WORKHORSE proteus

300, 600, and 1200 kHz Acoustic Doppler Current Profiler

Operation Manual

TELEDYNE MARINE
Everywhereyoulook™

P/N A95-6002-00 (September 2025)

https://www.teledynemarine.com/rdi

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Revision History

September 2025

- Preliminary Release

Conventions Used in this Manual

Thank you for purchasing a Teledyne RD Instruments (TRDI) Workhorse Proteus Acoustic Doppler Current Profiler (ADCP). This Operation Manual is designed to help Workhorse Proteus users to get familiar with the system. Conventions used in the Workhorse Proteus Operation Manual have been established to help learn how to use the system quickly and easily.

Software menu items are printed in bold: i.e., **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 (*ADCP Utilities*) and file names (*Test.txt*).

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

```
**************************************************************************
Workhorse Proteus
Teledyne RD Instruments (c) 2025
All rights reserved.
Firmware Version 1.0.0.105
**************************************************************************

System is not Deployed

>
```

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

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

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

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

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

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:

Teledyne RD Instruments	Teledyne RD Instruments Europe
14020 Stowe Drive Poway, California 92064	2A Les Nertieres 5 Avenue Hector Pintus 06610 La Gaude, France
Phone +1 (858) 842-2600	Phone +33(0) 492-110-930
Sales – rdisales@teledyne.com	Sales – rdie@teledyne.com
Field Service – rdifs@teledyne.com	Field Service – rdiefs@teledyne.com

Client Services Administration – rdicsadmin@teledyne.com

Web: https://www.teledynemarine.com

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.

NOTES

Chapter 1

OVERVIEW

This chapter covers:

System Overview

The Proteus ADCP assembly contains the end-cap, housing, transducer ceramics, and electronics. The standard acoustic frequencies are 1200, 600, and 300 kHz. See the Outline Installation Drawings for dimensions and weights.

Picture	Description
	The Serial (Red) and Ethernet (Blue) cables connect the Proteus ADCP to the computer and external power supply. When a cable is not connected, use the dummy plug to protect the connector.
	The end-cap holds the two Impulse MCIL-8-FS connectors. The Power/Comm connectors are available as horizontal or vertical orientation. The Power/Comm Ethernet and Serial underwater cables/dummy plugs have identical connectors on the wet ends and have different color heat shrink labels to match the correct adapter: Serial = Red Ethernet = Blue When assembling the unit, match the forward mark on the end-cap with forward mark on the transducer. The Vent plug provides a way for internal pressure to escape once the plug is backed out and is no longer sealed yet the threads remain engaged. This is important in cases where there's a concern about the plug becoming a projectile should there be internal pressure inside the housing.
	The Sentinel ADCP includes a longer housing to hold a battery. The internal alkaline battery pack has 550 watt-hours (Wh) of usable energy at 0 C. Lithium batteries have a capacity of approximately 2100 Wh.
	The forward mark shows the location of mounting the system. When assembling the unit, match the forward mark on the transducer with the forward mark on the end-cap.
	The Thermistor measures the water temperature.
	The pressure sensor measures water pressure (depth).
	The urethane faces cover the transducer ceramics. Never set the transducer on a hard surface. The urethane faces may be damaged.
	The standard Proteus housing allows deployment depths to 300 meters.
	The Proteus electronics and transducer ceramics are mounted to the transducer head. The dots embossed on the transducer indicate the beam number.
	Proteus ADCPs come standard with one 64GB Micro SD memory card. Use *ADCP Utilities* software to download data.

Proteus Models and Options

The following section explains the different models and options available for Proteus ADCPs.

Proteus Monitor

The Monitor is designed to measure real-time current profiles from temporary or permanent mounting in the ocean, near-shore, harbors, and lakes. The Monitor ADCP system consists of an ADCP, pigtail cable, 64GB Micro SD memory card, and software. The Monitor system requires the addition of a Windows® compatible computer to collect data.

Using an External Battery with a Monitor ADCP enables the system for self-contained deployments, which is why a memory card is always included in all Proteus systems.

Figure 1. Monitor ADCP 1200, 600, and 300 kHz

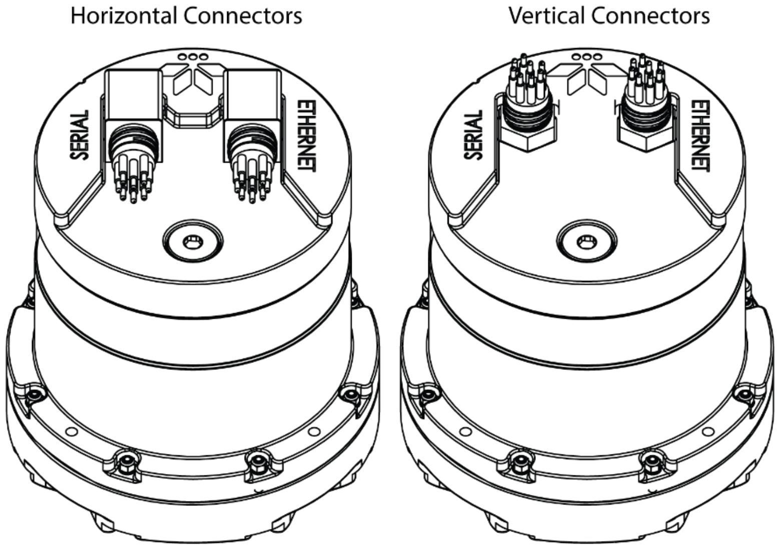
Proteus Sentinel

The Sentinel is designed for several-month autonomous current profile deployment from temporary or permanent mounting in the ocean, near-shore, harbors, and lakes. The Sentinel ADCP system consists of an ADCP, cables, battery pack, 64GB Micro SD memory card, and software. The battery capacity can be increased with upgrades for longer deployments. The Sentinel can also be used for direct-reading current profile operation. The Sentinel system requires the addition of a Windows® compatible computer to configure the ADCP and replay collected data.

Figure 2. Sentinel ADCP 600 and 300 kHz

Workhorse Proteus Options

- **Horizontal or vertical Power/Comm connectors**. Must be selected when the system is ordered.



- **Bottom Track** – You can use your Proteus ADCP from moving boats and ships with the Bottom Track upgrade. Once the Bottom Track upgrade is added, a Workhorse Proteus ADCP can measure both water depth and boat velocity over the ground.
- **Waves** – Waves data acquisition firmware feature upgrade (Future release).
- **External Battery** – Adding an external battery can increase the deployment length for Sentinel ADCPs. Use an External Battery with a Monitor ADCP to provide backup power or for self-contained deployments (future release).
- **Lithium Battery Pack** – The optional Lithium Battery packs can be used interchangeably in the Sentinel system and the external battery case. This battery pack is assembled using lithium battery cells that provide 23.4 VDC with a capacity of approximately 2100 Wh. The battery includes a safety circuit that protects the battery and users against short circuits.

Setting up the Workhorse Proteus System

Use this section to connect the Workhorse Proteus system to a computer and establish communications. Install the *ADCP Utilities* software to communicate with the Workhorse Proteus.

Computer and Software Considerations

The Workhorse Proteus system includes the utility program *ADCP Utilities* to help set up, use, test, and deploy the Workhorse Proteus. Use this program to "talk" to the Workhorse Proteus and to create command files. *ADCP Utilities* is included on the Teledyne software portal. For detailed information on how to use *ADCP Utilities*, see the help file and the Workhorse Proteus deployment guides.

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

- Windows 10® or Windows 11® Desktop, Laptop, or Netbook computer
- Screen resolution above 1024 x 768
- Ethernet or Serial Port

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

Software Installation

The Proteus documentation and software are downloaded.

1. Follow the instruction sheet on downloading TRDI software and manuals.
2. Software is available on https://tm-portal.force.com/TMsoftwareportal. Install *ADCP Utilities*.
3. Use our online customer portal at https://www.teledynemarine.com/support/RDI/technical-manuals to download manuals or other Teledyne RDI documentation. Download the Proteus Operation Manual and Deployment Guide. PDF versions of all Proteus documentation are available for download.

For more information on *ADCP Utilities*, click the Help icon (Help) to open the ADCP Utilities Software help file.

Proteus Getting Started Guide

Proteus Deployment Guide

Proteus Operation Manual

Power Overview

Workhorse Proteus ADCPs require 15 to 48 VDC to operate. Typically, 24 VDC is used. Either an external DC power supply or battery can provide this power.

- Alternate power sources are recommended to be 24 to 48V and 5A (or higher) to support a long duration bottom tracking ping. It should also not produce interference within the operating bandwidth of the ADCP, which can be verified by using it to power the ADCP in situ and then using the FFT utility in *ADCP Utilities* software.
- The system will operate from 10V to 52V, but acoustic transmit will be disabled if the voltage is detected below 15V or above 50V.
- If the input voltage drops below 15V during high current events such as inrush or acoustic transmit, acoustic transmit disable will occur. If it drops below 10V, power fail will occur.
- Voltage drop issues can be caused by using a long cable, low initial power supply voltage, or undersized (current limited) power supply.

Monitor/Sentinel Power Considerations

A fresh alkaline battery provides +29.1 VDC.

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 ADCP. The capacitors provide a store of energy for use during transmit. The inrush current is as high as 5 Amps rms. The 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 ADCP electronics to start.

AC Power Adapter

The optional AC power adapter is 24V and 5A. This is sufficient to address surge and inrush current. **This power adapter shouldn't be used for data collection. It is designed for testing and data download only.** Use the A73-3001-00 Power Adapter cable to connect to a power supply.

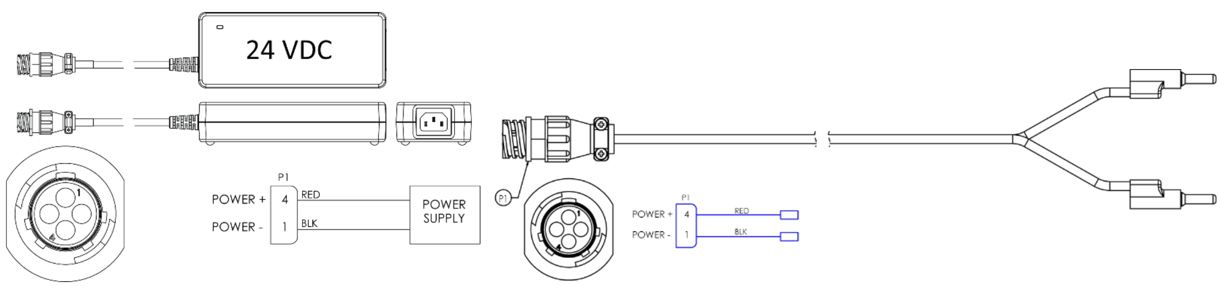


Figure 3. Optional A73-3000-00 AC 24 VDC Power Adapter & A73-3001-00 Power Adapter Cable

Do not use older Workhorse AC Adapters P/N 717-3014-00 that supply 48 VDC.

Battery Power

The Sentinel Proteus ADCP includes a longer housing to hold one battery pack.

- Each alkaline battery pack has 550 watt-hours (Wh) of usable energy at 0 C. When fresh, the voltage is +29.1 VDC. When depleted, the voltage drops to 20 VDC or less.
- The optional Lithium Battery Packs can be used interchangeably in Workhorse Proteus systems. This battery pack is assembled using lithium battery cells that provide 23.4 VDC with a capacity of approximately 2100 Wh of usable energy at 0°C. The battery includes a safety circuit that protects the battery and users against short circuits.

Keep in mind the following about Workhorse Proteus battery packs:

- Store batteries in a cool dry location (0 to 21 degrees C).
- Do not store batteries inside the ADCP for extended periods. The batteries may leak.
- Use batteries within one year of the manufacture date (use by warning date*).

Using other battery packs:

- Do not to use a Workhorse battery pack to deploy the system. It cannot support the high current demand over a long deployment.
- Do not use a Sentinel V battery pack to deploy the system. It does not have sufficient voltage to support a long deployment.

Do not deploy the system with alkaline batteries that are older than the Warning date. It should be noted, that while a battery pack will not be dead after the Warning Date, the actual performance of the battery is in doubt, and TRDI does not warranty any deployment started with a battery pack that is past its warning date.

The optional Lithium battery packs are restricted to Cargo Aircraft Only. Do NOT return Workhorse Proteus systems with the optional Lithium battery packs installed.

TRDI batteries have four dates on them:

Manufacture Date is the date the battery was built and final tested.

TRDI Ship by Date provides the maximum duration that the battery will remain on our shelves before we ship and is 6 months after our manufacture date.

Warning Date* provides the last date when the battery should be used to start a deployment and is 12 months from the manufacture date.

Expiration Date provides the date when the battery should no longer be considered useful and is 2 years from the manufacture date.

*A battery pack used to start a deployment prior to the Warning Date means that it will perform as expected and provide the required power for any deployment that was created using the TRDI planning module. For example, if your deployment is going to be 12 months long and the battery label shows it is nine months old, it is safe to use the battery.

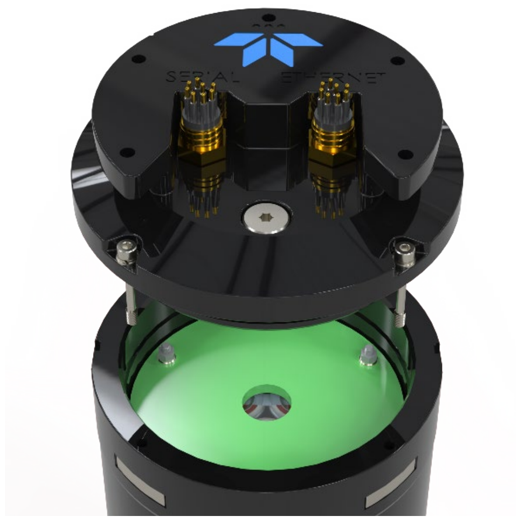
Lithium battery packs are longer than alkaline packs. Remove the spacer at the bottom of the battery module when using Lithium batteries; Add the spacer when using alkaline batteries.

Initial Battery Connection

When you first receive a Sentinel system, the batteries are installed, but the battery power cable is not connected.

To connect the batteries:

1. Remove the end-cap (see End-Cap Removal procedures).
2. The battery pack power cable connector is tucked around the battery compression plate. Carefully pull it free.
3. Connect the battery pack power cable to the end-cap cable connector (see Battery Replacement).
4. Install the end-cap (End-Cap Replacement).



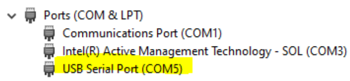
Communication Adapters

USB Adapters

If you require a USB to serial adapter, TRDI recommends the Connectiveperipherals ES-U-1001-R10. Possibly any device with FTDI drivers and devices will also work.

If there is an available internet connection, Windows 10/11 will install the USB driver on first connection. If necessary, install the Virtual COM Port (VCP) driver to make the USB adapter appear as an additional COM port. The free FTDI driver download page is available here: https://ftdichip.com/drivers/

Use Windows Device Manager® to determine the USB to Serial adapter COM port number. Remove the adapter, wait a moment, note the list of ports, reinsert the adapter and note the new port.



If your laptop doesn't have an Ethernet port, you can still connect to a wired network using a USB-to-Ethernet adapter. These adapters plug into a USB port on your laptop and allow you to connect an Ethernet cable to it. Make sure the adapter supports Gigabit Ethernet and is designed for high-speed performance.

RS-422 to RS-232 Converters

If the Proteus system is set for RS-422, then check to make sure the host computer supports RS-422 or use a RS-232 to RS-422 converter. TRDI recommends the Advantech BB-422PP9R serial converter.

Network Switch

TRDI recommends the Netgear Gigabit switch GS108.

Connecting the Proteus Cables

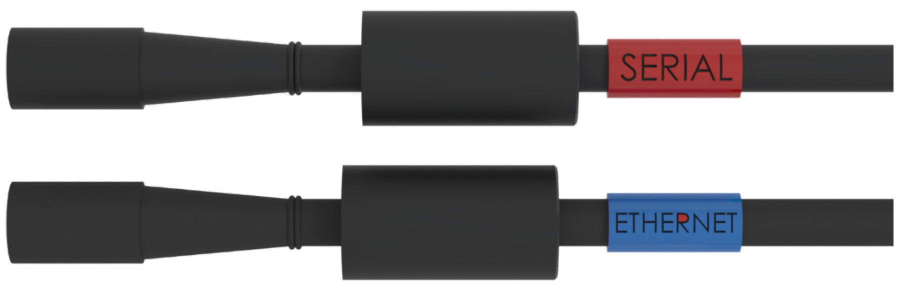
Use this section to connect the Workhorse Proteus to a computer and establish communications. Install the *ADCP Utilities* software to communicate with the ADCP.

The command-and-control port can be Serial or Ethernet, and the Serial and Ethernet cables can both be connected at the same time. The last port used to send a break is the command-and-control port. If the connection is Ethernet only, TRDI recommends setting **Auto connect** to **ON** (see Using the Network Page in ADCP Utilities).

To set up the Workhorse Proteus ADCP:

1. Lubricate the cable connector(s) and connect to the Serial and/or Ethernet connectors. If only one cable is connected, connect a dummy plug on the unused connector.

> The Ethernet and Serial cables have different color heat shrink labels to match the correct adapter:
>
> Serial = Red
>
> Ethernet = Blue



2. Attach the cable to the computer's communication port as needed:
3. Connect +24VDC power to the cable. The power supply only needs to be connected to one cable or can be connected to both. The Proteus takes power from the highest voltage source.

Factory Set Serial Communications

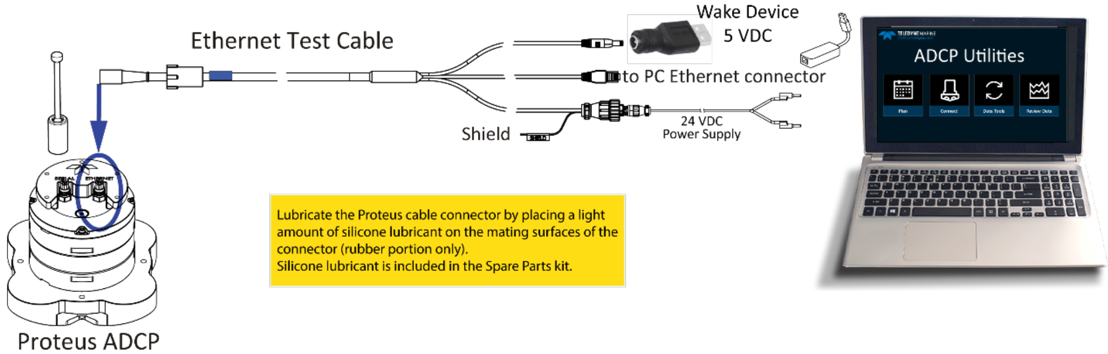
The Proteus system command-and-control port can be Ethernet or Serial, and the Serial and Ethernet cables can both be connected. The last port used to send a break is the command-and-control port.

RS-232 and RS-422 communications can be changed with a jumper cable. See Changing Communications Setting. The factory set communications is indicated by a red 232 or 422 label.

Ethernet Connection to the Workhorse Proteus

Ethernet Test Cable Connection

- Remove the dummy plug and connect the Ethernet test cable to the Proteus Ethernet connector.
- Connect a dummy plug on the unused Serial connector.
- Connect the ethernet cable from the Workhorse Proteus directly to the PC's Ethernet connector or use a USB to Ethernet adapter.
- Connect +24VDC to the cable power connector. On power up, the system runs a self-test, and the LED will blink (see LED Indications for a description of the LED blink patterns).
- Connect the Wake device to the Ethernet wake line barrel connector. Connect to a USB 5VDC power source. Any USB power source can be used, for example a computer or laptop, a power bank phone backup device, a generic USB power charger adapter.



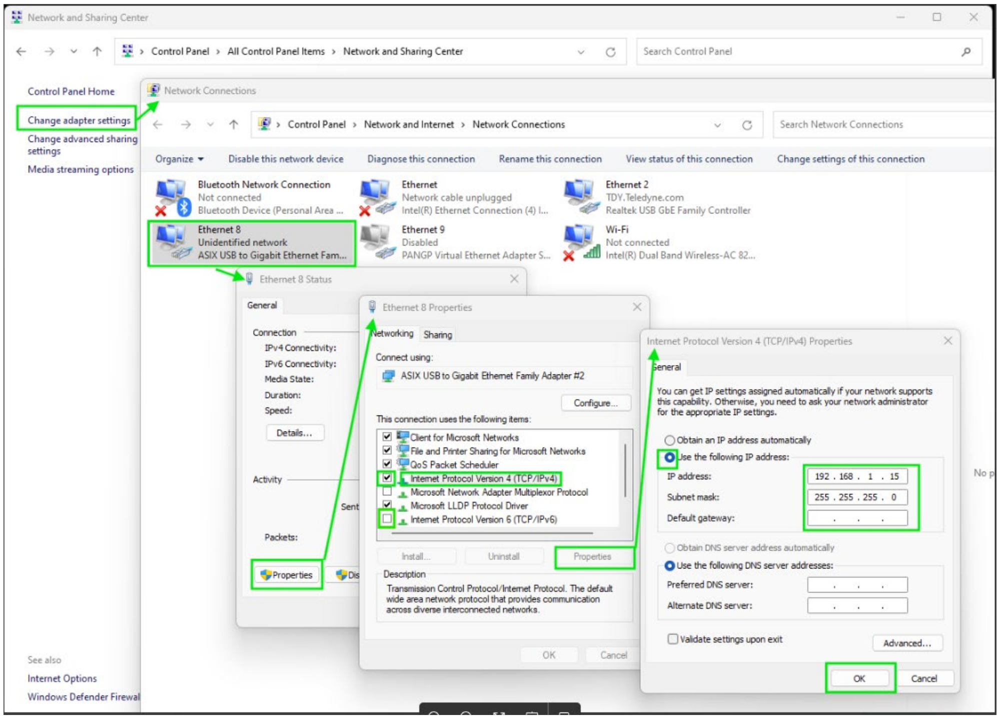
To Configure the IP Address

The default Ethernet connection uses a Manual/Static IP address. The first three numbers of the IP address must match, and the fourth number must not be the same. The Subnet Mask 255.255.255.0 (default) must be the same on both the computer and the Proteus.

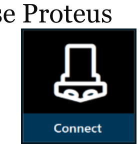
1. Go to the PC's Control Panel, Network and Sharing Center.
2. Click on **Change adapter settings** in the left-hand column.
3. Select the correct ethernet port (don't select the Bluetooth or Wi-Fi port, it is a bit of a guessing game between any remaining Ethernet ports).
4. Right-click on this connection and select **Properties**. Enter your admin credentials when prompted.

You must have Administrator privileges on the PC.

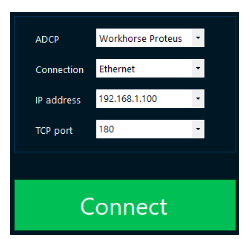
5. Highlight **Internet Protocol Version 4 (TCP/IPv4)** and select **Properties**.
6. Select **Use the Following IP address** and enter the address and gateway as needed. Note that the last number here (15) can be any of several numbers – but not 100. What you are doing here is giving the PC an address on this subnet, while reserving the address 100 for the Workhorse Proteus ADCP.
7. Uncheck the **Internet Protocol Version 6 (TCP/IP v6)** box.



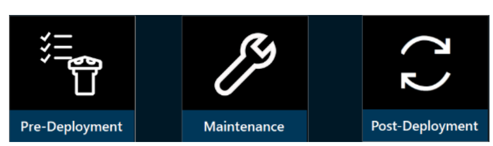
8. Click **OK** and then **Close**. After some time, the original screen showing no internet connections will change to show an "Unidentified network" and the red X is gone. If it still shows the red X, disconnect and then connect the Wake device.
9. The ethernet connection is complete. Use *ADCP Utilities* and connect to the Workhorse Proteus using the ADCP's Manual/Static IP address 192.168.1.100.



To establish Ethernet communications with the Workhorse Proteus:



1. Start the *ADCP Utilities* software.
2. Click the **Connect** button.
3. Select the **ADCP** type Workhorse Proteus.
4. Select **Ethernet**.
5. Enter the ADCP's static IP address in the **IP address** box.
6. Enter the **Port Number** 180.
7. Click the green **Connect** button. If the system is pinging, click **Stop Deployment**.
8. Select the **Pre-deployment**, **Maintenance** or **Post Deployment** button. See the *ADCP Utilities* software help file for more information.



Serial Connection to the Workhorse Proteus

Serial Cable Connection

- Remove the dummy plug and connect the Serial cable to the Proteus Serial connector.
- Connect a dummy plug on the unused Ethernet connector.
- Connect a USB Serial adapter to a USB port if the ADCP is configured as RS-232.
- Use a RS-422 to RS-232 converter if the ADCP is configured as RS-422.
- Connect +24VDC to the cable.

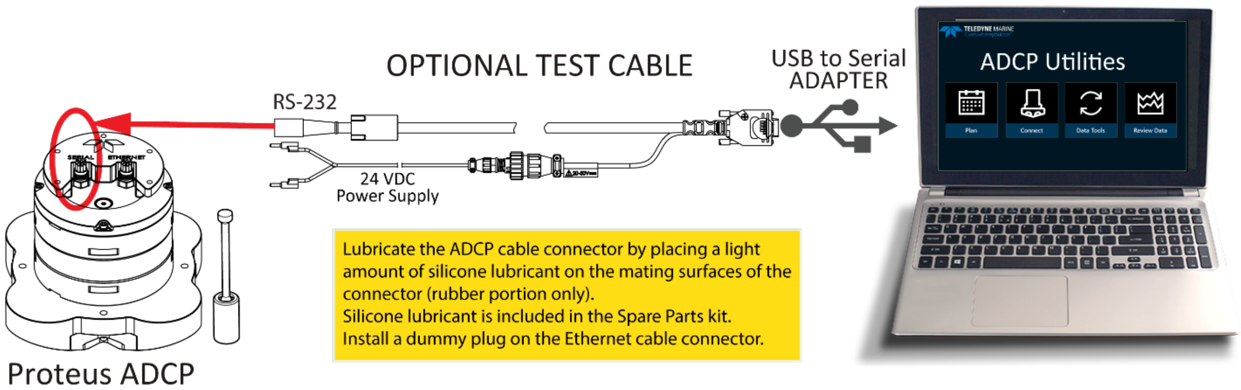
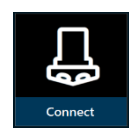
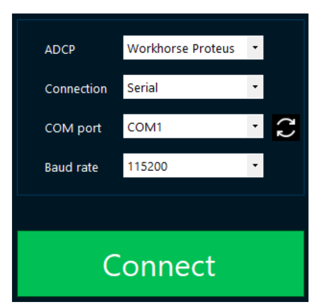


Figure 4. Workhorse Proteus Serial Connections

To establish Serial communications with the Workhorse Proteus:

1. On power up, the system runs a self-test, and the LED will blink (see LED Indications for a description of the LED blink patterns).
2. Start the *ADCP Utilities* software.
3. Click the **Connect** button.
4. Select the **ADCP** type Workhorse Proteus.
5. Select **Serial**.
6. Select the **COM Port** the serial cable is connected to and set the **Baud Rate** to 115200 from the drop-down lists.
7. Click the green **Connect** button. If the system is pinging, click **Stop Deployment**.
8. Select the **Pre-deployment**, **Maintenance** or **Post Deployment** button. See the *ADCP Utilities* software help file for more information.





The optional Serial test cable part number is A73-6000-xxx, where xxx is the length in meters.

Dual Ethernet/Serial Connection

The command-and-control port can be Serial or Ethernet, and the Serial and Ethernet cables can both be connected at the same time. The last port used to send a break is the command-and-control port.

- Connect the Workhorse Proteus serial cable to the serial connector and the Ethernet cable to the Ethernet connector.
- Use a RS-422 to RS-232 converter if the ADCP is configured as RS-422.
- The Power supply only needs to be connected to one cable or can be connected to both. The Proteus takes power from the highest voltage source.
- Connect the Ethernet wake lines to a USB 5VDC power source. Any USB power source can be used, for example a computer or laptop, a power bank phone backup device, a generic USB power charger adapter.
- Use *ADCP Utilities* and connect to the system using either Serial or Ethernet communications.

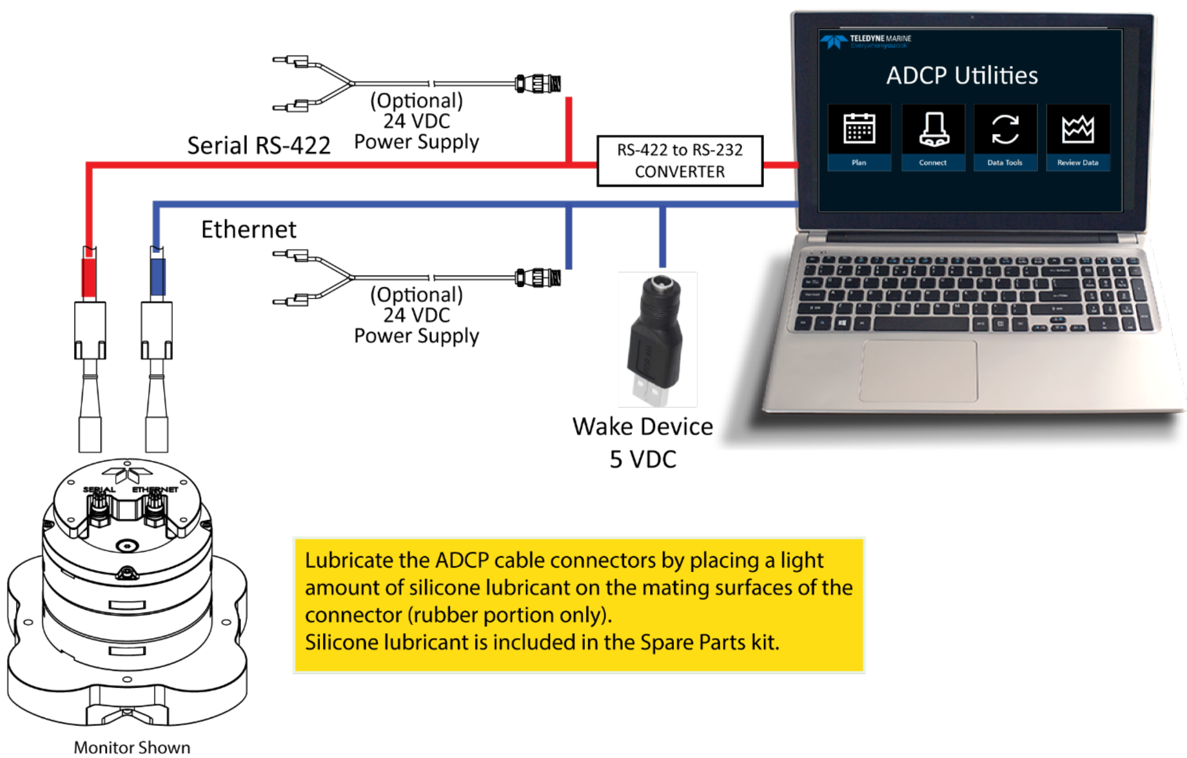


Figure 5. Workhorse Proteus Dual Serial and Ethernet Connection

Serial pigtail cable part number is A73-6001-xxx, where xxx is the length in meters.
Ethernet pigtail cable part number is A73-6003-xxx, where xxx is the length in meters.

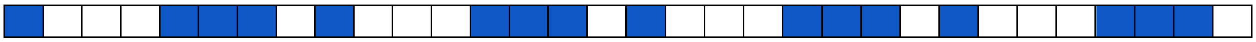
For reliable communications, the RS-232 cable to computer must be less than 25-meters length. For cables longer than 25-meters, use RS-422 communications. The maximum length for RS-422 communications is 1200-meters.

Two-Letter commands (2L) sent on the serial port can interfere with data download (and other operations) when connected to ADCP Utilities on the Ethernet port.

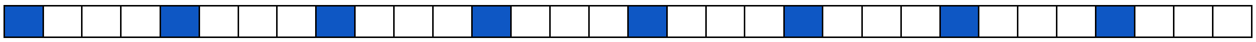
LED Indications

There is one blue LED mounted on the transducer housing. The blink rates indicate the Workhorse Proteus status as defined below. The LED blinks in an 8-bit pattern representing two seconds of time. Each bit represents 0.25 seconds. A 1 indicates the LED is on, a 0 indicates the LED is off.

