     37     38
   nom     43     43     42     43

result     PASS   PASS   PASS   PASS
>
```

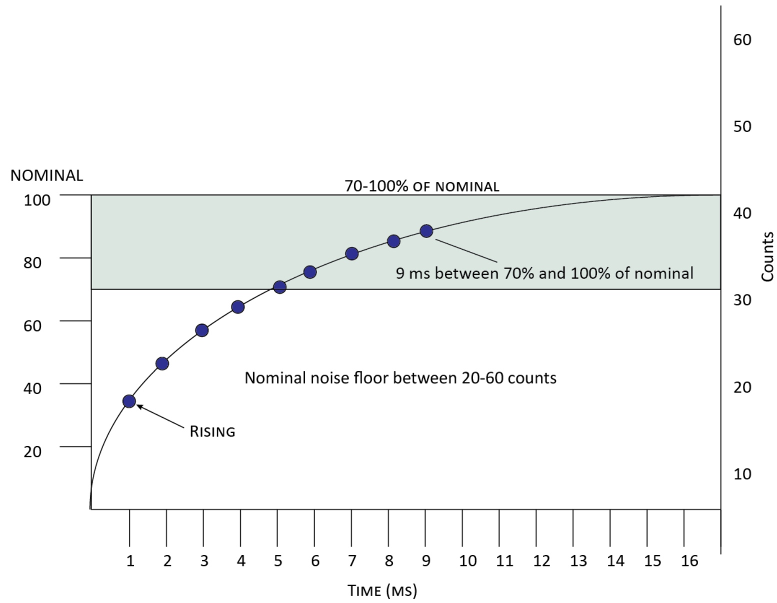


Figure 42. PT7 RSSI Bandwidth Test

Criteria for failure. Any one of the following conditions will flag failure for the beam:

- Nominal noise floor <20 or >60
- Counts for ms 1 through 4 not rising
- 9th ms sample not between 70 and 100% of nominal counts

To verify a RSSI failure, re-run the PT7 test in a different location and change the orientation 180 degrees to determine if any external interference is an issue: Even try running PT7 at a different time of day to eliminate powerful radio transmitters.

The ADCP should be in non-moving water during this test to get valid test results.

Recorder Commands

The following paragraphs list all the H-ADCP recorder commands. The recorder is set on/off using the CF command. During a deployment, if the recorder card(s) are full, the H-ADCP will stay deployed, but no more data is written to the recorder. Data will not be overwritten.

Not all data formats can be recorded. Carefully review the PD command and the output data format before setting the CF command to set the Serial Output and if the data recorder is on or off.

If the recorder card(s) are full, the H-ADCP cannot be restarted (error message = Recorder full).

Available Recorder Commands

This section lists the available Recorder commands.

```
>r?
Available Commands:

RA ----------------------- Number of Deployments Recorded
RB ----------------------- Recorder Built-In-Test
RE ----------------------- Recorder Erase
RF ----------------------- Recorder Space used/free (bytes)
RN   g , ---------------- Set Deployment Name
RR ----------------------- Recorder diRectory
RS ----------------------- Recorder Space used/free (Mb)
RY ----------------------- Upload Recorder Files to Host
R? ----------------------- Display Recorder Commands

>
```

RA - Number of Deployments

Purpose Shows the number of deployments recorded on the internal recorder.

Format RA

Recommended Setting. Use as needed.

Description RA lists the number of deployments recorded on the optional internal recorder.

RB - Recorder Built-In Test

Purpose Tests the recorder.

Format RB

Recommended Setting. Use as needed. The recorder test is included in the PA command.

Description RB tests the recorder RAM, detects the number of memory cards, checks communication, and checks recorder functions using non-destructive methods.

Example See below.

```
>rb?
RECORDER TESTS:
  PC Card #0..............................NOT DETECTED
  PC Card #1..............................DETECTED
    Card Detect...........................PASS
    Communication.........................PASS
    DOS Structure.........................PASS
    Sector Test (Short)...................PASS

Recorder tests complete.
```

RE – Erase Recorder

Purpose Erases/initializes recorder memory.

Format RE ErAsE

Description RE ErAsE erases the recorder memory. This command *is* case sensitive.

Recommended Setting. Use as needed.

Example See below.

```
>RE ErAsE
[ERASING...]
```

RF – Recorder Free Space (Bytes)

Purpose Lists the amount of used and free recorder space in bytes.

Format RF

Description RF lists the amount of recorder space used and free in bytes.

Recommended Setting. Use as needed.

Example See below

```
>RF
RF = 0,10407936 -------- REC SPACE USED (BYTES), FREE (BYTES)
```

This shows the H-ADCP contains a 10-MB recorder.

RN – Set Deployment Name

Purpose Sets the deployment name used for future deployments.

Format RN AAAAA

Default RN _RDI_

Recommended Setting. Use as needed.

Description RN sets the deployment name to be used for any future deployments. The deployment name must be exactly five characters in length, and may contain letters, numbers, or the underscore (i.e. "_") character. If no deployment name is specified, a default of "_ RDI_" is used. The deployment name is used as part of the DOS file name for data files stored on the recorder. For example, the file "_RDI_000.000" would contain data for the first deployment named "_RDI_" (the 000 in the filename indicates the first deployment). The

".000" file extension indicates that this is the first file in the deployment sequence. A ".001" extension will be used if the deployment spills over onto the second PCMCIA card in the recorder. Each PCMCIA card is set up as a separate DOS disk drive with its own DOS file structure. Deployments that are recorded completely on a single PCMCIA device will only have the ".000" file extension.

RR – Show Recorder File Directory

Purpose Lists the files on the recorder in the style of a DOS directory listing.

Format RR

Recommended Setting. Use as needed.

Description RR lists the files stored on the recorder in the form of a DOS directory listing. Each PCMCIA device is listed as a separate drive.

RS - Recorder Free Space (Megabytes)

Purpose Lists the amount of used and free recorder space in megabytes.

Format RS

Recommended Setting. Use as needed.

Description RS lists the amount of recorder space used and free in megabytes.

Example See below

```
>RS
RS = 000,010 -------- REC SPACE USED (MB), FREE (MB)
```

This shows the H-ADCP contains a 10-MB recorder.

RY – Upload Recorder Files

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

Format RY

Recommended Setting. Use as needed.

Description RY 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 binary files. This command may be used to recover deployment data without opening the pressure case of the H-ADCP unit.

Alternatively, the PCMCIA recorder cards may be removed from the unit and placed into a PCMCIA slot in any MS-DOS based computer so equipped. The data files may then be accessed in the same manner as from any other disk drive.

Do not use Windows® to erase the files on the PCMCIA card. Windows® sometimes creates hidden files, which will cause issues for the H-ADCP at the next deployment. Place the PCMCIA card in the H-ADCP and use the RE command to erase the card.

Timing Commands

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

Available Timing Commands

This section lists the available Timing commands.

```
>t?
TB = 00:00:00.00 --------- Time per Burst (hrs:min:sec.sec/100)
TC = 00000 --------------- Ensembles Per Burst (0-65535)
TE = 00:00:00.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
TF = **/**/**,**:**:** --- Time of First Ping (yr/mon/day,hour:min:sec)
TG = ****/**/**,**:**:** - Time of First Ping (CCYY/MM/DD,hh:mm:ss)
TP = 00:00.05 ------------ Time per Ping (min:sec.sec/100)
TS = 07/08/20,11:20:36 --- Time Set (yr/mon/day,hour:min:sec)
TT = 2007/08/20,11:20:36 - Time Set (CCYY/MM/DD,hh:mm:ss)
>
```

Timing Command Descriptions

TB - Time per Burst

Purpose	Sets the interval between "bursts" of pings.
Format	TB hh:mm:ss.ff
Range	hh = 00 to 23 hours mm = 00 to 59 minutes ss = 00 to 59 seconds ff = 00 to 59 hundredths of seconds

Recommended Setting. Special applications only.

Description: The TB and TC commands work together to allow the H-ADCP to sample in a "burst mode." In some applications, it is desirable for the H-ADCP to ping for a short period of time at a high ping rate ("burst"), wait for a set period of time, and then repeat the process. You also must set the time per ensemble, time between pings, and number of pings per ensemble.

Example: Deployment timing example:

```
TB 01:00:00.00   (time per burst)
TC 20            (ensembles per burst)
TE 00:00:01.00   (time per ensemble)
TP 00:00.20      (time between pings)
WP 2             (pings per ensemble)
```

The H-ADCP will average two pings (WP-command) 0.2 seconds apart (TP-command). It then sends the ensemble to the recorder or through the I/O cable. This process is repeated once a second (TE-command) for a total of twenty ensembles (TC-command). After the 20th ensemble is processed, the H-ADCP sleeps for one hour (TB-command) from the time of the first ping of the first ensemble until the second burst begins.

TC - Ensemble per Burst

Purpose	Sets the number of ensembles per burst.
Format	TC*nnnnn*
Range	0 to 65535 ensembles per burst
Default	TC0

Recommended Setting. Special applications only.

Description	Setting TC to zero disables the burst mode (i.e., TB-command inactive). See the TB-command for details on how these two commands interact.

TE – Time per Ensemble

Purpose	Sets the minimum interval between data collection cycles (data ensembles).
Format	TEhh:mm:ss.ff
Range	*hh* = 00 to 23 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TE00:00:00.00

Recommended Setting. Set using *WavesMon.*

Description	During the ensemble interval set by TE, the H-ADCP transmits the number of pings set by the WP-command. If TE = 00:00:00.00, the H-ADCP starts collecting the next ensemble immediately after processing the previous ensemble.
Example	TE01:15:30.00 tells the H-ADCP to collect data ensembles every 1 hour, 15 minutes, 30 seconds.

1. The H-ADCP automatically increases TE if (WP x TP > TE).
2. The time tag for each ensemble is the time of the first ping of that ensemble.

TF – Time of First Ping

Purpose	Sets the time the H-ADCP wakes up to start data collection.
Format	TF*yy/mm/dd, hh:mm:ss*
Range	*yy* = year 00 to 99 *mm* = month 01 to 12 *dd* = day 01 to 31 (leap years are accounted for) *hh* = hour 00 to 23 *mm* = minute 00 to 59 *ss* = second 00 to 59

Recommended Setting. Set using *WavesMon.*

Description	TF delays the start of data collection. This lets you deploy the H-ADCP in the Standby mode and have it automatically start data collection at a preset time (typically used in

battery operated instruments). When the command is given to the H-ADCP to start pinging, TF is tested for validity. If valid, the H-ADCP sets its alarm clock to TF, goes to sleep, and waits until time TF before beginning the data collection process.

Example If you want the exact time of the first ping to be on November 23, 1992 at 1:37:15 pm, you would enter TF92/11/23, 13:37:15. If you want the H-ADCP to begin pinging immediately after receiving the CS-command (see notes), do not enter a TF-command value.

1. Although you may send a TF-command to the H-ADCP, you also must send the CS-command before deploying the H-ADCP.

2. If the entry is not valid, the H-ADCP sends an error message and does not update the wake-up time.

3. Sending a <BREAK> clears the TF time.

TG – Time of First Ping (Y2k Compliant)

Purpose Sets the time the H-ADCP wakes up to start data collection.

Format TG*ccyy/mm/dd, hh:mm:ss*

Range

cc	= century	19 to 20
yy	= year	00 to 99
mm	= month	01 to 12
dd	= day	01 to 31 (leap years are accounted for)
hh	= hour	00 to 23
mm	= minute	00 to 59
ss	= second	00 to 59

Recommended Setting. Set using *WinSC*.

Description TG delays the start of data collection. This lets you deploy the H-ADCP in the Standby mode and have it automatically start data collection at a preset time (typically used in battery operated instruments). When the command is given to the H-ADCP to start pinging, TG is tested for validity. If valid, the H-ADCP sets its alarm clock to TG, goes to sleep, and waits until time TG before beginning the data collection process.

Example If you want the exact time of the first ping to be on November 23, 2000 at 1:37:15 pm, you would enter TG 2000/11/23, 13:37:15. If you want the H-ADCP to begin pinging immediately after receiving the CS-command (see notes), do not enter a TG -command value.

1. Although you may send a TG -command to the H-ADCP, you also must send the CS-command before deploying the H-ADCP.

2. If the entry is not valid, the H-ADCP sends an error message and does not update the wake-up time.

3. Sending a <BREAK> clears the TG time.

TP – Time Between Pings

Purpose	Sets the *minimum* time between pings.
Format	TP*mm:ss.ff*
Range	*mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TP00:01.00 (300 kHz), TP00:00.20 (600 kHz)

Recommended Setting. Set using *WavesMon.*

Description The H-ADCP interleaves individual pings within a group so they are evenly spread throughout the ensemble.

During the ensemble interval set by TE, the H-ADCP transmits the number of pings set by the WP-command. TP determines the spacing between the pings. If TP = 0, the H-ADCP pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs for processing. Several commands determine the actual ping time (WF, WN, WS, and actual water depth).

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

The H-ADCP automatically increases TE if (WP x TP) > TE.

Note that excessively short ping times will prevent keyboard input from being recognized.

TS – Set Real-Time Clock

Purpose	Sets the H-ADCP's internal real-time clock.
Format	TS*yy/mm/dd, hh:mm:ss*

Range

yy	= year	00 to 99
mm	= month	01 to 12
dd	= day	01 to 31
hh	= hour	00 to 23
mm	= minute	00 to 59
ss	= second	00 to 59

Recommended Setting. Set using *TRDI Toolz* or *Waves.*

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

1. When the H-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. If the entry is not valid, the H-ADCP sends an error message and does not update the real-time clock.

TT – Set Real-Time Clock (Y2k Compliant)

Purpose Sets the H-ADCP's internal real-time clock.

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

Range

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

Recommended Setting. Set using *TRDI Toolz* or *Waves.*

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

1. When the H-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. If the entry is not valid, the H-ADCP sends an error message and does not update the real-time clock.

Water Profiling Commands

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

Standard Water Profiling Commands

This section lists the most often used Water Profiling commands.