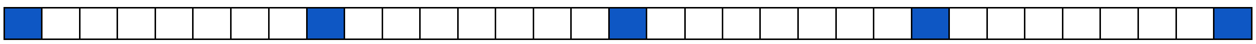
Not Deployed: The pattern is 10001110 and repeats if the system is active. Visually (8 seconds shown):



Deployed to Ping Now: The pattern is 10001000 and repeats for fifteen minutes. Visually (8 seconds shown):

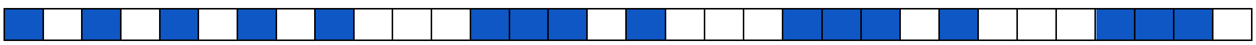


Deployed to ping in the future: The pattern is 1000000 and repeats for fifteen minutes. Visually (8 seconds shown):

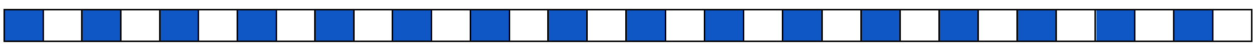


On cold-start power up, the Workhorse Proteus runs a self-test. If the self-test passed, the pattern is 10101010 for two seconds, followed by the "not deployed" state. Visually (8 seconds shown):

Self-Test Passed:



If the self-test does not pass, then the pattern is 10101010 and is repeated until successful user intervention. Visually:



Using Ethernet Communications

The Ethernet adapter inside the Proteus system is powered off if not enabled using one of the available settings in *ADCP Utilities* that control connection or using the Wake device connected to 5VDC power.

- **Start networking**: The **Start network** command temporarily powers up the Ethernet adapter and attempts to establish connections per its network settings. If a connection is not established, or if it is lost, it will power off after a timeout. This method requires that the serial communications is connected (see Switching From Serial to Ethernet Comms).
- **Auto-connect**: With the **Auto connect** setting enabled, the Ethernet adapter is always powered and available for connection when the system is powered up and awake. Depending on other power settings, this may be “all the time the system is powered”.
- **Ethernet Wake**: The Ethernet wake signal requires the application of 5V or a hardware break. If the USB adapter is being used, it must be newly inserted (or removed and reinserted) to send the Ethernet wake signal. Additionally, the Ethernet wake signal may need to be sent several times (three) over several seconds to fully wake the Ethernet.

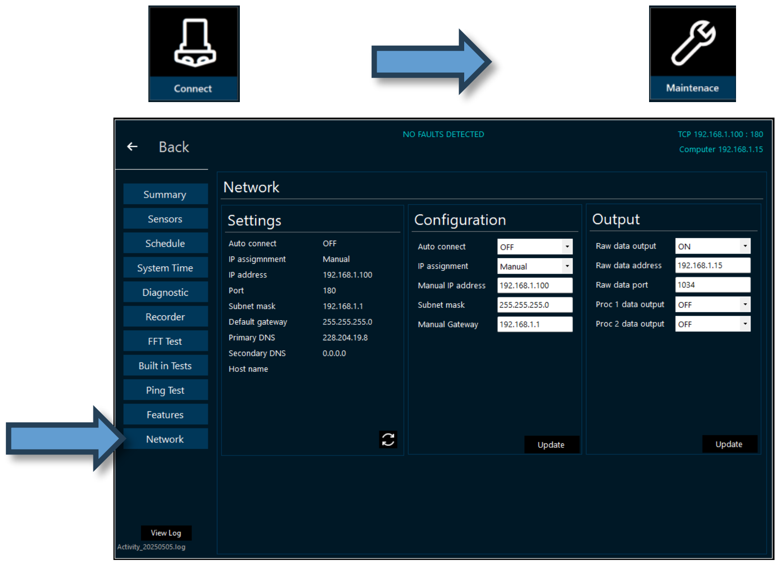
Protocols:

- **Ethernet Command and Control**: The system uses Ethernet Port (1) for command and control and data download using TCP/IP protocol. The **IP Assignment** protocol can be **Manual** or Dynamic IP (**DHCP**).
- **Ethernet data output ports**: The Ethernet data output ports (2-4) utilize UDP protocol. UDP is a connection-less protocol. Therefore, UDP packets can be lost in an unreliable or highly congested network.
  - **Raw Data output**: The system uses Ethernet Port (2) for raw data output and must use the same **Subnet mask** as Ethernet Port (1).
  - **Processed Data out**: The system has two Ethernet Port (3-4) for processed (ensemble) data output. (future release).

Using the Network Page in ADCP Utilities

Use the Network page to configure the Ethernet settings.

1. Using *ADCP Utilities*, connect to the system using the Ethernet port.
2. Go to the **Maintenance**, **Network** page.

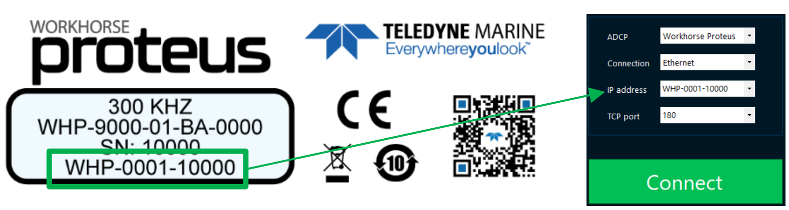


IP Assignment

The Dynamic Host Configuration Protocol (DHCP) is a network management protocol used on Internet Protocol (IP) networks for automatically assigning IP addresses and other communication parameters to devices connected to the network. A DHCP server can manage IP settings for devices on its local network by assigning IP addresses to those devices automatically and dynamically. DHCP servers may be configured to fall back to other methods if this fails.

Manual IP Assignment (default setting) allocation uses a fixed address allocation IP address. An administrator maps a unique identifier for each client to an IP address, which is offered to the requesting client. See Ethernet Connection to the Workhorse Proteus for details on how to configure the IP address.

The Host name as shown on the Proteus housing ID Label can be used for both DHCP and Manual IP assignment in place of the fixed IP address.



Network Output

To send data over the Ethernet, set the **Raw data output** to ON. Enter the **Raw data address** and **Raw data port**. Then click on the **Update** button. The raw data port utilizes UDP protocol. UDP is a connection-less protocol. Therefore, UDP packets can be lost in an unreliable or highly congested network.

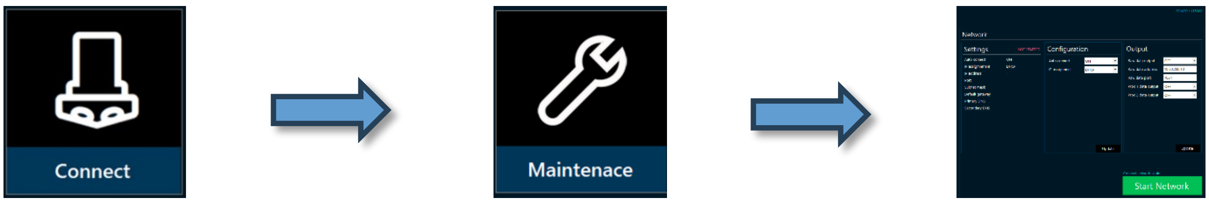
Auto Connect

With the **Auto connect** setting enabled, the Ethernet adapter is always powered and available when the system is powered. The system must be restarted for **Auto connect** to take effect.

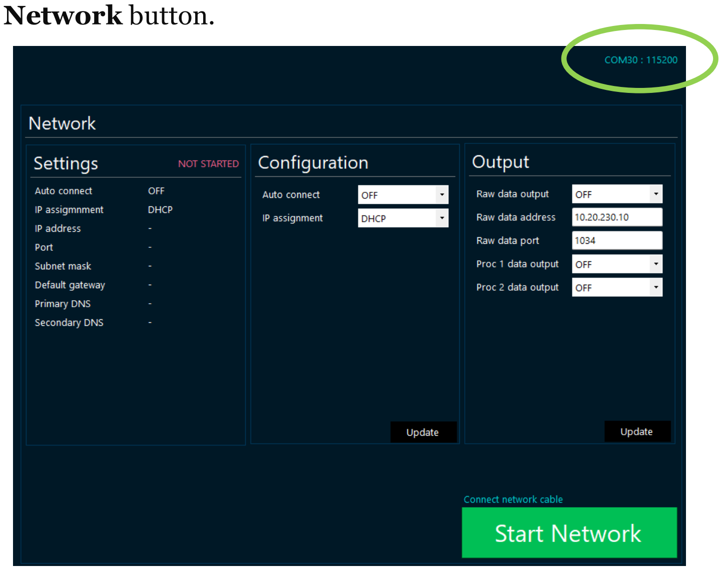
Switching From Serial to Ethernet Comms

Use the Network page to switch from Serial to Ethernet communications.

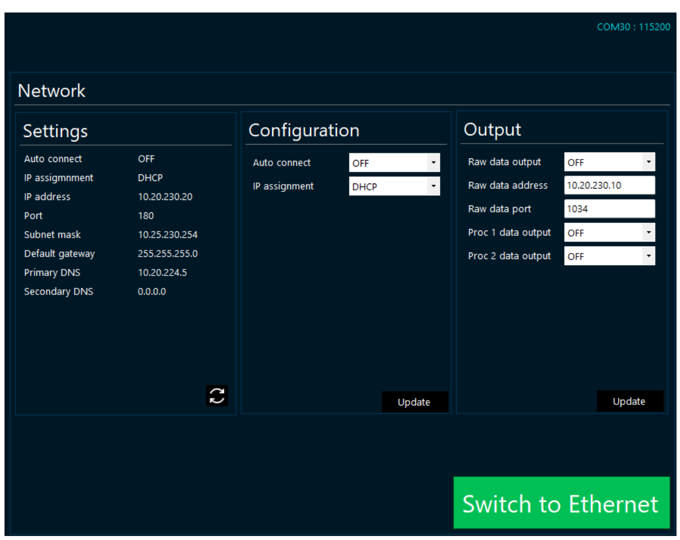
1. Connect the Serial cable to the ADCP and the computer's serial port.
2. Connect the Ethernet cable to the ADCP and to the network.
3. Using *ADCP Utilities*, connect to the system using the Serial port.
4. Go to the **Maintenance**, **Network** page.



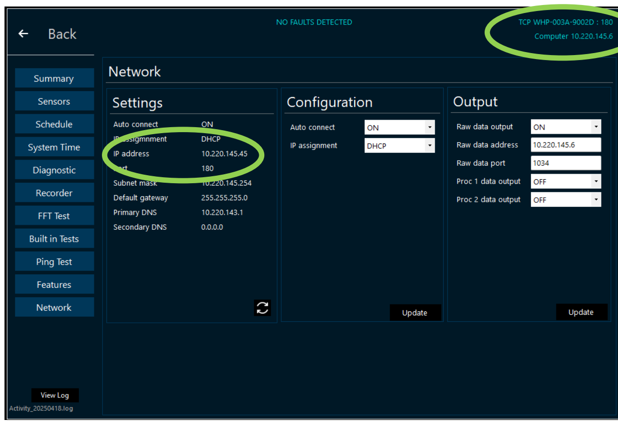
5. Click the **Start Network** button.



6. Click the **Switch to Ethernet** button.



7. Ethernet communication is now active, and the network connection are shown in the top right corner. Use the **IP address** or the **host name** to connect to the ADCP the next time you need to connect to the ADCP using Ethernet communications.



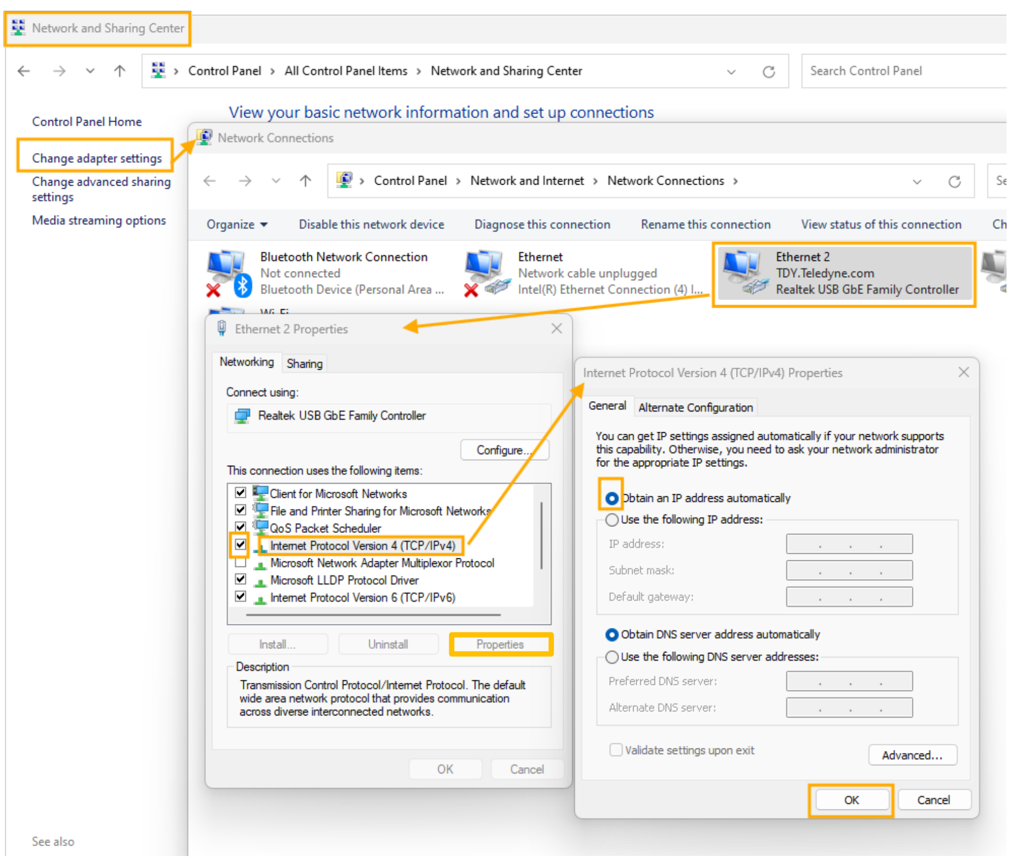
DHCP Connection

PCs and laptop native Ethernet port or USB Ethernet adapters can be setup for DHCP (network) connection with the Proteus ADCP as shown below.

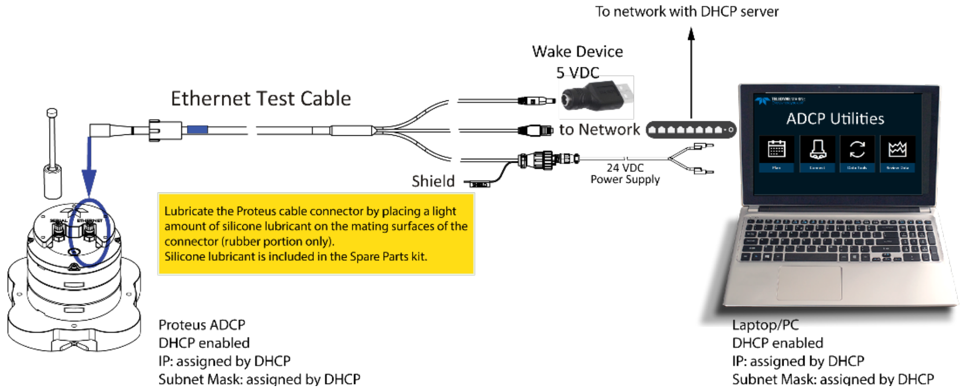
This is also how to re-enable an Ethernet port to connect with the corporate network when done with using for direct connection (if it is the computer's primary Ethernet port).

To set up for DHCP connection:

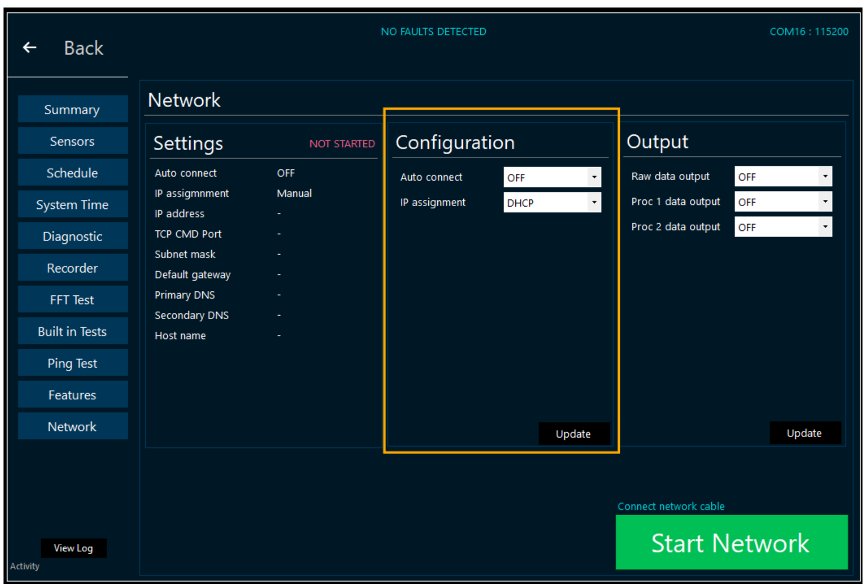
1. Return to the Network and Sharing center until you reach this window:



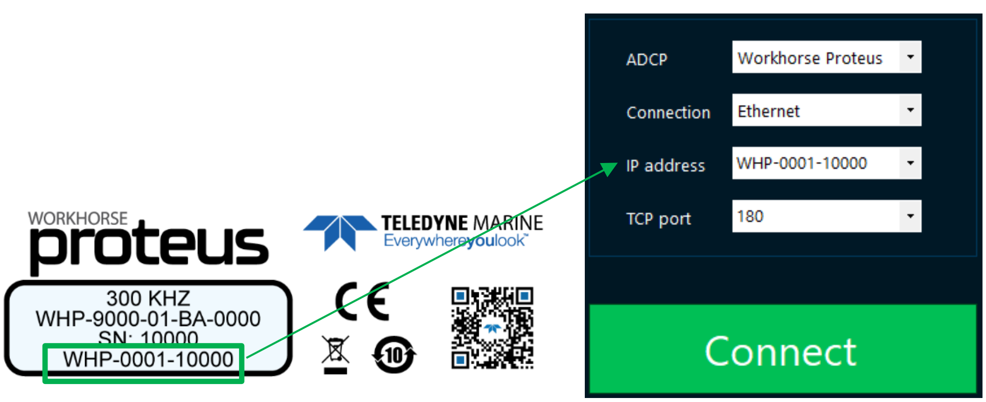
2. Select **Obtain an IP address automatically**.
3. Click **OK** and **Close**. When you connect the PC or Proteus to a LAN, it will be discovered by the DNS and reconnected.



Proteus to Network Connection.



Proteus Settings for DHCP network connection

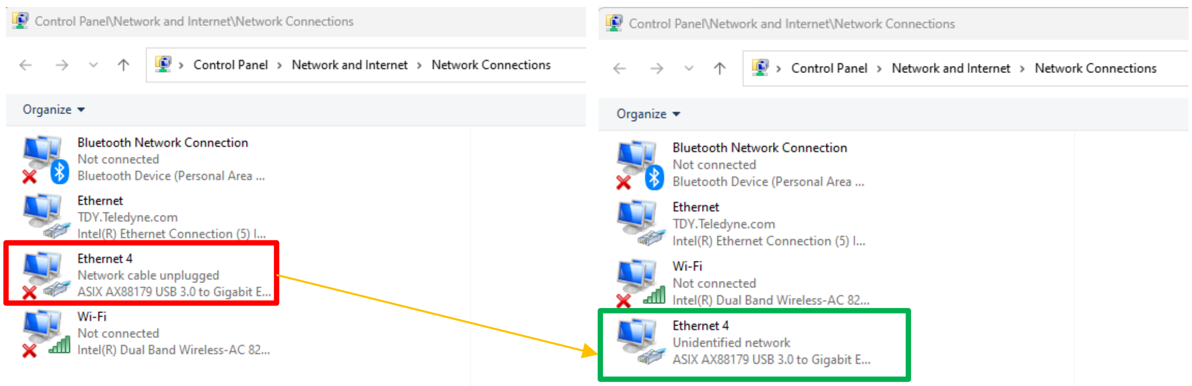


Connect using the Host name WHP-0001-10000

Problems with Ethernet Connection

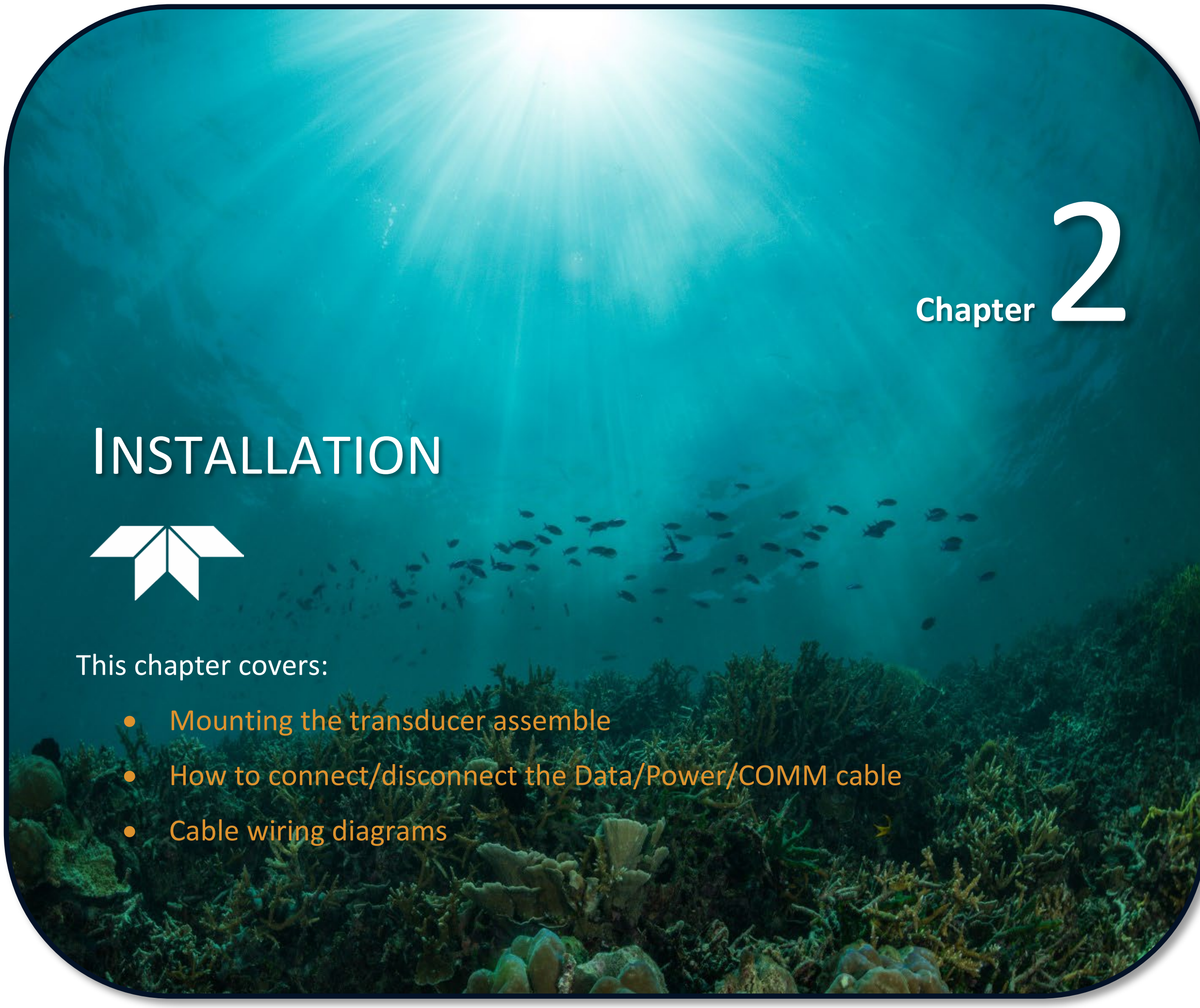
If the Ethernet connection is lost or the settings have been updated, go to the Control Panel Network and Sharing Center. Click on **Change adapter settings** in the left-hand column and verify the connection.

- Unplug the Wake device. Wait a few seconds and then reconnect it to a 5VDC USB power source. The connection should change to Unidentified network.
- If the ADCP power was cycled, disconnect the Wake device, apply power to the ADCP and wait for the self-test to complete. Once the LED shows the self-test completed, then connect the Wake device.



If the connection will be Ethernet only, TRDI recommends setting **Auto connect** to ON.

NOTES



Chapter 2

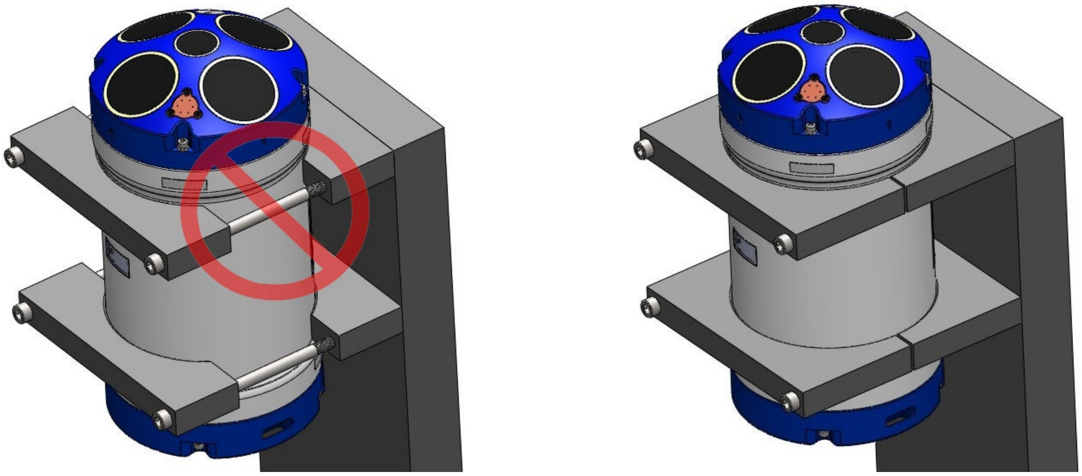
INSTALLATION

This chapter covers:

- Mounting the transducer assemble
- How to connect/disconnect the Data/Power/COMM cable
- Cable wiring diagrams

Mounting the Instrument

The preferred method of mounting the Workhorse Proteus is using clamps that grip the circumference of the housing. The fallback method of mounting the instrument is to use the holes on the end-cap or transducer. See the Outline Installation Drawings for dimensions.



Poor Design	**Good Design**
When clamping the ADCP to a mount, the clamp must not have a large gap between the front and rear clamp. Using this type of design can cause the housing to deform or even break if the clamps are over tightened. This will cause the ADCP to flood.	Design clamps that fully surround the housing. Design the gap as small as possible so that when the clamp is fully tightened it will not deform the housing or cause excessive pressure on the housing.

Figure 6. Mounting the Instrument with a Clamp Design

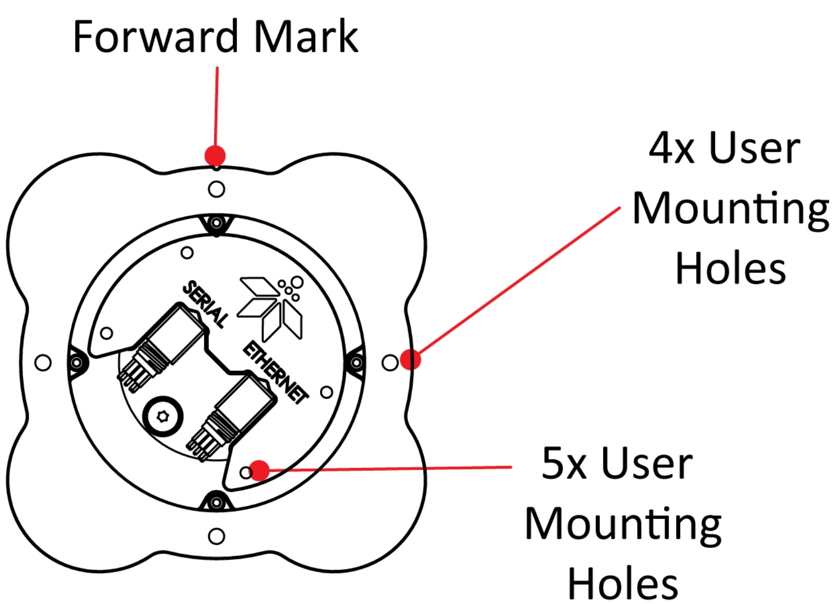


Figure 7. User Mounting Holes

Power/Comm Cable and Dummy Plugs

The underwater connectors (on the housing) and the cables, and dummy plugs use molded wet-mate 8-pin connectors.

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

To disconnect the cable:

1. Turn the locking sleeve counterclockwise until it is fully loose and slides back.
2. Grasp the cable or dummy plug close to the housing and pull the cable or dummy plug straight away from the connector.

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 rubber portion on 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.
3. Check the keyed portions are properly aligned and insert the dummy plug / cable onto the connector. While keeping a slight inward pressure on the cable connector and ensuring that the connector is straight, thread the locking sleeve onto the receptacle to complete the connection.

Do NOT use any tools to tighten the locking sleeve ring. It should only be "finger tight".

The Ethernet and Serial cables have different color heat shrink labels to match the correct connector:

Serial = Red

Ethernet = Blue

Connecting the External Battery Case

The optional External Battery Pack holds two 450 Watt-hours (Wh) batteries. The external battery can be connected to either the Serial or Ethernet connector, or both. Use a dummy plug on any unused connector.

External Battery is a future release.

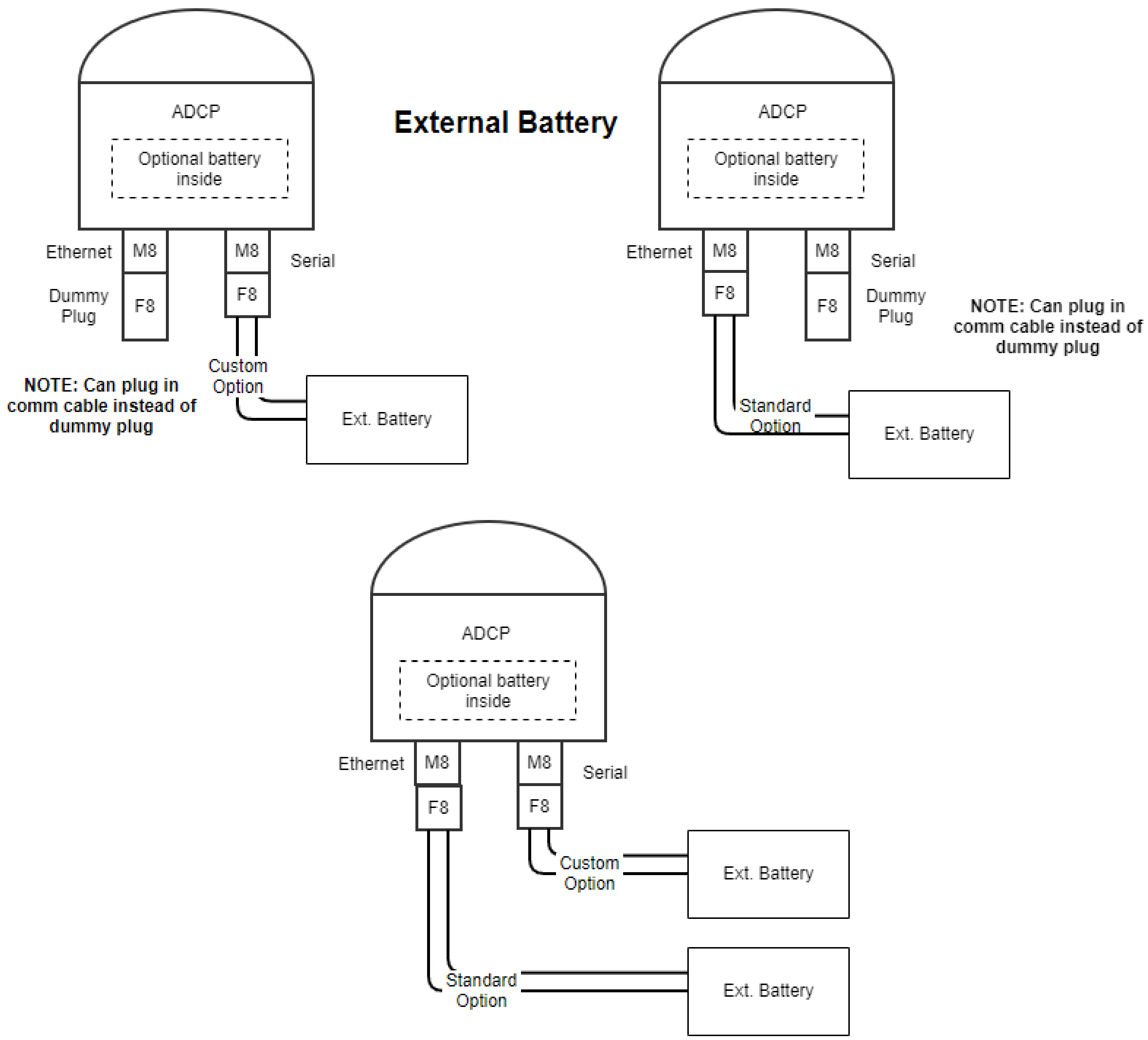


Figure 8. External Battery Pack Connection

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.