```
>w?
WD = 111 100 000 --------- Data Out (Vel;Cor;Amp  PG;St;P0  P1;P2;P3)
WF = 0175 ---------------- Blank After Transmit (cm)
WN = 030 ----------------- Number of depth cells (1-255)
WP = 00030 --------------- Pings per Ensemble (0-16384)
WS = 0800 ---------------- Depth Cell Size (cm)
WV = 185 ----------------- Mode 1 Ambiguity Vel (cm/s radial)
>expert?
Expert Mode is OFF
>experton
Expert Mode is ON
>w?
WA = 255 ----------------- False Target Threshold (Max) (0-255 counts)
WB = 1 ------------------- Bandwidth Control (0=Wid,1=Nar)
WC = 064 ----------------- Correlation Threshold
WD = 111 100 000 --------- Data Out (Vel;Cor;Amp  PG;St;P0  P1;P2;P3)
WE = 1500 ---------------- Error Velocity Threshold (0-5000 mm/s)
WF = 0175 ---------------- Blank After Transmit (cm)
WI = 0 ------------------- Clip Data Past Bottom (0=OFF,1=ON)
WJ = 1 ------------------- Rcvr Gain Select (0=Low,1=High)
WL = 000,005 ------------- Water Reference Layer:  Begin Cell (0=OFF), End Cell
WN = 030 ----------------- Number of depth cells (1-255)
WP = 00030 --------------- Pings per Ensemble (0-16384)
WQ = 0 ------------------- Sample Ambient Sound (0=OFF,1=ON)
WS = 0800 ---------------- Depth Cell Size (cm)
WT = 0000 ---------------- Transmit Length (cm) [0 = Bin Length]
WU = 0 ------------------- Ping Weighting (0=Box,1=Triangle)
WV = 185 ----------------- Mode 1 Ambiguity Vel (cm/s radial)
WW = 004 ----------------- Mode 1 Pings before Mode 4 Re-acquire
WY = 1,185 --------------- WM 1: Bandwidth (0=WB, 1=NB), Amb. Vel.(cm/s)
```

WA - False Target Threshold Maximum

Purpose	Sets a false target (fish) filter.
Format	WA*nnn*
Range	*nnn* = 0 to 255 counts (255 disables this filter)
Default	WA255

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

Description The H-ADCP uses the WA-command to screen water-track data for false targets (usually fish). WA sets the maximum difference between echo intensity readings among the four profiling beams. If the WA threshold value is exceeded, the H-ADCP rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.

A WA value of 255 turns off this feature.

WB - Bandwidth Control

Purpose Sets profiling mode 1 bandwidth (sampling rate). Narrow bandwidths allow the H-ADCP to profile farther, but the standard deviation is increased by as much as 2.5 times.

Format WB*n*

Range *n* = 0 (Wide), 1 (Narrow)

Default WB1

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

Description See table below.

Table 28: Bandwidth Control

Bandwidth	Sample rate	Data variance	Profiling range
0 = Wide (25%)	High	Low	Low
1 = Narrow (6.25%)	Low	High	High

WC - Low Correlation Threshold

Purpose Sets the minimum threshold of water-track data that must meet the correlation criteria.

Format WC*nnn*

Range *nnn* = 0 to 255 counts

Default WC64

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

Description The H-ADCP uses WC to screen water-track data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and depth cell size (WS). WC sets the threshold of the correlation below, which the H-ADCP flags the data as bad and does not average the data into the ensemble.

The default threshold for all frequencies is 64 counts. A solid target would have a correlation of 255 counts.

WD – Data Out

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

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

Example WD 111 100 000 (default) tells the H-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. If WP = zero, the H-ADCP does not collect water-profile data.
3. Spaces in the command line are allowed.
4. Status data is not used, as it does not mean anything.

WE - Error Velocity Threshold

Purpose Sets the maximum error velocity for good water-current data.

Format WE*nnnn*

Range *nnnn* = 0 to 9999 mm/s

Default WE1500

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

Description The WE-command sets a threshold value used to flag water-current data as good or bad. If the H-ADCP's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. WE screens for error velocities in both beam and transformed-coordinate data. Setting the WE command to zero (WE0) disables error velocity screening.

WF – Blank after Transmit

Purpose: Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.

Format: WF*nnnn*

Range: *nnnn* = 0 to 9999 cm

Default: WF175 (300 kHz), WF100 (600 kHz)

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

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

1. The distance to the middle of depth cell #1 is a function of blank after transmit (WF), depth 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 depth cells that cannot be screened by the H-ADCP.

WI - Clip Data Past Bottom

Purpose: Allows the H-ADCP to flag velocity data from beyond the bottom as bad.

Format: WI*n*

Range: *n* = 0 (Off), 1 (on)

Default: WI0

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

Description: When the WI-command is set to WI0 (default), the H-ADCP sends/records all velocity data readings even when the H-ADCP determines the data is beyond the bottom. WI1 tells the H-ADCP to flag data determined to be beyond the bottom as bad (data value set to -32768 [8000h]).

WJ - Receiver Gain Select

Purpose: Allows the H-ADCP to reduce receiver gain by 40 dB.

Format: WJ*n*

Range: *n* = 0 (Low), 1 (High)

Default: WJ1

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

Description: WJ0 tells the H-ADCP to reduce receiver gain by 40 dB. This may increase data reliability in shallow-water applications where there is a high content of backscatter material. WJ1 (the default) uses the normal receiver gain.

WL - Water Reference Layer

Purpose	Sets depth cell range for water-track reference layer averaging.
Format	WLsss,eee
Range	sss = Starting depth cell (0 to 128; 0 disables this feature)
	eee = Ending depth cell (1 to 128)
Default	WL0,5

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

Description You can use the WL-command to lower the effects of transducer motion on present measurements for multiple-ping ensembles (WP > 1). The H-ADCP does this by averaging the velocities of a column of water and subtracting that average from each of the depth cell velocities. The H-ADCP accumulates the resulting average velocity and depth cell velocities. At the end on an ensemble, the H-ADCP adds the average reference velocity back to the normalized depth cell velocities. This results in quieter data for depth cells in which there were few good samples.

WN – Number of Depth Cells

Purpose	Sets the number of depth cells over which the H-ADCP collects data.
Format	WN*nnn*
Range	*nnn* = 1 to 255 depth cells
Default	WN30

Recommended Setting. Set using *WavesMon*.

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

WP – Pings per Ensemble

Purpose	Sets the number of pings to average in each data ensemble.
Format	WP*nnnnn*
Range	*nnnnn* = 0 to 16384 pings
Default	WP30

Recommended Setting. Set using *WavesMon*.

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

1. If WP = zero the H-ADCP does not collect water-profile data.
2. The H-ADCP automatically extends the ensemble interval (TE) if WP x TP > TE.

WQ - Sample Ambient Sound

Purpose Samples ambient sound.

Format WQ*n*

Range *n* = 0 (Off), 1 (On)

Default WQ0

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

Description When WQ is set to 1, the H-ADCP samples RSSI before the water ping. WQ uses an 8-meter blank and 8-meter depth cell before sending water-profiling pings.

WS – Depth Cell Size

Purpose Selects the volume of water for one measurement cell.

Format WS*nnnn*

Range See below

Default See below

	300kHz	600kHz
Range	20 to 1600 cm	10 to 800 cm
Default	WS800	WS400

Recommended Setting. Set using *WavesMon*.

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

If you set WS to a value less than its minimum value or greater than its maximum value, the H-ADCP will accept the entry, but uses the appropriate minimum or maximum value. For example, if you enter WS0001 for a 300kHz system, the H-ADCP uses a value of 20 cm for WS. Similarly, if you enter WS8000, the H-ADCP uses a value of 1600 cm for WS.

WT - Transmit Length

Purpose Selects a transmit length different from the depth cell length (cell sampling interval) as set by the WS-command.

Format WT*nnnn*

Range *nnnn* = 0 to 3200 cm

Default WT0

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

Description When WT is set to zero, the transmit signal is set to the depth cell size (WS-command). This is the default setting. Setting WT allows selection of a transmit length different then the area depth cell size (sampling length).

WU - Ping Weight

Purpose: Selects the weight of each ping in an ensemble.

Format: WU*n*

Range: *n* = 0 (Box weighting), 1 (Triangle weighting)

Default: WU0

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

Description: The WU command allows the user to choose the ensemble weighting method. WU0 selects Box weighting which is a simple average of the velocities in each ensemble. WU1 selects Triangle weighting, where the first and last velocities are weighted the least, and the middle velocity is weighted the most.

Example: For an ensemble of 5 pings, the weights would appear as below.

Table 29: Ping Weights

	Ping 1	Ping 2	Ping 3	Ping 4	Ping 5
WU0	1	1	1	1	1
WU1	1/3	2/3	1	2/3	1/3

The velocity reported for each ensemble is calculated as the sum of the weighted velocities divided by the sum of the weights.

The WL command (Water reference layer) must be turned on when triangle weighting is used (WU1).

WV – Ambiguity Velocity

Purpose: Sets the radial ambiguity velocity.

Format: WV*nnn*

Range: *nnn* = 2 to 700 cm/s

Default: WV185

Recommended Setting. It is strongly recommended that the WV command be left at its' default value of 185.

Description: Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur. Rule of thumb: Set WV to the maximum relative horizontal velocity between water-current speed and H-ADCP speed.

The WV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam when operating in water mode 1 (default mode). WV is used to improve the single-ping standard deviation. The lower the value of the WV command, the lower the single-ping standard deviation.

Set the WV command based on the maximum apparent velocity (ADCP motion plus water speed). The following formula is used to determine the setting of the WV command: WV = (Max. Apparent Vel. cm/s) * sin(beam angle) * 1.5

Note that the minimum setting of the WV command is WV002 and the maximum setting due to internal processing limitations is limited based on the setting of the bandwidth command, WB.

WV is limited to 330 cm/s in Narrow bandwidth mode (WB1), which increases the profiling range by 10% compared to Broad bandwidth mode (WB0).

When the WB command is set to WB0, the max value is WV700.

In either case, while you can set a value as low as 2 cm/s, this will likely cause ambiguity errors. TRDI recommends setting WV to ≥ 100cm/s for most applications.

The 1.5 value is a safety factor.

Table 30: WV-command Maximum Setting (20 Degree)

WB Command	Bandwidth	WV (max cm/s)	Apparent Velocity (max cm/s)
0	25%	700	1,705
1	12%	330	804

WW – Mode 1 Pings before Mode 4 Re-Acquire

Purpose Sets the number of Mode 1 pings sent before a Mode 4 ping is attempted.

Format WW*nnn*

Range *nnn* = 0 to 999 pings

Default WW4

Recommended Setting. Leave this command at the default setting.

Description WW is the number of Mode 1 pings generated by the H-ADCP before a Mode 4 ping is tried. The H-ADCP uses this value when Mode 4 is in use and the bottom is lost. If WW=0, the H-ADCP continually tries to generate Mode 4 pings.

For H-ADCP systems, the profiling mode is set to Mode 1 and can not be changed to Mode 4.

WY – Mode 1 Bandwidth

Purpose Sets the profiling Mode 1 bandwidth (sampling rate) and the radial ambiguity velocity.

Format WY*b,aaa*

Range *b* = 0 (Wide), 1 (Narrow)
aaa = 2 to 700 cm/s (330 cm/s in Narrow mode)

Default WY1,185

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

Description The WY command sets the WB and WV commands using one command. For more information, see WB - Bandwidth Control and WV – Ambiguity Velocity.

Example Setting the WY command to WY0,175 will set the WB command to WB0 and the WV command to WV175.

Advanced Commands

The following sections describe the advanced commands available for the H-ADCPs.

Sound Velocity Smart Sensor Commands

The H-ADCP uses these commands for Sound Velocity Smart Sensor (SVSS) applications.

Available Sound Velocity Smart Sensor Command

```
>d?
Available Commands:

DW  0 -------------------- Current ID on RS-485 Bus
DB 411 ------------------- RS-485 Port Control (Baud; N/U; N/U)
DX ----------------------- Set SVSS to RAW Mode
DY ----------------------- Set SVSS to REAL Mode
DZ ----------------------- Get Single SCAN from SVSS
DS 20081 0 ---------------- Load SpeedOfSound with SVSS Sample (BITResult)
D? ----------------------- Display SVSS Commands

>
```

Sound Velocity Smart Sensor Descriptions

DB - RS-485 Port Control

Purpose Change the communication parameters of the RS-485 bus.

Format DBxyz

Range x = 0 to 7 Baud Rate, see CB - Serial Port Control.
y =l to 5 Unused
z =l to 2 Unused

Default DB411

Recommended Setting. Use as needed.

Description This command changes the communication parameters of the RS-485 bus. Currently only the Baud Rate is changed, but all parameters are still required.

If the DB command is not set to the same baud rate as the CB command, than the Master/Slave triggering is not reliable. When changing the DB command, confirm the change by immediately following the DB change with a CK command (see CK command).

The DB command is not affected by the CR command once the CK command has been sent (see CR – Retrieve Parameters).

DS - Load SpeedOfSound with SVSS Sample (BIT Result)

Purpose Load the SpeedOfSound variable with a single real scan from the SVSS.

Format DS

Recommended Setting. Use as needed.

Description This command loads the SpeedOfSound variable with a measured value from the SVSS, in a manner similar to the manner the variable is loaded during deployment. The EZ command must be issued prior to this command or the function will be bypassed. Set the EZ command to EZ3xxxxxx. The three enables communication with the SVSS. Upon successful completion of the function call, the SpeedOfSound variable will contain the new value. Any errors in the function will result in the BIT Result (Table 37) = xxxxxlxx xxxxxxxx which is displayed after the value.

DW - Current ID on RS-485 Bus

Purpose Change the device ID sent out before attempting to communicate.

Format DWx

Range x = 0 to 31

Default DW0

Recommended Setting. Use as needed.

Description This command sets the RS-485 Bus ID and sends the ID out onto the bus with the parity forced high. This wakes up the slave device for communications.

DX - Set SVSS to RAW Mode

Purpose Set the SVSS to Raw mode.

Format DX

Recommended Setting. Use as needed.

Description This command sends "RA" out on the RS-485 bus. If the SVSS is listening, it will change its data output mode to RAW. RAW data is columnar un-calibrated counts.

DY - Set SVSS to REAL Mode

Purpose Set the SVSS to Real mode.

Format DY

Recommended Setting. Use as needed.

Description This command sends “RE” out on the RS-485 bus. If the SVSS is listening, it will change its data output mode to REAL. REAL data is in units of m/s and the form XXXX.XX

DZ - Get Single SCAN from SVSS

Purpose This command gets a single scan of data from the SVSS.

Format DZ

Recommended Setting. Use as needed.

Description This command sends “s” out on the RS-485 bus. If the SVSS is listening, it will respond (-23ms later) with one scan of data. The data format will be determined by the last format command (“DX” or “DY”) sent to the SVSS. The data will be echoed back by the H-ADCP.

Waves Commands

Waves is a feature upgrade for 300 kHz NB H-ADCPs (see Feature Upgrades).

For information on how to use the Waves commands, see the Waves User's Guide.

Available Waves Commands

```
>h?
Available Commands:

HA 255 ------------------- Waves False Target Threshold (Fish Rejection)
HB 05 -------------------- Number of Automatically Choosen Bins (20 Max)
HD 111000000 ------------- Waves Selected Data (Vel;Pres;Surf HPR;; ;;)
HF 00000 ----------------- Waves Flow Ctrl (Res;Res;Res;Ser;Rec)
HP 0000 ------------------ Number of Pings per Record
HR 01:00:00.00 ----------- Time between Wave Bursts (hh:mm:ss.ff)
HS 001,010,021,022,023 --- Bins selected for Directional wave data recording
HT 00:00:00.50 ----------- Time between Wave Pings  (hh:mm:ss.ff)
HV 001,010,021,022,023 --- Bins selected for Velocity Spectrum data recording
H? ----------------------- Display Waves Menu Help