The Power/Communications cable connects the ADCP to the computer. The transducer-end connector is molded on, so you can use it below the waterline. The cable is custom-made in lengths specified by the user. Route this cable so:

- You can install it with the connectors attached.
- 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 9).
- Secure all cables to the mounting structure in such a manor so that no forces are exerted on any connector. Secure the cable as close to the connector as possible without causing any stress to the connector.
- You can easily replace it if it fails.
- The wet-end connector is an Impulse MCIL-8-FS which is 2.09cm (0.82 inches) long, 0.62cm (0.24 inches) diameter.

You may also need to route the External Battery case cables.

Figure 9. Do not use Zip-Ties Directly on Cables

> When attaching the 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. **Protect the cables with hose if zip-ties are used.**

Cable Wiring Diagrams

This section has information on Workhorse Proteus 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 Workhorse Proteus cable locations, connectors, and pin-outs.

> Where shown, the color code is for reference only; your cable may be different.
>
> Where shown, IN refers to signals going into the ADCP and OUT refers to signals coming out of the ADCP.
>
> xxx is the cable length in meters.

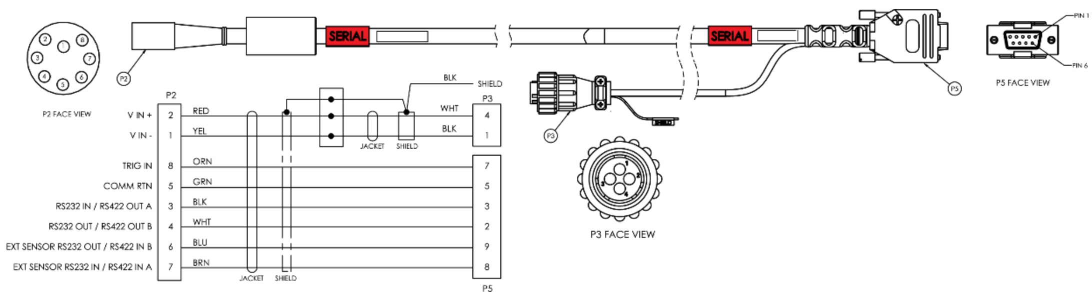


Figure 10. Serial Power/Comm Cable A73-6000-xxx Wiring

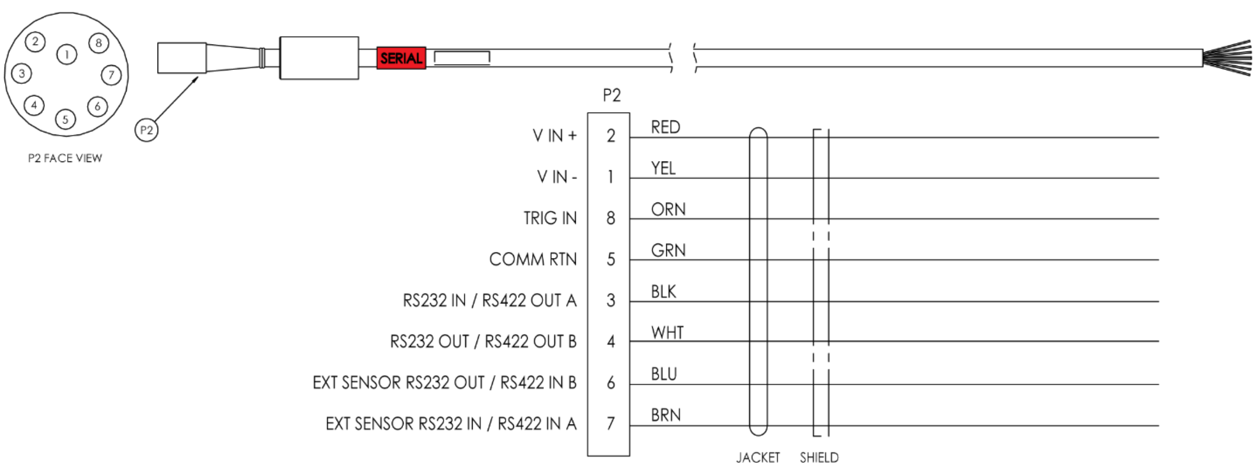


Figure 11. Serial Pigtail Power/Comm Cable A73-6001-xxx Wiring

> For reliable communications, the RS-232 cable to computer must be less than 25-meters length. For cables longer than 25-meters, use RS-422 communications.

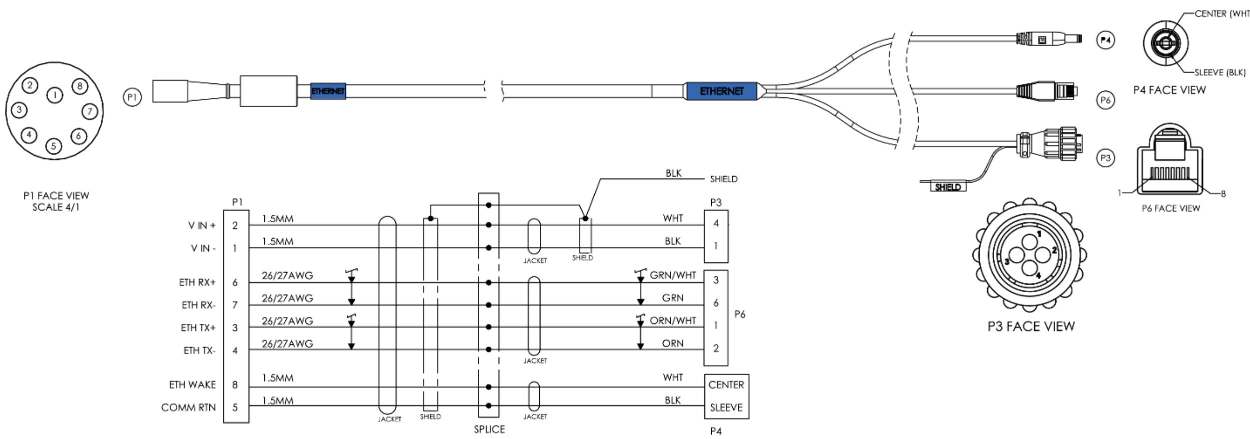


Figure 12. Ethernet Power/Comm Cable A73-6002-xxx Wiring

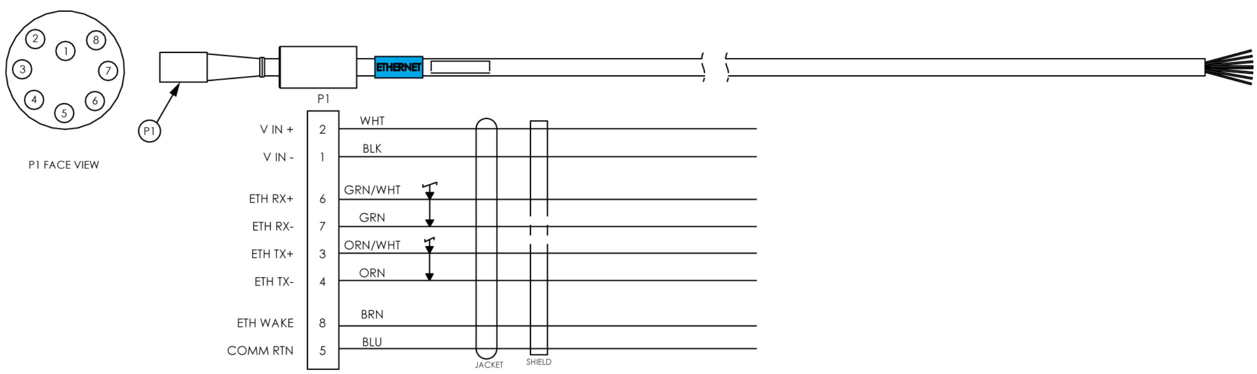


Figure 13. Ethernet Pigtail Power/Comm Cable A73-6003-xxx Wiring

Bottom Mounts

Bottom mounts can range from simple PVC frames to Trawl Resistant Bottom Mounts. Below is a sample of some of the types of bottom mounts available for Workhorse Proteus ADCPs.

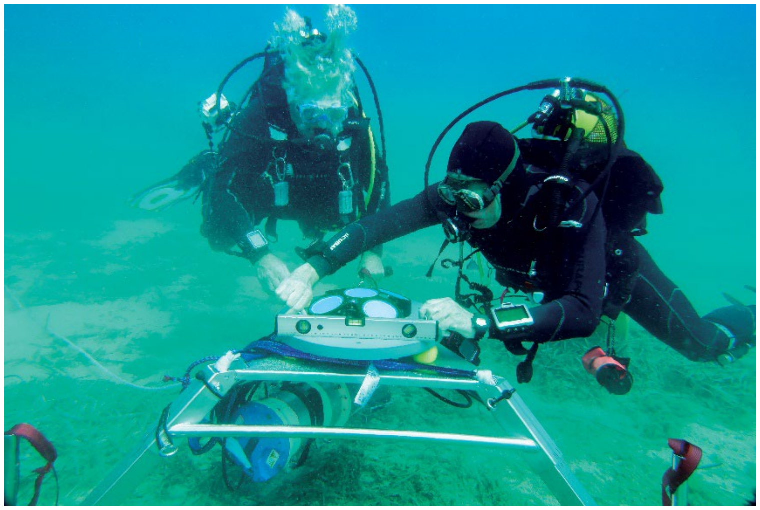


Figure 14. View from the Bottom

Photo courtesy of Loic Michel, Teledyne RD Instruments, France.

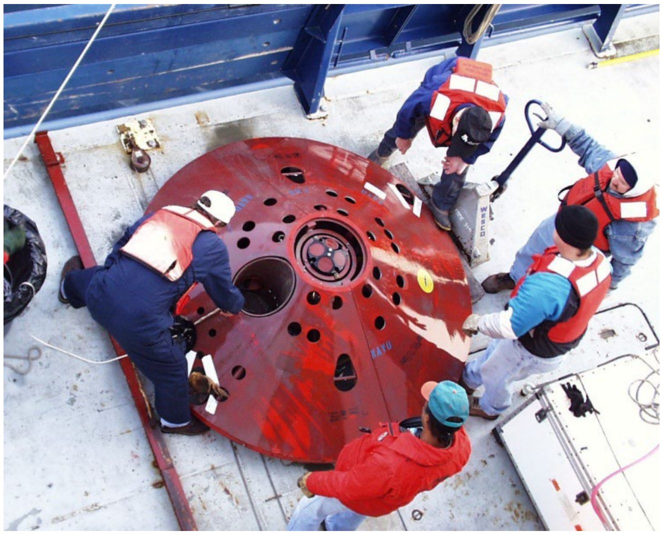


Figure 15. Trawl Resistant Bottom Mount

Photo courtesy of Maureen Wieler, Mooring Systems.

Buoy Mounts and Load Cages

Buoy mounts and load cage frames are designed to allow the Workhorse Proteus to profile unobstructed by the mooring hardware. Below is a sample of some the types of buoy and load cage mounts available for Workhorse Proteus ADCPs.

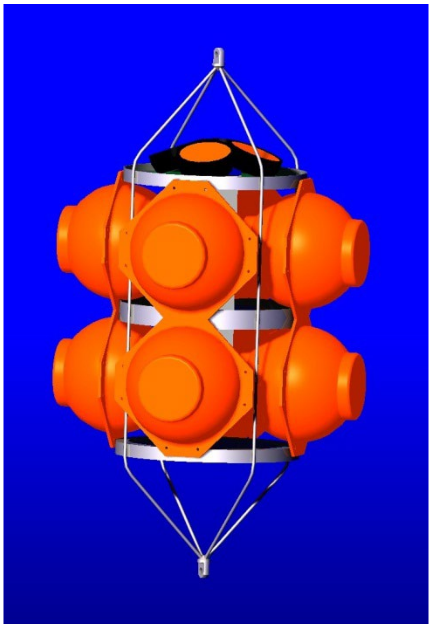


Figure 16. Deep-Water Mount

Photo courtesy of the Oceanscience Group.

Figure 17. Buoy Mount with External Battery

Photo courtesy of Maureen Wieler, Mooring Systems.

Figure 18. Load Cage

Photo courtesy of Angela Cates, UNM.

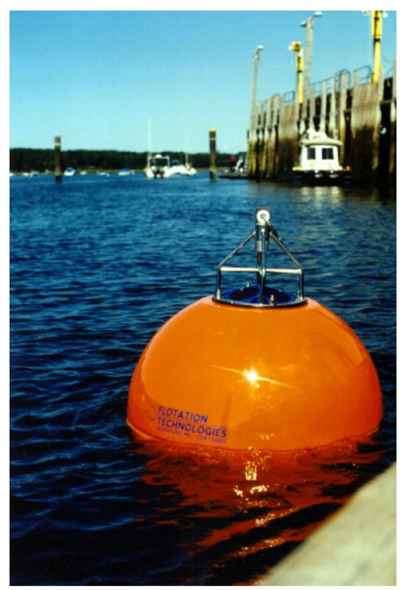


Figure 19. Buoy Mount

Photo courtesy of Flotation Technologies.

In-Hull Mounting

The in-hull mounted ADCP is common when it is intended to keep the system on a single vessel or when over-the-side mounting is not practical for your vessel. For this type of mounting, there are issues of beam clearance and access.

Transducer Head Mounting Considerations

You must consider several potential problems before installing the transducer head assembly. Read this section before deciding where to install the transducer assembly. See the outline installation drawings for specifications on our standard ADCP transducer heads.

Location

Ideally, you want to install the transducer head:

- Where it is accessible to remove biofouling.
- Away from shipboard protrusions that reflect ADCP energy. Allow for a reflection-free clearance of 15° around each beam (see the outline installation drawings).
- Away from other acoustic/sonar devices, especially those operating at the same frequency (or harmonic) of the ADCP.
- Close to the ship's fore-to-aft centerline. As distance from the centerline increases, vertical accelerations caused by the roll of the ship also increase. These accelerations can cause additional uncertainties in ADCP velocity measurements.

Other considerations may be:

- Ease of installation.
- Portability (wanting to move the instrument from vessel to vessel).
- Permanent installation.

With all these choices, there are good and bad points. We will show you several options for installation and then go through specific concerns that you may have to deal with once you install or mount the ADCP.

Sea Chest In-Hull Mounting

A sea chest (Figure 20) is a fixture that surrounds and holds the transducer head, protecting it from debris in the water. The bottom of the sea chest must be open to seawater to allow the acoustic beams to pass through freely. If using a sea chest interests you, call TRDI for the latest information.

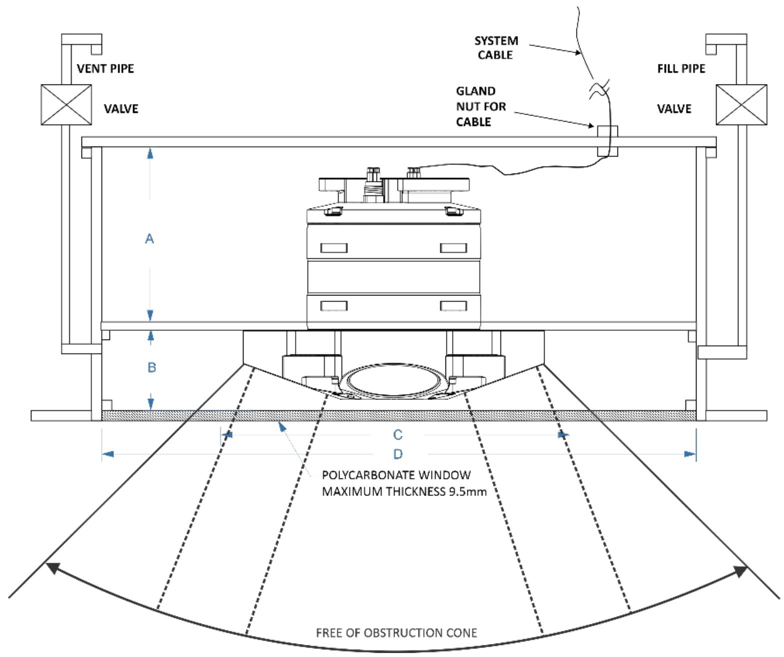


Figure 20. **Sea Chest In-Hull Mounting (Monitor 300 kHz)**

See the Outline Installation Drawings for dimensions.

Special Notes:

1. No liability is assumed by Teledyne RD Instruments for users using this conceptual well drawing. Users realize that this drawing is provided as a basis for the user to construct their own well. It is expected that the user will have their well design inspected and approved by a naval architect.
2. The top plate of the well is intended as the primary seal for the vessel. The window and transducer can provide additional seal but should not be considered the primary sealing mechanism for the vessel.
3. This conceptual well drawing is designed such that it would be possible to remove the transducer from beneath the vessel while in dry dock.
4. The gasket material between the transducer housing and the vessel flange should be used that will both seal and provide electrical isolation between the transducer housing and the vessel flange. Typical gasket material used is silicone rubber 3-6.35mm thick.
5. Inserts in the transducer housing mounting holes may be used to provide additional isolation from vessel.
6. The walls of the well should be coated with a material to absorb reflected sound in the well. The recommend material for both 300 and 600 kHz systems is Precision Acoustics F48 anechoic tile.
7. Vent and fill pipes should be above the water line of the vessel, and it is recommended that a gate valve be installed to seal off these pipes.
8. Window thickness should not exceed 9.5 mm of Polycarbonate material. Thinner Polycarbonate window is OK.
9. Window faces should be parallel to the transducer face to within 2 degrees for best performance; angle should never exceed 5 degrees.

Mounting Considerations

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

Orientation

TRDI recommends mounting the transducer head with the forward mark (see Figure 7, page 24) aligned with the vessel's bow. This will make Beam 3 rotated to a ship-relative angle of 45°. This causes the magnitude of the signal in each beam to be about the same. This improves error rejection, reduces the effect of ringing (see Acoustic Isolation), and increases the ADCP's effective velocity range by a factor of 1.4. If you align Beam 3 at an angle other than zero, you must nullify this offset. You can do this using a direct command (see EA – Heading Alignment) or through the *VmDas* program.

Use the ship's roll and pitch reference to mount the transducer head as level as possible. If the head is not level, depth cell (bin) mapping will be incorrect. Large misalignments can cause large velocity measurement errors. If you cannot mechanically make the transducer head level, you can use *VmDas* to enter offset values for roll and pitch.

Fairing

Fairings are structures that produces a smooth outline and reduces drag or water resistance. The fairing also diverts floating objects away from the transducer. A fairing that is shaped like a teardrop, sloped such that the leading edge (closer to the bow) is higher than the back edge, and extends below the hull (typically 12 inches) will divert the air bubbles away from the transducer faces.

Acoustic Window

Acoustic windows can be used to produce overall performance improvements in vessel-mounted ADCPs. Additionally, if the ship operates where there is danger of barnacle damage or a high density of ice or other floating objects, then the use of an acoustic window is the only option.

It is theoretically possible to use a window successfully; however, there are several advantages and disadvantages to consider before using an acoustic window.

Advantages

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

Disadvantages

- The range of the ADCP will be reduced because the window can and will absorb some of the transmit and receive energy.
- The transmit signal could be reflected into the well, causing the well to "ring" like a bell. This will cause the data being collected during the ringing to be biased. Some ships have reported a loss in range as great as 50 meters. The ringing may be dampened by applying sound absorbing material on the well walls, see Ringing.
- The transmit signal could be reflected off the window and back into the other beams.

Our experience has allowed us to put together some minimum specific recommendations:

Window orientation. The acoustic window should be flat and parallel to the transducer mounting plate. Note this is not an absolute requirement. However, if the water temperatures inside the window and outside the window are not the same, all four beams will be refracted, and actual velocity components will be rotated into a new coordinate system. In particular, some of the horizontal velocity will appear as a vertical velocity.

Window material. Important acoustic properties of the window include acoustic refractive index (which should be as close as possible to that of water), insertion loss (which should be as small as possible) and speed of sound. There are two acoustic refractive indices: one for shear waves and one for plane waves. The acoustic refractive indices are simply the ratios of speed of sound in water to speed of sounds in the material. Insertion loss combines absorption and reflection of sound, and it depends on both the thickness and the material properties of the window. In particular, you should avoid using window thickness equal to odd multiples of shear mode quarter-waves (Dubbelday and Rittenmeyer, 1987; Dubbleday, 1986). Refer to Selfridge (1985) and Thompson (1990) for more information. Note that the speeds of sound in plastics decrease with increasing temperature and that causes the resonant frequencies to shift. This can be a large effect. Neither Selfridge nor Thompson has much information on the temperature coefficients of sound speeds.

Our experience has shown that Polycarbonate windows are very good for the Workhorse Proteus. The thickness of the materials depends on the frequency you intend to use. Table 1 will help to choose the maximum thickness you should use.

One concern with window selection is that it be able to support the weight of the water inside the well once the ship is dry-docked. TRDI recommends that you always fill/drain the well at the same time you are either filling/draining the dry dock area.

Table 1: Window Thickness

Frequency	Recommended Thickness	Maximum Thickness
300	0.375 inches	1 inch
600	0.25 inches	0.5 inches
1200	0.25 inches	0.5 inches

Spacing between window and transducer. The primary geometrical factor in design of windows is the reflection of one beam into another beam, causing crosstalk between the beams. The optimum distance for the bottom of the transducer assembly from the window is 0.25 inches ±0.125 inches.

Window aperture. The window aperture must be sufficient to pass the beams without causing diffraction. If the window is placed next to the transducer, then the aperture diameter should be the same as the distance between transducer cup corners. If the window is placed away from the transducer, then the aperture should be larger than all four beams plus about one transducer ceramic diameter.

Free Flow and Windows

If filling and draining the well is an issue, then you may want to use a window but allow the water to freely exchange from outside the well to inside the well.

Our Japanese representative uses 0.25 inch thick Low Density Polethylene (LDPE). He then drills two 30mm holes in the window along the edges. The inside walls are painted with anti-fouling paint. This allows the water to be full of anti-foulant during the time the ship is docked, which is when the barnacle growth occurs. The holes allow the water to exchange when the ship is in motion and allows for draining when the ship is dry-docked (a 0.25" window will not support the weight of the water). He has never had a failure with the window and has seen only a minimal loss in range (5-30 meters).

It is best if the window is parallel to the bottom edge of the transducer cups. The transducer cups are at a 20° angle. If the window is at an angle to the transducer, it will change the absorption. We do not have experience with different angles, but we have had customers use domes or have the window follow the contour of the ship bottom without real problems.

The optimum distance for the bottom of the transducer assembly from the window is 0.25 inches ±0.125 inches. Never allow the transducer to touch the window. The farther away the transducer cups are from the window, the more the sound is reflected off of one beam and then reflected into another beam.

Acoustically-absorbing sea chest liner. A sound absorbing material should be used inside the well to minimize the effects of sound ringing within the well. The recommend material for both 300 and 600 kHz systems is Precision Acoustics F48 anechoic tile.

Fluid in the sea chest. If you have not placed holes in the window and you are not going to work in an area where freezing is an issue, then the sea chest should be filled with fresh water. Fresh water decreases the issues of corrosion in the sea chest. If you will be in an area where freezing of fresh water would be an issue, then seawater can be used.

Only use Propylene Glycol and not Ethylene Glycol because the latter can harm the transducer urethane over time.

Some users have placed Propylene Glycol into the fresh water well to prevent freezing. TRDI recommends using a 40% Polypropylene Glycol + 60% freshwater mixture or 10% Polypropylene Glycol + 90% freshwater mixture depending on the water freezing temperature. Although this causes the water to have an inverted speed of sound (SoS) change to that of fresh water or salt water, SoS does not impact 2D velocities on a Phased Array Transducer.

You will have to perform post processing on the data sets from the Workhorse Proteus. It must have the velocity data scaled properly based on the speed of sound in the sea chest. Propylene glycol causes the water to have an inverted speed of sound change to that of fresh water or salt water. This means that TRDI's standard software programs will not be scale the data properly. You will have to record separately the speed of sound in the sea chest and then in post processing correct the ADCP velocity data appropriately.

Transducer calibration. The factor used to correct velocity for speed of sound variations should be based on the speed of sound of the fluid inside the sea chest. Changes of speed of sound resulting from temperature changes may be computed from the temperature sensor on the transducer.

Air Bubbles

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

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

If you use locally made or existing extension hardware instead of the hardware available from TRDI, you may need to make an adapter plate to connect your hardware to our transducer head. See the Outline Installation Drawings for the dimensions and layout of the transducer head bolt holes for your system.

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

Flow Noise

Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the ADCP. You can reduce the flow across the transducer faces with a sea chest, fairing, or acoustic window.

Corrosion

The Proteus ADCP is made of plastic and uses titanium bolts. Although the plastic ADCP will not corrode, the bolts may corrode. Plan regular inspections of mounting hardware for signs of corrosion. Replace any parts that are questionable (corrosion can be further reduced if the well is covered with a window and then filled with fresh water).

Ringing

The ADCP transmits an acoustic pulse into the water. The main lobe of this pulse bounces off particles in the water and the signals returned from these particles are used to calculate the velocity of the water.

As stated, the main lobe of the transmitted pulse is what we are using to process and calculate a velocity. The transmitted pulse, however, is made up of many side lobes off the main lobe. These side lobes will come in contact with transducer beam itself and other items in either the water or the well.

The energy from the side lobes will excite the transducer and anything bolted to the transducer. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. We refer to this as "ringing."

If the ADCP is in its receive mode while the transducer is ringing then it will receive both the return signals from the water and the "ringing." Both of these signals are then processed by the ADCP. The ringing causes bias to the velocity data.

All ADCPs "ring" for some amount of time. Therefore, each ADCP requires a blanking period (time of no data processing) to keep from processing the ringing energy. Each ADCP frequency has a different typical ringing duration. The typical ringing period for each ADCP frequency is as follows; 300kHz ADCPs is 2 meters, 600kHz ADCPs is 1.5 meters, and 1200kHz ADCPs is 0.8 meters. These typical ringing values are recommended as the minimum setting for all ADCPs using default set ups.

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

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

The recommend material for both 300 and 600 kHz systems is Precision Acoustics F48 anechoic tile.

Acoustic Isolation

Try to minimize the acoustic coupling between the transducer head and the ship. Without adequate acoustic isolation, the transducer output will "ring" throughout the ship and feeds back into the ADCP receive circuits. Ringing causes bias errors in water-track velocities and results in the loss of data in the closest depth cells (bins). Reflections inside a sea chest with an acoustic window also can cause ringing.

You can attain acoustic isolation several ways. At a minimum, use gaskets to isolate all contact points between the ship and the transducer head. Design your installation for:

- A minimum number of contact points between the transducer head and the ship.
- Minimal contact area.
- Single points of contact for positioning and support (when possible).

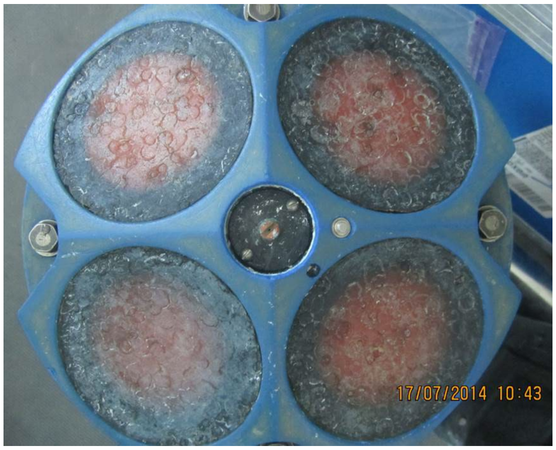
You also should try to separate the transducer head from the ship using intermediate connections. This is because direct connections transfer the most acoustic energy.

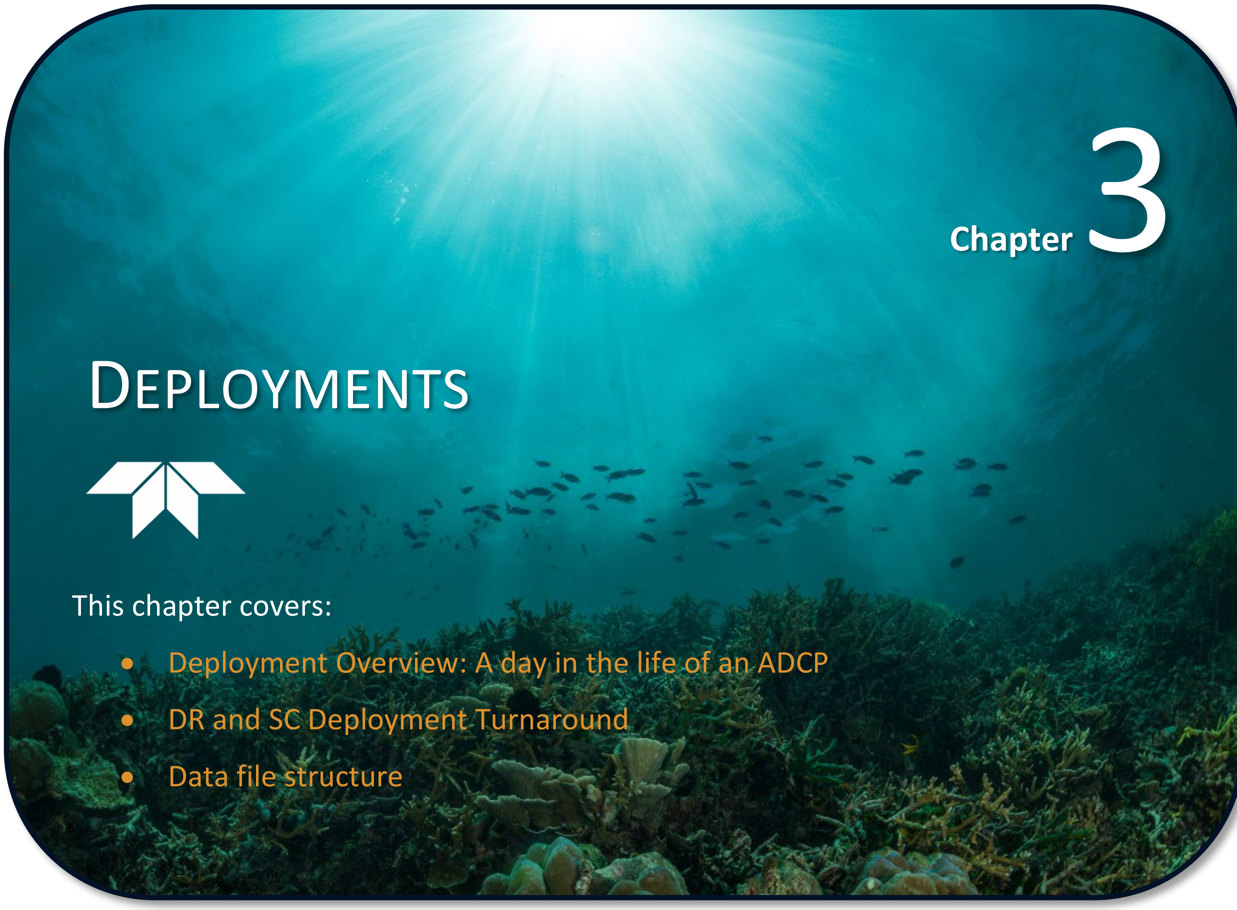
Maintenance

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

Vessel mounted ADCPs are subject to biofouling. Soft-bodied organisms usually cause no problems, but hard barnacle shells can cut through the urethane transducer faces causing transducer failure and leakage into the ADCP.

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





Chapter 3

DEPLOYMENTS

This chapter covers:

Deployment Overview: A Day in the Life of an ADCP

Prior to Going to Sea:

- Uncrate, inspect, basic communications established.
- Mount into deployment hardware.
- Apply antifouling paint (some users apply it before mounting).
- Calibrate the compass. Workhorse Proteus system are obviously big and heavy, most users have or build a jig to accomplish this.
- The deployment plan may be loaded now.

Travel to Ship:

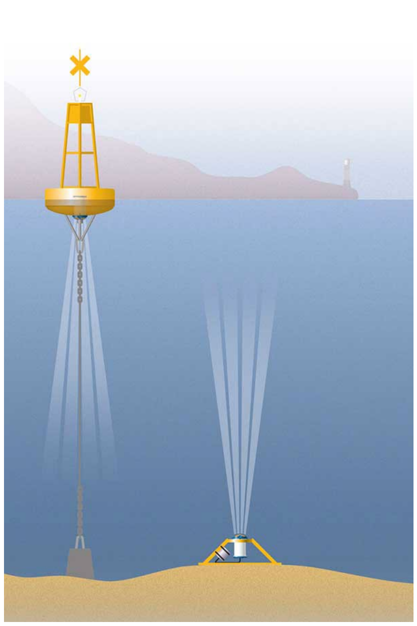
- If by air, likely to transport in unpressurized cargo hold where temperatures gets to -40 and below.
- If by sea, likely to transport in container where temperatures can get over +45C.