>
```

Waves Command Descriptions

HA – Waves False Target Threshold

Purpose Sets a false target (fish) filter.

Format HA*nnn*

Range *nnn* = 0 to 255 counts (255 disables this filter)

Default HA255

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

Description The H-ADCP uses the HA-command to screen water-track data for false targets (usually fish). HA sets the maximum difference between echo intensity readings among the four profiling beams. If the HA threshold value is exceeded, the H-ADCP rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.

HB – Automatically Chosen Bins for Wave Processing

Purpose Set the number of automatically chosen bins for doing Directional Wave Spectra.

Format HB*n*

Range *n* = 1 to 20 bins (*n* = 0 disables auto-bin selection)

Default HB5

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

Description Bins are selected consecutively starting below the "contaminated area." If more than three bins are selected, and there are sufficient bins in the column, a mid column beam will be selected. If more than four bins are selected, and there are sufficient bins in the column, the first bin will be selected.

HD – Waves Data Out

Purpose Select the data output in the Waves Packet Structure.

Format HD *abc def ghi*

Range *abc def ghi* can be 1 (On) or 0 (Off).

Default HD 111 000 000

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

Description This command selects which data will be output in the waves packet data.
a – Velocity
b – Pressure
c – Surface Track
d – Heading, Pitch, and Roll
e-i – Reserved

HF – Waves Flow Control

Purpose Sets various H-ADCP waves data flow-control parameters.

Format HF*nnnnn*

Range Firmware switches (Res;Res;Res;Ser;Rec) see Table 31

Default HF00000

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

Description The HF command is similar to the CF command (see CF - Flow Control). When the HF command is HF22222 (default), it uses the same settings as the CF command. The HF and CF commands control if the data goes to the recorder and/or to the serial port. This allows you to output Waves data (packets) independently from the standard water current profiles.

Table 31: Waves Flow Control

Command	Description
HFxxx22	Use the same settings as the CF command (default)
HFxxx1x	Enable Serial Output – Sends the currents and waves data ensemble out the RS-232/422 serial interface.
HFxxx0x	Disable Serial Output – No waves ensemble data are sent out the RS-232/422 interface.
HFxxxx1	Enable Data Recorder – Records waves data ensembles on the recorder (if installed).
HFxxxx0	Disable Data Recorder – No waves data ensembles are recorded on the recorder.

The default HF22222 will be displayed as HF00000 when a "HF?" command is run.

HP – Waves Pings per Wave Record

Purpose Set the number of pings per wave record.

Format HP*n*

Range *n* = 0 to 8400

Default HP0

Recommended Setting. Set using *WavesMon*.

Description The command sets the number of pings collected per wave record (or burst). With this value set to zero, Waves data collection is disabled.

HR – Time Between Wave Records

Purpose Set the maximum interval between the start of each wave record.

Format HR *hh:mm:ss.xx*
hh – hours
mm – minutes
ss – seconds
xx – hundredths of seconds

Range 00:00:00.00 – 23:59:59.99

Default HR01:00:00.00

Recommended Setting. Set using *WavesMon*.

Description This command sets the maximum interval between the start of consecutive wave records. If the number of pings per record * the time between pings is greater than the time between wave records, then the previous wave record will complete before starting the next one.

HS – Bins for Directional Wave Spectrum

Purpose	Set the list of bins to use for directional wave spectrum data if the H-ADCP is not selecting bins automatically.
Format	HS n1,n2...n20(Max)
Range	n? = 1 - # of Water Profiling Bins (WN).
Default	HS1, 10, 21, 22, 23

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

Description	This command sets the bins to be used for directional wave spectrum processing if automatic bin selection is off. The list can contain a maximum of 20 bins. The limit of each element in the list is set by the number of current profiling bins being collected. This list is completely separate from the Velocity Spectrum bin list, to allow the selection of different bins for Directional Wave and Velocity Spectrum processing.
Example	If automatic bin selection is turned off (HB = 0), and the H-ADCP is collecting 50 bins of current profiling data, the highest single element in the list n1-n20 is limited to 50.

HT – Time Between Wave Record Pings

Purpose	Set the maximum interval between each wave ping.
Format	HT *hh*:*mm*:*ss*.*xx* *hh* – hours *mm* – minutes *ss* – seconds *xx* – hundredths of seconds
Range	00:00:00.00 – 23:59:59.99
Default	HT00:00:00.50

Recommended Setting. Set using *WavesMon*.

Description	This command sets the maximum interval between consecutive wave pings. If the number of pings per record * the time between pings is greater than the time between wave records, then the previous wave record will complete before starting the next one.

HV – Bins for Velocity Spectrum

Purpose	Set the list of bins to use for velocity spectrum data if the H-ADCP is not selecting bins automatically.
Format	HV n1,n2...n20(Max)
Range	n? = 1 - # of Water Profiling Bins (WN).
Default	HV1, 10, 21, 22, 23

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

Description	This command sets the bins to be used for velocity spectrum processing if automatic bin selection is off. The list can contain a maximum of 20 bins. The limit of each element in the list is set by the number of current profiling bins being collected. This list is complete separate from the Directional Wave Spectrum bin list, to allow the selection of different bins for Directional Wave and Velocity Spectrum processing.
Example	If automatic bin selection is turned off (HB = 0), and the H-ADCP is collecting 50 bins of current profiling data, the highest single element in the list n1-n20 is limited to 50.

Ping Synchronization Commands

The Teledyne RD Instruments Sleepy Sensor Synchronization (TRDS3) protocol allows an H-ADCP to synchronize measurements with another H-ADCP or any other instrument that adheres to the RDS3 specification.

Available Ping Synchronization Commands

```
>s?
SA = 001 ----------------- Synch Before/After Ping/Ensemble Bottom/Water/Both
SB = 1 ------------------- Enable Channel B Breaks (1=YES,0=NO)
SI = 00000 --------------- Synch Interval (0-65535)
SM = 0 ------------------- Mode Select (0=OFF,1=MASTER,2=SLAVE,3=NEMO)
SS = 0 ------------------- RDS3 Sleep Mode (0=No Sleep)
ST = 00000 --------------- Slave Timeout (seconds,0=indefinite)
SW = 00000 --------------- Synch Delay (1/10 msec)
>
```

To see the S commands as listed above, the Experton command must be used (see Expert Mode).

Ping Synchronization Command Descriptions

SA - Synchronize Before/After Ping/Ensemble

Purpose Sets the rough timing of the synchronization pulse.

Format SA*xyz*

Range *x* = 0, 1
y = 0, 1
z = 0, 1, 2

Default SA001

Recommended Setting. Special applications only.

This command has no effect unless SM = 1 or 2.

Description Use the SA command to set the rough timing of the synchronization pulse. The first parameter determines whether the Master (or Slave) will send (or wait for) a synchronization pulse before or after the conditions set in parameters y and z. If the second parameter is set to Ping, the third parameter determines what kind of ping to synchronize on. If parameter y is set to Ensemble, the third parameter is ignored (but must still be entered).

Table 32: Synchronization Parameters

Parameter	Description
SA000	Send (wait for) pulse before a bottom ping.
SA001	Send (wait for) pulse before a water ping.
SA002	Send (wait for) pulse before both pings
SA100	Send (wait for) pulse after a bottom ping.
SA101	Send (wait for) pulse after a water ping.
SA102	Send (wait for) pulse after both pings.
SA01X	Send (wait for) pulse before ensemble.
SA11X	Send (wait for) pulse after ensemble.

SB – Enable Channel B Breaks

Purpose Allows the H-ADCP to ignore a <Break> on the Channel B RS-422 lines.

Format SB*n*

Range *x* = 0 (disable hardware-break detection on Channel B)
x = 1 (enable hardware-break detection on Channel B)

Default SB1

Recommended Setting. Special applications only.

Description Set SB0 to prevent noise from being processed as a <Break> on the RS-422 lines. This command is used when another system is connected to the H-ADCP over the RS-422 lines. In this configuration, disconnecting or connecting the other system can cause the H-ADCP to interpret this as a <Break> over Channel B. A break will cause the H-ADCP to stop pinging and the deployment will be interrupted.

To set the SB command to SB0, do the following:

1. Send SB0.
2. Immediately following the SB0 command, send a Break (see Break).
3. The SB0 command is now in effect and the H-ADCP will ignore potential <Breaks> on the Channel B RS-422 lines.

Use SB0 only when the H-ADCP does not conserve power (i.e. go to sleep) between samples (see CL – Sleep Enable and SS - RDS3 Sleep Mode).

When changing the SB command, confirm the change by immediately following the SB change with a BREAK (see Break).

The SB command must be set to SB0 to use the Master/Slave setup.

The SB command is not affected by the CR command (see CR – Retrieve Parameters)

This command is available in firmware versions 11.08 and higher.

SI - Synchronization Interval

Purpose Sets how many pings/ensembles to wait before sending the next synchronization pulse.

Format SI*nnnnn*

Range *nnnnn* = 0 to 65535

Default SI0

Recommended Setting. Special applications only.

This command has no effect unless SM = 1

Description Use the SI command to set how many pings/ensembles (depending on the SA command) to wait before sending the next synchronization pulse.

SM - RDS3 Mode Select

Purpose	Sets the RDS3 Mode.
Format	SM*n*
Range	*n* = 0 (Off), 1 (RDS3 Master), 2 (RDS3 Slave), 3 (NEMO)
Default	SM0

Recommended Setting. Special applications only.

Description SM sets the RDS3 Mode. SM0 turns off the RDS3 mode and disables all other commands on this menu. SM1 sets the RDS3 Master mode and enables the SA, SI, SS, and SW commands. SM2 sets the RDS3 Slave mode and enables the SA, SS, and ST commands. SM3 sets the NEMO Mode and enables the SW command.

When the SM command is used, the communication switch on the H-ADCP's PIO board must be in the RS232 position.

SS - RDS3 Sleep Mode

Purpose	Sets the RDS3 Sleep Mode.
Format	SS*x*
Range	*x* = 0, 1 (0 = No Sleep, 1 = Sleep)
Default	SS0

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

This command has no effect unless SM = 1 or 2

Description This command sets the RDS3 Sleep Mode. When x is set to No Sleep, the instrument remains awake while waiting for the next ping time (or synchronization pulse) in a loop. When x is set to Sleep, the instrument sleeps between pings (or synchronization pulses.) There are limitations to using the Sleep Mode. A TRDI WH, setup as a slave, can only synchronize to within 2.5 ms of the Master. When the Slave is in No Sleep Mode, the slave can ping to within 500 microseconds of the master. The benefits of power saving cost are synchronization accuracy.

Table 33: Sleep Mode Parameters

Parameter	Description
SS0	Wait between pings (synchronization pulses) in a loop.
SS1	Wait between pings (synchronization pulses) in a sleep state.

ST - Slave Timeout

Purpose Sets the amount of time a slave will wait to hear a synch pulse before proceeding on its own.

Format ST*n*

Range *n* = 0 to 10800 seconds

Default ST0

Recommended Setting. Special applications only.

This command has no effect unless SM = 2

Description ST sets the amount of time a slave will wait to hear a synch pulse before proceeding on its own. If a slave times out, it will automatically ping according to the CF, TP, TE, WP, and BP command settings. This is a fail-safe mechanism designed to allow the slave to proceed on its own should communications with the master H-ADCP fail. Setting ST = 0 tells the slave to wait indefinitely.

SW - Synchronization Delay

Purpose Sets the amount of time to wait after sending the pulse.

Format SW*n*

Range *n* = 0 to 65535 (units of 0.1 milliseconds)

Default SW00075

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

This command has no effect unless SM = 1 or 3

Description Use the SW command to set the amount of time to wait after sending the pulse before proceeding. For example, setting the SW command to SW20000 will add a delay of 2 seconds. This allows precise timing of measurements.

When a Master attempts to ping a slave H-ADCP, it sends out a pulse to the slave H-ADCP. The slave H-ADCP has a different code path than the Master H-ADCP and thus, they will take different amounts of time to start the ping. By adding in the default Master Delay of 7.5 ms, the code paths are evened up to allow the units to start the pings at about the same time (typically within 100 microseconds of each other).

Example Master/Slave Setup

To set the Master/Slave:

1. Connect the master and slave ADCPs to two PC comports via a master/slave cable.
2. Apply power to the ADCPs.
3. Establish RS-232 communications between *TRDI Toolz* and the master and slave ADCPs.
4. Set both the master and slave ADCP to the same baud rate (see Note 1).
5. Send a BREAK to the master ADCP.
6. Verify that the master ADCP outputs the RS-232 banner (see Note 2).
7. Send a CR1 and CK command to the master ADCP.
8. Send a BREAK to the slave ADCP.
9. Verify that the slave ADCP outputs the RS-232 banner.
10. Send a CR1 and CK to the slave ADCP.
11. Send the configuration commands to the master ADCP, omitting the CS command to start sampling.
12. Send the configuration commands to the slave ADCP including the CS command to start sampling.
13. Now send the CS command to the master ADCP.

    The master samples, and triggers the slave, which samples. This continues until the power is not available, or the user or some other force intervenes.

To terminate data collection:

1. Send a BREAK to the master ADCP (see note 2).
2. Verify that the master ADCP outputs the RS-232 banner (see note 2).
3. Send a CZ command to the master ADCP.
4. Send a BREAK to the slave ADCP.
5. Verify that the slave ADCP outputs the RS-232 banner (see note 2).
6. Send the CZ command to the slave ADCP.

1. The master and slave ADCP must use the same baud rate. Baud rate options depend on whether the master and slave ADCP are allowed to go to low power mode between samples. When the master and slave cannot go to low power mode between samples, the user can select all baud rates less than 115200 (i.e. one can use 1200, 2400, 4800, 9600, 19200, 38400, or 57600 baud).

When the master and slave ADCP can go to low power mode between samples, the user can select 1200, 2400, 4800, or 9600 baud.

2. The master slave cable connects the units via an RS-485 bus so the master ADCP can trigger the slave ADCP to sample. The RS-485 bus can alternately be used for RS-422 communications. However, during initialization, when the master ADCP receives a BREAK and outputs the wakeup banner, it also may cause the slave ADCP to output an incomplete banner. When this occurs, send additional BREAKs to the master ADCP until the slave ADCP outputs a full RS-422 banner.

Example Wakeup Banners

RS232 Banner

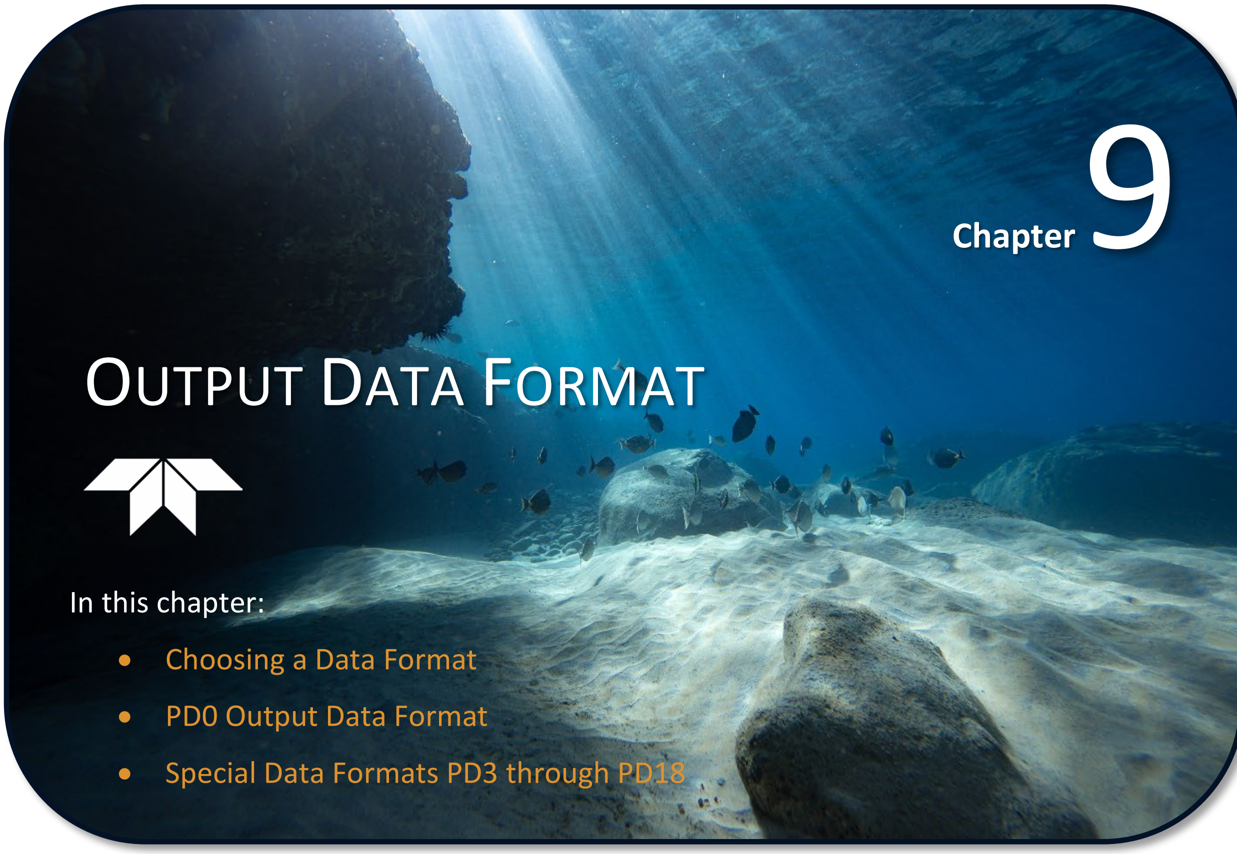
```
[BREAK Wakeup A]
WorkHorse Broadband H-ADCP Version 11.08
Teledyne RD Instruments (c) 1996-2007
All Rights Reserved.
>
```

RS422 Banner