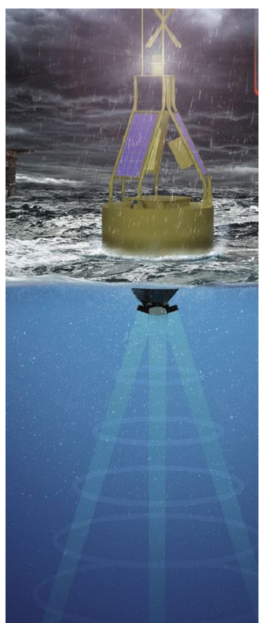
Deployment on surface buoy looking down

When ready for deployment, mount into surface buoy. Any mounting hardware that has been removed since the compass calibration needs to be mounted in a repeatable way.

If it was not loaded previously, the instrument is configured and deployed now. The LED should be blinking to indicate the following:

- Direct read operations:
  - Data on serial port or Ethernet port
- Self-Contained Operations:
  - CS command sent, system to ping immediately



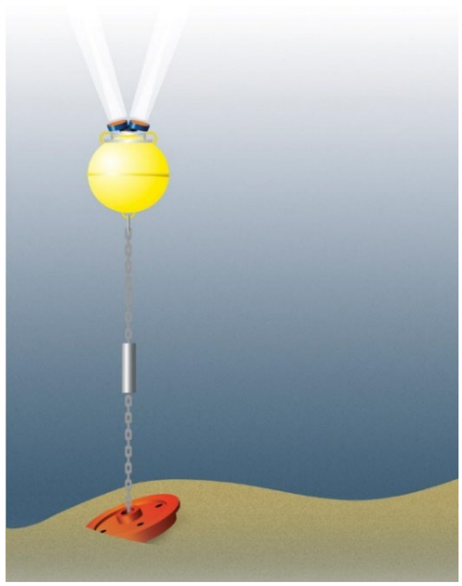


In the classic, surface use case, the ADCP is mounted in a load cage and integrated into a surface buoy. It is typically powered by 12V batteries (marine deep-discharge batteries) which are recharged by solar cells.

Deployment at mid-depth on a mooring looking up or down.

Similar to surface mooring, except now the Workhorse Proteus is one of the instruments attached to the line after the surface buoy has been deployed.

Typically, the mooring line will be parted and attached to a load cage at the top and bottom. The load cage will usually have flotation included. If the mooring line is parted, and there are inductive communications planned for instruments below the Workhorse Proteus, then an insulated cable needs to connect the mooring line across the cage.



Deployed:

If real time or near real time communications are planned for the mooring, they will be tested before the vessel steams away. If necessary, a workboat might be deployed to the surface buoy to assist with this.

Deployments generally last a year. Sometimes shorter if they are near enough to shore, but R/Vs are expensive and generally not available for long runs if the mooring is far from shore.

Anything that casts a shadow in the ocean will eventually attract fish. And fish will attract fishing boats. The fishing boats will often drag lines and/or nets over the mooring line as they attempt to capture the fish down there, so anything on the mooring line needs to either shed or cut those entanglements – which otherwise can easily pull them off the line.

Mooring Recovery

The acoustic release is fired (using the redundant release if necessary) and the mooring recovered in basically the same order as above: the surface buoy is pulled aboard, and the mooring line run through the crane davit. The line is then brought in, stopping periodically for the mooring party to pull the instruments and flotation in and detach them one by one. The anchor is left on the bottom.

The data is downloaded and, if the instrument is to be redeployed, the batteries changed.

The compass cannot be recalibrated at sea. Traditionally our users have allowed no more than one battery change before returning the instrument to shore for maintenance. A post deployment calibration is then used to back calibrate the second deployment.

Mooring through ice

Biggest difference from above is that the anchor is deployed first through the ice, then the instruments attached, then the surface float. It has to be this way because the mooring cannot pay out behind the vessel. This is even more dangerous because from the moment the anchor is attached until the surface flotation is released the line is under tremendous pressure.

Bottom mount, open ocean

The instrument is mounted into appropriate hardware (trawl resistant or not) with some means of recovery (either a marker buoy or an acoustically released pop-up buoy). It can either be lowered to the bottom with a crane or, occasionally, simply dropped. The bottom mount will be recovered with the instrument (though weights might be dropped).

Bottom mount, under ice

Usually these are at high latitudes where beaching icebergs might be a concern. The idea is to get them as low in the water as possible and, basically, hope for the best. Since compasses are often unreliable at high latitudes they are generally not used. Instead, the ADCP will be mounted in such a way that it cannot rotate, and the heading corrected by either prior knowledge of the predominate tidal direction(s) or by deploying them with a heading device that does work at high latitudes mounted to the bottom mount while it is deployed and then recovered for use elsewhere. In the latter, it is assumed that the instrument and mount are not moved during the deployment.

Direct-Reading Turnaround

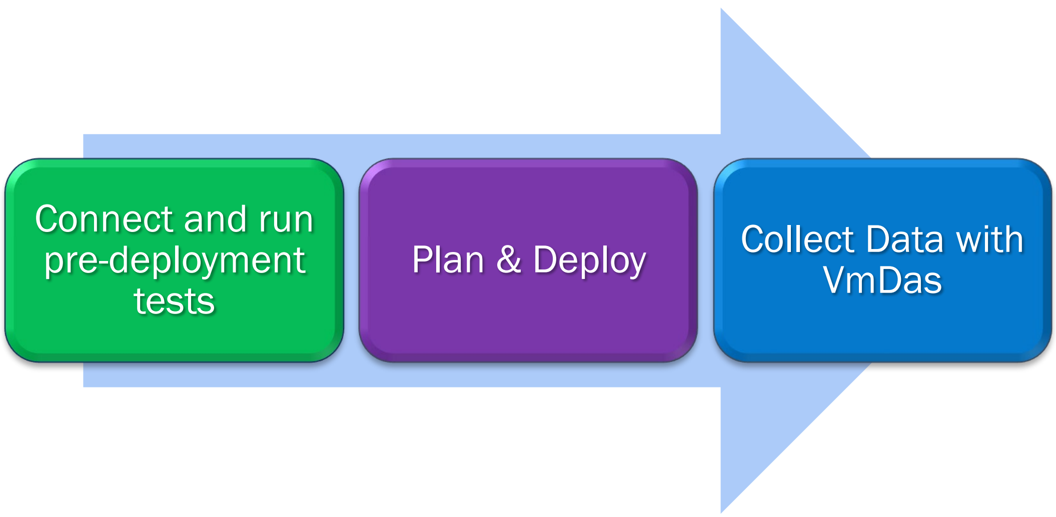
Direct-Read deployments in real time collect, view, and process data collected using the *VmDas* software that is included as part of the ADCP Utilities software.

The typical Direct-Reading deployment involves the following tasks:

1. Connect to the Workhorse Proteus ADCP using *ADCP Utilities*. Use *ADCP Utilities* to run the pre-deployment tests.
2. Plan a vessel-mount deployment.
3. Click the **Deploy** button on *ADCP Utilities* and then choose *VmDas*.

- *VmDas* will start collecting data.

If needed, stop collecting data and modify any customized or specific VmDas settings. For example, there may be a need to turn on the use of GPS or an external heading/pitch/roll device or turn on data export. See the VmDas User's Guide by clicking on the Help menu. *VmDas* will remember the settings on the Data Options screens and use them each time data collection is started.



All real-time data is collected, viewed, processed, and played back using *VmDas*.

When using the Vessel Mount wizard, no data is recorded to the Workhorse Proteus's internal recorder. Data is recorded to the *ADCP Utilities* working folder.

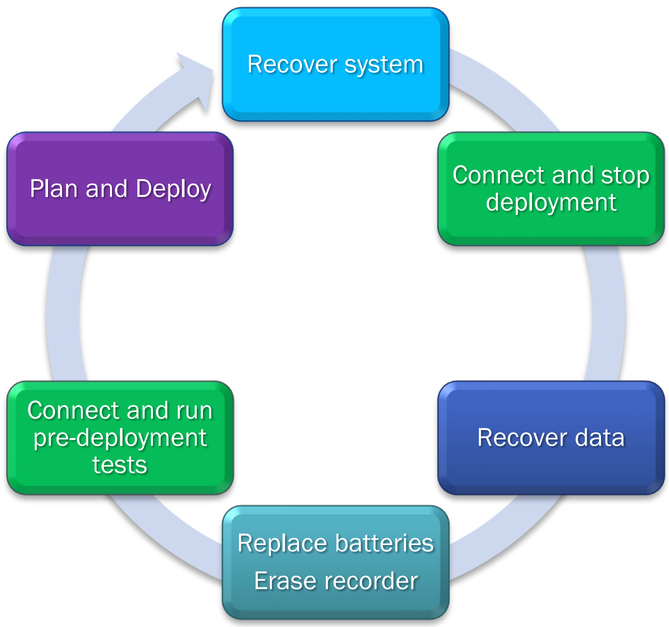
For information on Direct-Reading deployments, see the *ADCP Utilities* help file and the Deployment Guide. For information on *VmDas*, see the VmDas User's Guide.

Sentinel Turnaround

The Workhorse Proteus Sentinel ADCP allows for turn-around time of a mooring deployment well under 60-minutes. During a typical turn, the data needs to be transferred, the batteries replaced, and the system prepared to redeploy.

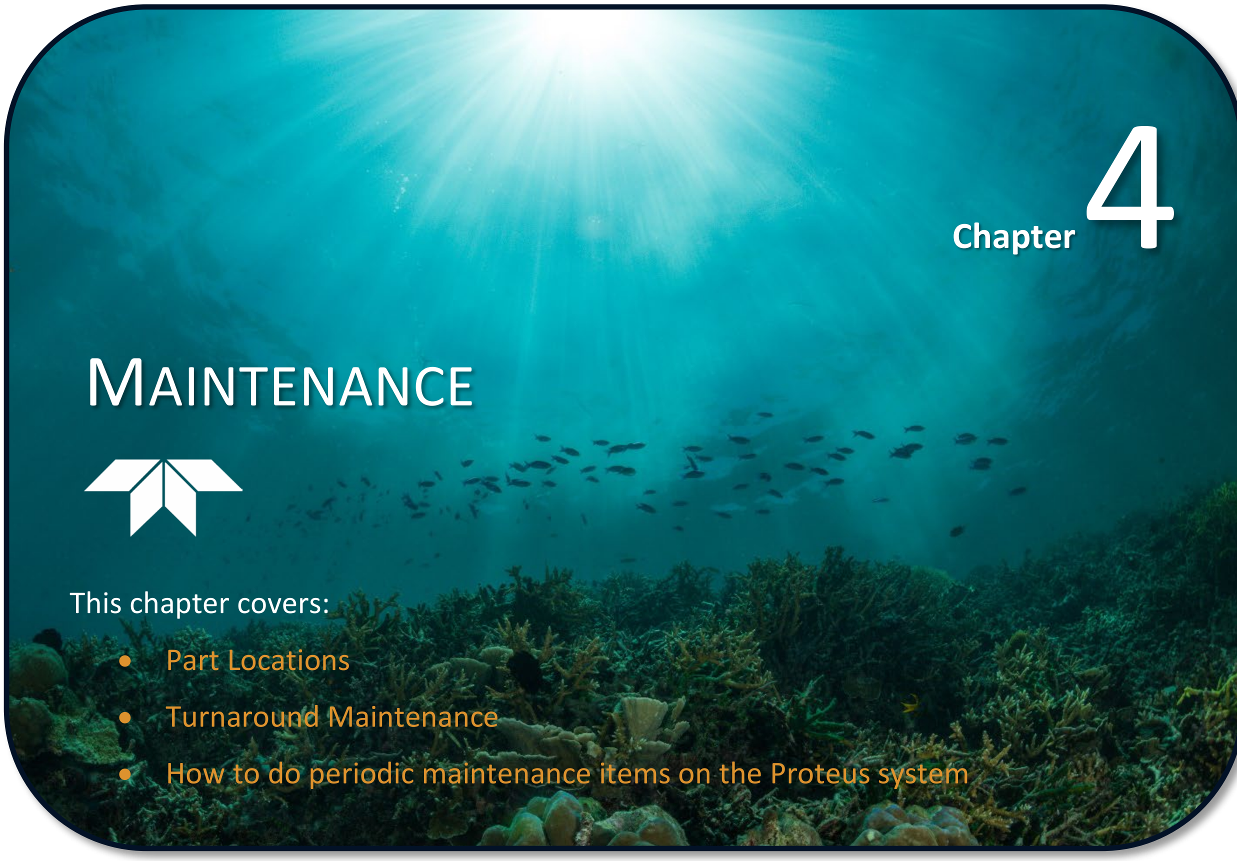
The Sentinel deployment typical turn-around involves the following tasks:

1. Recover the ADCP to the deck of the support vessel.
2. Connect to the ADCP using *ADCP Utilities*. Download the data to the laptop.
    - It is recommended that all data is downloaded and verified before the memory card is erased.
3. Replace the batteries.
4. Erase the memory card recorder using *ADCP Utilities*.
5. Close the Sentinel housing and run the pre-deployment tests.
6. Plan the deployment with *ADCP Utilities* and redeploy the ADCP.



Sentinel data is viewed, processed, and played back using *ADCP Utilities*.

For information on Self-Contained deployments, see the *ADCP Utilities* help file and the Deployment Guide.



Chapter 4

MAINTENANCE

This chapter covers:

- Part Locations
- Turnaround Maintenance
- How to do periodic maintenance items on the Proteus system

Parts Location Drawings

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

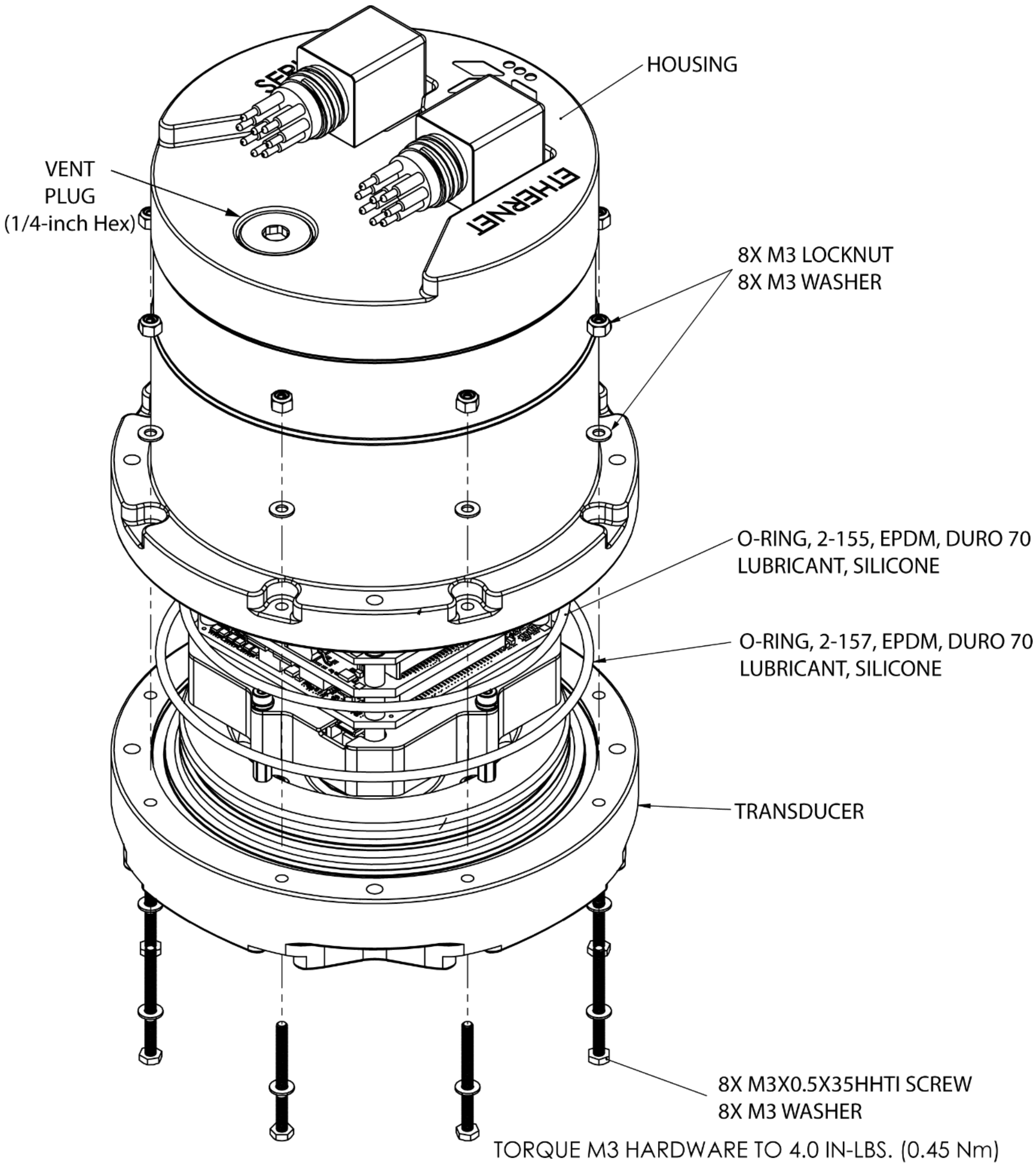


Figure 21. 1200 KHz Direct-Reading Parts Location

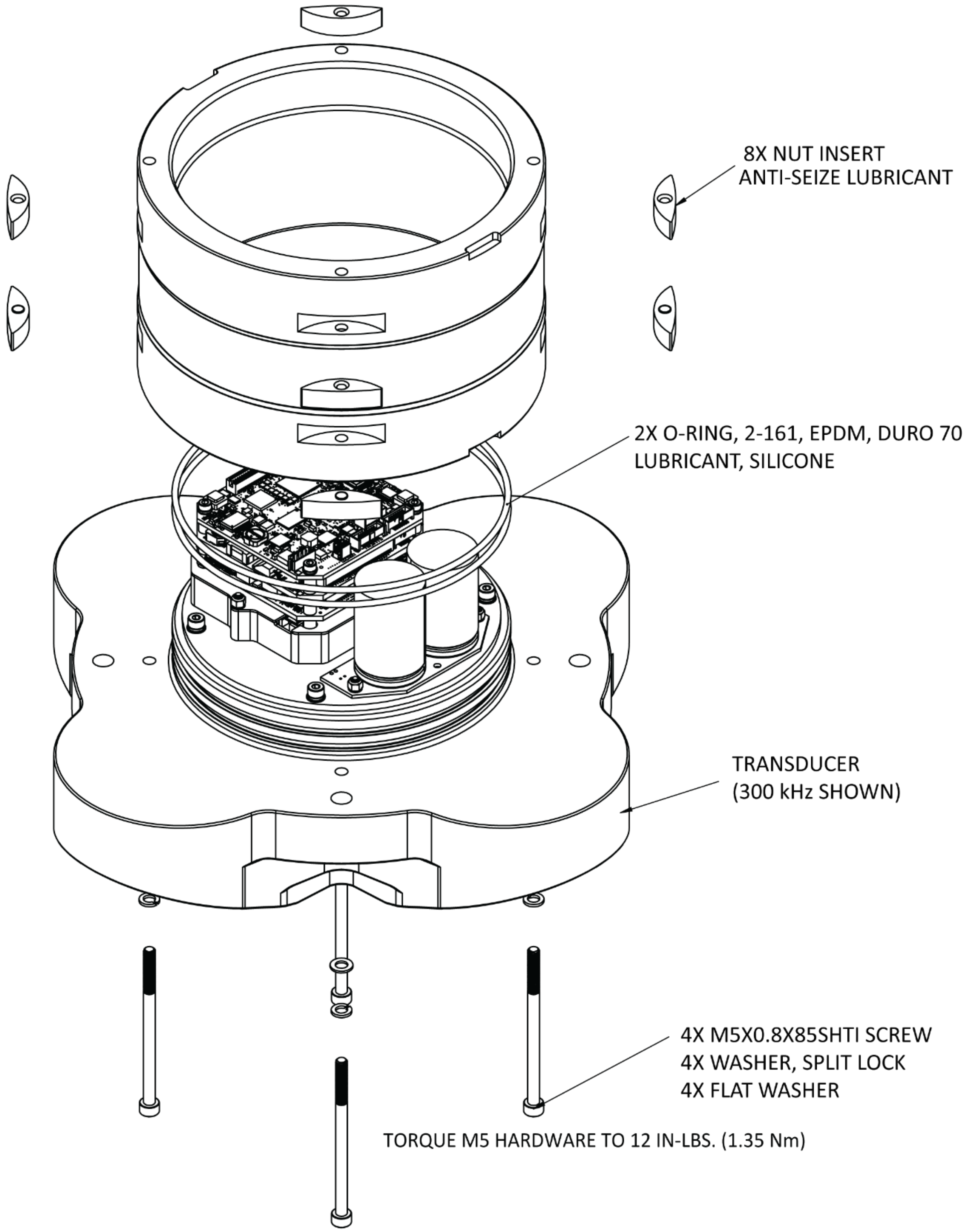


Figure 22. 300/600 kHz Direct-Reading Parts Location – Housing

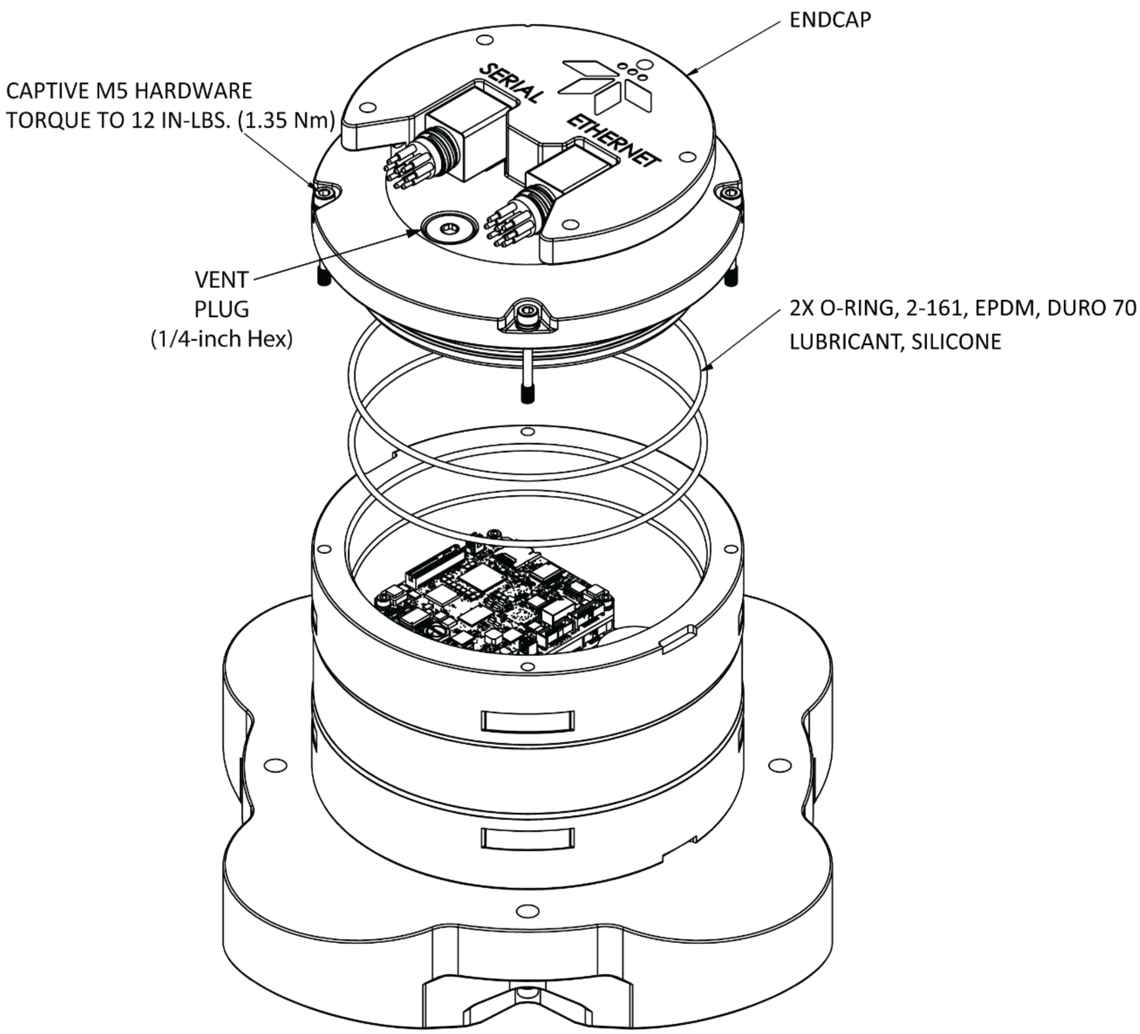


Figure 23. 300/600 kHz Direct-Reading Parts Location – Endcap

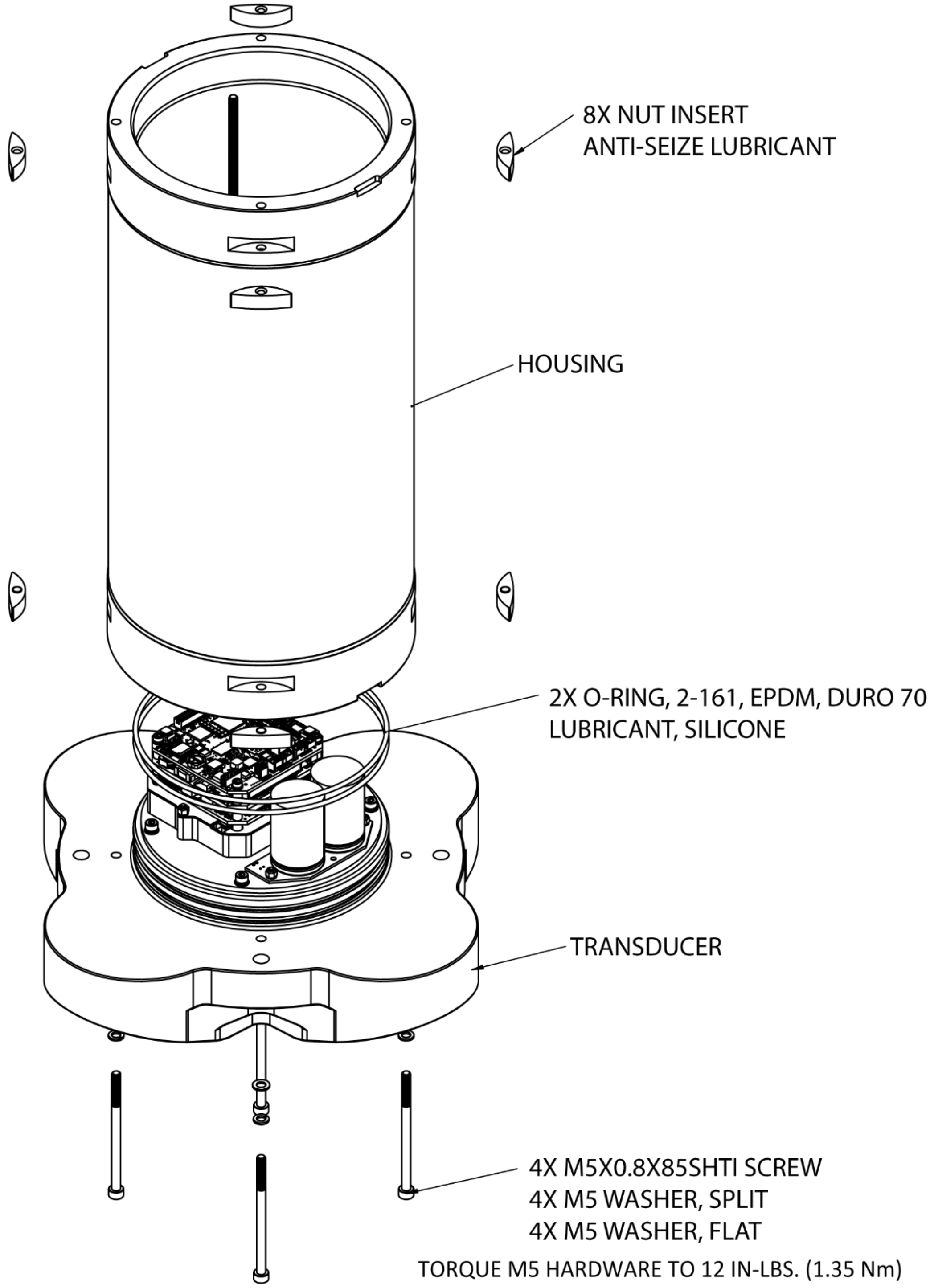


Figure 24. 300/600 kHz Self-Contained Parts Location – Housing

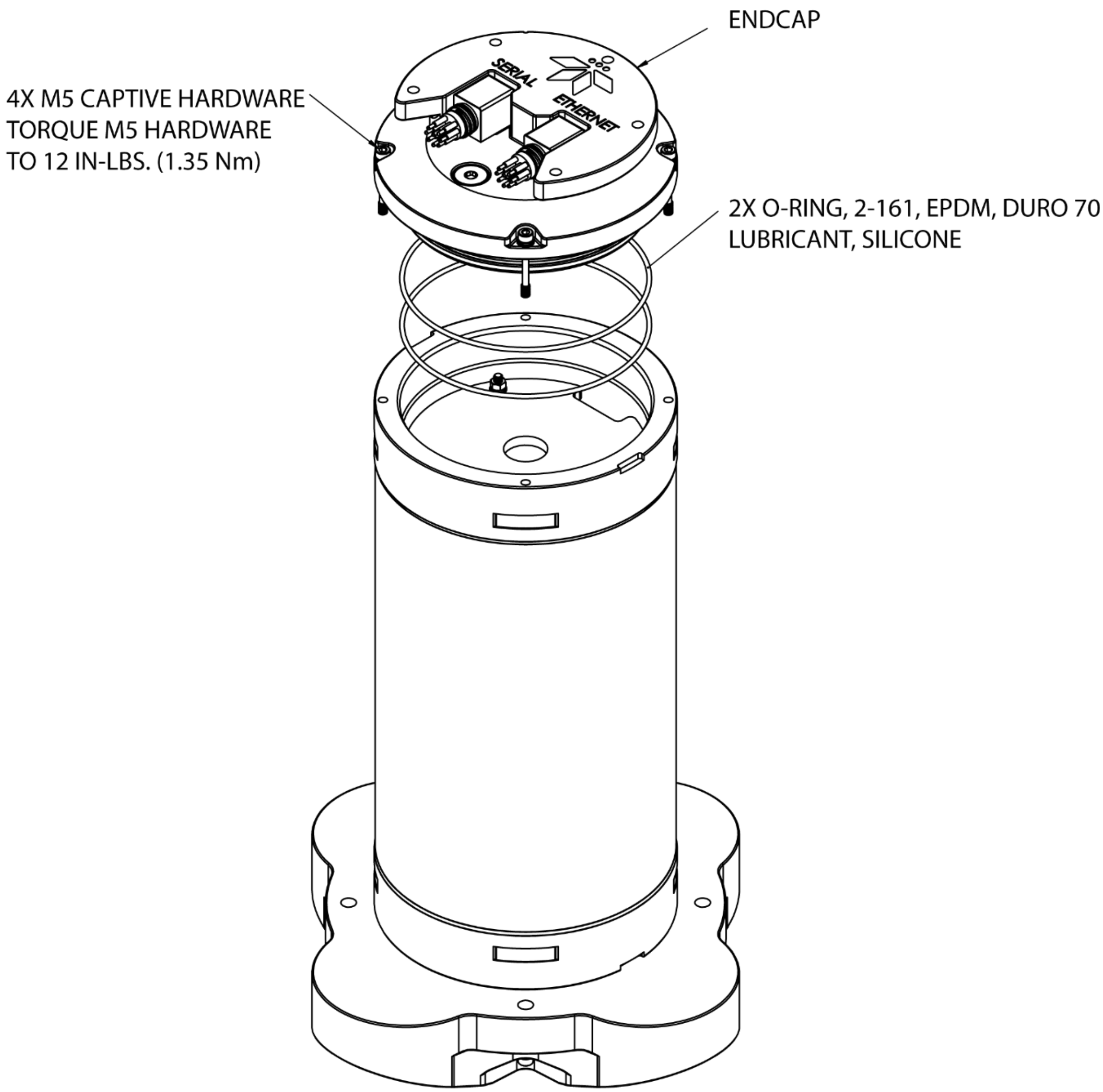


Figure 25. 300/600 kHz Self-Contained Parts Location – Endcap

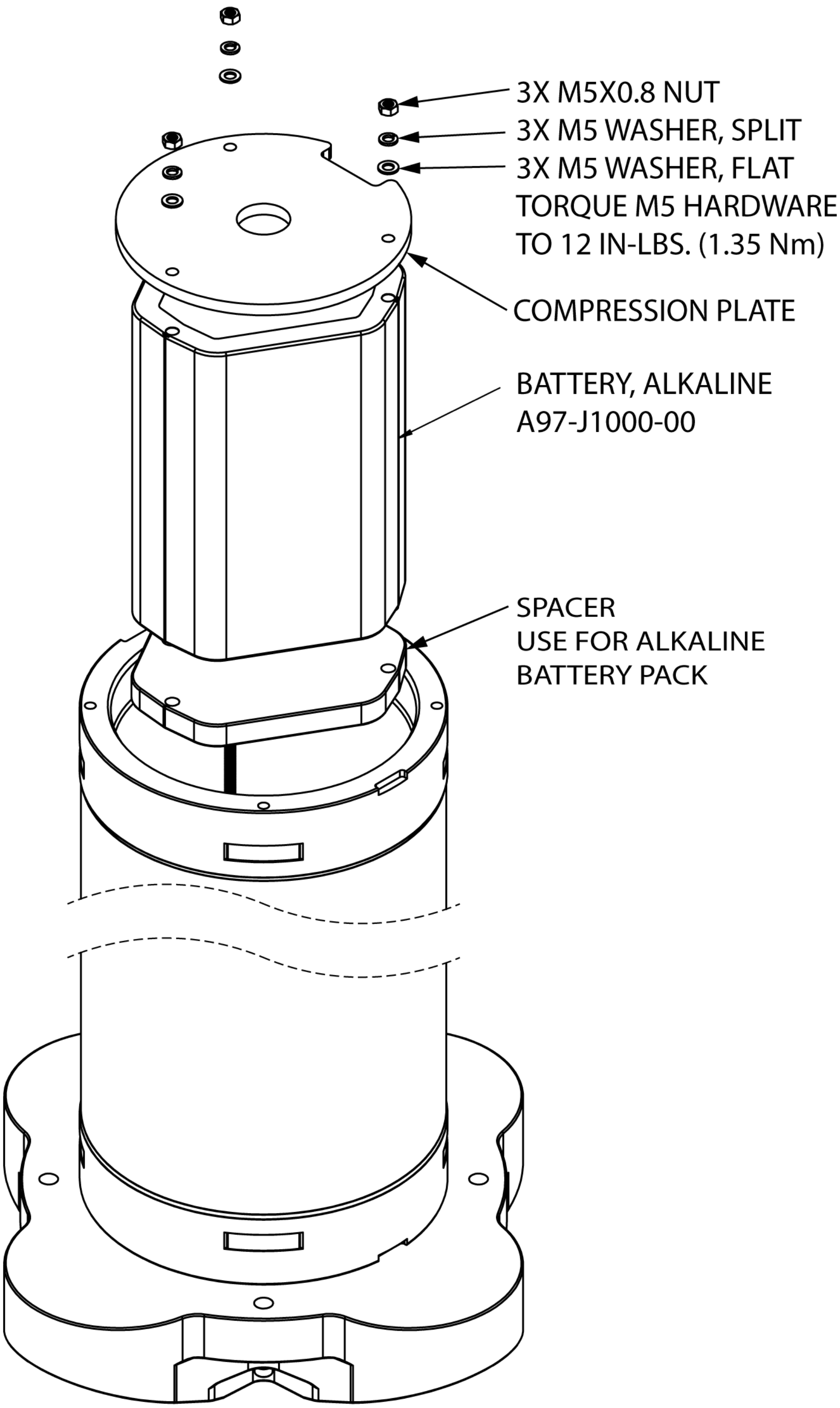


Figure 26. 300/600 kHz Self-Contained Parts Location – Battery

Spare Parts Kits

Table 2. A75K6000-00 KIT, TOOLS AND SPARES, WHP300/600 SENTINEL and MONITOR

Part Number	Description	Qty
84Z-6000-00	TOOL BAG, CANVAS	1
2-161-EPDM-70	O-RING, 2-161, EPDM, DURO 70	4
97Z-6084-00	O-RING, 2-015 .070DIAX.551 ID, EPDM, DURO 90A, VENT PLUG	2
97Z-6084-01	O-RING, 3-904, .072DIAX.351 ID, EPDM, DURO90A, VENT PLUG	2
5020	SILICONE LUBRICANT	1
A81-4007-00	NUT INSERT, HOUSING, TITANIUM, WHP	4
DES1	DESICCANT, SEALED BAG, 1/2 UNIT MIL PAK	4
DES2	DESICCANT, SEALED BAG,1/3 UNIT	
Z97-E1004-00	TOOL HEX KEY, 1/4IN, BALL END	1
Z97-E1005-00	TOOL HEX KEY, 4MM, BALL END	1
Z97-F1006-00	WAKE DEVICE, ETHERNET	1
A73-3001-00	CABLE, POWER ADAPTER, 206430-2 CONN TO BANANA PLUG	1