```
[BREAK Wakeup B]
WorkHorse Broadband H-ADCP Version 11.08
Teledyne RD Instruments (c) 1996-2007
All Rights Reserved.
>
```

Incomplete Banner

```
[BR
```



Chapter 9

OUTPUT DATA FORMAT

In this chapter:

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

Choosing a Data Format

The H-ADCP can output data in several user selectable formats using the PD command (see PD - Data Stream Select). Depending on the output format selected, data will be either binary or ASCII text.

Binary Output Data Format

Use the binary format (CFxx1xx) when recording/processing H-ADCP data on an external device. The binary format uses less storage space and has a faster transmission time than the Hex ASCII format. A dumb terminal is of little use in binary format because the terminal interprets some of the data as control characters.

All of TRDI's software supports binary PD0 formatted data only.

Hexadecimal-ASCII Output Data

Use the hexadecimal-ASCII (Hex ASCII) format (CFxx2xx) when you are viewing raw H-ADCP data on a computer/dumb terminal. This format uses the standard ASCII codes for 0 through F to represent numeric values as hexadecimal digits. Other standard ASCII characters (text) and control commands (carriage return, line feed, end of file, etc.) are interpreted normally. In the Hex ASCII mode, the ADCP sends data in one line of ASCII characters. There are no carriage returns and/or line feed sequences (CR/LF) sent from the ADCP. The CRT provides a CR/LF after 60 characters.

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

Individual parameters within a data string may be enabled / disabled. All binary output formats have the option of outputting data in HEX-ASCII instead of true binary using the CF command (see CF - Flow Control). HEX-ASCII is an ASCII representation of the binary data. Binary output formats include PD0, 3, 4, 5 and 10. Text output formats include PD6, 8, and 9.

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

- **PD0** – PD0 is Teledyne RD Instrument's standard format. PD0 is a binary output format. It provides the most information possible including a header, fixed and variable leader, bottom track, and water profile information. The fixed and variable leader is a recording of time, H-ADCP setup, orientation, heading, pitch, roll, temperature, pressure, and self-test diagnostic results. Data fields to be output are user selectable.
- **PD3** – PD3 is a binary output format of bottom track speed over the bottom, speed through the water, and range to bottom information.
- **PD4** – PD4 is a binary output format of bottom track speed over the bottom, speed through the water, and range to bottom information.
- **PD5** – PD5 is a superset of PD4 and includes information on salinity, depth, pitch, roll, heading, and distance made good.
- **PD6** – PD6 is a text output format. Data is grouped into separate sentences containing system attitude data, timing and scaling, and speed through the water relative to the instrument, vehicle, and earth. Each sentence contains a unique starting delimiter and comma delimited fields.

- **PD8** – PD8 outputs ensemble data as formatted text. A new-line character terminates each line. Two new-line characters terminate an ensemble. PD8 data is only for serial output; the H-ADCP will output PD8 ASCII data out the serial port and record PD0 data to the recorder card (if enabled).
- **PD14 –** is the standard output used with WorkHorse H-ADCPs.

Special Application Output Formats

- **PD16** and **PD18** – are for use with Sea-Bird acoustic modems.

The following table is a summary of the type of data outputted by PD0 through PD14 data output formats. Note that this is not an exhaustive list and it is advised to check out the full description of a format before choosing it above another.

Table 34: Summary of Output Data Formats

	PD0	PD3	PD4	PD5	PD6	PD8	PD14	PD16	PD18
System Info	☑		☑	☑					
Temperature	☑	☑	☑	☑	☑	☑	☑		
Depth	☑			☑	☑		☑		
Tilts (H,P,R)	☑	☑		☑	☑	☑	☑		
Time of Ping	☑	☑	☑	☑	☑	☑	☑	☑	☑
Speed of Sound	☑		☑	☑	☑	☑			
Water Profile Configuration	☑								
Water Profile Velocities	☑					☑			
Correlation Magnitude	☑					☑			
Echo Intensity	☑					☑			
Percent Good	☑								
Bottom Range	☑	☑	☑	☑	☑		☑		
Bottom Velocity (SOG*)	☑	☑	☑	☑	☑		☑		
Water-Mass Layer Velocity (STW*)	☑	☑	☑	☑	☑		☑		
Bottom Track Configuration	☑								
Distance Over Ground				☑					
Sea-Bird								☑	☑
Binary	☑	☑	☑	☑			☑		
ASCII					☑	☑		☑	
NMEA									☑
Serial Output	☑	☑	☑	☑	☑	☑	☑	☑	☑
Recorded on PC Card	PD0	None	PD4	PD5	None	PD0	PD14	PD0	PD0

*SOG = Speed Over Ground
*STW = Speed Through Water

PD0 Output Data Format

The following description is for the standard PD0 H-ADCP output data format. Figure 44 through Figure 51 shows the ASCII and binary data formats for the H-ADCP PD0 mode. Table 35 through Table 45 defines each field in the output data structure.

The binary output data formats are composed of at least one data type, i.e. a group of bytes all related by their dynamic or field. For instance in the PD0 data format, variables that do not change during the deployment are stored in the Fixed Leader data type of leader ID 0000h, whereas the dynamic variables, except velocities, which dynamically change during the deployment are stored under the Variable Leader data type of leader ID 8000h. This distinction is based on the dynamic; other distinctions are present such as velocity types such as data type of leader ID 0001h which groups all the Water Profile Velocity data and leader ID 0006h stores all Bottom Track Velocity data. The H-ADCP sends all the data for a given type for all depth cells and all beams before the next data type begins.

The advantage of using the leader ID is that one can simply scan for them as the binary data is received in real time on the serial lines and then use the output data format description table to jump directly to the desired data. The PD0 Header ID is 7F7Fh, which makes it easy to detect. In the PD0 Header are the number of bytes in the ensemble, the number of data types and the offset respective to each data type location in the binary ensemble. This gives you the choice between jumping down to the data type using the offsets or detecting the data type ID after you have detected the header ID.

PD0 is the only binary output data format which provides a Header that describes the data included in the ensemble since some data types presence in the PD0 output are dependent on commands parameters. For example, if the number of Bottom Track pings is 0 (BP0), then there will be no Bottom track data type in the ensemble. The table below shows which data types are always output against command dependable data types:

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (59 BYTES)
	VARIABLE LEADER DATA (65 BYTES)
WD command WP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM TRACK DATA** (85 BYTES)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 43. PD0 Standard Output Data Buffer Format

Some data outputs are in bytes per depth cell. For example, if the WN-command (number of depth cells) = 30 (default), WD command = WD 111 100 000 (default), WP command > 0, BP command > 0, the required data buffer storage space is 841 bytes per ensemble.

There are seven data types output for this example: Fixed Leader, Variable Leader, Velocity, Correlation Magnitude, Echo Intensity, Percent Good, and Bottom Track.

```
 20   BYTES OF HEADER DATA (6 + [2 x 7 Data Types])
 59   BYTES OF FIXED LEADER DATA (FIXED)
 65   BYTES OF VARIABLE LEADER DATA (FIXED)
242   BYTES OF VELOCITY DATA (2 + 8 x 30)
122   BYTES OF CORRELATION MAGNITUDE DATA (2 + 4 x 30)
122   BYTES OF ECHO INTENSITY (2 + 4 x 30)
122   BYTES OF PERCENT-GOOD DATA (2 + 4 x 30)
 85   BYTES OF BOTTOM TRACK DATA (FIXED)
  2   BYTES OF RESERVED FOR TRDI USE (FIXED)
  2   BYTES OF CHECKSUM DATA (FIXED)
----------------------------------------------------------------
841   BYTES OF DATA PER ENSEMBLE
```

PDDecoder Library in C language

The Teledyne Marine PDDecoder library is an open source library written in C language to decode the PD0 data formats that are commonly output by Teledyne Marine/Teledyne RD Instruments ADCPs.

Available for download from the Teledyne Marine software portal:

https://tm-portal.force.com/TMsoftwareportal

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 35 for a description of the fields.

Figure 44. Binary Header Data Format

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

Table 35: 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 H-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 51).
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 H-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 H-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 2n+13 to 2n+16	11,12 thru 2n+5, 2n+6	Address Offsets for Data Types #3-n / Offset for Data Type #3 through #n	These fields contain internal memory address offset where the H-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								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	REAL/SIM FLAG								
8	LAG LENGTH								
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS {WN}								
11	PINGS PER ENSEMBLE {WP}								LSB
12									MSB
13	DEPTH CELL LENGTH {WS}								LSB
14									MSB
15	BLANK AFTER TRANSMIT {WF}								LSB
16									MSB
17	PROFILING MODE {WM}								
18	LOW CORR THRESH {WC}								
19	NO. CODE REPS								
20	%GD MINIMUM {WG}								
21	ERROR VELOCITY MAXIMUM {WE}								LSB
22									MSB
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS {TP}								
26	COORDINATE TRANSFORM {EX}								
27	HEADING ALIGNMENT {EA}								LSB
28									MSB
29	HEADING BIAS {EB}								LSB
30									MSB
31	SENSOR SOURCE {EZ}								
32	SENSORS AVAILABLE								
33	BIN 1 DISTANCE								
34									
35	XMIT PULSE LENGTH BASED ON {WT}								LSB
36									MSB

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
37	(starting cell) WP REF LAYER AVERAGE {WL} (ending cell)								LSB
38									MSB
39	FALSE TARGET THRESH {WA}								
40	SPARE								
41	TRANSMIT LAG DISTANCE								LSB
42									MSB
43	CPU BOARD SERIAL NUMBER								MSB
↓									↓
50									LSB
51	SYSTEM BANDWIDTH {WB}								LSB
52									MSB
53	SYSTEM POWER {CQ}								
54	SPARE								
55	INSTRUMENT SERIAL NUMBER								MSB
↓									
58									LSB
59	BEAM ANGLE								

See Table 36 for a description of the fields

Figure 45. Fixed Leader Data Format

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

Table 36: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word (00 00h).
5,6	3	fv / CPU F/W Ver.	Contains the version number of the CPU firmware.
7,8	4	fr / CPU F/W Rev.	Contains the revision number of the CPU firmware.
9-12	5,6	Sys Cfg / System Configuration	This field defines the H-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 - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - SENSOR CONFIG #1 - - 0 1 - - - - SENSOR CONFIG #2 - - 1 0 - - - - SENSOR CONFIG #3 - 0 - - - - - - XDCR HD NOT ATT. - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 0 15E BEAM ANGLE - - - - - - 0 1 20E BEAM ANGLE - - - - - - 1 0 30E BEAM ANGLE - - - - - - 1 1 OTHER BEAM ANGLE 0 1 0 0 - - - - 4-BEAM JANUS CONFIG 0 1 0 1 - - - - 5-BM JANUS CFIG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD) Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).
13,14	7	PD / Real/Sim Flag	This field is set by default as real data (0).
15,16	8	Lag Length	Lag Length. The lag is the time period between sound pulses. This is varied, and therefore of interest in, at a minimum, for the WM5, WM8 and WM11 and BM7 commands.
17,18	9	#Bm / Number of Beams	The number of beams is set to 4 to maintain compatibility with existing software.
19,20	10	WN / Number of Cells	Contains the number of depth cells over which the H-ADCP collects data (WN-command). Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP-command). If WP = 0, the H-ADCP does not collect the WD water-profile data. Note: The H-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 / Depth Cell Length	Contains the length of one depth cell (WS-command). Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)

Table 36: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
29-32	15,16	WF / Blank after Transmit	Contains the blanking distance used by the H-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	Signal Processing Mode	Contains the Signal Processing Mode. This field will always be set to 1.
35,36	18	WC / Low Corr Thresh	Contains the minimum threshold of correlation that water-profile data can have to be considered good data (WC-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	WG / %Gd Minimum	Contains the minimum percentage of water-profiling pings in an ensemble that must be considered good to output velocity data. Scaling: LSD = 1 percent; Range = 1 to 100 percent
41-44	21,22	WE / Error Velocity Threshold	This field, initially set by the WE-command, contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, the H-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 H-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 H-ADCP collected data.
			`xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES)`
			`xxx01xxx = INSTRUMENT COORDINATES`
			`xxx10xxx = SHIP COORDINATES`
			`xxx11xxx = EARTH COORDINATES`
			`xxxxx1xx = TILTS (PITCH AND ROLL) USED IN SHIP OR EARTH TRANSFORMATION`
			`xxxxxx1x = 3-BEAM SOLUTION USED IF ONE BEAM IS BELOW THE CORRELATION THRESHOLD SET BY THE WC-COMMAND`
			`xxxxxxx1 = BIN MAPPING USED`

53-56	27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (EA-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
57-60	29,30	EB / Heading Bias	Contains a correction factor for electrical/magnetic heading bias (EB-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees

Table 36: 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`
			`x1xxxxxx = CALCULATES EC (SPEED OF SOUND) FROM ED, ES, AND ET`
			`xx1xxxxx = USES ED FROM DEPTH SENSOR`
			`xxx1xxxx = USES EH FROM TRANSDUCER HEADING SENSOR`
			`xxxx1xxx = USES EP FROM TRANSDUCER PITCH SENSOR`
			`xxxxx1xx = USES ER FROM TRANSDUCER ROLL SENSOR`
			`xxxxxx1x = USES ES (SALINITY) FROM CONDUCTIVITY SENSOR`
			`xxxxxxx1 = USES ET FROM TRANSDUCER TEMPERATURE SENSOR`
			NOTE: If the field = 0, or if the sensor is not available, the H-ADCP uses the manual command setting. If the field = 1, the H-ADCP uses the reading from the internal sensor or an external synchro sensor (only applicable to heading, roll, and pitch). Although you can enter a “2” in the EZ-command string, the H-ADCP only displays a 0 (manual) or 1 (int/ext sensor).

63,64	32	Sensor Avail	This field reflects which sensors are available. The bit pattern is the same as listed for the EZ-command (above).
65-68	33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first depth cell (bin). This distance is a function of depth cell length (WS), the profiling mode (WM), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-72	35,36	WT Xmit pulse length	This field, set by the WT-command, contains the length of the transmit pulse. When the H-ADCP receives a <BREAK> signal, it sets the transmit pulse length as close as possible to the depth cell length (WS-command). This means the H-ADCP uses a WT command of zero. However, the WT field contains the actual length of the transmit pulse used. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
73,74 75,76	37,38	WL / WP Ref Lyr Avg (Starting cell, Ending cell)	Contains the starting depth cell (LSB, byte 37) and the ending depth cell (MSB, byte 38) used for water reference layer averaging (WL-command). Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells
77,78	39	WA / False Target Threshold	Contains the threshold value used to reject data received from a false target, usually fish (WA-command). Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
79,80	40	Spare	Contains the CX-command setting. Range = 0 to 5
81-84	41,42	LagD / Transmit lag distance	This field, determined mainly by the setting of the WM-command, contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters
85-100	43-50	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).
101-105	51-52	WB / System Bandwidth	Contains the WB-command setting. Range = 0 to 1
106-107	53	System Power	Contains the CQ-command setting. Range 0 to 255.
108-109	54	Spare	Spare
110-119	55-58	Serial #	Instrument serial number. The CPU Board Serial number is stored in Big Endian (MSB sent first).
120 -121	59	Beam Angle	Beam angle

Variable Leader Data Format

BYTE	7	6	5	4	3	2	1	0	
	BIT POSITIONS								
1	VARIABLE LEADER ID								80h
2									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	HEADING {EH}								LSB
20									MSB
21	PITCH (TILT 1) {EP}								LSB
22									MSB
23	ROLL (TILT 2) {ER}								LSB
24									MSB
25	SALINITY {ES}								LSB
26									MSB
27	TEMPERATURE {ET}								LSB
28									MSB
29	MPT MINUTES								
30	MPT SECONDS								
31	MPT HUNDREDTHS								
32	HDG STD DEV								
33	PITCH STD DEV								
34	ROLL STD DEV								

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
35	ADC CHANNEL 0								
36	ADC CHANNEL 1								
37	ADC CHANNEL 2								
38	ADC CHANNEL 3								
39	ADC CHANNEL 4								
40	ADC CHANNEL 5								
41	ADC CHANNEL 6								
42	ADC CHANNEL 7								
43	ERROR STATUS WORD (ESW) {CY?}								LSB
44									
45									
46									MSB
47	SPARE								
48									
49	PRESSURE								LSB
50									
51									
52									MSB
53	PRESSURE SENSOR VARIANCE								LSB
54									
55									
56									MSB
57	SPARE								
58	RTC CENTURY								
59	RTC YEAR								
60	RTC MONTH								
61	RTC DAY								
62	RTC HOUR								
63	RTC MINUTE								
64	RTC SECOND								
65	RTC HUNDREDTH								

See Table 37 for a description of the fields.

Figure 46. Variable Leader Data Format

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

Table 37: Variable Leader Data Format

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

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 H-ADCP's real-time clock (RTC) that the current data ensemble began. The TS-command (Set Real-Time Clock) initially sets the clock. The H-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 H-ADCP's Built-in Test function. A zero code indicates a successful BIT result.
			`BYTE 13   BYTE 14   (BYTE 14 RESERVED FOR FUTURE USE)`
			`1xxxxxxx xxxxxxxx = RESERVED`
			`x1xxxxxx xxxxxxxx = RESERVED`
			`xx1xxxxx xxxxxxxx = RESERVED`
			`xxx1xxxx xxxxxxxx = DEMOD 1 ERROR`
			`xxxx1xxx xxxxxxxx = DEMOD 0 ERROR`
			`xxxxx1xx xxxxxxxx = RESERVED`
			`xxxxxx1x xxxxxxxx = TIMING CARD ERROR`
			`xxxxxxx1 xxxxxxxx = RESERVED`

29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
37-40	19,20	EH / Heading	Contains the H-ADCP heading angle (EH-command). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees
41-44	21,22	EP / Pitch (Tilt 1)	Contains the H-ADCP pitch angle (EP-command). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
45-48	23,24	ER / Roll (Tilt 2)	Contains the H-ADCP roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing H-ADCPs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing H-ADCPs, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees

Table 37: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
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
57,58 59,60 61,62	29 30 31	MPT minutes MPT seconds MPT hundredths	This field contains the Minimum Pre-Ping Wait Time between ping groups in the ensemble.
63,64 65,66 67,68	32 33 34	H/Hdg Std Dev P/Pitch Std Dev R/Roll Std Dev	These fields contain the standard deviation (accuracy) of the heading and tilt angles from the gyrocompass/pendulums. Scaling (Heading): LSD = 1°; Range = 0 to 180° Scaling (Tilts): LSD = 0.1°; Range = 0.0 to 20.0°

69-70
71-72
73-74
75-76
77-78
79-80
81-82
83-84
	35
	36
	37
	38
	39
	40
	41
	42
		ADC Channel 0
		ADC Channel 1
		ADC Channel 2
		ADC Channel 3
		ADC Channel 4
		ADC Channel 5
		ADC Channel 6
		ADC Channel 7
			These fields contain the outputs of the Analog-to-Digital Converter (ADC) located on the DSP board. The ADC sequentially samples one of the eight channels per ping group (the number of ping groups per ensemble is the maximum of the WP). These fields are zeroed at the beginning of the deployment and updated each ensemble at the rate of one channel per ping group. For example, if the ping group size is 5, then:
			`END OF ENSEMBLE No.    CHANNELS UPDATED`
			`Start                  All channels = 0`
			`1                      0, 1, 2, 3, 4`
			`2                      5, 6, 7, 0, 1`
			`3                      2, 3, 4, 5, 6`
			`4                      7, 0, 8, 2, 3`
			`↓                      ↓`
			Here is the description for each channel:
			`CHANNEL  DESCRIPTION`
			`0        XMIT CURRENT`
			`1        XMIT VOLTAGE`
			`2        AMBIENT TEMP`
			`3        PRESSURE (+)`
			`4        PRESSURE (-)`
			`5        ATTITUDE TEMP`
			`6        ATTITUDE`
			`7        CONTAMINATION SENSOR`
			Note that the ADC values may be “noisy” from sample-to-sample, but are useful for detecting long-term trends. See Converting ADC Channels for more information.

85-86	43	Error Status Word	Contains the long word containing the bit flags for the CY? Command. The ESW is cleared (set to zero) between each ensemble.
			Note that each number above represents one bit set – they may occur in combinations. For example, if the long word value is 0000C000 (hexadecimal), then it indicates that both a cold wake-up (0004000) and an unknown wake-up (00008000) occurred.
			`Low 16 BITS`
			`LSB`
			`BITS 07 06 05 04 03 02 01 00`
			`     x  x  x  x  x  x  x  1  Bus Error exception`
			`     x  x  x  x  x  x  1  x  Address Error exception`
			`     x  x  x  x  x  1  x  x  Illegal Instruction exception`
			`     x  x  x  x  1  x  x  x  Zero Divide exception`
			`     x  x  x  1  x  x  x  x  Emulator exception`
			`     x  x  1  x  x  x  x  x  Unassigned exception`
			`     x  1  x  x  x  x  x  x  Watchdog restart occurred`
			`     1  x  x  x  x  x  x  x  Battery Saver power`

Table 37: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
87-88	44		Low 16 BITS MSB BITS 15 14 13 12 11 10 09 08 x x x x x x x 1 Pinging x x x x x x 1 x Not Used x x x x x 1 x x Not Used x x x x 1 x x x Not Used x x x 1 x x x x Not Used x x 1 x x x x x Not Used x 1 x x x x x x Cold Wakeup occurred 1 x x x x x x x Unknown Wakeup occurred
89-90	45		High 16 BITS LSB BITS 24 23 22 21 20 19 18 17 x x x x x x x 1 Clock Read error occurred x x x x x x 1 x Unexpected alarm x x x x x 1 x x Clock jump forward x x x x 1 x x x Clock jump backward x x x 1 x x x x Not Used x x 1 x x x x x Not Used x 1 x x x x x x Not Used 1 x x x x x x x Not Used
91-92	46		High 16 BITS MSB BITS 32 31 30 29 28 27 26 25 x x x x x x x 1 Not Used x x x x x x 1 x Not Used x x x x x 1 x x Not Used x x x x 1 x x x Power Fail (Unrecorded) x x x 1 x x x x Spurious level 4 intr (DSP) x x 1 x x x x x Spurious level 5 intr (UART) x 1 x x x x x x Spurious level 6 intr (CLOCK) 1 x x x x x x x Level 7 interrupt occurred
93-96	47-48	Reserved	Reserved for TRDI use.
97-104	49-52	Pressure	Contains the pressure of the water at the transducer head relative to one atmosphere (sea level). Output is in deca-pascals (see How Does the H-ADCP Sample Depth and Pressure?). Scaling: LSD=1 deca-pascal; Range=0 to 4,294,967,295 deca-pascals
105-112	53-56	Pressure variance	Contains the variance (deviation about the mean) of the pressure sensor data. Output is in deca-pascals. Scaling: LSD=1 deca-pascal; Range=0 to 4,294,967,295 deca-pascals
113-114	57	Spare	Spare
115-116	58	RTC Century	These fields contain the time from the H-ADCP's Y2K compliant real-time clock (RTC) that the current data ensemble began. The TT-command (Set Real-Time Clock) initially sets the clock. The H-ADCP does account for leap years.
117-118	59	RTC Year	
119-120	60	RTC Month	
121-122	61	RTC Day	
123-124	62	RTC Hour	
125-126	63	RTC Minute	
127-128	64	RTC Seconds	
129-130	65	RTC Hundredths	

Converting ADC Channels

The ADC channels in the H-ADCP are defined as follows:

Channel	Signal
0	Transmit current
1	Transmit voltage
2	Ambient Temperature
3	Pressure High (+)
4	Pressure Low (-)
5	Attitude Temperature
6	Attitude Mux (X & Y tilts)
7	Contamination Sensor

Note that while each H-ADCP ADC channel is 16-bits, and the full 16-bit values are used for most internal calculations (except for IXmt and VXmt), the raw counts that get output in the PD0 data are truncated to just the upper 8-bits. It is not possible to get the exact value from the ADC outputs.

XMT Voltage and Current Channels:

The H-ADCP uses a frequency-indexed table to set the scale factors for the Transmit voltage and Transmit current ADC channels:

Transmit voltage	Transmit current	Frequency (kHz)
2092719	43838	76.8
592157	11451	153.6
592157	11451	307.2
380667	11451	614.4
253765	11451	1228.8
253765	11451	2457.6

The transmit voltage and current values are calculated for the built-in-test by multiplying the ADC upper 8-bit value by the scale factor (they are very rough values). However, the transmit voltage and current measurements are not necessarily accurate, since the sampling is not synchronized to the phasing of the inputs. The voltage and current tables are scaled by 1000000.

Examples (for a 600 kHz H-ADCP):

Transmit Voltage:

(90 counts * 380667) / 1000000 ➔ 34.26 Volts

Transmit Current:

(103 counts * 11451) / 1000000 ➔ 1.795 Amps

Temperature Channels:

The temperature values are produced by plugging the 16-bit raw ADC count value into a second-order polynomial whose coefficients are hard-coded, plus an additional offset that is set via the &K command:

Temperature = offset + ((a3*x + a2)*x + a1)*x + a0 where:

a0 = 9.82697464E1
a1 = -5.86074151382E-3
a2 = 1.60433886495E-7
a3 = -2.32924716883E-12

Pressure Channel:

Pressure sensor internal factory reference points only; no user support.

Attitude Mux Channel:

This channel is multiplexed between the X and Y tilt signals, and the ADC values for this channel in the output data are therefore not meaningful.

Contamination Sensor:

This data is not used. The readings are generally not consistent.

How Does the H-ADCP Sample Depth and Pressure?

1. For each ping, the ADC samples the pressure sensor five times and averages the data. This is an attempt to reduce the Standard Deviation.
2. Using the Pressure coefficients, the pressure data from the ADC is converted to kPa.
3. That data is converted to dm and corrected for salinity with the following equation:

   Depth (dm) = Pressure(kPa) * (1.02-0.00069*ES), where ES is the Salinity setting.

   This is the depth value recorded in the PD0 variable leader when the H-ADCP is fitted with a pressure sensor and that the EZ command is set to EZx1xxxxx.
4. The pressure data is converted from kPa to deca-Pascals by multiplying it by 100. This value in deca Pascals is recorded in the PD0 variable leader data.

Converting kpa to Depth

The formula for converting kpa to depth (using *WinADCP*) is as follows:

(kpa(1.02-0.00069*Salinity)*(1000/Fresh Water Density))/10

Velocity Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VELOCITY ID								LSB 00h
2									MSB 01h
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
5	DEPTH CELL #1, VELOCITY 2								LSB
6									MSB
7	DEPTH CELL #1, VELOCITY 3								LSB
8									MSB
9	DEPTH CELL #1, VELOCITY 4								LSB
10									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
13	DEPTH CELL #2, VELOCITY 2								LSB
14									MSB
15	DEPTH CELL #2, VELOCITY 3								LSB
16									MSB
17	DEPTH CELL #2, VELOCITY 4								LSB
18									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 128 CELLS)								↓
1019	DEPTH CELL #128, VELOCITY 1								LSB
1020									MSB
1021	DEPTH CELL #128, VELOCITY 2								LSB
1022									MSB
1023	DEPTH CELL #128, VELOCITY 3								LSB
1024									MSB
1025	DEPTH CELL #128, VELOCITY 4								LSB
1026									MSB

See Table 38 for description of fields

Figure 47. Velocity Data Format

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

The H-ADCP packs velocity data for each depth cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The H-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. To obtain absolute velocities, algebraically remove the velocity of the instrument. For example,