Table 3. A75K6001-00 KIT, TOOLS AND SPARES, WHP1200 MONITOR

Part Number	Description	Qty
84Z-6000-00	TOOL BAG, CANVAS	1
97Z-6084-00	O-RING, 2-015 .070DIAX.551 ID, EPDM, DURO 90A, VENT PLUG	2
97Z-6084-01	O-RING, 3-904, .072DIAX.351 ID, EPDM, DURO90A, VENT PLUG	2
5020	SILICONE LUBRICANT	1
DES2	DESICCANT, SEALED BAG, 1/3 UNIT	2
2-157-EPDM-70	O-RING, 2-157, EPDM, DURO 70	1
2-155-EPDM-70	O-RING, 2-155, EPDM, DURO 70	1
M3X0.5X35HHTI	SCREW, HEX HEAD, TITANIUM GRADE 2	8
M3WASHSTDTI	WASHER, FLAT 7MM OD, TITANIUM GRADE 2	16
M3X0.5LOCKNUTTI	NUT, NYLON INSERT, LOCK, TITANIUM GRADE 2	8
Z97-F1006-00	WAKE DEVICE, ETHERNET	1
A73-3001-00	CABLE, POWER ADAPTER, 206430-2 CONN TO BANANA PLUG	1

Maintenance Schedule

To ensure that you continue to receive optimal results from your Teledyne RD Instruments product(s), TRDI recommends that every 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.

Maintenance Items

Inspect the ADCP to spot problems:

Item	TRDI Recommended Period
Transducer Beams	The urethane coating is important to 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 27). **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. For example, when replacing the battery, the end-cap is removed. Replace the end-cap O-rings each time the end-cap is removed. **TRDI recommends you use new O-rings if you are preparing for a deployment.**
Housing and End Cap	Inspect for damage and replace as needed before each deployment.
Hardware (bolts, etc.)	Check all bolts, washers, and split washers for signs of corrosion before each deployment. **TRDI recommends replacement after every deployment or once per year whichever is longer. Damaged hardware should never be used.**
Cables and Connectors	Check the end-cap Power/Comm connectors for cracks or bent pins (see Figure 28) before each deployment. 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.

Figure 27. Transducer View

Figure 28. End-Cap View

Disassembly and Assembly Procedures

This section explains how to remove and replace the end-cap to gain access to the batteries. Read all instructions before doing the required actions.

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.

To remove the end-cap:

1. Dry the outside of the ADCP.
2. Disconnect the Power/Comm cables and install the dummy plugs.
3. Stand the ADCP on its transducer faces on a soft pad.
4. Inspect the housing and end cap bolts for any signs of damage.
5. To avoid any possible injury, it is ALWAYS recommended to vent the system:

   Use the Vent Plug to vent the system before opening the housing. Using a ¼" hex key, 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 opening the housing.
6. Once you are sure that there is no internal pressure, fully loosen the captive M5 hardware from the end-cap. Note that the 1200 kHz Proteus uses a one-piece housing with M3 hardware. See the Parts Location Drawings for details.
7. Carefully pull the end-cap away from the housing until you can gain access to the connector jacks.
8. Disconnect the internal Power/Comm cable connectors. 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.

End-Cap Replacement

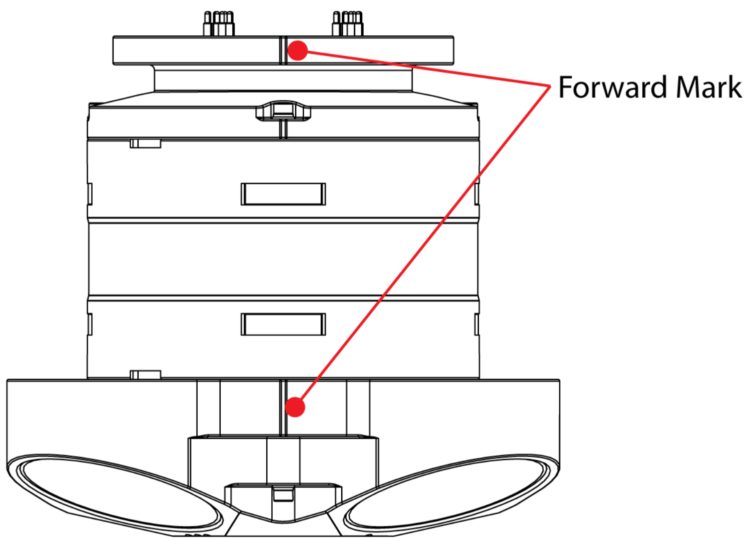
To replace the end-cap:

1. Stand the Workhorse Proteus on its transducer face on a soft pad.
2. Inspect, clean, and lubricate the O-rings on the end-cap. Apply a very thin coat of silicone lube on the O-rings.

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

Only a thin film of silicone lubricant should be applied to the O-ring such that a consistent, shiny gloss appears on the O-ring absent of clumps of grease.

3. Install a new desiccant bag (see Replacing the Desiccant Bags)
4. Connect the internal Power/Comm cable connectors.
5. Place the end-cap on the housing, aligning the mating holes and the forward mark on the end-cap with the forward mark 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 and bore O-rings remain in their retaining groove.



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

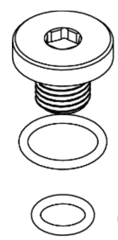
6. Examine the titanium captive end-cap assembly screws and washers for corrosion; replace if necessary. The Parts Location Drawings shows the assembly order of the end-cap mounting hardware. All the hardware items are needed to seal the Workhorse Proteus properly. Note that the 1200 kHz Proteus uses a one-piece housing with M3 hardware.
7. Install all four sets of hardware until “finger-tight.”
8. Tighten the bolts equally until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the O-rings evenly. Tighten the bolts to the recommended torque value of 12 pound-inches 300/600 kHz systems, 4 pound-inches 1200 kHz systems. See the Parts Location Drawings for details.

Apply equal pressure to the O-rings as you tighten the bolts. If one bolt is tightened more than the others, the O-rings can become pinched or torn.

Do not over tighten the bolts that hold the transducer, housing, and end-cap together. If you tighten too much, 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 bolts is 12 IN-LBS (1.35 Nm) for 300/600 kHz systems, 4 IN-LBS (0.45 Nm) for 1200 kHz systems.

9. Lubricate and inspect the Vent Plug O-rings. Place the lower 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.
10. Install the Vent plug until "finger-tight."
11. Using a ¼" hex key, tighten the Vent Plug to the recommended torque value of 35 IN-LBS (3.95 Nm).



Tighten the Vent Plug to the recommended torque value of 35 IN-LBS (3.95 Nm).

Replacing the Battery Packs

The Sentinel Proteus system uses battery packs to provide power. Batteries should be replaced when the voltage falls below 20 VDC. Battery voltage can be read using *ADCP Utilities*.

Workhorse Proteus batteries are shipped inside the ADCP but **not connected**. Connect the battery and seal the system before deployment.

To replace the battery pack:

1. Remove the end-cap (see End-Cap Removal Procedures).
2. Disconnect the battery cable going to the bottom of the end-cap.
3. Remove the compression plate by removing the M5 hardware.
4. Slide out the used battery.
5. Hold the cable harness up and out of the way of the battery packs. Lower the battery pack into the housing. Make sure the cable is not pinched by the battery pack.

Lithium battery packs are longer than alkaline packs. Remove the spacer at the bottom of the battery module when using Lithium batteries; Add the spacer when using alkaline batteries.

6. Install the compression plate using the M5 hardware. Torque the M5 nuts to 10.0 IN-LBS to hold the battery in place.
7. Connect the battery cable going to the endcap.
8. Install the end-cap (see End-cap Replacement).

Use the spacer for alkaline batteries, no spacer for Lithium.

Lithium Battery Packs

The optional Lithium Battery Packs can be used interchangeably in Sentinel Proteus systems. This battery pack is assembled using lithium battery cells that provide 23.4 VDC with a capacity of approximately 2100 Wh. The battery includes a safety circuit that protects the battery and users against short circuits.

Follow the instructions provided in Replacing the Sentinel Battery Packs when replacing the Lithium battery pack in a Sentinel system or the external battery case. The Lithium battery will fit on the posts the same as the alkaline battery.

Disposal of used battery packs should be done in accordance with applicable regulations, which vary from country to country. In most countries, trashing of used batteries is forbidden and disposal can be done through non-profit organizations mandated by local authorities or organized by professionals.

The optional Lithium battery packs are restricted to Cargo Aircraft Only. Do NOT return Proteus units with the optional Lithium battery pack installed.

Periodic Maintenance Items

Replacing the Desiccant Bags

Desiccant bags are used to dehumidify the housing interior. Desiccant is essential in deployments with plastic housings. The factory-supplied desiccant lasts a year at specified Workhorse Proteus 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 whenever you are preparing to deploy or store the Workhorse Proteus for an extended time.

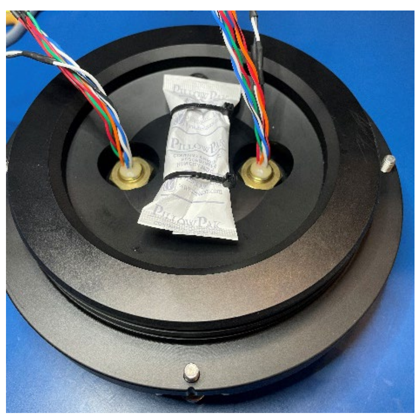
Do not open the desiccant bag. Contact with the silica gel can cause nose, throat, and skin irritation.

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 just before the deployment.

To replace the desiccant:

1. Remove the end-cap (see End-Cap Removal Procedures).
2. Remove the new desiccant bag and moisture indicator from the airtight aluminum bag.
3. Remove the old desiccant bag and zip tie a new one on the end-cap.



4. Install the end-cap (see End-Cap Replacement).

Cleaning the Thermistor Cover

To respond quickly to changes in the water temperature, water must be able to flow over the sensor. Do not block the sensor or paint over it with antifouling paint. Remove any biofouling as soon as possible.

> The Thermistor is embedded in the transducer head. The sensor is under a titanium cover that is highly resistant to corrosion.

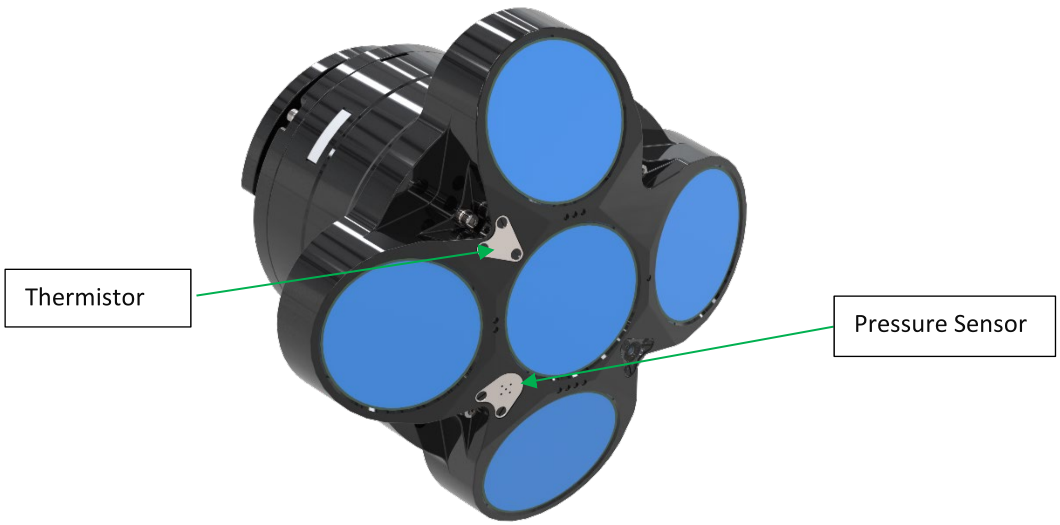


Figure 29. Thermistor and Pressure Sensor

Cleaning the Pressure Sensor Cover

To read the water pressure, water must be able to flow through the cover on the pressure sensor. The tiny holes in the cover may at times be blocked. Use the following procedure and Figure 29 to clean the cover.

> The pressure sensor is optional. It may not be included on your system.
>
> Use extreme caution to not touch or put any pressure on the face of the pressure sensor. The sensor face contains a sensitive membrane that can be easily damaged. If the membrane is damaged the pressure sensor will fail.
>
> Never poke a needle or other object through the holes while the plate is installed over the pressure sensor. You could perforate the sensor, causing it to fail.
>
> Only use low-flow fresh water to flush out any sand in the sensor cavity.

To clean the pressure sensor port:

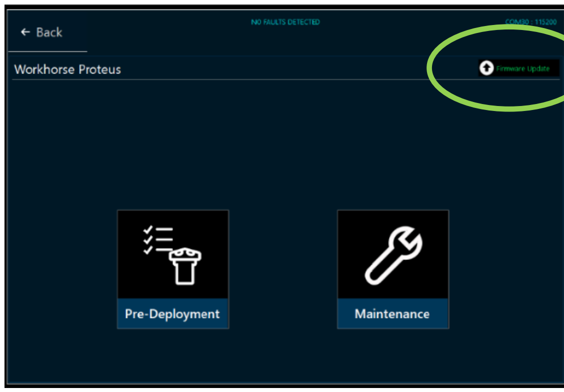
1. Place the ADCP on its' end-cap. Use a soft pad to protect the ADCP.
2. Use a straight-slot screwdriver to remove the pressure sensor cover.
3. Gently clean out the holes in the cover with a needle.
4. Flush out any sand in the sensor cavity using low flow fresh water.
5. Install the cover. Tighten the screws "finger tight" (2 in/lbs). Do not over tighten the screws or you may strip the threads on the housing. If this happens, return the ADCP to TRDI for repair.

Installing Firmware Upgrades

Firmware upgrades can be downloaded from TRDI's 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. Download and unzip the firmware file.
2. Connect to the system using *ADCP Utilities*.
3. Click **Firmware Update**. Select the **.bin* firmware update file.



Firmware and Feature updates can only be installed using *ADCP Utilities*.
DO NOT use *TRDI Toolz* or other software.

Removing power during firmware updates carries a limited risk of making the system inoperable. **Power should not be removed during firmware updates.**

Installing Feature Upgrades

Feature upgrade files can be requested from TRDI's Field Service (rdifs@teledyne.com).

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

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 ADCP. If you need to update the firmware, do this before installing the feature upgrade.

To install a feature update:

1. Download and unzip the feature file. Save the *Proteus_xxxxx.feature* file to your computer.
2. Connect to the system using *ADCP Utilities*.
3. On the **Maintenance** page, click **Feature Update**. Select the **.feature* update file.
4. The installation program will start. The program is encoded with the Proteus's serial number and the requested feature upgrade. It takes several minutes to load the new feature and the screen may be blank during the update process. Do not close *ADCP Utilities* while the feature is installing.
5. Once the feature install is complete, the Proteus will reboot. Close *ADCP Utilities* and reconnect to the Proteus.
6. Start *ADCP Utilities* and verify the feature upgrade has been installed.

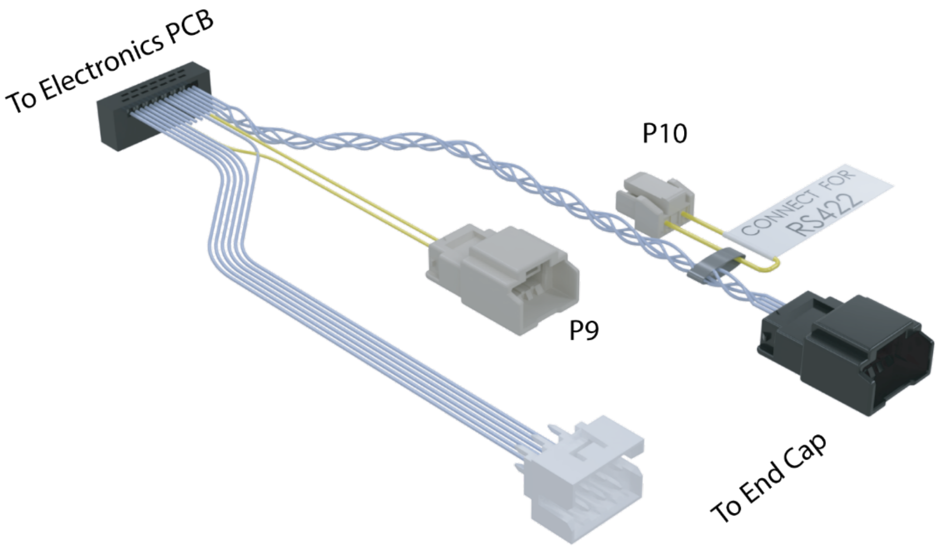
Changing Communications Setting

A jumper cable on the internal power/comm cable changes the communication settings between RS-232 and RS-422. If the jumper is connected, the system is set for RS-422 communications. Remove the jumper for RS-232 communications.

> Your computer and the Workhorse Proteus must both be set to the same communication setting. Use a RS-232-to-RS-422 converter if the Proteus is using RS-422 communications and your computer only has an RS-232 COM port.

To switch communication settings:

1. Remove the end cap/housing. Note that the 1200 kHz Proteus uses a one-piece housing with M3 hardware. See the Parts Location Drawings for details.
2. Locate the jumper P10 on the internal power/comm cable.
3. Connect or disconnect the jumper P10 from P9 on the internal power/comm cable as needed. If the jumper is connected, the system is set for RS-422 communications.
4. Replace the end cap/housing.



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 Workhorse Proteus 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 system. Therefore, you should take steps to prevent biofouling during shallow water deployments.

The best-known way to control biofouling is cleaning the ADCP transducer faces often. However, in many cases this is not possible.

The following options can help reduce biofouling:

- Coat the entire 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).
- ClearSignal is a clear non-toxic coating that resists biofouling because of the non-stick properties of the coating itself. For more information, see ClearSignal Biofouling Control System (clearsignalcoating.com).

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/

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. Applying a coating may reduce the measurement range of the 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 - 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, 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 ADCP includes the optional pressure sensor, do not block the sensor port. The sensor port has small holes in the center of the cover (see Pressure Sensor Maintenance). During anti-fouling paint application, tape off the cover. 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 cover and eventually clog the sensor port. 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.

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

NOTES

Chapter 5

TROUBLESHOOTING

This chapter covers:

- Ethernet Link Lost
- DHCP Network Connection
- Velocity Bias or Amplitude Anomalies
- Unit keeps powering off and on
- Data is not being output

Ethernet Link Lost

TRDI always recommends closing the *ADCP Utilities* connection to the system by clicking on the X (✖) in the top corner and then power down the Workhorse Proteus before disconnecting the Ethernet cable. If the Ethernet link drops while an active connection exists with TRDI Software, then you may need to cycle power to the Workhorse Proteus to reconnect.

If the connection is Ethernet only, TRDI recommends setting **Auto connect** to **ON** (see Using the Network Page in ADCP Utilities).

Exceptions when Auto connect is off

- If the software is exited or the connection to the Workhorse Proteus is closed but the Workhorse Proteus is still powered when the ethernet cable is unplugged, you have approximately one hour to reconnect before a power cycle is required. After an hour the entire Workhorse Proteus system will go to sleep.
- If the software connection is not closed and the Workhorse Proteus is still powered when the ethernet cable is unplugged, you have approximately one minute to reconnect before a power cycle is required.

DHCP Network Connection

Issue: Cannot connect to the Workhorse Proteus using the Workhorse Proteus's System ID.

Solution: A DHCP server will give the Workhorse Proteus a different address each day. This is normal and should be expected on a DHCP network. Depending on the timing, the Windows® PC may not try to query for the new IP address. Windows normally caches this association, and until that entry ages out of the table, Windows will keep using the cached IP address (meaning it will stubbornly keep trying to use the old IP address after it has changed). It may be necessary to force Windows to flush its cache to re-run the query.

To force Windows to flush the Hostname cache:

1. Open a command window as an Administrator.
   a. In the Windows search box, enter **cmd**.
   b. Right-click on the Command Prompt and select **Open as Administrator**.
   c. Enter any required credentials/passwords.
2. Enter the command **ipconfig /flushdns**.
3. Enter the command **nbtstat -R**.

Velocity Bias or Amplitude Anomalies

Issue: An unexpected velocity, correlation, or signal intensity/amplitude is measured. These may be most obvious near or past the end of the water profile. These may be consistent or intermittent.

Solution: An interference signal may be in the water or in the power source or cables. Use the FFT utility in *ADCP Utilities* to detect and identify interference. Use in as close to the same environment and equipment setup as possible for best results.

Unit keeps powering off and on

Issue: ADCP restarting unexpectedly after deploying.

Solution:

- Insufficient power supply current or voltage. Using a 24 to 48V, 5A power supply is recommended.
- Low/depleted battery.

The system will operate from 10V to 52V, but acoustic transmit will be disabled if the voltage is detected below 15V or above 50V.

Data is not being output

Issue: Data is not being output over the serial port.

Solution:

- Serial data output may not be enabled. See CF command.
- Data buffering may be enabled. See CD command.
- Data processing/Ensemble output setting might be incorrect. See CV command.

Transmit Voltage Consistency

If using a rapid pinging schedule and high-power settings, the transmit power may not reliably reach high power levels for each ping. If consistent high power is very important, use 24V or higher input voltage and extra time between pings.

To verify the transmit voltage for a given setup, deploy using the desired schedule and power setting while the transducers are in water, then review the TX Voltage data output in the PD0 data format Variable Leader bytes 72 - 73 from the recorded or output data.

Chapter 6

RETURNING SYSTEMS TO TRDI FOR SERVICE

This chapter covers:

- How to pack and ship the Proteus
- How to get an RMA number
- Where to send the Proteus for repair

Shipping the Workhorse Proteus

This section explains how to ship the Workhorse Proteus.

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

When shipping the Workhorse Proteus 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 Workhorse Proteus.

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 Workhorse Proteus 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 Workhorse Proteus arrives with the minimum possible delay. Any deviation from these instructions increases the potential for delay.

Step 1 - Request a Return Material Authorization

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

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

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship via air freight, prepaid

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

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

Mark the Package(s)

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

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

Step 4 - Urgent shipments

Send the following information by fax or telephone to TRDI.

Attention: Customer Service Administration

Fax: +1 (858) 842-2822

Phone: +1 (858) 842-2700

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

Returning Systems to TRDI Europe Factory

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

Step 1 - Request a Return Material Authorization

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

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

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship Via Air Freight, Prepaid

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

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

Mark the package(s) as follows:

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

Step 4 - Include Proper Customs Documentation

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

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

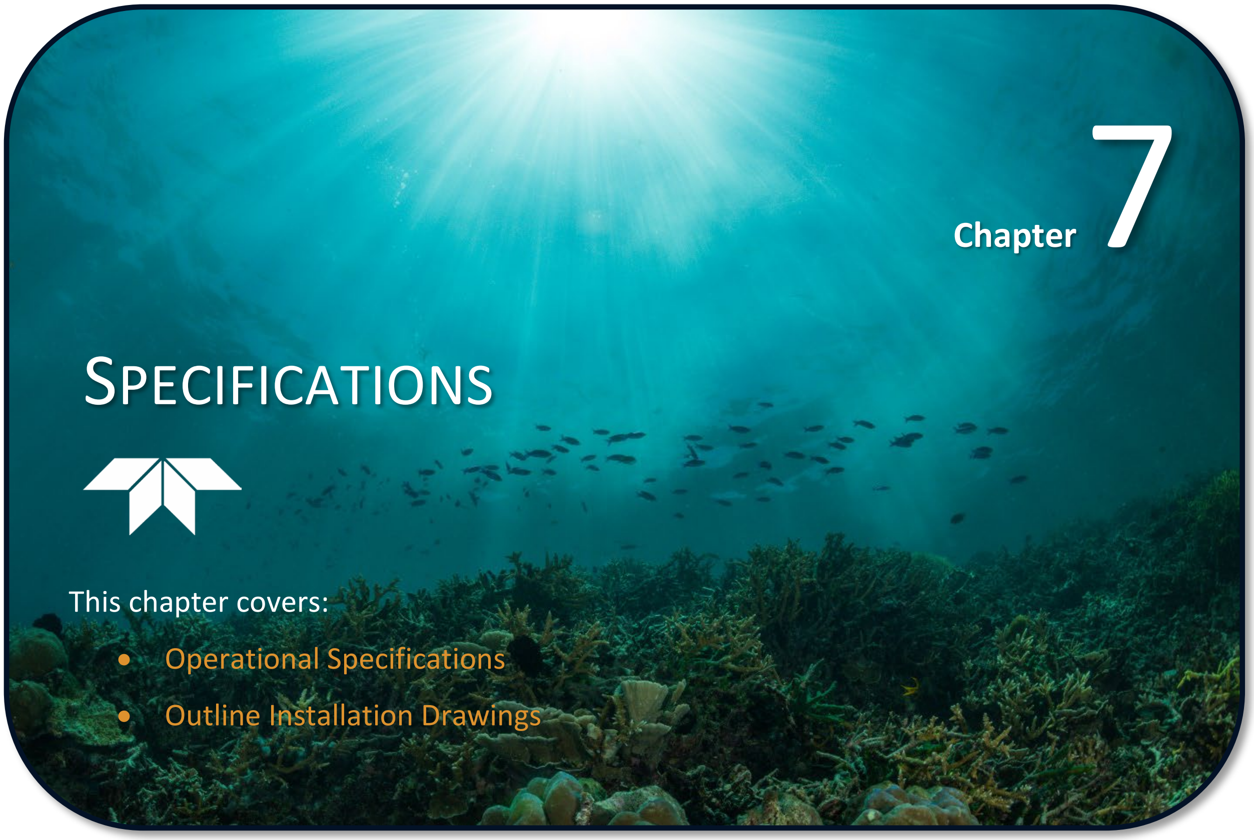
Step 5 - Send the Following Information by Fax or Telephone to TRDI

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

This chapter covers:

- Operational Specifications
- Outline Installation Drawings

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

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

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

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

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

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

When water profiling the Workhorse Proteus 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 Workhorse Proteus produces two profiles, one for velocity, and one for echo intensity.

The following tables list the specifications for the Workhorse Proteus. About the specifications:

1. Except where noted, these specification tables applies to typical setups and conditions. Typical setups use the default input values for each parameter (exceptions include Pings per Ensemble and Number of Depth Cells). Typical conditions assume uniform seawater velocities at a given depth, moderate shear, moderate Workhorse Proteus motion, and typical echo intensity levels.
2. The total measurement error of the Workhorse Proteus is the sum of:

- Long-term instrument error (as limited by instrument accuracy),
- The remaining statistical uncertainty after averaging,
- Errors introduced by measurement of Workhorse Proteus heading and motion.

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

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

Table 4. Profiling Range

	1200 kHz	600 kHz	300 kHz
long-range mode*	17 m	65 m	166 m
high-resolution mode*	13 m	50 m	126 m
Bottom Tracking (BT) Range*	27 m	103 m	280 m
Minimum Bottom Tracking Altitude	0.8 m	1.4 m	2 m
Bottom Track Base Accuracy (cm/s)	±1.15% ± 0.4	±1.15% ± 0.4	±1.15% ± 0.4
Bottom Track High Accuracy (cm/s)	0.3% of measured value ±0.3	0.3% of measured value ± 0.3	0.5% of measured value ± 0.3
Cell Size	0.05 to 4.0 m	0.1 to 6.0 m	0.2** to 8.0 m
Minimum Blanking	0.3 m	0.5 m	1.0 m
Maximum Sampling Rate	16 Hz	8 Hz	4 Hz
Max Sampling Rate with Five Beams	8 Hz	4 Hz	2 Hz

*Ranges specified are typical at temperature 5°C and salinity 35 PSU, using maximum transmit voltage.
** TRDI recommends using 1m depth cell size minimum for a 300kHz system.

Base Accuracy 1.15% Bottom Track (ECCN 6A991 Export-Compliant) and High Accuracy Bottom Track (ECCN 6A001.b.2 Export license required) modes are mutually exclusive. Only one may be enabled.