```
RELATIVE WATER CURRENT VELOCITY:    EAST 650 mm/s
INSTRUMENT VELOCITY            : (-) EAST 600 mm/s
ABSOLUTE WATER VELOCITY        :     EAST  50 mm/s
```

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

EX-CMD	COORD SYS	VEL 1	VEL 2	VEL 3	VEL 4
EX00xxx	BEAM	TO BEAM 1	TO BEAM 2	TO BEAM 3	0
EX01xxx	INST	X AXIS	Y AXIS	0	ERROR VEL
EX10xxx	SHIP	X AXIS	Y AXIS	VERTICAL	ERROR VEL (tilt applied)
EX11xxx	EARTH	EAST	NORTH	VERTICAL	ERROR VEL (heading applied)

Positive values indicate water movement toward the H-ADCP.

Table 38: Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word (00 01h).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
9-12	5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2. See above.
13-16	7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3. See above.
17-20	9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4. See above.
21-2052	11-1026	Cells 2 – 128 (if used)	These fields store the velocity data for depth cells 2 through 128 (depending on the setting of the WN-command). These fields follow the same format as listed above for depth cell 1.

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

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	RESERVED								
7	DEPTH CELL #2, FIELD #1								
8	DEPTH CELL #2, FIELD #2								
9	DEPTH CELL #2, FIELD #3								
10	RESERVED								
↓	(SEQUENCE CONTINUES FOR UP TO 128 BINS)								↓
511	DEPTH CELL #128, FIELD #1								
512	DEPTH CELL #128, FIELD #2								
513	DEPTH CELL #128, FIELD #3								
514	RESERVED								

See Table 39 through Table 41 for a description of the fields.

Figure 48. Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

The number of depth 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 H-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.

Table 39: Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word (00 02h).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
11,12	6	RESERVED	RESERVED
13 – 1028	7 – 514	Cells 2 – 128 (if used)	These fields store correlation magnitude data for depth cells 2 through 128 (depending on the WN-command) for all three beams. These fields follow the same format as listed above for depth cell 1.

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

Table 40: Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the echo intensity data identification word (00 03h).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
11,12	6	RESERVED	RESERVED
13 – 1028	7 – 514	Cells 2 – 128 (if used)	These fields store echo intensity data for depth cells 2 through 128 (depending on the WN-command) for all three beams. These fields follow the same format as listed above for depth cell 1.

The percent-good data field is a data-quality indicator that reports the percentage (0 to 100) of good data collected for each depth cell of the velocity profile. The setting of the EX-command (Coordinate Transformation) determines how the H-ADCP references percent-good data as shown below.

EX-Command	Coordinate System	Velocity 1	Velocity 2	Velocity 3	Velocity 4
		Percentage Of Good Pings For:			
xxx00xxx	Beam	Beam 1	Beam 2	Beam 3	RESERVED
		Percentage Of:			
xxx01xxx xxx10xxx xxx11xxx	Inst Ship Earth	Field 1 Partial Solution Transformation (note 1)	Field 2 Transformations Rejected (note 2)	Field 3 No Solution Available in Bin	Field 4 Full Solution Transformations

1. Because profile data did not exceed correlation threshold (WC).

2. Because the error velocity threshold (WE) was exceeded.

At the start of the velocity profile, the backscatter echo strength is typically high on all three beams. Under this condition, the H-ADCP uses all three beams to calculate the orthogonal and error velocities. As the echo returns from far away depth cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the H-ADCP to reject some of its depth cell data. This causes the H-ADCP to calculate velocities with two beams instead of three beams. When the H-ADCP does 2-beam solutions, it stops calculating the error velocity because it needs three beams to do this. At some further depth cell, the H-ADCP rejects all cell data because of the weak echo. As an example, let us assume depth cell 60 has returned the following percent-good data.

```
FIELD #1 = 50, FIELD #2 = 5, FIELD #3 = 50, FIELD #4 = 0
```

The H-ADCP is very similar to the standard WorkHorse ADCP with four vertical beams. The H-ADCP measures X and Y velocities on the Horizontal instead of X, Y, and Z on the Vertical. The third beam on the H-ADCP provides the error velocity and acts in the same way as the fourth beam on a vertical system.

If the EX-command was set to collect velocities in BEAM coordinates, the example values show the percentage of pings having good solutions in cell 60 for each beam based on the Low Correlation Threshold (WC-command). Here, beam 1=50%, beam 2=5% and Beam 3=50%. These are neither typical nor desired percentages. Typically, you would want all beams to be about equal and greater than 25%.

On the other hand, if velocities were collected in INSTRUMENT coordinates and bin 60 returned the following percent-good, the results would be interpreted differently.