Table 5: Profile Parameters

Item	Specification
Velocity accuracy	
1200 and 600 kHz	± 0.3% of the water velocity relative to the ADCP ± 3mm/s
300 kHz	± 0.5% of the water velocity relative to the ADCP ± 5mm/s
Velocity resolution	0.1 cm/s
Velocity range	± 5m/s (default), ± 20m/s (maximum)
Number of depth cells	1 to 255
Precision at default cell size	3.6 cm/s

Table 6: Echo Intensity Profile

Item	Specification
Vertical resolution	Depth cell size
Dynamic range	80 dB
Precision	± 1.5dB (relative measure)
	Independent high-resolution echosounder ping

Table 7: Transducer and Hardware

Item	Specification
Beam angle	20°
Center frequency (kHz)	1228.8 (1200 kHz), 614.4 (600 kHz), 307.2 (300 kHz)
Beam Width	2.26° (600 and 1200 kHz), 3.33° (300 kHz)
Configuration	4-beam, convex; 5th beam vertical
Internal memory	64 GB Micro SD card
Communications	Ethernet (802.11 b/g/n/TCIP) and configurable RS232/422 (both are standard features)
Depth Rating	300 m
Materials	Transducer, housing, and end cap: plastic; all titanium hardware
Connector	Metal shell; 8-pin MCBH

Table 8: Standard Sensors

Temperature (Transducer Mounted)	
Range	-5° to 45° C
Precision	± 0.5°C
Resolution	0.01°
Update rate	2Hz
Heading	
Heading accuracy, static	±2°
Heading accuracy, dynamic**	±3°
Heading range/Resolution	360°, all axis / 0.01°
Sampling rate	Same as measurement rate (up to 1Hz)
Tilt	
Pitch and roll range / resolution	± 90° (pitch) ± 180° (roll) / 0.01°
Tilt accuracy, static	± 0.5° (up to 30° tilts from vertical, in both beams up or beams down orientation)
Tilt accuracy, dynamic**	± 2° (up to 30° tilts from vertical, in both beams up or beams down orientation)
Accelerometer, dynamic range	± 2g or higher
Magnetometer dynamic range	± 1.3 Gauss
Gyro dynamic range	± 250°/sec or higher
Sampling rate	Same as measurement rate (up to 1Hz)
Pressure Sensor*	
Range	0 to 300 m
Accuracy	0.1% full scale or greater
Precision	0.002% of full scale or greater
Update rate	2Hz

* The pressure sensor does NOT require calibration for its entire life.
** Dynamic specifications depends on the type of motion.

Table 9: Environmental Specifications

Item	Specification
Operating temperature with or without batteries	-5° to 45°C (see note)
Short Term Storage/Shipping (<45days) temperature (Batteries Installed)	-5° to 45°C
Long Term Storage (>45days) temperature (Batteries Installed)	O° C to 21° C
Long Term Storage (>45days) temperature (Batteries Removed)	-30° to 60°C
Long Term (>45days) Battery Storage	Batteries should be stored in cool dry air with a temperature range of O° C to 21° C
Battery Shelf Life	Use within one year

Acoustic transmit can be temporarily disabled due to high internal temperature. This can occur within the stated operational temperature range (45deg C) but is only expected when a combination of several of the following conditions are met.

- High ambient temperature
- High power transmit settings
- Very rapid and continuous sampling
- In air (not submerged)

See Table 22: Variable Leader Data Format, page 156, bytes 13 and 14.

Table 10: Power

System	Specification
Monitor/Sentinel	
DC input	15 to 48 VDC (24VDC typical) external power supply or 29.1 VDC Internal/External Battery Pack
Transmit power, Water profiling, and Vertical profiling	
1200 kHz	Default: 3W per beam. 2.1W, 8.7W and 15.5W per beam settings optional
600 kHz	Default: 8W per beam. 5.7W, 23W and 41W per beam settings optional
300 kHz	Default: 25W per beam. 18W, 73W and 130W per beam settings optional
Transmit power, Bottom track, and Vertical range	
1200 kHz	Default: 3W per beam. 2.1W per beam settings optional
600 kHz	Default: 8W per beam. 5.7W per beam settings optional
300 kHz	Default: 25W per beam. 18W per beam settings optional

Note: The system will operate from 10V to 52V, but acoustic transmit will be disabled if voltage is detected below 15V or above 50V.

Outline Installation Drawings

The following drawings show the Workhorse Proteus dimensions and weights.

Table 11: Outline Installation Drawings

Description	Drawing #	Revision
Workhorse Proteus Sentinel 300 kHz	A96-9000	XA
Workhorse Proteus Monitor 300 kHz	A96-9001	XC
Workhorse Proteus Sentinel 600 kHz	A96-9002	XA
Workhorse Proteus Monitor 600 kHz	A96-9003	XB
Workhorse Proteus Monitor 1200 kHz	A96-9005	XB

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.

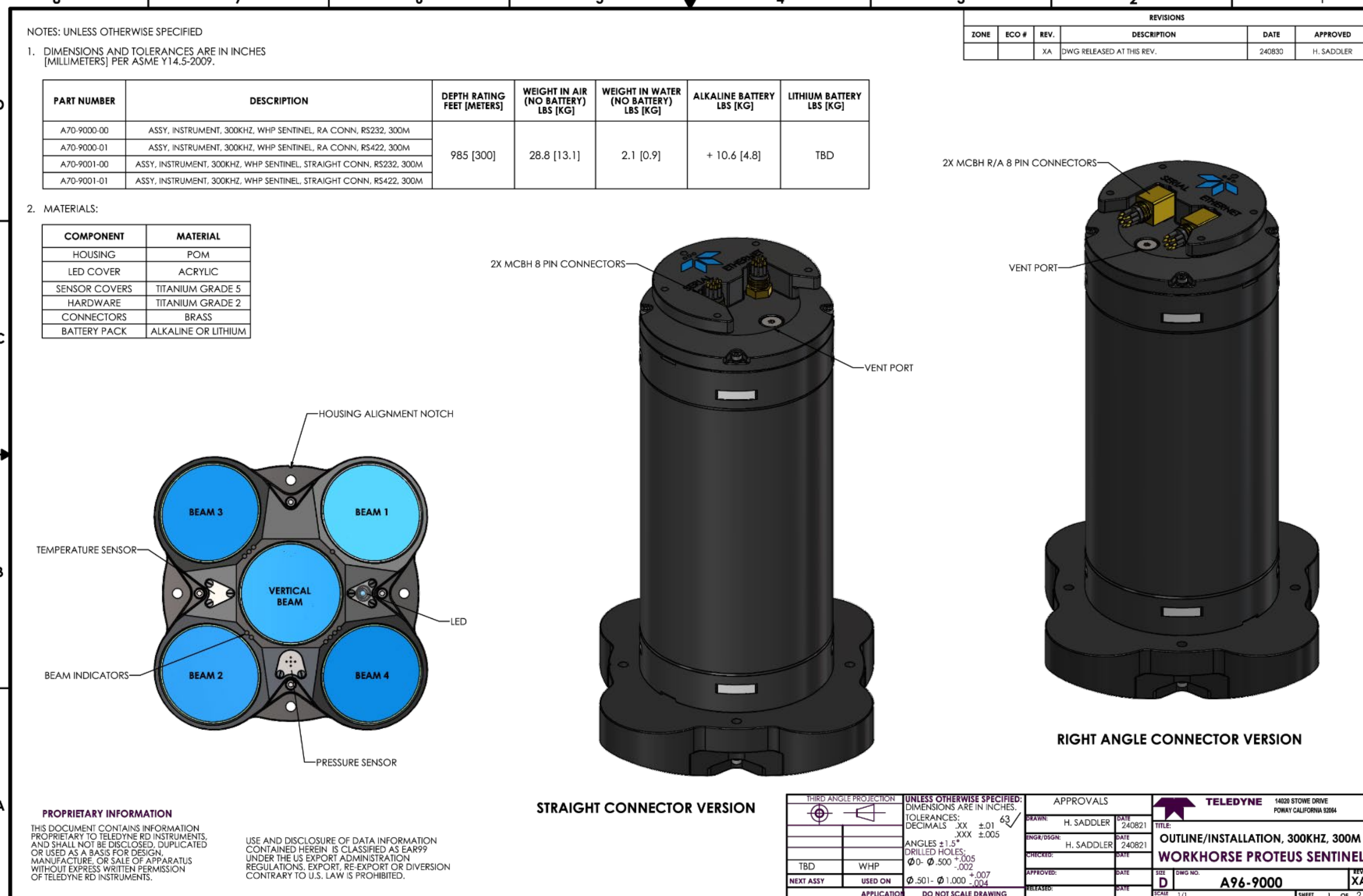
NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS AND TOLERANCES ARE IN INCHES [MILLIMETERS] PER ASME Y14.5-2009.

PART NUMBER	DESCRIPTION	DEPTH RATING FEET [METERS]	WEIGHT IN AIR (NO BATTERY) LBS [KG]	WEIGHT IN WATER (NO BATTERY) LBS [KG]	ALKALINE BATTERY LBS [KG]	LITHIUM BATTERY LBS [KG]
A70-9000-00	ASSY, INSTRUMENT, 300KHZ, WHP SENTINEL, RA CONN, RS232, 300M	985 [300]	28.8 [13.1]	2.1 [0.9]	+ 10.6 [4.8]	TBD
A70-9000-01	ASSY, INSTRUMENT, 300KHZ, WHP SENTINEL, RA CONN, RS422, 300M					
A70-9001-00	ASSY, INSTRUMENT, 300KHZ, WHP SENTINEL, STRAIGHT CONN, RS232, 300M					
A70-9001-01	ASSY, INSTRUMENT, 300KHZ, WHP SENTINEL, STRAIGHT CONN, RS422, 300M					

2. MATERIALS:

COMPONENT	MATERIAL
HOUSING	POM
LED COVER	ACRYLIC
SENSOR COVERS	TITANIUM GRADE 5
HARDWARE	TITANIUM GRADE 2
CONNECTORS	BRASS
BATTERY PACK	ALKALINE OR LITHIUM



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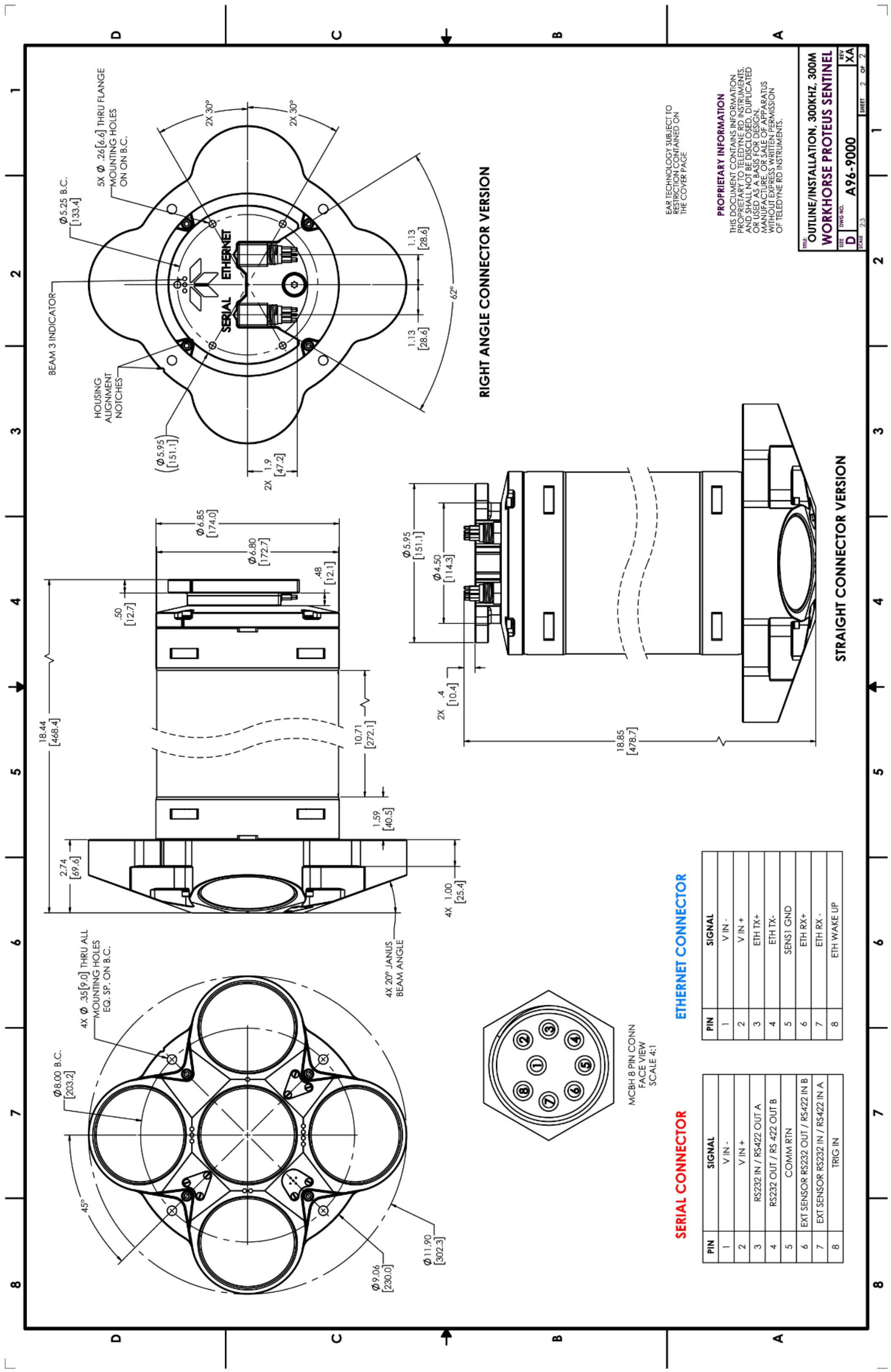
RIGHT ANGLE CONNECTOR VERSION
STRAIGHT CONNECTOR VERSION
SERIAL
ETHERNET
BEAM 3 INDICATOR
HOUSING ALIGNMENT NOTCHES
Ø5.25 B.C. [133.4]
5X Ø .26[6.6] THRU FLANGE MOUNTING HOLES ON ON B.C.
2X 30°
62°
1.13 [28.6]
(Ø5.95 [151.1])
2X 1.9 [47.2]
Ø6.85 [174.0]
Ø6.80 [172.7]
.48 [12.1]
.50 [12.7]
18.44 [468.4]
10.71 [272.1]
1.59 [40.5]
2.74 [69.6]
4X 1.00 [25.4]
4X 20° JANUS BEAM ANGLE
Ø5.95 [151.1]
Ø4.50 [114.3]
2X .4 [10.4]
18.85 [478.7]
4X Ø .35[9.0] THRU ALL MOUNTING HOLES EQ. SP. ON B.C.
Ø8.00 B.C. [203.2]
45°
Ø9.06 [230.0]
Ø11.90 [302.3]
MCBH 8 PIN CONN FACE VIEW SCALE 4:1
SERIAL CONNECTOR
PIN | SIGNAL
1 | V IN -
2 | V IN +
3 | RS232 IN / RS422 OUT A
4 | RS232 OUT / RS 422 OUT B
5 | COMM RTN
6 | EXT SENSOR RS232 OUT / RS422 IN B
7 | EXT SENSOR RS232 IN / RS422 IN A
8 | TRIG IN
ETHERNET CONNECTOR
PIN | SIGNAL
1 | V IN -
2 | V IN +
3 | ETH TX+
4 | ETH TX-
5 | SENS1 GND
6 | ETH RX+
7 | ETH RX -
8 | ETH WAKE UP
EAR TECHNOLOGY SUBJECT TO RESTRICTION CONTAINED ON THE COVER PAGE
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OUTLINE/INSTALLATION, 300KHZ, 300M
WORKHORSE PROTEUS SENTINEL
D
A96-9000
XA
SCALE 2:3
SHEET 2 OF 2

REVISIONS

ZONE	ECO #	REV.	DESCRIPTION	DATE	APPROVED
		XA	DWG RELEASED AT THIS REV.		
		XB	ADDED PART NUMBERS AND MISSING DIMENSIONS	240830	H. SADDLER
		XC	UPDATED MATERIALS TABLE. REMOVED BATTERY PACK.	240918	H. SADDLER

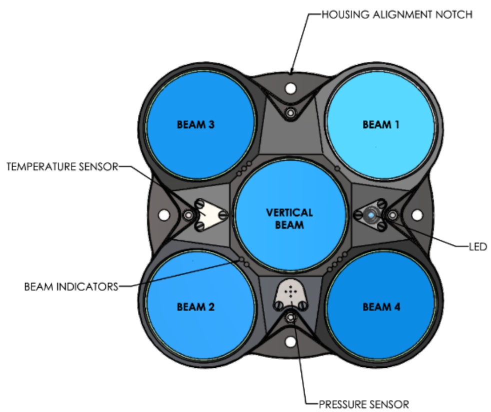
NOTES: UNLESS OTHERWISE SPECIFIED

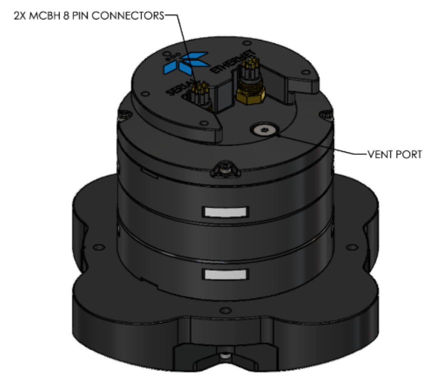
1. DIMENSIONS AND TOLERANCES ARE IN INCHES [MILLIMETERS] PER ASME Y14.5-2009.

PART NUMBER	DESCRIPTION	DEPTH RATING FEET [METERS]	WEIGHT IN AIR LBS [KG]	WEIGHT IN WATER LBS [KG]
A70-9002-00	ASSY, INSTRUMENT, 300KHZ, WHP MONITOR, RA CONN, RS232, 300M	985 [300]	18.8 [8.5]	5.1 [2.3]
A70-9002-01	ASSY, INSTRUMENT, 300KHZ, WHP MONITOR, RA CONN, RS422, 300M			
A70-9003-00	ASSY, INSTRUMENT, 300KHZ, WHP MONITOR, STRAIGHT CONN, RS232, 300M			
A70-9003-01	ASSY, INSTRUMENT, 300KHZ, WHP MONITOR, STRAIGHT CONN, RS422, 300M			

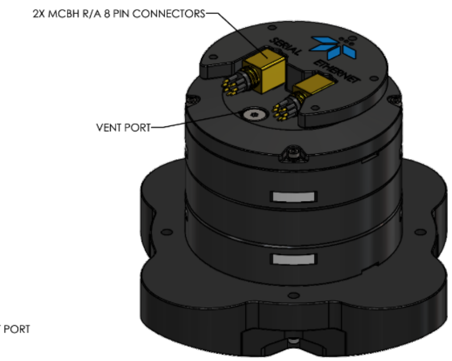
2. MATERIALS:

COMPONENT	MATERIAL
HOUSING	POM
LED COVER	ACRYLIC
SENSOR COVERS	TITANIUM GRADE 5
HARDWARE	TITANIUM GRADE 2
CONNECTORS	BRASS





STRAIGHT CONNECTOR VERSION



RIGHT ANGLE CONNECTOR VERSION

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THIRD ANGLE PROJECTION

NEXT ASSY	USED ON
TBD	WHP

APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES.
TOLERANCES:
DECIMALS .XX ±.01
.XXX ±.005
63
ANGLES ±1.5°
DRILLED HOLES:
Ø 0- Ø .500 +.005 -.002
Ø .501- Ø 1.000 +.007 -.004
DO NOT SCALE DRAWING

APPROVALS

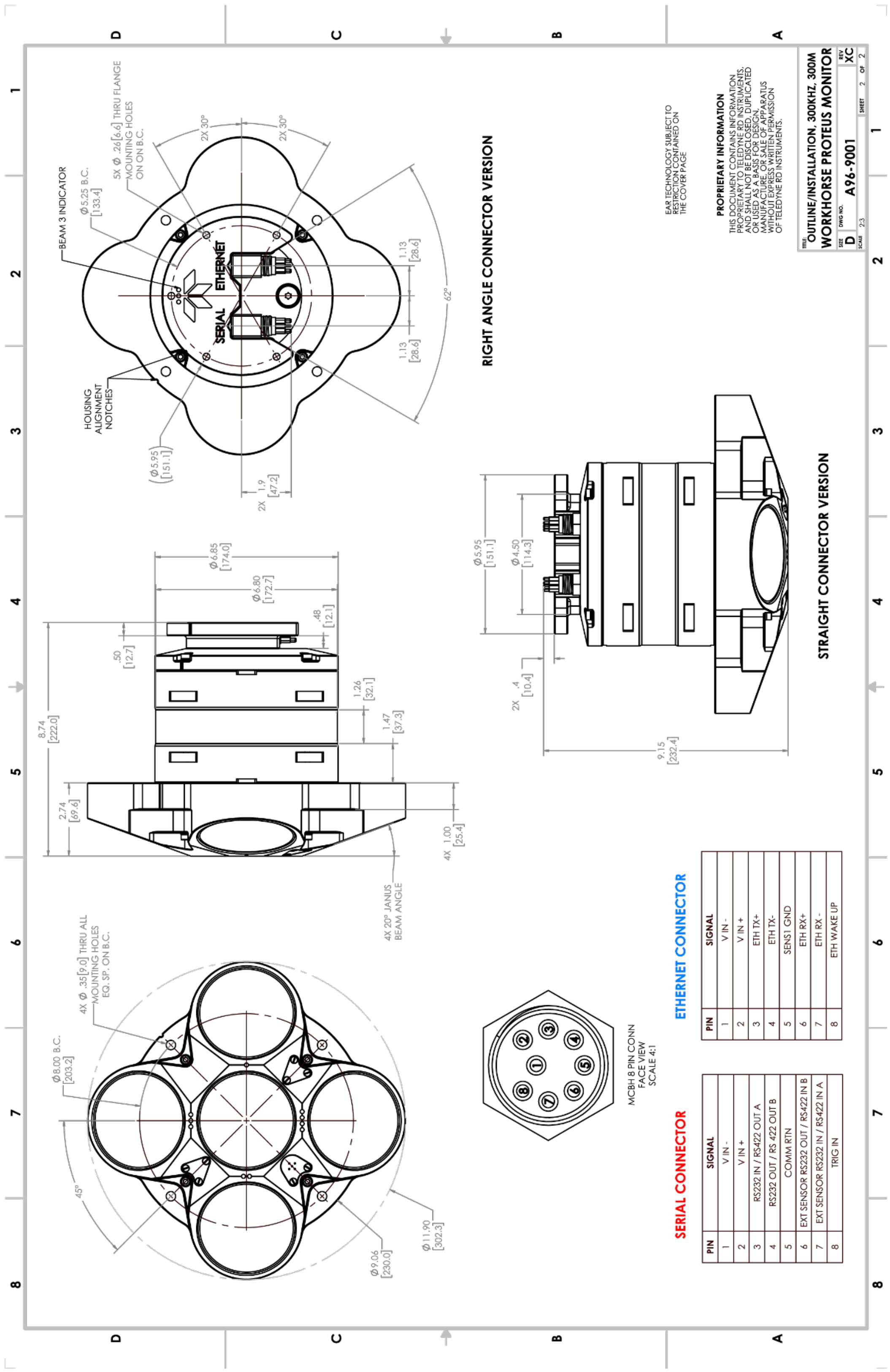
		DATE
DRAWN:	H. SADDLER	240821
ENGR/DSGN:	H. SADDLER	240821
CHECKED:		
APPROVED:		
RELEASED:		

TELEDYNE 14020 STOWE DRIVE POWAY CALIFORNIA 92064

TITLE: OUTLINE/INSTALLATION, 300KHZ, 300M WORKHORSE PROTEUS MONITOR

SIZE D DWG NO. A96-9001 REV XC

SCALE 1/1 SHEET 1 OF 2



SERIAL CONNECTOR

PIN	SIGNAL
1	V IN -
2	V IN +
3	RS232 IN / RS422 OUT A
4	RS232 OUT / RS 422 OUT B
5	COMM RTN
6	EXT SENSOR RS232 OUT / RS422 IN B
7	EXT SENSOR RS232 IN / RS422 IN A
8	TRIG IN

ETHERNET CONNECTOR

PIN	SIGNAL
1	V IN -
2	V IN +
3	ETH TX+
4	ETH TX-
5	SENS1 GND
6	ETH RX+
7	ETH RX -
8	ETH WAKE UP

ZONE	ECO #	REV.	DESCRIPTION	DATE	APPROVED
		XA	DWG RELEASED AT THIS REV.	240830	H. SADDLER

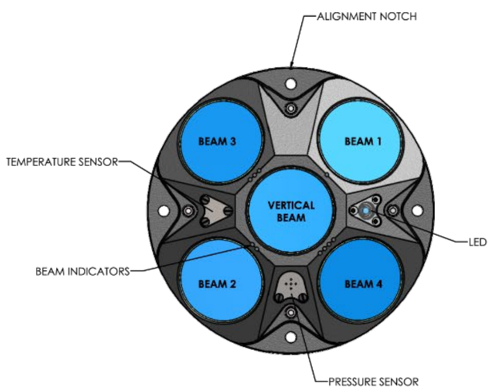
NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS AND TOLERANCES ARE IN INCHES [MILLIMETERS] PER ASME Y14.5-2009.

PART NUMBER	DESCRIPTION	DEPTH RATING FEET [METERS]	WEIGHT IN AIR (NO BATTERY) LBS [KG]	WEIGHT IN WATER (NO BATTERY) LBS [KG]	ALKALINE BATTERY LBS [KG]	LITHIUM BATTERY LBS [KG]
A70-9004-00	ASSY, INSTRUMENT, 600KHZ, WHP SENTINEL, RA CONN, RS232, 300M	985 [300]	23.1 [10.5]	-0.7 [-0.3]	+ 10.6 [4.8]	TBD
A70-9004-01	ASSY, INSTRUMENT, 600KHZ, WHP SENTINEL, RA CONN, RS422, 300M					
A70-9005-00	ASSY, INSTRUMENT, 600KHZ, WHP SENTINEL, STRAIGHT CONN, RS232, 300M					
A70-9005-01	ASSY, INSTRUMENT, 600KHZ, WHP SENTINEL, STRAIGHT CONN, RS422, 300M					

2. MATERIALS:

COMPONENT	MATERIAL
HOUSING	POM
LED COVER	ACRYLIC
SENSOR COVERS	TITANIUM GRADE 5
HARDWARE	TITANIUM GRADE 2
CONNECTORS	BRASS
BATTERY PACK	ALKALINE OR LITHIUM



STRAIGHT CONNECTOR VERSION

RIGHT ANGLE CONNECTOR VERSION

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THIRD ANGLE PROJECTION

NEXT ASSY	USED ON
TBD	WHP

APPLICATION

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES: DECIMALS .XX ±.01 .XXX ±.005 63 ANGLES ±1.5° DRILLED HOLES: Ø0 - Ø.500 +.005 -.002 Ø.501 - Ø1.000 +.007 -.004

DO NOT SCALE DRAWING

APPROVALS		DATE
DRAWN:	H. SADDLER	240821
ENGR/DSGN:	H. SADDLER	240821
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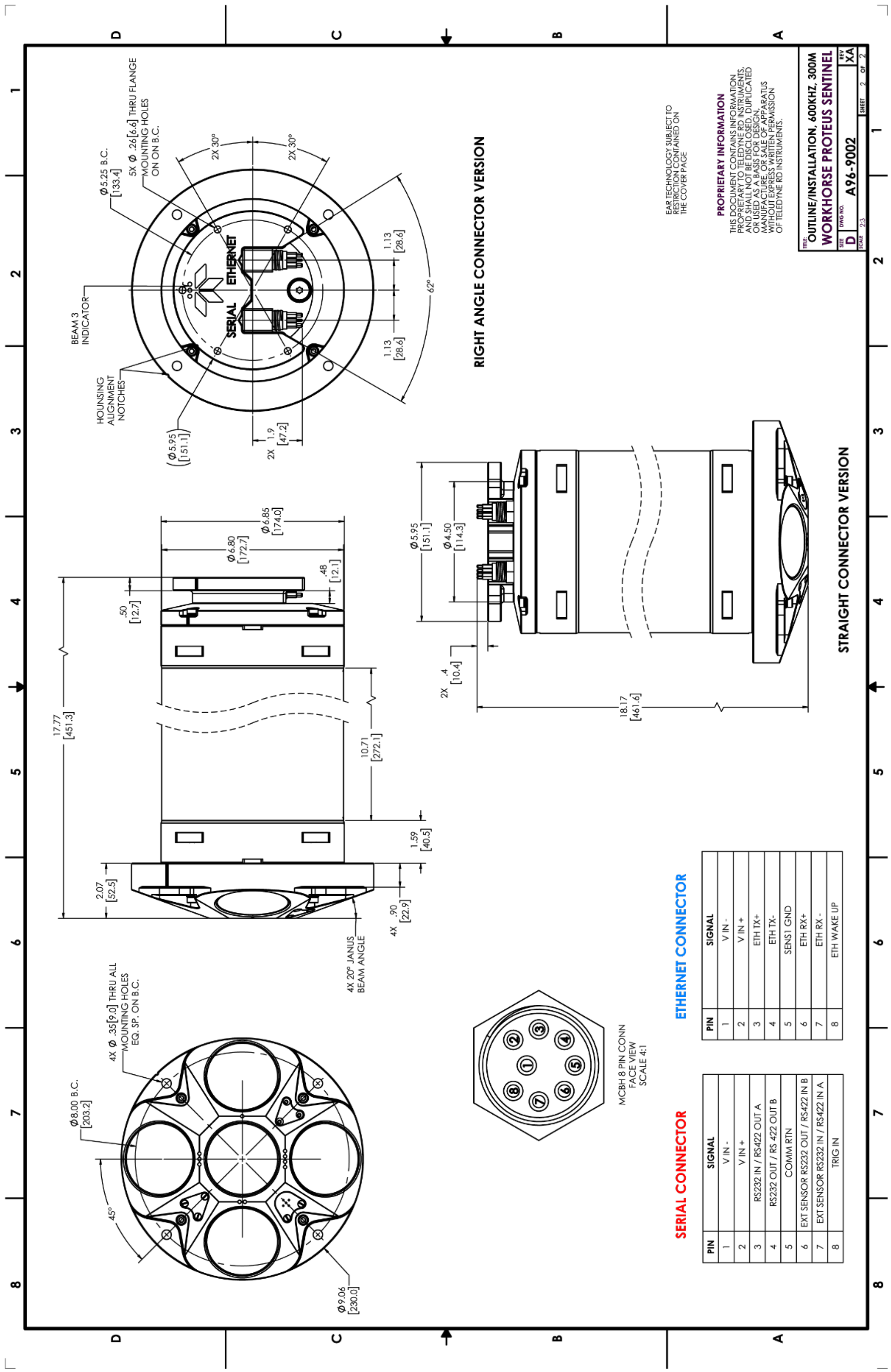
APPROVED:		
RELEASED:		

TELEDYNE 14020 STOWE DRIVE POWAY CALIFORNIA 92064

TITLE: OUTLINE/INSTALLATION, 600KHZ, 300M WORKHORSE PROTEUS SENTINEL

SIZE D DWG NO. A96-9002 REV XA

SCALE 1/1 SHEET 1 OF 2



SERIAL CONNECTOR

PIN	SIGNAL
1	V IN -
2	V IN +
3	RS232 IN / RS422 OUT A
4	RS232 OUT / RS 422 OUT B
5	COMM RTN
6	EXT SENSOR RS232 OUT / RS422 IN B
7	EXT SENSOR RS232 IN / RS422 IN A
8	TRIG IN

ETHERNET CONNECTOR

PIN	SIGNAL
1	V IN -
2	V IN +
3	ETH TX+
4	ETH TX-
5	SENS1 GND
6	ETH RX+
7	ETH RX -
8	ETH WAKE UP

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS AND TOLERANCES ARE IN INCHES [MILLIMETERS] PER ASME Y14.5-2009.