```
FIELD #1 = 50, FIELD #2 = 5, FIELD #3 = 45, FIELD #4 = 0
```

FIELD 1 - Percentage of Partial Solutions - Shows percentage of successful velocity calculations (50%) resulting in Partial Solutions. A Partial Solution is a solution that does not result in an error velocity. This occurs because there is not enough information to compute the error velocity.

FIELD 2 - Percentage of transformations rejected - Shows percent of error velocity (5%) that was less than the WE-command setting. The WE command has a default of 5000 mm/s. This large WE setting effectively prevents the H-ADCP from rejecting data based on error velocity.

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

FIELD 4 - Percentage of Full Solutions - 0% of the velocity data collected during the ensemble for range cell 60 generated a Full Solution. A Full Solution indicates that an error velocity is available.

Table 41: Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word (00 04h).
5,6	3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
7,8	4	Depth cell 1, Field 2	Stores percent-good data for depth cell #1, field 2. See above.
9,10	5	Depth cell 1, Field 3	Stores percent-good data for depth cell #1, field 3. See above.
11,12	6	Depth cell 1, Field 4	Stores percent-good data for depth cell #1, field 4. See above.
13-1028	7-514	Depth cell 2 – 128 (if used)	These fields store percent-good data for depth cells 2 through 128 (depending on the WN-command), following the same format as listed above for depth cell 1.

These fields contain information about the status and quality of H-ADCP data. A value of 0 means the measurement was good. A value of 1 means the measurement was bad.

Table 42: Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the status data identification word (00 05h).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, beam #1. See above.
7,8	4	Depth cell 1, Field 2	Stores status data for depth cell #1, beam #2. See above.
9,10	5	Depth cell 1, Field 3	Stores status data for depth cell #1, beam #3. See above.
11,12	6	Depth cell 1, Field 4	Stores status data for depth cell #1, beam #4. See above.
13-1028	7-514	Depth cell 2 – 128 (if used)	These fields store status data for depth cells 2 through 128 (depending on the WN command) for all four beams. These fields follow the same format as listed above for depth cell 1.

Binary Bottom-Track Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	BOTTOM-TRACK ID								LSB 00h
2									MSB 06h
3	BT PINGS PER ENSEMBLE {BP}								LSB
4									MSB
5	BT DELAY BEFORE RE-ACQUIRE {BD}								LSB
6									MSB
7	BT CORR MAG MIN {BC}								
8	BT EVAL AMP MIN {BA}								
9	BT PERCENT GOOD MIN {BG}								
10	BT MODE {BM}								
11	BT ERR VEL MAX {BE}								LSB
12									MSB
13	RESERVED								
14									
15									
16									
17	BEAM#1 BT RANGE								LSB
18									MSB
19	BEAM#2 BT RANGE								LSB
20									MSB
21	BEAM#3 BT RANGE								LSB
22									MSB
23	RESERVED								LSB
24									MSB
25	BEAM#1 BT VEL								LSB
26									MSB
27	BEAM#2 BT VEL								LSB
28									MSB
29	BEAM#3 BT VEL								LSB
30									MSB
31	RESERVED								LSB
32									MSB
33	BEAM#1 BT CORR.								
34	BEAM#2 BT CORR.								
35	BEAM#3 BT CORR.								
36	RESERVED								

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
37	BEAM#1 EVAL AMP								
38	BEAM#2 EVAL AMP								
39	BEAM#3 EVAL AMP								
40	RESERVED								
41	BEAM#1 BT %GOOD								
42	BEAM#2 BT %GOOD								
43	BEAM#3 BT %GOOD								
44	RESERVED								
45	REF LAYER MIN {BL}								LSB
46									MSB
47	REF LAYER NEAR {BL}								LSB
48									MSB
49	REF LAYER FAR {BL}								LSB
50									MSB
51	BEAM#1 REF LAYER VEL								LSB
52									MSB
53	BEAM #2 REF LAYER VEL								LSB
54									MSB
55	BEAM #3 REF LAYER VEL								LSB
56									MSB
57	RESERVED								LSB
58									MSB
59	BM#1 REF CORR								
60	BM#2 REF CORR								
61	BM#3 REF CORR								
62	RESERVED								
63	BM#1 REF INT								
64	BM#2 REF INT								
65	BM#3 REF INT								
66	RESERVED								
67	BM#1 REF %GOOD								
68	BM#2 REF %GOOD								
69	BM#3 REF %GOOD								
70	RESERVED								
71	BT MAX. DEPTH {BX}								LSB
72									MSB
73	BM#1 RSSI AMP								
74	BM#2 RSSI AMP								

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
75	BM#3 RSSI AMP								
76	RESERVED								
77	GAIN								
78	(*SEE BYTE 17)								MSB
79	(*SEE BYTE 19)								MSB
80	(*SEE BYTE 21)								MSB
81	(*SEE BYTE 23)								MSB
82	RESERVED								
83									
84									
85									

Figure 49. Binary Bottom-Track Data Format

This data is output only if the BP-command is > 0 and PD0 is selected. See Table 43 for a description of the fields.

The PD0 output data format assumes that the instrument is stationary and the bottom is moving. DVL (Speed Log) output data formats (see Special Output Data Formats) assume that the bottom is stationary and that the H-ADCP or vessel is moving.

The H-ADCP uses these commands for “range” to boundary applications. The H-ADCP is NOT designed for moving vessel Bottom Track applications.

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

Table 43: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the bottom-track data identification word (00 06h).
5-8	3,4	BP/BT Pings per ensemble	Stores the number of bottom-track pings to average together in each ensemble (BP-command). If BP = 0, the H-ADCP does not collect bottom-track data. The H-ADCP automatically extends the ensemble interval (TE) if BP x TP > TE. Scaling: LSD = 1 ping; Range = 0 to 999 pings
9-12	5,6	BD/BT delay before reacquire	Stores the number of H-ADCP ensembles to wait after losing the bottom before trying to reacquire it (BD-command). Scaling: LSD = 1 ensemble; Range = 0 to 999 ensembles
13,14	7	BC/BT Corr Mag Min	Stores the minimum correlation magnitude value (BC-command). Scaling: LSD = 1 count; Range = 0 to 255 counts
15,16	8	BA/BT Eval Amp Min	Stores the minimum evaluation amplitude value (BA-command). Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	BG/BT %Gd Minimum	Stores the minimum percentage of bottom-track pings in an ensemble that must be good to output velocity data (BG-command).
19,20	10	BM/BT Mode	Stores the bottom-tracking mode (BM-command).

Table 43: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
21-24	11,12	BE/BT Err Vel Max	Stores the error velocity maximum value (BE-command). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
25-32	13–16	Reserved	Reserved
33-48	17-24	BT Range/Beam #1-3 BT Range	Contains the two lower bytes of the vertical range from the H-ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range = 0. See bytes 78 through 81 for MSB description and scaling. Scaling: LSD = 1 cm; Range = 0 to 65535 cm
49-64	25-32	BT Velocity/Beam #1-3 BT Vel	The meaning of the velocity depends on the EX (coordinate system) command setting. The four velocities are as follows: a) Beam Coordinates: Beam 1, Beam 2, Beam 3, Beam 4 b) Instrument Coordinates: 1->2, 4->3, toward face, error c) Ship Coordinates: Starboard, Fwd, Upward, Error d) Earth Coordinates: East, North, Upward, Error
65-72	33-36	BTCM/Beam #1-3 BT Corr.	Contains the correlation magnitude in relation to the sea bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes (Table 5).
73-80	37-40	BTEA/Beam #1-3 BT Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo. Scaling: LSD = 1 count; Range = 0 to 255 counts
81-88	41-44	BTPG/Beam #1-3 BT %Good	Contains bottom-track percent-good data for each beam, which indicate the reliability of bottom-track data. It is the percentage of bottom-track pings that have passed the H-ADCP's bottom-track validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
89-92 93-96 97 – 100	45,46 47,48 49,50	Ref Layer (Min, Near, Far)	Stores the minimum layer size, the near boundary, and the far boundary of the BT water-reference layer (BL-command). Scaling (minimum layer size): LSD = 1 dm; Range = 0-999 dm Scaling (near/far boundaries): LSD = 1 dm; Range = 0-9999 dm
101- 116	51-58	Ref Vel/Beam #1-4 Ref Layer Vel	Contains velocity data for the water reference layer for each beam. Reference layer velocities have the same format and scale factor as water-profiling velocities (Table 38). The BL-command explains the water reference layer.
117- 124	59-62	RLCM/Bm #1-3 Ref Corr	Contains correlation magnitude data for the water reference layer for each beam. Reference layer correlation magnitudes have the same format and scale factor as water-profiling magnitudes (Table 5).
125- 132	63-66	RLEI/Bm #1-3 Ref Int	Contains echo intensity data for the reference layer for each beam. Reference layer intensities have the same format and scale factor as water-profiling intensities.
133- 140	67-70	RLPG/Bm #1-3 Ref %Good	Contains percent-good data for the water reference layer for each beam. They indicate the reliability of reference layer data. It is the percentage of bottom-track pings that have passed a reference layer validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
141- 144	71,72	BX/BT Max. Depth	Stores the maximum tracking depth value (BX-command). Scaling: LSD = 1 decimeter; Range = 80 to 9999 decimeters
145-152	73-76	RSSI/Bm #1-3 RSSI Amp	Contains the Receiver Signal Strength Indicator (RSSI) value in the center of the bottom echo as determined by each beam. Scaling: LSD ≈ 0.45 dB per count; Range = 0 to 255 counts
153, 154	77	GAIN	Contains the Gain level for shallow water. See WJ-command.

Table 43: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
155-162	78-81	BT Range MSB/Bm #1-3	Contains the most significant byte of the vertical range from the H-ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range=0. See bytes 17 through 24 for LSB description and scaling. Scaling: LSD = 65,536 cm, Range = 65,536 to 16,777,215 cm
163-170	82-85	Reserved	Reserved

Binary Reserved BIT Data Format

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

Figure 50. Binary Reserved BIT Data Format

This data is always output. See Table 44 for a description of the fields.

Table 44: 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

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

Figure 51. Binary Checksum Data Format

This data is always output. See Table 45 for a description of the fields.

Table 45: Checksum Data Format

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

Special Output Data Formats

The PD3, PD4, PD5, and PD6 commands select the desired DVL (speed log) output data format. PD8 is a special ASCII output data format. PD14 is a condensed 2D output format for H-ADCPs only.

The DVL binary output data buffers can contain header, configuration, bottom-velocity, water-mass reference-layer, range to bottom, status, built-in test, sensor, and distance made good data (plus a checksum). The H-ADCP collects all data in the output buffer during an ensemble.

Figure 52 through Figure 54 shows the format of these buffers and the sequence in which the H-ADCP sends the data. Table 46 through Table 48 list the format, bytes, fields, scaling factors, and a detailed description of every item in the DVL binary output buffers.

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

The DVL output data formats assume that the bottom is stationary and that the H-ADCP or vessel is moving. The PD0 Bottom Track output data format (see Binary Bottom-Track Data Format) assumes that the instrument is stationary and the bottom is moving.

The H-ADCP uses these commands for "range" to boundary applications. The H-ADCP is NOT designed for moving vessel Bottom Track applications.

DVL Binary Data Format (PD3)

Byte	BIT POSITION 7	6	5	4	3	2	1	0	
1	DVL DATA ID 7Eh								
2	DATA STRUCTURE*								
3	STARBOARD/EAST VELOCITY (With Respect To BTM)								LSB
4									MSB
5	FORWARD/NORTH VELOCITY (With Respect To BTM)								LSB
6									MSB
7	UPWARD VELOCITY (With Respect To BTM)								LSB
8									MSB
9	STARBOARD/EAST VELOCITY (With Respect To WATER REF)								LSB
10									MSB
11	FORWARD/NORTH VELOCITY (With Respect To WATER REF)								LSB
12									MSB
13	UPWARD VELOCITY (With Respect To WATER REF)								LSB
14									MSB
15	BM1 RNG TO BTM								LSB
16									MSB
17	BM2 RNG TO BTM								LSB
18									MSB
19	BM3 RNG TO BTM								LSB
20									MSB
21	BM4 RNG TO BTM								LSB
22									MSB
23	RANGE TO BTM (AVERAGE)								LSB
24									MSB
25	SPARE								
↓									↓
↓									↓
40									
41	SENSOR/OTHER DATA								
42	PING TIME: HOUR								
43	MINUTE								
44	SECOND								
45	HUNDREDTH								
46	HEADING								LSB
47									MSB

Byte	Field	
48	PITCH	LSB
49		MSB
50	ROLL	LSB
51		MSB
52	TEMPERATURE	LSB
53		MSB
54	BIT RESULTS	LSB
55		MSB
56	CHECKSUM	LSB
57		MSB

Figure 52. DVL Binary Data Format (PD3)

DVL Output Data Format (PD3) Details

The H-ADCP sends this data format only when the PD3 command is used. In multiple byte parameters, the least significant byte always comes before the more significant bytes.

Table 46: DVL Output Data Format (PD3) Details

Hex Digit	Binary Byte	Field	Description
1,2	1	DVL Data ID	Stores the DVL (speed log) identification word (7Eh)
3,4	2	Reserved	Reserved
5-8	3,4	X-Vel Btm	† Bit #0: Always output. If the data bit is set to 0, then Ship coordinates are used. If the data bit is set to 1, then Earth coordinates are used. These fields contain the velocity of the vessel in relation to the bottom in mm/s. Positive values indicate vessel motion to (X) Starboard/East, (Y) Forward/North, (Z) Upward.
9-12	5,6	Y-Vel Btm	
13-16	7,8	Z-Vel Btm	† Bit #1: Vertical velocities.
17-20	9,10	X-Vel Water	† Bit #2: These fields contain the velocity of the vessel in relation to the water reference layer in mm/s. Positive values indicate vessel motion to (X) Starboard/East, (Y) Forward/North, (Z) Upward.
21-24	11,12	Y-Vel Water	
25-28	13,14	Z-Vel Water	† Bit #1 and Bit #2
29-32	15,16	Bm1	† Bit #3: These fields contain the vertical range from the H-ADCP to the bottom as determined by each beam. This vertical range does not compensate for the effects of pitch and roll. When a bottom detection is bad, the field is set to zero. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm
33-36	17,18	Bm2 Rng to	
37-40	19,20	Bm3 Bottom	
41-44	21,22	Bm4	
45-48	23,24	Avg Rng to Btm	† Bit #4: These fields contain the average vertical range from the H-ADCP to the bottom as determined by each beam.
49-80	25-40	Spare	Spare

Table 46: DVL Output Data Format (PD3) Details

Hex Digit	Binary Byte	Field	Description

81,82	41	Sensor/Other Data	† Output if Bit #7 of "Data to Follow" byte is set. These fields contain the Sensor/Other data.
			`Bit #`
			`0 = Time`
			`1 = Heading`
			`2 = Pitch`
			`3 = Roll`
			`4 = Temperature`
			`5 = Active Built-In-Test`

83-90	42,43	Time: HH,MM	‡ Sensor/Other Data Bit #0: These fields contains the time of the ping in Hours, Minutes Seconds, Hundredths of seconds respectively.
	44,45	Time: SS,HH	
91-94	46,47	Heading	‡ Sensor/Other Data Bit #1: this field contains the Heading in hundredths of degrees.
95-98	48,49	Pitch	‡ Sensor/Other Data Bit #2: this field contains the Pitch in hundredths of degrees.
99-102	50,51	Roll	‡ Sensor/Other Data Bit #3: this field contains the Roll in hundredths of degrees.
103-106	52,53	Temp	‡ Sensor/Other Data Bit #4: this field contains the Temperature in hundredths of degrees.

107-110	54,55	BIT results	‡ Sensor/Other Data Bit #5: this field contains the Built-In-Test results. Each bit specifies the result of built-in-test during an ensemble. If the bit is set, the test failed.
			`BYTE 54 BYTE 55 (BYTE 55 RESERVED FOR FUTURE USE)`
			`1xxxxxxx xxxxxxxx = RESERVED`
			`x1xxxxxx xxxxxxxx = RESERVED`
			`xx1xxxxx xxxxxxxx = RESERVED`
			`xxx1xxxx xxxxxxxx = DEMOD 1 ERROR`
			`xxxx1xxx xxxxxxxx = DEMOD 0 ERROR`
			`xxxxx1xx xxxxxxxx = RESERVED`
			`xxxxxx1x xxxxxxxx = DSP ERROR`
			`xxxxxxx1 xxxxxxxx = RESERVED`

111-114	56,57	Checksum	This is the 16-bit checksum of all the preceding binary bytes.

† This block of data is only output if the bit is set in the Data to Follow byte.
‡ This block of data is only output if the bit is set in the Sensor/Other Data byte.

DVL Binary Data Format (PD4/PD5)

Byte	BIT POSITION 7	6	5	4	3	2	1	0	
1	DVL DATA ID 7Dh								
2	DATA STRUCTURE*								
3	NO. OF BYTES								LSB
4									MSB
5	SYSTEM CONFIG								
6	X-VEL BTM								LSB
7									MSB
8	Y-VEL BTM								LSB
9									MSB
10	Z-VEL BTM								LSB
11									MSB
12	E-VEL BTM								LSB
13									MSB
14	BM1 RNG TO BTM								LSB
15									MSB
16	BM2 RNG TO BTM								LSB
17									MSB
18	BM3 RNG TO BTM								LSB
19									MSB
20	BM4 RNG TO BTM								LSB
21									MSB
22	BOTTOM STATUS								
23	X-VEL REF LAYER								LSB
24									MSB
25	Y-VEL REF LAYER								
26									
27	Z-VEL REF LAYER								
28									
29	E-VEL REF LAYER								
30									
31	REF LAYER START								
32									
33	REF LAYER END								
34									
35	REF LAYER STATUS								

36	TOFP-HOUR
37	TOFP-MINUTE
38	TOFP-SECOND
39	TOFP-HUNDREDTHS
40	BIT RESULTS
41	
42	SPEED OF SOUND
43	
44	TEMPERATURE
45	
46	CHECKSUM
47	

Figure 53. DVL Binary Data Format (PD4/PD5)

*If 0, then PD4 (Bytes 1-47)
*If 1, then PD5 (Bytes 1-45 + Table 48)

DVL Output Data Format (PD4/PD5) Details

The H-ADCP sends this data format only when the PD4 or PD5 command is used.

Table 47: DVL Output Data Format (PD4/PD5) Details

Hex Digit	Binary Byte	Field	Description
1,2	1	DVL Data ID	Stores the DVL (speed log) identification word (7Dh).
3,4	2	Data Structure	Identifies which data pattern will follow based on the PD-command. 0 = PD4 = Bytes 1 through 47 from Figure 53. 1 = PD5 = Bytes 1 through 45 from Figure 53 and bytes 46 through 88 from Figure 54. Note: PD6 is ASCII-only; see Table 49.
5-8	3,4	No. of Bytes	Contains the number of bytes sent in this data structure, not including the final checksum.
9,10	5	System Config	Defines the DVL hardware/firmware configuration. Convert to binary and interpret as follows. BIT 76543210 00xxxxxx BEAM-COORDINATE VELOCITIES 01xxxxxx INSTRUMENT-COORDINATE VELOCITIES 10xxxxxx SHIP-COORDINATE VELOCITIES 11xxxxxx EARTH-COORDINATE VELOCITIES xx0xxxxx TILT INFORMATION NOT USED IN CALCULATIONS xx1xxxxx TILT INFORMATION USED IN CALCULATIONS xxx0xxxx 3-BEAM SOLUTIONS NOT COMPUTED xxx1xxxx 3-BEAM SOLUTIONS COMPUTED xxxxx010 300-kHz DVL xxxxx011 600-kHz DVL xxxxx100 1200-kHz DVL

Table 47: DVL Output Data Format (PD4/PD5) Details

<table>
<tr><th>Hex Digit</th><th>Binary Byte</th><th>Field</th><th>Description</th></tr>
<tr><td>11-14
15-18
19-22
23-26</td><td>6,7
8,9
10,11
12,13</td><td>X-Vel Btm
Y-Vel Btm
Z-Vel Btm
E-Vel Btm</td><td>These fields contain the velocity of the vessel in relation to the bottom in mm/s. Positive values indicate vessel motion to east (X), north (Y), and up (Z). LSD = 1 mm/s (see NOTES at end of this table).</td></tr>
<tr><td>27-30
31-34
35-38
39-42</td><td>14,15
16,17
18,19
20,21</td><td>Bm1
Bm2 Rng to
Bm3 Bottom
Bm4</td><td>These fields contain the vertical range from the H-ADCP to the bottom as determined by each beam. This vertical range does not compensate for the effects of pitch and roll. When a bottom detection is bad, the field is set to zero.
Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm</td></tr>
<tr><td>43,44</td><td>22</td><td>Bottom Status</td><td>This field shows the status of bottom-referenced correlation and echo amplitude data. Convert to binary and interpret as follows. A zero code indicates status is OK.
BIT 76543210
1xxxxxxx BEAM 4 LOW ECHO AMPLITUDE
x1xxxxxx BEAM 4 LOW CORRELATION
xx1xxxxx BEAM 3 LOW ECHO AMPLITUDE
xxx1xxxx BEAM 3 LOW CORRELATION
xxxx1xxx BEAM 2 LOW ECHO AMPLITUDE
xxxxx1xx BEAM 2 LOW CORRELATION
xxxxxx1x BEAM 1 LOW ECHO AMPLITUDE
xxxxxxx1 BEAM 1 LOW CORRELATION</td></tr>
<tr><td>45-48
49-52
53-56
57-60</td><td>23,24
25,26
27,28
29,30</td><td>Velocity 1
Velocity 2
Velocity 3
Velocity 4</td><td>These fields contain the velocity of the vessel in relation to the water-mass reference layer in mm/s. The setting of the EX-command (Coordinate Transformation) determines how the H-ADCP references the velocity data.
<table>
<tr><th>EX-CMD</th><th>COORD SYS</th><th>Velocity 1</th><th>Velocity 2</th><th>Velocity 3</th><th>Velocity 4</th></tr>
<tr><td>xxx00xxx</td><td>Beam</td><td>To Beam 1</td><td>To Beam 2</td><td>To Beam 3</td><td>To Beam 4</td></tr>
<tr><td>xxx01xxx</td><td>Instrument</td><td>Bm1-Bm2</td><td>Bm4-Bm3</td><td>To Xducer</td><td>Err Vel</td></tr>
<tr><td>xxx10xxx</td><td>Ship</td><td>Port-Stbd</td><td>Aft-Fwd</td><td>To Surface</td><td>Err Vel</td></tr>
<tr><td>xxx11xxx</td><td>Earth</td><td>To East</td><td>To North</td><td>To Surface</td><td>Err Vel</td></tr>
</table>
Positive values indicate water movement (see notes at end of this table).</td></tr>
<tr><td>61-64
65-68</td><td>31,32
33,34</td><td>Ref Layer Start
Ref Layer End</td><td>These fields contain the starting boundary (near surface) and the ending boundary (near bottom) of the water-mass reference layer (BL-command). If the minimum size field is zero, the H-ADCP does not calculate reference-layer data.
Scaling: LSD = 1 dm; Range = 0-9999 dm</td></tr>
<tr><td>69,70</td><td>35</td><td>Ref Layer Status</td><td>This field shows the status of reference layer depth and correlation data. Convert to binary and interpret as follows. A zero code indicates status is OK.
BIT 76543210
xxx1xxxx ALTITUDE IS TOO SHALLOW
xxxx1xxx BEAM 4 LOW CORRELATION
xxxxx1xx BEAM 3 LOW CORRELATION
xxxxxx1x BEAM 2 LOW CORRELATION
xxxxxxx1 BEAM 1 LOW CORRELATION</td></tr>
<tr><td>71,72
73,74
75,76
77,78</td><td>36
37
38
39</td><td>TOFP Hour
TOFP Minute
TOFP Second
TOFP Hundredth</td><td>These fields contain the time of the first ping of the current ensemble.</td></tr>
</table>

Table 47: DVL Output Data Format (PD4/PD5) Details

Hex Digit	Binary Byte	Field	Description

79-82	40,41	BIT Results	These fields contain the results of the H-ADCP's Built-in Test function. A zero code indicates a successful BIT result.
			`BYTE 40  BYTE 41 (BYTE 41 RESERVED FOR FUTURE USE)`
			`1xxxxxxx xxxxxxxx = RESERVED`
			`x1xxxxxx xxxxxxxx = RESERVED`
			`xx1xxxxx xxxxxxxx = RESERVED`
			`xxx1xxxx xxxxxxxx = DEMOD 1 ERROR`
			`xxxx1xxx xxxxxxxx = DEMOD 0 ERROR`
			`xxxxx1xx xxxxxxxx = RESERVED`
			`xxxxxx1x xxxxxxxx = DSP ERROR`
			`xxxxxxx1 xxxxxxxx = RESERVED`

83-86	42,43	Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s
87-90	44,45	Temperature	Contains the temperature of the water at the transducer head. Scaling: LSD = 0.01 C; Range = -5.00 to +40.00 C
91-94	46,47	Checksum	This field contains a modulo 65536 checksum. The H-ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum. NOTE: This field contains the checksum only when the PD4-command is used. If PD5 is used, the remaining bytes are explained in Table 48.

The H-ADCP packs velocity data into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The H-ADCP scales velocity data in millimeters per second (mm/s). A value of –32768 (8000h) indicates a bad velocity.

Bottom or reference-layer velocities will be all valid or all invalid. That is, if the X-velocity is valid then the Y and Z-velocities are valid; if X is not valid, Y and Z are not valid.

The H-ADCP allows 3-beam transformations when the fourth beam is invalid. Indication of a 3-beam transformation for bottom-track is valid bottom velocities and one and only one beam's range to bottom is marked bad (zero).

There is no indication that a 3-beam transformation was performed for water reference layer velocity data.

DVL Binary Data Format (PD5)

Byte	7	6	5	4	3	2	1	0	
	BIT POSITION								
46	SALINITY								
47	DEPTH								LSB
48									MSB
49	PITCH								LSB
50									MSB
51	ROLL								LSB
52									MSB
53	HEADING								LSB
54									MSB
55	DISTANCE MADE GOOD/BTM (EAST)								LSB
56									
57									
58									MSB
59	DISTANCE MADE GOOD/BTM (NORTH)								LSB
60									
61									
62									MSB
63	DISTANCE MADE GOOD/BTM (UP)								LSB
64									
65									
66									MSB
67	DISTANCE MADE GOOD/BTM (ERROR)								LSB
68									
69									
70									MSB
71	DISTANCE MADE GOOD/REF (EAST)								LSB
72									
73									
74									MSB
75	DISTANCE MADE GOOD/REF (NORTH)								LSB
76									
77									
78									MSB

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

Figure 54. DVL Binary Data Format (PD5)

DVL Output Data Format (PD5) Details

The H-ADCP sends this data format (Figure 53 and Figure 54) only when the PD5 command is used. Table 47 explains the first part of this data structure.

Table 48: DVL Output Data Format (PD5) Details

Hex Digit	Binary Byte	Field	Description
91,92	46	Salinity	Contains the salinity value of the water at the transducer head (ES-command). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
93-96	47,48	Depth	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
97-100	49,50	Pitch	Contains the H-ADCP pitch angle (EP-command). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
101-104	51,52	Roll	Contains the H-ADCP roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing H-ADCPs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing H-ADCPs, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
105-108	53,54	Heading	Contains the H-ADCP heading angle (EH-command). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees
109-116 117-124 125-132 133-140	55-58 59-62 63-66 67-70	DMG/Btm East DMG/Btm North DMG/Btm Up DMG/Btm Error	These fields contain the Distance Made Good (DMG) over the bottom since the time of the first ping after initialization or <BREAK>. Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 dm
141-148 149-156 157-164 165-172	71-74 75-78 79-82 83-86	DMG/Ref East DMG/Ref North DMG/Ref Up DMG/Ref Error	These fields contain the distance made good over the water-mass reference layer since the time of the first ping after initialization or <BREAK>. Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 dm
173-176	87,88	Checksum	This field contains a modulo 65536 checksum. The H-ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum.

DVL Output Data Format (PD6)

The H-ADCP sends this data format only when the PD6 command is used. The H-ADCP outputs data in the following line order. The H-ADCP may not sent all data lines. Examples: (1) If BK = zero, the H-ADCP does not send water-mass data (line items beginning with W); (2) If BK = three, the H-ADCP does not send bottom-track data (line items beginning with B).

PD6 output data format cannot be recorded – it must be output through the serial port only. Do not use this output data format for a self-contained deployment.

Table 49: DVL Output Data Format (PD6)

Line	Description
1	**SYSTEM ATTITUDE DATA** **:SA,±PP.PP,±RR.RR,HH.HH <CR><LF>** where: PP.PP = Pitch in degrees RR.RR = Roll in degrees HHH.HH = Heading in degrees
2	**TIMING AND SCALING DATA** **:TS,YYMMDDHHmmsshh,SS.S,+TT.T,DDDD.D,CCCC.C,BBB <CR><LF>** where: YYMMDDHHmmsshh = Year, month, day, hour, minute, second, hundredths of seconds SS.S = Salinity in parts per thousand (ppt) TT.TT = Temperature in C DDDD.D = Depth of transducer face in meters CCCC.C = Speed of sound in meters per second BBB = Built-in Test (BIT) result code
3	**WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA** **:WI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF>** where: ±XXXXX = X-axis vel. data in mm/s (+ = Bm1 Bm2 xdcr movement relative to water mass) ±YYYYY = Y-axis vel. data in mm/s (+ = Bm4 Bm3 xdcr movement relative to water mass) ±ZZZZZ = Z-axis vel. data in mm/s (+ = transducer movement away from water mass) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
4	**WATER-MASS, SHIP-REFERENCED VELOCITY DATA** **:WS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF>** where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement rel. to water mass) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement rel. to water mass) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from water mass) S = Status of velocity data (A = good, V = bad)
5	**WATER-MASS, EARTH-REFERENCED VELOCITY DATA** **:WE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF>** where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = H-ADCP movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = H-ADCP movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = H-ADCP movement to surface) S = Status of velocity data (A = good, V = bad)

Table 49: DVL Output Data Format (PD6)

Line	Description
6	**WATER-MASS, EARTH-REFERENCED DISTANCE DATA** **:WD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF>** where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to water-mass center in meters TTT.TT = Time since last good-velocity estimate in seconds
7	**BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA** **:BI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF>** where: ±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom) ±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom) ±ZZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
8	**BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA** **:BS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF>** where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement relative to bottom) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement relative to bottom) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from bottom) S = Status of velocity data (A = good, V = bad)
9	**BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA** **:BE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF>** where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = H-ADCP movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = H-ADCP movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = H-ADCP movement to surface) S = Status of velocity data (A = good, V = bad)
10	**BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA** **:BD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF>** where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to bottom in meters TTT.TT = Time since last good-velocity estimate in seconds

The PD6 output does not pad spaces with zeroes. The spaces are left intact. The example below shows a realistic output from a H-ADCP locked onto the bottom.

```
:SA,  -2.31,  +1.92, 75.20
:TS,04081111563644,35.0,+21.0,   0.0,1524.0,  0
:WI,-32768,-32768,-32768,-32768,V
:BI,   +24,    -6,   -20,    -4,A
:WS,-32768,-32768,-32768,V
:BS,   -13,   +21,   -20,A
:WE,-32768,-32768,-32768,V
```

```
:BE,    +17,    +18,    -20,A
:WD,        +0.00,        +0.00,        +0.00,  20.00,  0.00
:BD,        -0.02,        -0.03,        +0.02,   7.13,  0.21
```

PD8 ASCII Output

The H-ADCP sends this data format only when the PD8 command is used. PD8 outputs ensemble data as formatted text. A new-line character terminates each line. Two new-line characters terminate an ensemble.

PD8 data is only for serial output. If you select PD8 and set the CF command to CFxxx01 (recorder on), the H-ADCP will output PD8 ASCII data out the serial port and record PD0 data to the recorder card. You can then use the PD0 data to troubleshoot any setup problems with the H-ADCP.

```
1997/02/28 11:16:50.07 00001
Hdg: 209.1 Pitch: 9.6 Roll: -9.1
Temp: 22.8 SoS: 1529 BIT: 00
Bin    Dir    Mag     E/W     N/S    Vert     Err  Echo1  Echo2  Echo3  Echo4
  1    --      --  -32768  -32768  -32768  -32768     43     49     46     43
  2    --      --  -32768  -32768  -32768  -32768     44     41     45     44
  3    --      --  -32768  -32768  -32768  -32768     43     41     45     43
  4    --      --  -32768  -32768  -32768  -32768     43     41     46     43
  5    --      --  -32768  -32768  -32768  -32768     43     41     45     43
  6    --      --  -32768  -32768  -32768  -32768     42     41     46     43
  7    --      --  -32768  -32768  -32768  -32768     43     42     46     43
  8    --      --  -32768  -32768  -32768  -32768     43     40     46     43
  9    --      --  -32768  -32768  -32768  -32768     43     41     45     44
 10    --      --  -32768  -32768  -32768  -32768     44     41     46     44
```

If all beams have good data, then direction and magnitude are output as well.

The BIT can output the following numbers depending on conditions:

- 00 = good
- 02 = Timing card error
- 08 = Demod 0 error
- 10 = Demod 1 error

PD8 output data format can not be recorded – it must be output through the serial port only. Do not use this output data format for a self-contained deployment.

H-ADCP Condensed 2D Output Format (PD14)

This section details the specification of an output format for data consisting of a header (with timestamp), a two dimensional profile of velocity, acoustic intensity, and standard error data, tilt sensor data, stage data, and a checksum. This format is primarily intended for use in horizontal H-ADCP applications. Data will be output in this format when PD14 is selected as the output format.

This Output Data Format is only available for Horizontal H-ADCPs with firmware version 11.05 or later.

PD14 Format

Table 50 below summarizes the PD14 format. The number of bytes in the ensemble, not including the checksum is reported in the NBytes field and is equal to 10 * NBins + 23 bytes, where NBins is the number of range cells in the profile. The NEnsemble field shows the number of ensembles since the start of a deployment and provides for tracking sequences of ensembles and distinguishing one ensemble from another. Tilts are reported as signed quantities in the interval –180.00 to +180.00 degrees. Stage measurements are reported as unsigned quantities in units of 1/10th mm. Velocities are reported as signed quantities in mm/sec. Acoustic intensities are reported in unsigned units of counts. Standard error will be reported as unsigned quantities in mm/sec. The checksum will be calculated as described by the CRC-16 algorithm using the polynomial $x^{16}+x^{15}+x^{2}+1$ with an initial register value of 0xFFFF.

PD14 Invalid Data

Several quantities may on occasion be out of range or may not pass quality checks. In such cases, an invalid result will be indicated. For tilts, an invalid result will be indicated by a value of –327.68 degrees. Invalid velocities are indicated by a value of –32768 mm/s. Invalid standard error will be indicated by a value of 65535 (all bits set). Invalid stage measurements are indicated by a value of 42949.67295 meters (all bits set). No provision will be made for any other invalid quantities in this format.

Table 50: PD14 Output Data Format

Position	Size	Name	Description
0	2	SOE	Start of ensemble - always 0x8F8F
2	2	NBytes	Number of bytes
4	2	NEnsemble	Number of ensembles since start of deployment
6	2	Year	4-digit year
8	1	Month	Month
9	1	Day	Day of month
10	1	Hour	Hour of day since midnight
11	1	Minutes	Number of minutes since the last hour
12	1	Seconds	Number of seconds since the last minute
13	1	Hundredths	Hundredths of a second since the last second
14	2	Tilt 1	Tilt 1 measurement in 1/100th degree
16	2	Tilt 2	Tilt 2 measurement in 1/100th degree
18	4	Vertical	Vertical stage measurement in 1/10th millimeter
22	1	NBins	Number of profile bins
23	2	X1	X component of velocity for bin 1
25	2	Y1	Y component of velocity for bin 1

Table 50: PD14 Output Data Format

Position	Size	Name	Description
-	-	-	-
4*n*+19	2	X*n*	X component of velocity for bin *n*
4*n*+21	2	Y*n*	Y component of velocity for bin *n*
4*N*+23	1	I11	Beam 1 intensity for bin 1 (NBins = *N*)
4*N*+24	1	I21	Beam 2 intensity for bin 1 (NBins = *N*)
-	-	-	-
4*N*+2*m*+21	1	I1*m*	Beam 1 intensity for bin *m* (NBins = *N*)
4*N*+2*m*+22	1	I2*m*	Beam 2 intensity for bin *m* (NBins = *N*)
6*N*+23	2	SX1	Standard error of X component of velocity for bin 1 (NBins = *N*)
6*N*+25	2	SY1	Standard error of Y component of velocity for bin 1 (NBins = *N*)
-	-	-	-
6*N*+4*m*+19	2	SX*m*	Standard error of X component of velocity for bin *m* (NBins = *N*)
6*N*+4*m*+21	2	SY*m*	Standard error of Y component of velocity for bin *m* (NBins = *N*)
10*N*+23	2	Checksum	CRC-16

Output Data Format (PD16)

PD16 will NOT output data when the system is in Beam Coordinates (see EX – Coordinate Transformation). The data has to have been transformed to output meaningful data.

When configured for PD16 and recording data to the recorder (CF11111), CS will start outputting data even if the card is full or missing.

The current generation of Sea-Bird acoustic modems uses the ‘$’ as a command terminator. This prevents them from handling the NMEA standard messages which all start with the ‘$’ character. Consequently, the current PD16 format is:

PRDIK,sn,yyddmm,hhmmss.ss,b_1,m_1,d_1,b_2,m_2,d_2,…,b_n,m_n,d_n*xx<cr><lf>

Where:

sn	= Serial Number
yyddmm	= Date
hhmmss.ss	= Time
b_x	= Bin Number
m_x	= Magnitude
d_x	= Direction
xx	= NMEA checksum

- In the event of bad data, the appropriate field will be left empty, with the commas present to indicate the absence of data.
- The bins to be displayed are selected using the PB command as in the case of PD12.
- The maximum length for the message is 480 bytes.

Sea-Bird Electronics has acknowledged that they have a problem and are said to be changing their firmware to support the NMEA standard. At that time, use PD18 to meet the NMEA standard.

Output Data Format (PD18)

PD18 is the same Output Data Format as PD16, but with the leading '$' necessary to fully comply with the NMEA format.

PD18 will NOT output data when the system is in Beam Coordinates (see EX – Coordinate Transformation). The data has to have been transformed to output meaningful data.

When configured for PD18 and recording data to the recorder (CF11111), CS will start outputting data even if the card is full or missing.

Appendix A

NOTICE OF COMPLIANCE

In this chapter:

- China RoHS requirements
- Material disclosure table

Date of Manufacture

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

Environmental Friendly Use Period (EFUP)

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

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

Some homogenous substance within the EIP contains toxic or hazardous substances or elements above the requirements listed in SJ/T 11363-2006. These substances are identified in Table 51.

WEEE

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

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

Teledyne RD Instruments USA	**Teledyne RD Instruments Europe**	**Teledyne RD Technologies**
14020 Stowe Drive Poway, California 92064	2A Les Nertieres 5 Avenue Hector Pintus 06610 La Gaude, France	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 51. 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
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
微处理器电路板 CPU PCB	X	O	O	O	O	O
输入输出口电路板 PIO PCB	X	O	O	O	O	O
机体装配 Housing Assy.	X	O	O	O	O	O
底座装配 End-Cap Assy.	X	O	O	O	O	O
交流电转换器 AC Voltage Adapter	X	O	O	O	O	O
水下专用电缆 Underwater Cable	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