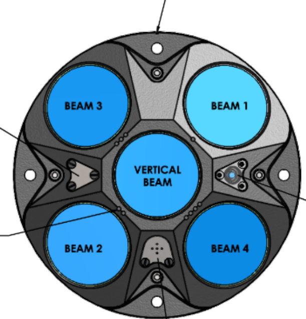
PART NUMBER	DESCRIPTION	DEPTH RATING FEET [METERS]	WEIGHT IN AIR LBS [KG]	WEIGHT IN WATER LBS [KG]
A70-9006-00	ASSY, INSTRUMENT, 600KHZ, WHP MONITOR, RA CONN, RS232, 300M	985 [300]	13.1 [5.9]	2.4 [1.1]
A70-9006-01	ASSY, INSTRUMENT, 600KHZ, WHP MONITOR, RA CONN, RS422, 300M			
A70-9007-00	ASSY, INSTRUMENT, 600KHZ, WHP MONITOR, STRAIGHT CONN, RS232, 300M			
A70-9007-01	ASSY, INSTRUMENT, 600KHZ, WHP MONITOR, STRAIGHT CONN, RS422, 300M			

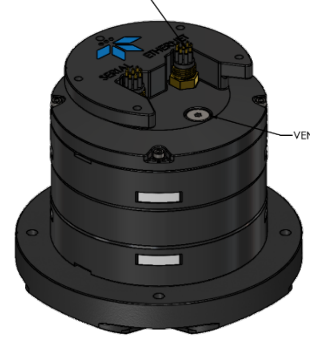
2. MATERIALS:

COMPONENT	MATERIAL
HOUSING	POM
LED COVER	ACRYLIC
SENSOR COVERS	TITANIUM GRADE 5
HARDWARE	TITANIUM GRADE 2
CONNECTORS	BRASS

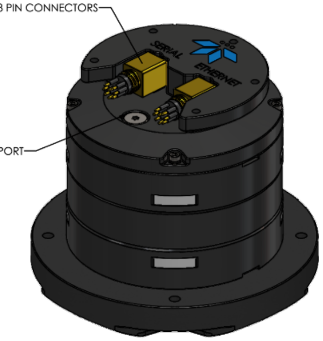
REVISIONS

ZONE	ECO #	REV.	DESCRIPTION	DATE	APPROVED
		XA	DWG RELEASED AT THIS REV.	240830	H. SADDLER
		XB	UPDATED MATERIALS TABLE. REMOVED BATTERY PACK.	240918	H. SADDLER





STRAIGHT CONNECTOR VERSION



RIGHT ANGLE CONNECTOR VERSION

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NEXT ASSY	USED ON
TBD	WHP

APPLICATION

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DO NOT SCALE DRAWING

APPROVALS

		DATE
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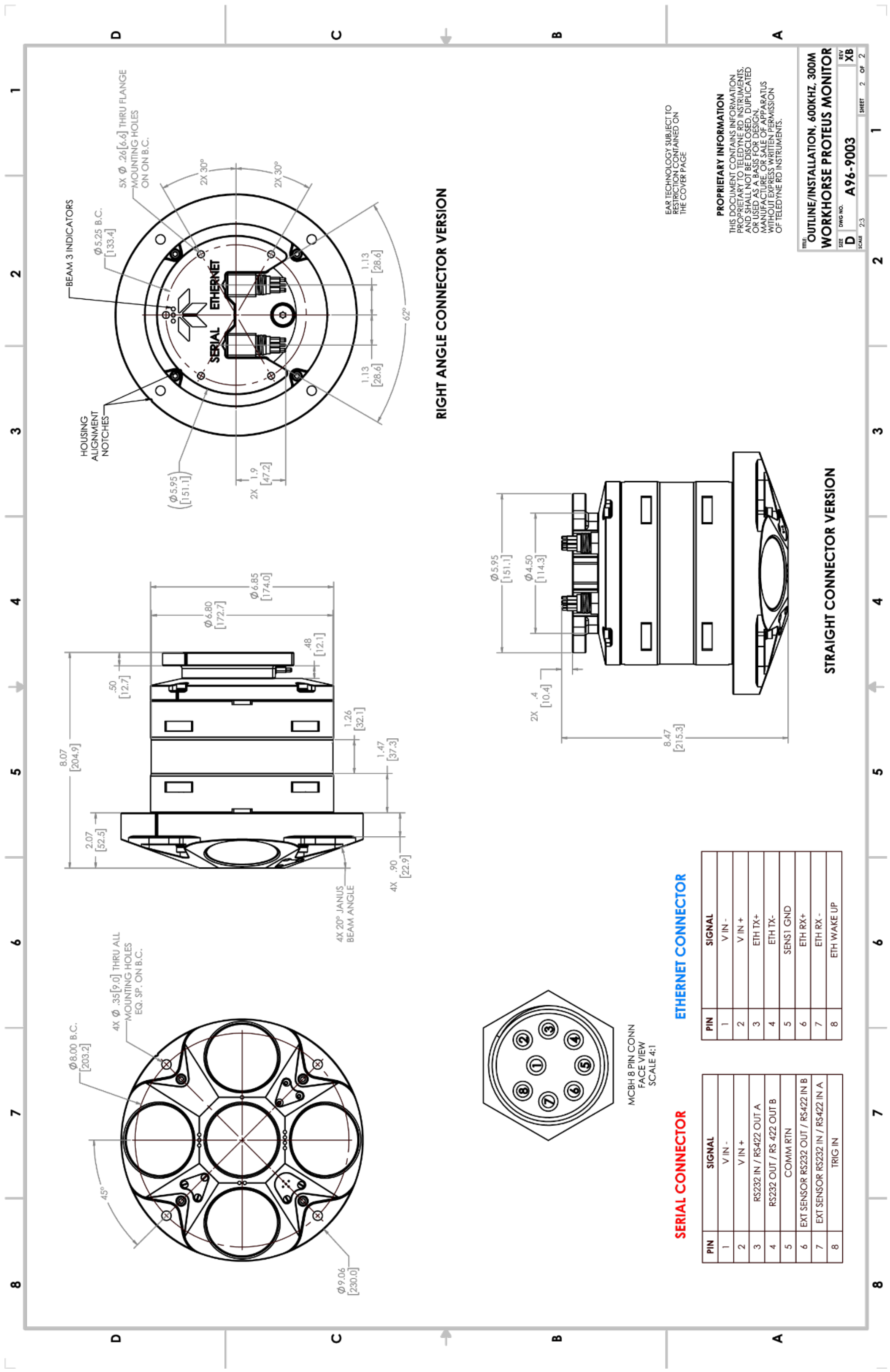
APPROVED:		
RELEASED:		

TELEDYNE 14020 STOWE DRIVE POWAY CALIFORNIA 92064

TITLE: OUTLINE/INSTALLATION, 600KHZ, 300M WORKHORSE PROTEUS MONITOR

SIZE D DWG NO. A96-9003 REV XB

SCALE 1/1 SHEET 1 OF 2



SERIAL CONNECTOR

PIN	SIGNAL
1	V IN -
2	V IN +
3	RS232 IN / RS422 OUT A
4	RS232 OUT / RS 422 OUT B
5	COMM RTN
6	EXT SENSOR RS232 OUT / RS422 IN B
7	EXT SENSOR RS232 IN / RS422 IN A
8	TRIG IN

ETHERNET CONNECTOR

PIN	SIGNAL
1	V IN -
2	V IN +
3	ETH TX+
4	ETH TX-
5	SENS1 GND
6	ETH RX+
7	ETH RX -
8	ETH WAKE UP

ZONE	ECO #	REV.	DESCRIPTION	DATE	APPROVED
		XA	DWG RELEASED AT THIS REV.		
		XB	UPDATED MATERIALS TABLE. REMOVED BATTERY PACK.	240918	H. SADDLER

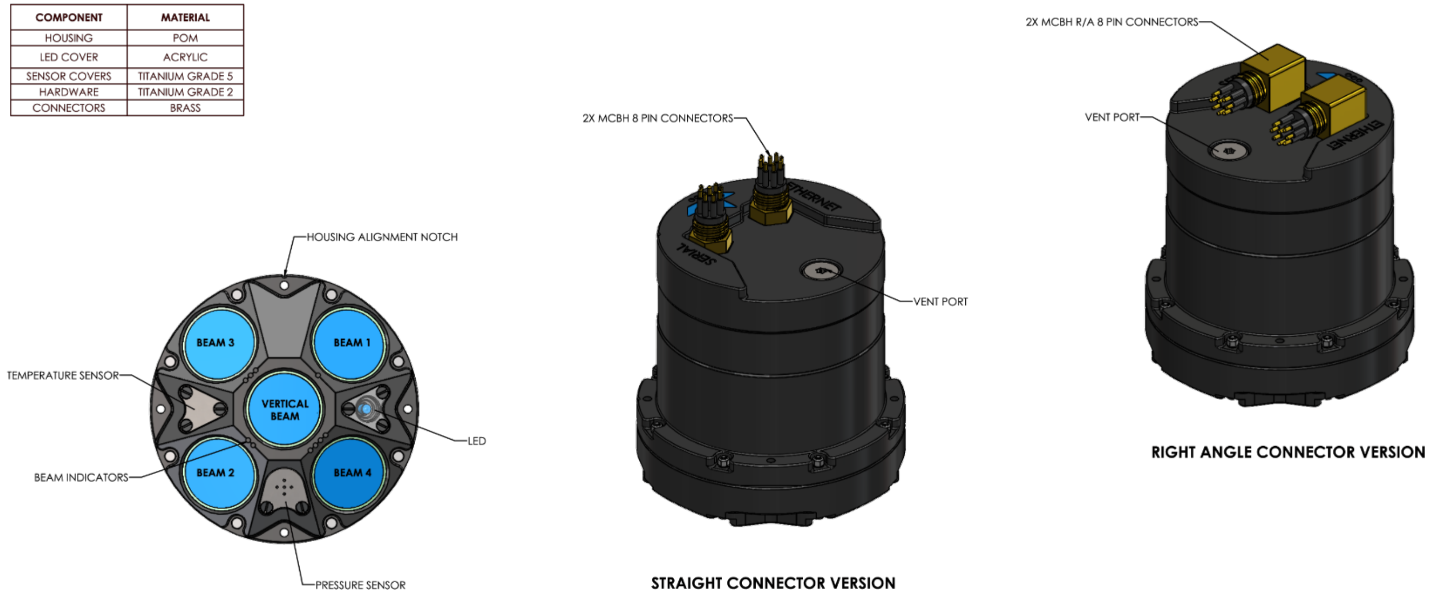
NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS AND TOLERANCES ARE IN INCHES PER ASME Y14.5-2009.

PART NUMBER	DESCRIPTION	DEPTH RATING FEET [METERS]	WEIGHT IN AIR LBS [KG]	WEIGHT IN WATER LBS [KG]
A70-9010-00	ASSY, INSTRUMENT, 1200KHZ, WHP MONITOR, RA CONN, RS232, 300M	985 [300]	5.1 [2.3]	1.0 [0.4]
A70-9010-01	ASSY, INSTRUMENT, 1200KHZ, WHP MONITOR, RA CONN, RS422, 300M			
A70-9011-00	ASSY, INSTRUMENT, 1200KHZ, WHP MONITOR, STRAIGHT CONN, RS232, 300M			
A70-9011-01	ASSY, INSTRUMENT, 1200KHZ, WHP MONITOR, STRAIGHT CONN, RS422, 300M			

2. MATERIALS:

COMPONENT	MATERIAL
HOUSING	POM
LED COVER	ACRYLIC
SENSOR COVERS	TITANIUM GRADE 5
HARDWARE	TITANIUM GRADE 2
CONNECTORS	BRASS



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NEXT ASSY: TBD — USED ON: WHP — APPLICATION

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES: DECIMALS .XX ±.01 .XXX ±.005 63
ANGLES ±1.5°
DRILLED HOLES: Ø0- Ø.500 +.005 -.002; Ø.501- Ø1.000 +.007 -.004
DO NOT SCALE DRAWING

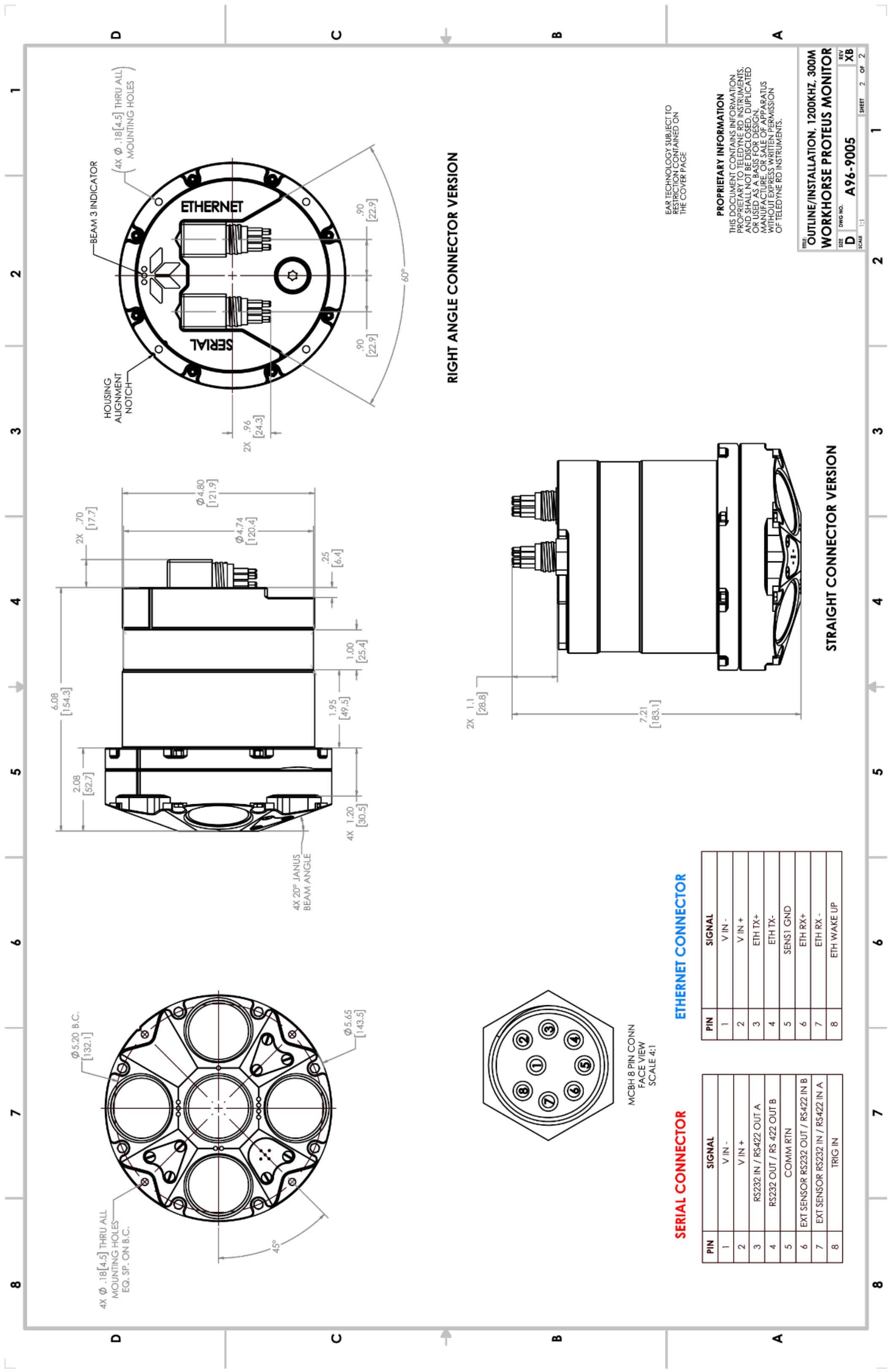
APPROVALS
DRAWN: H. SADDLER DATE 240821
ENGR/DSGN: H. SADDLER DATE 240821
CHECKED: DATE
APPROVED: DATE
RELEASED: DATE

TELEDYNE 14020 STOWE DRIVE POWAY CALIFORNIA 92064

TITLE: OUTLINE/INSTALLATION, 1200KHZ, 300M WORKHORSE PROTEUS MONITOR

SIZE D — DWG NO. A96-9005 — REV XB — SCALE 1/1 — SHEET 1 OF 2

TELEDYNE MARINE Everywhereyoulook™


RIGHT ANGLE CONNECTOR VERSION
STRAIGHT CONNECTOR VERSION
ETHERNET
SERIAL
BEAM 3 INDICATOR
HOUSING ALIGNMENT NOTCH
4X Ø .18[4.5] THRU ALL MOUNTING HOLES
4X Ø .18[4.5] THRU ALL MOUNTING HOLES EQ. SP. ON B.C.
Ø5.20 B.C. [132.1]
Ø5.65 [143.5]
4X 20° JANUS BEAM ANGLE
MCBH 8 PIN CONN FACE VIEW SCALE 4:1
SERIAL CONNECTOR
PIN | SIGNAL
1 | V IN -
2 | V IN +
3 | RS232 IN / RS422 OUT A
4 | RS232 OUT / RS 422 OUT B
5 | COMM RTN
6 | EXT SENSOR RS232 OUT / RS422 IN B
7 | EXT SENSOR RS232 IN / RS422 IN A
8 | TRIG IN
ETHERNET CONNECTOR
PIN | SIGNAL
1 | V IN -
2 | V IN +
3 | ETH TX+
4 | ETH TX-
5 | SENS1 GND
6 | ETH RX+
7 | ETH RX -
8 | ETH WAKE UP
EAR TECHNOLOGY SUBJECT TO RESTRICTION CONTAINED ON THE COVER PAGE
PROPRIETARY INFORMATION
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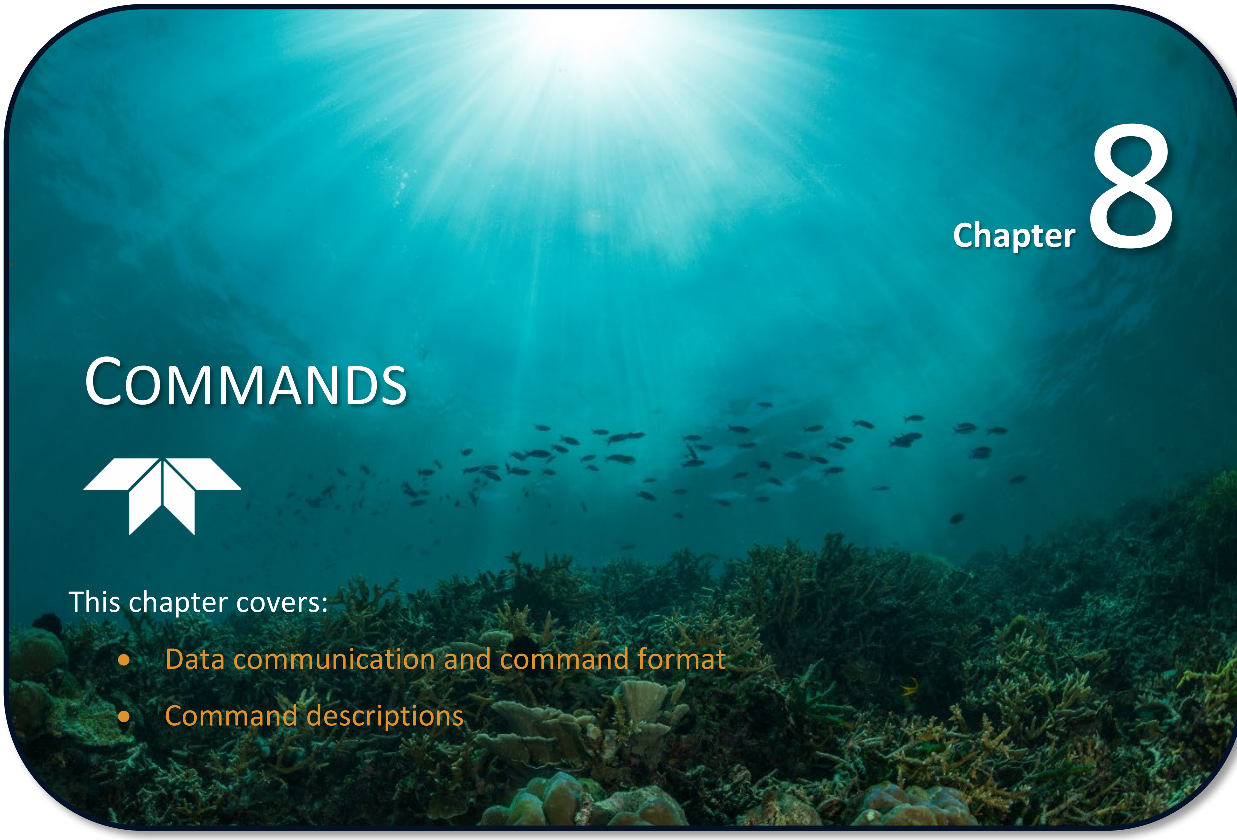
OUTLINE/INSTALLATION, 1200KHZ, 300M WORKHORSE PROTEUS MONITOR
SIZE D
DWG NO. A96-9005
REV XB
SCALE 1:1
SHEET 2 OF 2



Chapter 8

COMMANDS

This chapter covers:

- Data communication and command format
- Command descriptions

This section defines the commands to set up and control the Workhorse Proteus. Teledyne RD Instruments recommend using the *ADCP Utilities* software to control the Workhorse Proteus because entering commands directly from a terminal can be difficult. Most Workhorse Proteus command settings use factory-set values (Table 12). If these values are changed without thought, the deployment may be ruined. *Be sure to know what effect each command has before using it*. Call Teledyne RD Instruments for help in understanding the function of any command.

When new firmware versions are released, some commands may be modified, added, or removed. Read the README file on the firmware download link.

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

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.

Data Communication

Using TRDI's *ADCP Utilities* PLAN, the Proteus ADCP is configured using an XML file, which are then sent to the Proteus as binary commands. *ADCP Utilities* validates each setting and the overall feasibility of the deployment (schedule, ping combos, etc.).

Optionally, the user can create a custom configuration set using the 2L (Two-Letter) commands using the *TRDI Toolz* software. 2L commands are limited in the complexity that they can setup a profile or schedule compared to binary commands. For example, the 2L commands can only configure one simple ping schedule, while *ADCP Utilities* can configure two schedules.

It is not recommended to setup Proteus using *ADCP Utilities*, then to change the setup using individual 2L commands afterward. Some settings such as W, Z, V, B and T overlap with complex settings from *ADCP Utilities*, so results may be unpredictable. When using 2L commands to setup Proteus, it is recommended to start with CR1 (Restore defaults) to avoid conflicts.

2L commands for status and test such as PS0, PA, PC2, Cstate, Cstop, CS will not conflict with an existing setup and are ok to use without restoring defaults.

Note that some interactions with Proteus are not supported using 2L command interface such as FFT and data download. These features are accessible using *ADCP Utilities*.

See the TRDI Toolz help file for information on how to send 2L commands to the Proteus ADCP.

2L command logic echoes to both the serial and Ethernet ports if opened which can interfere with operations done on other port. For example, 2L commands sent on the serial port can interfere with data download (and other operations) when connected to ADCP Utilities on the Ethernet port.

Command Input Processing

Input commands set Workhorse Proteus operating parameters, start data collection, run built-in tests (BIT), and asks for output data. All 2L commands are ASCII character(s) and must end with a carriage return <CR>. For example,

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

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

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

If a valid command is entered that produces output data, the Workhorse Proteus 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 Workhorse Proteus responds with an error message similar to the following.

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

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

Data Output Processing

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

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

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

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

Command Summary

Table 12 gives a summary of the Workhorse Proteus input commands, their format, default setting, whether the Workhorse Proteus will allow the command change if sent while pinging, and a brief description of the parameters they control. Commands that start with the # sign are considered "expert" commands. Commands sent while pinging will be used on the next ensemble after the one during which they are received.

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

The Workhorse Proteus system accepts command changes during operation without the need to stop the ping cycle (by sending a <BREAK>). This allows for dynamic setup configuration (Yes = Deployed/Not Deployed, No = Not Deployed) without stopping the operation of the Workhorse Proteus. These dynamic setup commands are defined in the column Dynamic Commands in the table below.

Table 12: Workhorse Proteus Input Command Summary

Command	Default	Dynamic Command	Description
?	N/A	N/A	Shows command menu
<BREAK> End	N/A	N/A	Wake up if asleep. Shift command/control active port to "this" (serial) port. Show banner.
= = = (soft break)	N/A	Yes	Shift command/control active port to "this" port. Show banner.
OL	N/A	Yes	Features
Bottom Track Commands			
B?	N/A	Yes	Lists available B commands
BA nnn	024	No	Evaluation Amplitude Min (0-255)
BC nnn	220	No	Correlation Magnitude Min (0-255)
BE nnnn	1000	No	Max Error Velocity (0-9999mm/s)
BF nnnnn	00000	No	Depth Guess (0=Auto, 1-9999 cm)
BI nnn	1200: 5 600: 10 300: 20	No	Gain Switch Altitude [0-999m]
BM n	BM8	No	Shallow mode enable
BP nnn	0	No	Pings per Ensemble (0-999)
BX nnnnn	1200: 450 600: 1250 300: 2000	No	Maximum Altitude (10-65535 dm)
Control System Commands			
C?	N/A	Yes	Lists available commands
CA	300	Yes	Communication Timeout (0=Off,10-65536 sec)
CD n	1	No	Ensemble Buffering [0=Off, 1=On]
CF *nnnnn*	11101	No	Flow control (EnsCyc; PngCyc; Binary; Serial; X)
CK	N/A	No	Keep parameters as user defaults
CL n	1	No	Sleep Enable (0=Disabled, 1=Enabled)
CN	N/A	No	Ethernet settings
CN 1	N/A	No	Show Network Setup
CN 2	192.168.001.100	No	Set Static IP Address [xxx.xxx.xxx.xxx]

Table 12: Workhorse Proteus Input Command Summary

Command	Default	Dynamic Command	Description
CN 3	1	No	DHCP Enable [1=DHCP, 0=Static]
CN 4	192.168.001.001	No	Set IP Gateway [xxx.xxx.xxx.xxx]
CN 5	255.255.255.000	No	Set Subnet Mask
CN 6	000.000.000.000:280	No	UDP Data Destination [xxx.xxx.xxx.xxx:pppp]
CN 7	N/A	No	Start Networking
CN 8	0	No	Raw Data Enable [0=Off, 1=On]
CN 9	010.020.230.010:1034	No	Raw Data Output [xxx.xxx.xxx.xxx:pppp]
CN A	0	No	Proc1 Data Enable [0=Off, 1=On]
CN B	010.020.230.010:1035	No	Proc1 Data Output [xxx.xxx.xxx.xxx:pppp]
CN C	0	No	Proc2 Data Enable [0=Off, 1=On]
CN D	010.020.230.010:1036	No	Proc2 Data Output [xxx.xxx.xxx.xxx:pppp]
CN E	0	No	Ethernet wake enable [0=Off, 1=On]
CQ n	1	No	Power Level (0-37V, 1-44V, 2-72V, 3-100V, 4-Vin)
CR *n*	N/A	No	Retrieve parameters (0 = User, 1 = Factory)
CS or **Tab**	N/A	No	Start pinging
CSTATE	N/A	Yes	Pinging State Query
CSTOP	N/A	Yes	Stop Pinging
CV *n*	0	No	Serial output data type (0=Raw, 1=Processed Ensemble)
CW *n*	00250	No	Trigger In Timeout (ms; 0=no timeout)
CX *n*	0	No	Trigger In Enable (0=Disable, 1=Enabled)
CZ	N/A	No	Power Down
Environmental Commands			
E?	N/A	Yes	Lists available commands
EA ±*nnnnn*	+00000	No	Heading Alignment [.01 deg cw]
EB +*nnnnn*	+00000	No	Heading Bias [.01 deg cw]
EC *nnnn*	1500	Yes	Speed of Sound (1400 to 1600 m/s)
ED *nnnn*	1100	Yes	Transducer Depth (0 to 65535 dm)
EH *nnnnn*	0	Yes	Heading nnnnn = 0 to 35999 (000.00 to 359.99 degrees)
EP ±*nnnnn*	+00000	Yes	Tilts ±nnnn = -6000 to 6000 (-60.00 to +60.00 degrees)
ER ±*nnnnn*	+00000	Yes	Roll ±nnnn = -17999 to 18000 (-179.99 to +180.00 degrees)
ES *nn*	35	Yes	Salinity (nn = 0 to 40)
ET ±*nnnn*	2100	Yes	Temperature ±nnnn = -500 to 4000 (-5.00 C to +40.00 C)
EU *n*	0	No	Orientation 0=down, 1=up
EX *nnnnn*	11111	No	Coordinate Transformation (cct3m)
EZ cdhprst	10000010 (temporary)	No	Sensor Source (C;D;H;P;R;S;T)
Performance and Testing Commands			
P?	N/A	Yes	Lists available commands
PA	N/A	No	Run Go/No-Go Tests
PC2	N/A	No	Display sensor data – non-scrolling
PD0	0	No	Set Output Format (0=ensemble; 27=ASCII)

Table 12: Workhorse Proteus Input Command Summary

Command	Default	Dynamic Command	Description
PS0	N/A	Yes	Display System Configuration
Recorder Commands			
R?	N/A	No	Show R Menu
RE	N/A	No	Clear data from recorder
RR	N/A	No	Show recorder files (and info)
RS	N/A	No	Show recorder free space (MB)
Sensor Commands			
S?	N/A	Yes	Lists available commands
SZ	N/A	No	Zero out keller30 Pressure
Timing Commands			
T?	N/A	Yes	Lists available commands
TE *hh:mm:ss.ff*	00:00:00.00	No	Time per ensemble (hours:minutes:seconds.100th of seconds)
TF *yy/mm/dd, hh:mm:ss*	N/A	No	Time of First Ping
TP *mm:ss.ff*	00:00.20	No	Time between pings (minutes:seconds.100th of seconds)
TS *yy/mm/dd, hh:mm:ss*	N/A	No	Set real-time clock (year/month/day, hours:minutes:seconds)
Vertical Beam Range Commands			
V?	N/A	Yes	Show V Menu
VA	24	No	AmpThresh [0..255]
VB	TBD	No	Blank after transmit (0-5000cm)
VF	0	No	Boundary Guess (0, 1 to 30,000 cm (0 = automatic))
VP	0	No	Vertical beam range number of pings [0..16384]
VX	1200: 450 600: 1250 300: 2000	No	Max Search Altitude
Broadband Water Profiling Commands			
W?	N/A	Yes	Lists available commands
WA *nnn*	Cat: 50 Dop: 255 (disable)	No	False target threshold maximum (0 to 255 counts)
WB n	0	No	Bandwidth Control (0=Wide,1=Narrow)
WC *nnn*	Cat: 64 Dop: 0 (disable)	No	Correlation threshold (0 to 255 counts)
WD *nnn nnn nnn*	DOP: WD 111 000 000 CAT: WD 111 100 000	No	Data Out {v;c;a;p;s;*;*;*;*}
WE *nnnn*	Cat: 2000 Dop: 9999 (disable)	No	Error velocity threshold (0 to 9999 mm/s)
WF *nnnn*	1200kHz: 0.3m, 600kHz: 0.5m, 300kHz: 1.0m	No	Blank After Transmit (0-9999 cm)
WG	50	No	Percent Good Threshold (1-100)
WJ n	1	No	Receiver Gain Select (0=Low, 1=High)
WM n	2	No	Water Profiling Mode [2]
WN *nnn*	030	No	Number of Depth Cells (1-255)
WP *nnn*	001	No	Number of Pings (0-16384)
WS *nnnn*	1200: 100cm 600: 200cm 300: 400cm	No	Depth Cell Size (cm)

Table 12: Workhorse Proteus Input Command Summary

Command	Default	Dynamic Command	Description
WT *nnnn*	0000	No	Transmit Length (cm) (0=Cell Size)
WV *nnn*	175	No	Ambiguity Velocity (cm/s radial)
			Vertical Profiling Commands
Z?	N/A	Yes	Show Z Menu
ZB	0	No	Bandwidth Control (0=Wide,1=Narrow)
ZC	Cat: 64 Dop: 0 (disable)	No	Correlation Threshold (0-255)
ZF	1200kHz: 0.3m, 600kHz: 0.5m, 300kHz: 1.0m	No	Blank After Transmit (0-9999 cm)
ZJ	1	No	Receiver Gain (0=Low, 1=High)
ZN	30	No	Number of Depth Cells (1-255)
ZP	0	No	Number of Pings (0-16384)
ZS	1200: 100cm 600: 200cm 300: 400cm	No	Depth Cell Size (cm)
ZT	0	No	Transmit Length (cm) (0=Cell Size)
ZV	175	No	Ambiguity Velocity (cm/s radial)

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 Workhorse Proteus 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 to view. When the Workhorse Proteus 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.

```
*****************************************************************************
Workhorse Proteus
Teledyne RD Instruments (c) 2025
All rights reserved.
Firmware Version 1.0.0.105
*****************************************************************************

System is not Deployed

>
```

```
>?
Available Commands:

B ------------------------ Bottom Mode Commands
C ------------------------ Control Commands
E ------------------------ Environment Commands
F ------------------------ Diagnostics Commands
O ------------------------ Features Commands
P ------------------------ Performance Test Commands
R ------------------------ Recorder Commands
S ------------------------ Sensor Commands
T ------------------------ Time Commands
V ------------------------ Vertical Beam Range Commands
W ------------------------ Water Profiling Commands
Y ------------------------ Display Banner
Z ------------------------ Vertical Profiling Commands
? ------------------------ Display Main Menu
>b?
Available Commands:

BA 024 ------------------- Evaluation Amplitude Min (0-255)
BC 220 ------------------- Correlation Threshold (0-255)
BE 1000 ------------------ Error Velocity Threshold (0-9999 mm/s)
BF 00000 ----------------- Depth Guess (0=Auto, 1-99999 cm)
BI 010 ------------------- Gain Switch Depth (0-999 m)
BM 8 --------------------- Mode (8, 9)
BP 00000 ----------------- Number of Pings (0-16384)
BX 01250 ----------------- Max Tracking Depth (10-65535 dm)
B? ----------------------- Display B-Command Menu

>wp?
WP 00001 --------------- Number of Pings [0-16384]
>
```

Break

Purpose Interrupts Workhorse Proteus without erasing present settings.

Format <BREAK>

Description A BREAK signal interrupts Workhorse Proteus ADCP processing, initializes the system, sends a wake-up (copyright) message, and places the Workhorse Proteus ADCP in the DATA I/O mode. The BREAK command does not erase any settings or data. Using *TRDI Toolz*, press the Break icon to send a BREAK. Note that the default for *TRDI Toolz* is to send a soft break.

```
*************************************************************************
Workhorse Proteus
Teledyne RD Instruments (c) 2025
All rights reserved.
Firmware Version 1.0.0.105
*************************************************************************

System is not Deployed

>
```

A break does not interrupt a deployment! This is by design, because there will be many cases where the user wishes to wake up but not interrupt the deployment. Using the CSTOP command is the only way to stop a deployment once communication is (re)established with a break.

If the Workhorse Proteus is NOT deployed, it will go to sleep in five minutes. This is true regardless of DR, SC, Serial COM, or Ethernet communications. The only exception is when Ethernet is connected, and a link is detected. In this case, the Workhorse Proteus will NOT go to sleep.

Soft Break

If a soft break (===) is received by the Workhorse Proteus, the banner and status will display. The deployment is not interrupted.

```
************************************************************************
Workhorse Proteus
Teledyne RD Instruments (c) 2025
All rights reserved.
Firmware Version 1.0.0.105
************************************************************************
Pinging
>
```

OL – Display Feature List

Purpose Lists the special firmware upgrades that are installed.

Format OL

Description Lists special features that are installed. See the *ADCP Utilities* software for information on how to install additional capability in the Workhorse Proteus.

Examples See below.

```
>ol                       FEATURES
---------------------------------------------------------------
Feature                                                Installed
---------------------------------------------------------------
Water Profile                                              Yes
Bottom Track                                               Yes

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

>
```

Bottom Track is a feature upgrade. Use *ADCP Utilities* software to install feature upgrades.

Y – Display Banner

Purpose Displays the banner message

Format Y

Description Only displays the banner message. This command does not interrupt the Workhorse Proteus.

Example See below.

```
>y
************************************************************************
Workhorse Proteus
Teledyne RD Instruments (c) 2025
All rights reserved.
Firmware Version 1.0.0.105
************************************************************************

System is not Deployed

>
```

Bottom Track Commands

The Workhorse Proteus uses the following commands to control Bottom Track parameters.

Available Bottom Track Commands

This section lists the available Bottom Track commands.

```
>b?
Available Commands:

BA 024 ------------------- Evaluation Amplitude Min (0-255)
BC 220 ------------------- Correlation Threshold (0-255)
BE 1000 ------------------ Error Velocity Threshold (0-9999 mm/s)
BF 00000 ----------------- Depth Guess (0=Auto, 1-99999 cm)
BI 010 ------------------- Gain Switch Depth (0-999 m)
BM 8 --------------------- Mode (8, 9)
BP 00000 ----------------- Number of Pings (0-16384)
BX 01250 ----------------- Max Tracking Depth (10-65535 dm)
B? ----------------------- Display B-Command Menu
```

Bottom-Track Command Descriptions

BA – Evaluation Amplitude Minimum

Purpose	Sets the minimum value for a valid bottom detection.
Format	BA *nnn*
Range	*nnn* = 0 to 255 counts
Default	BA 024

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.

BC – Correlation Threshold

Purpose	Sets minimum correlation magnitude for valid velocity data.
Format	BC *nnn*
Range	*nnn* = 0 to 255 counts
Default	BC 220

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

Description	Sets a minimum threshold for good bottom-track data. The 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. a solid target).

BE – Error Velocity Threshold

Purpose	Sets maximum error velocity for good bottom-track water-current data.
Format	BE n
Range	n = 0 to 9999 mm/s
Default	BE 1000

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

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

The default setting is set purposely high. TRDI recommends extreme caution and testing before changing this setting. Data rejected by this command is lost and cannot be regained.

BF – Depth Guess

Purpose	Sets a “best-guess” of expected bottom range for internal calculations.
Format	BF nnnnn
Range	nnnnn = 0, 1 to 9999 cm (0 = automatic)
Default	BF 0

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

Description When set to a non-zero value, the Workhorse Proteus 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 Workhorse Proteus uses to search for the bottom if lost.

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

BI – Gain Switch Altitude

Purpose Selects the maximum vertical distance from the transducer to the bottom at which the Workhorse Proteus operates at low gain.

Format BI *nnn*

Range *nnn* = 0 to 999 meters

Default BI 5 (1200 kHz), BI 10 (600 kHz), BI 20 (300 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 to detect the bottom throughout the range of the system.

BM - BT Shallow Mode Enable

Purpose Sets the shallow bottom track mode.

Format BM *n*

Range *n* = 8, 9

Default BM 8

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

Description: Bottom Mode 8 was developed for the following improvements in shallow operations:

- Much improved accuracy by pinging Beams around, one at a time.
- Better handling of slopes by independently setting lags on each beam based on accurate bottom detection before each ping.
- Better handling of station keeping application using longer lag.
- Higher resolution Bottom Detection using short lag Bottom Feeler pings.

Table 13: BM8 Minimum Tracking Depths

Frequency	BM8 Minimum Tracking Depths (m)	BM9 Minimum Tracking Depths (m)
1200KHz	0.3	TBD
600KHz	0.5	TBD
300KHz	1.0	TBD

Bottom Mode 9 is identical to Bottom Mode 8 except that it does not have a shallow mode.

BP – Bottom-Track Pings

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

Format BP *n*

Range *n* = 0 to 16384 pings

Default BP 0

Recommended Setting. Set using *ADCP Utilities*.

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

The Workhorse Proteus interleaves bottom-track pings with water-track pings (see TP - Time Between Pings) with the bottom track ping being the first ping in an ensemble.

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

BX – Maximum Tracking Depth

Purpose Limits the search range for bottom tracking.

Format BX *nnnn* decimeters (meters x 10)

Range *nnnn* = 10 to 65535 dm

Default BX 450 (1200 kHz), BX 1250 (600 kHz), BX 2000 (300 kHz)

Recommended Setting. The default setting for this command is recommended for most applications. The command will accept values within the stated range, but if it is higher than the default value, the default value will be used.

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

Example If you know the maximum depth in the deployment area is 100 meters (1000 decimeters), set BX to a value slightly larger than 1000 dm, say 1250 dm, instead of 2000 dm. Now if the ADCP loses track of the bottom, it will stop searching for the bottom at 1250 dm (125 m) rather than spend time searching down to 2000 dm (200 m).

The BX command limits the search range for bottom tracking. If the 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 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 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 ADCP will be less likely to hold a lock on the bottom if there is any slope beyond the BX range.

Control System Commands

The Workhorse Proteus uses the following commands to control certain system parameters.

Available Control System Commands

This section lists the available Control System commands.

```
>c?
Available Commands:

CA 00300 ----------------- Communication Timeout (0=Off,10-65535 sec)
CD 0 --------------------- Ensemble Buffering (0=Off, 1=On)
CF 11100 ----------------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CK ----------------------- Save Command Parameters
CL 1 --------------------- Sleep Enable (0=Disable, 1=Enable)
CN ----------------------- Network Menu
CQ 1 --------------------- Power Level (0-37V, 1-44V, 2-72V, 3-100V, 4-Vin)
CR ----------------------- Retrieve Parameters (0=USER, 1=FACTORY)
CS ----------------------- Start Pinging
CSTATE ------------------- Pinging State Query
CSTOP -------------------- Stop Pinging
CV 1 --------------------- Serial output data type (0=Raw, 1=Processed Ensemble)
CW 00250 ----------------- Trigger In Timeout (ms; 0=no timeout)
CX 0 --------------------- Trigger In Enable (0=Disable, 1=Enabled)
CZ ----------------------- Power Down Catalyst
C? ----------------------- Display C-Command Menu

>
```

CA – Communication Timeout

Purpose	Sets the timeout period for the activity timer.
Format	CA *nnnnn*
Range	*nnnnn* = 0 (off), 10 to 65535 seconds
Default	CA 00300

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

Description: The CA command sets the activity timeout period, in seconds. The activity timer is reset when a valid command is received. If no valid command is received within the timeout period, the Workhorse Proteus will redeploy.

CD – Ensemble Buffering

Purpose	Sets ensemble buffering on or off.
Format	CD *n*
Range	*n* = 0: Disable (DR), 1: Running buffer (SC)
Default	CD 0

> CD 0 disables buffering. This should be used in direct read or test applications where timely data output is required.
>
> CD 1 should be used in self-contained applications where the power efficiency is a priority, the data recorder is the primary data receptacle, and data output is either disabled or not time sensitive.

Description Ensemble buffering is used to reduce the number of sleep/wake cycles required to optimize the overall use of system battery energy. However, it is subordinate to ping timing and will maintain the user's desired ping schedule.

CF – Flow Control

Purpose Sets various data flow-control parameters.

Format CF *nnnnn*

Range Firmware switches (see description)

Default CF 11111

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

Description The CF-command defines whether the Workhorse Proteus: generates pings immediately or manually; sends serial output data in binary format; sends output data to the serial interface, sends or does not send output data to the recorder card.

Table 14: Flow Control

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a "cstop" 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. Enter "cs" to output another ensemble. Enter "cstop" to stop this cycling.
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 system is not echoed. This feature manually controls ping timing within the ensemble. Note the prompt output by the system when ready to ping is a less-than symbol ("<"), to distinguish it from the normal command prompt.
CFxx1xx	Binary data output – should be left at 1.
CFxx0xx	Not allowed.
CFxxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/422 serial interface.
CFxxx0x	Disable Serial Output.
CFxxxx1	Enable data recorder (SD memory card).
CFxxxx0	Disable data recorder (SD memory card).

CK – Save Command 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. The Workhorse Proteus maintains data stored in the non-volatile memory (user settings) even if power is lost. It does not need a battery. Use the CR command to recall parameters stored in non-volatile memory (see CR – Retrieve Parameters).

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

CL – Sleep Enable

Purpose	Determines whether the Workhorse Proteus will attempt to conserve power by sleeping between pings.
Format	CL *n*
Range	*n* = 0 to 1 (0=Disabled, 1=Enabled)
Default	CL 1

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

Description See table below.

Command	Description
CL 0	Workhorse Proteus never sleeps
CL 1	Workhorse Proteus sleeps if enough time between pings

CN – Network Menu

Purpose	Configures the Workhorse Proteus Ethernet network.
Format	CN*n*
Range	*n*= 1 to E
Default	N/A

Recommended Setting. Set using *ADCP Utilities*. See Using Ethernet Communications for examples.

UDP is a connection-less protocol. Therefore, UDP packets can be lost in an unreliable or highly congested network.

Description See below.

```
>cn?
Available Commands:

CN1 ---------------------- Show Network Setup and status
CN2 192.168.001.100 ------ Set Static IP Address [xxx.xxx.xxx.xxx]
CN3 1 -------------------- DHCP Enable [1=DHCP, 0=Static]
CN4 192.168.001.001 ------ Set IP Gateway [xxx.xxx.xxx.xxx]
CN5 255.255.255.000 ------ Set Subnet Mask
CN6 0 -------------------- Ethernet Auto Connect [0=Off, 1=On]
CN7 ---------------------- Start Networking
CN8 0 -------------------- Raw Data Enable [0=Off, 1=On]
CN9 010.020.230.010:1034 - Raw Data Output [xxx.xxx.xxx.xxx:pppp]
CNA 0 -------------------- Proc1 Data Enable [0=Off, 1=On]
CNB 010.020.230.010:1035 - Proc1 Data Output [xxx.xxx.xxx.xxx:pppp]
CNC 0 -------------------- Proc2 Data Enable [0=Off, 1=On]
CND 010.020.230.010:1036 - Proc2 Data Output [xxx.xxx.xxx.xxx:pppp]
CNE -----------------------Ethernet wake enable [0=Off, 1=On]
CN? ---------------------- Display CN-Command Menu
>
```

CN1 – Show Network Setup

Displays the basic network information. The CN1 command changes from showing the IP address as "(Not Initialized)" when an Ethernet connection is made (see Fallback Operation).

```
>cn1
Network Configuration:
Hostname:                   WHP-xxxx-yyyy
IPv4 Address:               0.0.0.0 (Not Initialized)
Subnet Mask:                0.0.0.0
Default Gateway:            0.0.0.0

UDP Data Destination:       0.0.0.0:280
>
```

Recommended Setting. Set using ADCP Utilities Network page.

CN2 – Set Static IP Address [xxx.xxx.xxx.xxx]

Sets the Workhorse Proteus's static DHCP server IP address.

```
>cn2 192.168.1.100
Set IP to 192.168.1.100
>
```

CN3 – DHCP Enable [1=DHCP, 0=Static]

Use the CN3 command to choose **STATIC** or **DHCP**. Use Dynamic Host Configuration Protocol (DHCP) server protocol when the network automatically provides an Internet Protocol (IP) host with its IP address and other related configuration information such as the subnet mask and default gateway.

If you are using a STATIC network, then configure the **Static IP Address**, **Subnet Mask**, and **Gateway Address** as needed.

```
>cn3 1
>
```

When the Workhorse Proteus is configured for DHCP operation, it will attempt to get its networking configuration from a server on the network. If a DHCP server does not respond, after a timeout Workhorse Proteus will "fall back" to use a Static network configuration. This prevents the Workhorse Proteus from being "unreachable" if placed on a network without a DHCP server. See Fallback Operation for more information.

CN4 – Set IP Gateway [xxx.xxx.xxx.xxx]

Specify the IP Gateway address.

```
>cn4 192.168.001.001
IP Gateway set to: 192.168.1.1
>
```

CN5 – Set Subnet Mask

Specify the Subnet mask.

```
>cn5 255.255.255.000
IP NetMask set to: 255.255.255.0
>
```

CN6 – Ethernet Auto Connect [0=Off, 1=On]

With the **Auto connect** setting enabled, the Ethernet adapter is always powered and available when the system is powered. You must cycle power to connect.

CN7 –Start Networking

The CN7 command is only used to force-start the Ethernet stacks on a Serial system, or for debugging.

CN8 – Raw Data Enable [0=Off, 1=On]

Enables or disables raw ensemble data output.

CN9 – Raw Data Output [xxx.xxx.xxx.xxx:pppp]

Specify the IP address and port of the remote machine where ensemble data is going to be sent. CN9 is configured as *xxx.xxx.xxx.xxx:pppp*, where *xxx* is the IP address and *pppp* is the port. See Using Ethernet Communications for examples. The default is 010.020.230.010:1034.

```
>cn9 010.020.230.010:1034
UDP Data destination set to: 010.020.230.010:1034
>
```

CNA – Proc1 Data Enable

Enables or disables processed ensemble data output.

```
CNA 0 -------------------- Proc1 Data Enable [0=Off, 1=On]
```

CNB – Proc1 Data Output

Specify the IP address and port of the remote machine where processed ensemble data is going to be sent. CNB is configured as *xxx.xxx.xxx.xxx:pppp*, where *xxx* is the IP address and *pppp* is the port.

```
CNB 010.020.230.010:1035 - Proc1 Data Output [xxx.xxx.xxx.xxx:pppp]
```

CNC – Proc2 Data Enable

Enables or disables processed ensemble data output.

```
CNC 0 -------------------- Proc2 Data Enable [0=Off, 1=On]
```

CND - Proc2 Data Output

Specify the IP address and port of the remote machine where processed ensemble data is going to be sent. CNB is configured as *xxx.xxx.xxx.xxx:pppp*, where *xxx* is the IP address and *pppp* is the port.

```
CND 010.020.230.010:1036 - Proc2 Data Output [xxx.xxx.xxx.xxx:pppp]
```

CNE – Ethernet Wake Enable

```
CNE -----------------------Ethernet wake enable [0=Off, 1=On]
```

TBD

CQ – Power Level

Purpose	Sets the transmit voltage level.
Format	CQ *n*
Range	*n* = 0-37V, 1-44V, 2-72V, 3-100V, 4-Vin (see table)
Default	CQ 1

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

Description Changes the acoustic transmit power setting. Settings 0-3 select a fixed transmit power setting that is independent from the system input voltage. Note that the maximum transmit power is limited to the 44v setting for bottom track pings and vertical range pings, so this power will be applied for those pings if any higher power settings are used.

Setting 4 scales the transmit power with the input voltage (Vin). This is consistent behavior with legacy products such as Workhorse.

System Frequency	CQ Setting	Transmit voltage (V)	Transmit power (Watts/beam)	
			Water Profiling (WP) and Vertical Profiling (ZP)	Bottom Track (BP) and Vertical Range (VP)
1200 kHz	0	37	2.1	2.1
	1 (default)	44	3	3
	2	72	8.7	3
	3	100	15.5	3
	4	Vin (Input voltage)	Vin^{2} x .0016	Vin^{2} x .0016
600 kHz	0	37	5.7	5.7
	1 (default)	44	8	8
	2	72	23	8
	3	100	41	8
	4	Vin (Input voltage)	Vin^{2} * .0042	Vin^{2} * .0042
300 kHz	0	37	18	18
	1 (default)	44	25	25
	2	72	73	25
	3	100	130	25
	4	Vin (Input voltage)	Vin^{2} * .013	Vin^{2} * .013

If using a rapid pinging schedule and high-power settings, the transmit power may not reliably reach high power levels for each ping. If consistent high power is very important, use 24V or higher input voltage and extra time between pings.

To verify the transmit voltage for a given setup, deploy using the desired schedule and power setting while the transducers are in water, then review the TX Voltage data output in the PD0 data format Variable Leader bytes 72 - 73 from the recorded or output data.

CR – Retrieve Parameters

Purpose Resets the Workhorse Proteus command set to factory settings.

Format CR *n*

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

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

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

Table 15: Retrieve Parameters

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

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

```
>cr1
[Parameters set to FACTORY defaults]

>
```

CS – Start Pinging (Go)

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

Format CS

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

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

CState – Pinging State Query

Purpose Displays the status of the Workhorse Proteus.

Format CState

> Recommended Setting. Use as needed.

Description Displays either “Pinging” or “Not Pinging”, depending on the state of the system.

```
>cstate
Not Pinging
>
```

CStop – Stop Pinging

Purpose Stops the current deployment.

Format CStop

Recommended Setting. Use *ADCP Utilities* to stop a deployment.

Description Stops autonomous sampling without resetting the Workhorse Proteus.

CV – Serial Output Data Type

Purpose Sets what data type is sent to the serial port.

Format CV *n*

Range *n* = 0, 1 (0=Raw, 1=Processed Ensemble)

Default CV 1

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

Description Use CV1 to select processed ensemble data using whichever format is selected using the PD command setting for output to the serial port.

Use CV0 to select unprocessed PD0 ping data for output to the serial port, regardless of PD command setting.

CW – Trigger In Timeout

Purpose Sets the trigger timeout.

Format CW *nnnnn*

Range *nnnnn* = 0 to 65535 milliseconds (0 = No timeout)

Default CW 00250

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

Description This command must be set when performing low latency triggering (see CX command). If the system does not receive a trigger before *nnnnn* ms, then the system will ping on its own according to the timing schedule set up with the T commands, and the trigger will be ignored.

CX – Trigger In Enable

Purpose Enables or disables the trigger.

Format CX *n*

Recommended Setting. Use as needed.

Range 0 = off, 1 = Enabled

Default CX 0

Description When cx 0, the input trigger is disabled.

When CX 1, the Workhorse Proteus will ping once within 1ms after the trigger transitions from low to high.

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

CZ – Power Down Catalyst

Purpose Tells the Proteus to power down.

Format CZ

Recommended Setting. Use as needed.

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

Example See below

```
>cz
Going to sleep
```

The CZ command may not power down the system immediately depending on internal processes.

If the system is deployed when CZ is sent it will still attempt to run/resume the deployment scheduled.

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

Environmental Commands

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

Available Environmental Commands

This section lists the available Environmental commands.

```
>e?
Available Commands:

EA +00000 ---------------- Heading Alignment (0.01 deg)
EB +00000 ---------------- Heading Bias (0.01 deg)
EC 1500 ------------------ Speed of Sound (m/s)
ED 00000 ----------------- Transducer Depth (0-65535 dm)
EH 00000 ----------------- Heading (0.01 deg)
EM 0000 ------------------ Disable Beam Mask (b1;b2;b3;b4, 0-Enabled, 1-Disabled)
EP +0000 ----------------- Pitch (0.01 deg)
ER +0000 ----------------- Roll (0.01 deg)
ES 35 -------------------- Salinity (0-40)
ET +2100 ----------------- Temperature (0.01 deg C)
EU 0 --------------------- Orientation (0=Down, 1=Up)
EX 00000 ----------------- Coord Transform (Type;Tilts;3Bm;Map)
EZ 1111101 --------------- Sensor Source (C;D;H;P;R;S;T)
E? ----------------------- Display E-Command Menu
>
```

EA – Heading Alignment

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

Format EA ±*nnnnn*

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

Default EA +00000

Set as needed.

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

Example The Workhorse Proteus is mounted on a ship/vehicle with beam 3 aligned at a +45 degree angle (i.e. clockwise) from the forward axis of the ship/vehicle. Use the EA command to tell the Workhorse Proteus where beam 3 is in relation to the ship's centerline. To convert +45 to an EA-command value, multiply the desired alignment angle in degrees by 100:

```
EA = +45.00 × 100 = +4500 = EA+04500
```

EB – Heading Bias

Purpose Corrects for electrical/magnetic bias between the Workhorse Proteus heading value and the heading reference.

Format EB ±*nnnnn*

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

Default EB +00000

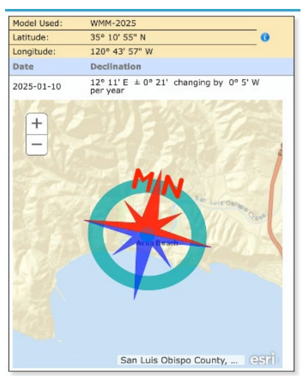
> Set as needed. VmDas uses this command to zero the heading bias.

Description EB is the heading angle that counteracts the local biasor magnetic variation (declination) between the Workhorse Proteus and the heading source. EB is added to heading (either in ship or instrument coordinates) for use in velocity transformation and ensemble output.

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

Examples The compass default is to output magnetic heading. To correct velocity with true heading, enter an EB command value. Magnetic variation is the angle between true north and magnetic north, where a positive value means true north is east of magnetic north. As such, declination depends on geographic location. It also changes very slowly over time. For the greatest accuracy, TRDI recommends checking the National Geophysical Data Center website (link below) to find the declination angle based on your latitude and longitude: http://www.ngdc.noaa.gov/geomag-web/#declination.

For example, if your "true" north reference is a + 12 degree clockwise offset from magnetic north, a reading of 12 degrees magnetic would be 0 degrees heading relative to the magnetic. So, add a negative 12 degree offset in for the EB command.



EC – Speed of Sound

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

Format EC *nnnn*

Range *nnnn* = 1400 to 1600 meters per second

Default EC 1500

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

Description EC (or the calculated speed of sound in the water) sets the sound speed value used by the Workhorse Proteus to scale vertical range and depth cell size if the EZ command 'c' field (speed-of-sound source) is set to 0. The Workhorse Proteus always uses a fixed speed of sound of 1500 m/s for velocity. See the primer for information on speed of sound calculations.

ED – Transducer Depth

Purpose	Sets the Workhorse Proteus transducer depth.
Format	ED nnnnn
Range	nnnnn = 0 to 65535 decimeters (meters x 10)
Default	ED 0

Use the EZ-command (see EZ - Sensor Source).

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

If the EZ *Transducer Depth* field = 1, the Workhorse Proteus overrides the manually set ED value and uses depth from the Keller pressure sensor. If the pressure sensor is not available, the Workhorse Proteus uses the ED command.

EH – Heading

Purpose	Sets the Workhorse Proteus heading.
Format	EH *nnnnn*
Range	*nnnnn* = 0 to 35999 (000.00 to 359.99 degrees)
Default	EH 00000

Use the EZ-command (see EZ - Sensor Source).

Description EH sets the Workhorse Proteus heading. This heading value is assumed to be in instrument coordinates.

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

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

If the EZ Heading field = 1, the Workhorse Proteus overrides the manually-set EH value and uses heading from the compass. If EZ Heading field is zero the Workhorse Proteus uses the manual EH command settings.

See EZ - Sensor Source for more details and restrictions for the case of mixed heading sources.

EP – Pitch

Purpose Sets the Workhorse Proteus pitch (tilt 1).

Format EP ±*nnnn*

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

Default EP +0000

> Use EP for pitch and ER for roll if using fixed values. The normal usage will be to get pitch and roll from the Compass, and leave EP and ER set to zero, with the corresponding EZ command flags set to 1 for internal sensor.

Description EP sets the Workhorse Proteus pitch (tilt 1). This pitch value is assumed to be in instrument coordinates.

Example Convert pitch and roll values of +14 degrees and -3.5 degrees to EP-command values referenced to ship coordinates.

```
Pitch in hundredths = 14.00 × 100 = EP 1400
```

ER – Roll

Purpose Sets the Workhorse Proteus roll angle that will be used by the system if the corresponding EZ bit is set to 0.

Format ER ±*nnnnn*

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

Default ER +0000

> Use EP for pitch and ER for roll if using fixed values. The normal usage will be to get pitch and roll from the Compass, and leave EP and ER set to zero, with the corresponding EZ command flags set to 1 for internal sensor.

Description This command allows the user to input a roll (tilt 2) value that will be used if the roll EZ bit is set to zero. See the description of the EZ command (EZ - Sensor Source) to see how this commands value is used.

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

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

ES – Salinity

Purpose Sets the water's salinity value.

Format ES *nn*

Range *nn* = 0 to 40

Default ES 35

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

Description The ES command sets the water's salinity value. The Workhorse Proteus uses ES in its speed of sound calculations. The Workhorse Proteus 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 ET 2100

Use the EZ-command (see EZ - Sensor Source).

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

EU – Up/Down Orientation

Purpose Sets the Workhorse Proteus up/down orientation.

Format EU *n*

Range *n* = 0 or 1 (0 = down, 1 = up)

Default EU 0

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

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

EX – Coordinate Transformation

Purpose Sets the coordinate transformation processing flags.

Format EX *cct3m*

Range *cc* = Coordinate Transformation
t = Pitch and Roll
3 = 3 beam solutions
m = Bin mapping

Default EX 00000

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 16: 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 Workhorse Proteus. Heading/Pitch/Roll not applied.
EX10xxx	Ship coordinates (Note 1) X, Y, Z vectors relative to the ship. Heading not applied. EA-command used. 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 commands used. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EXxx1xx	Use tilts (pitch and roll) in transformation (Note 2)
EXxxx1x	Allows 3-beam solutions if one beam is below the correlation threshold set by WC (see Note 3)
EXxxxx1	Allow bin mapping. Dynamic bin mapping (acceleration-compensated pitch/roll) used. (see Note 4)

1. For ship and earth-coordinate transformations to work properly set the Heading Alignment (EA - Heading Alignment) and Heading Bias (EB - Heading Bias) correctly. Ensure that the tilt and heading sensors are active (EZ - Sensor Source).

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

3. When all four beams are providing good data, the instrument screens the velocity data by comparing the magnitude of the Error Velocity to a WC commanded threshold. The Error Velocity has redundant information among the four beam velocities. This is done for all coordinate systems other than Beam. A 3-beam solution is produced if, on a particular ping, only three beams have good data, and in that case only, error velocity screening cannot be performed. When 3-beam solutions are enabled, the Workhorse Proteus still computes a 4-beam solution with error velocity screening on all pings where all four beams have good data. There are operating circumstances where due to the bottom slope and/or pitch only three beams are able to have adequate reflection from the bottom, while the fourth beam is not. The three beam solution makes it possible to operate in such severe environments.

4. Dynamic Bin Mapping is used to accurately align the bins from each beam along a real horizontal plane to compensate for a dynamically tilting device. Aligning the bins horizontally provides a more accurate calculation of velocities in the data, which is calculated in horizontal "slices" representing a vertical profile of water velocities.

EZ – Sensor Source

Purpose Selects the source of environmental sensor data.

Format EZ *cdhprst*

Range Firmware switches {c;d;h;p;r;s;t} (see description)

Default EZ 1111101

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

Description Setting the EZ-command firmware switches tells the Workhorse Proteus to use data from a manual setting or from an associated sensor. When a switch value is nonzero, the Workhorse Proteus overrides the manual E-command setting and uses data from the appropriate sensor.

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

Table 17: Sensor Source Switch Settings

FIELD		VALUE = 0	VALUE = 1
C	Speed of sound	Manual EC (see EC - Speed of Sound)	Calculates using available depth, salinity and temperature
D	Depth	Manual ED (see ED - Depth of Transducer)	Internal Keller pressure sensor
H	Heading	Manual EH (see EH - Heading)	Compass
P	Pitch (tilt 1)	Manual EP (see EP - Pitch Angles)	Compass
R	Roll (tilt 2)	Manual ER (see ER - Roll Angle)	Compass
S	Salinity	Manual ES (see ES – Salinity)	Not Allowed
T	Temp	Manual ET (see ET - Temperature)	Internal transducer sensor

Example EZ1111101 means calculate speed of sound from available depth, salinity, and temperature, use Keller pressure sensor for depth, use Compass for heading, pitch, and roll, ES command sets salinity, uses the TRDI internal temperature sensor.

Fault Log Commands

The Proteus 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. Usage: FC 4321
FD ----------------------- Display fault log
FX ----------------------- Clear Diagnostics Information. Usage: FX 9999
F? ----------------------- Display F-Command Menu
>
```

Fault Log Command Descriptions

FC – Clear Fault Log

Purpose Clears the fault log.

Format FC 4321

Recommended Setting. Use ADCP Utilities Diagnostic screen to see/clear system faults and download diagnostic logs.

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

```
>fc 4321..........
 Fault Log Cleared.
Clearing buffer @0x00801000
Done [i=2048].

>
```

FD – Display Fault Log

Purpose Displays the fault log.

Format FD

Recommended Setting. Use ADCP Utilities Diagnostic screen to see/clear system faults and download diagnostic logs.

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

Example

```
>fd
Total Unique Faults   =     5
Overflow Count        =     0
Time of first fault:    21/05/13,12:32:33.18
Time of last fault:     21/07/08,13:14:43.54

Fault Log:
Entry #  0 Code=0206h  Count=    6  Delta=1414772 Time=21/05/19,15:20:36.64
 Parameter = 00018F00h
  Timeout waiting for device ready.
Entry #  1 Code=0a0ah  Count=    1  Delta=    0 Time=21/07/08,13:14:42.04
```

```
 Parameter = 00000000h
  Fluxgate circuit excessive offset drift.
Entry #  2 Code=0a0bh  Count=    1  Delta=    0 Time=21/07/08,13:14:42.54
 Parameter = 00000000h
  Tilt circuit excessive offset drift.
Entry #  3 Code=0a0dh  Count=    1  Delta=    0 Time=21/07/08,13:14:43.04
 Parameter = 00000000h
  Attitude temperature sensor out of range.
Entry #  4 Code=0a17h  Count=    1  Delta=    0 Time=21/07/08,13:14:43.54
 Parameter = 00000000h
  Ambient temperature sensor out of range.
End of fault log.
```

FX – Clear Diagnostics Information

Purpose Clears the Diagnostics Information.

Format FX 9999

> **Recommended Setting.** Use ADCP Utilities Diagnostic screen to see/clear system faults and download diagnostic logs.

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

```
>fx 9999..........
 Diagnostics Information Cleared.
Clearing buffer @0x00801000
Done [i=2048].

>
```

Performance and Testing Commands

The Workhorse Proteus uses the following commands for calibration and testing.

Available Performance and Testing Commands

This section lists the available Performance and Testing commands.

```
>p?
Available Commands:

PA 0 --------------------- Run Go/No-Go Tests
PC ----------------------- Built In Tests, PC0 = Help
PD 0 --------------------- Set Output Format (0=Ensemble,27=ASCII)
PS ----------------------- System Info [0=Config]
P? ----------------------- Display P-Command Menu
```

PA – Run Go/No-Go Tests

Purpose	Sends/displays results of a series of system diagnostic tests.
Format	PA
Range	N/A
Default	N/A
Description	These diagnostic tests check the major modules and signal paths. TRDI recommends running this command before a deployment.
Example	See below

```
>PA
This could take up to 30 seconds
       EC Vin Test: FAIL
      Temp. Sensor: PASS
   Pressure Sensor: DISABLED
    Compass Sensor: DISABLED
           DP VMEM: PASS
        DP DSC ADC: PASS
       DP DSC QSPI: PASS
      CAT/EC COMMs: PASS
      CAT/DP COMMs: PASS
      System Clock: PASS
          CAT VMEM: PASS
          CAT PMEM: PASS
         CAT Disks: PASS
       File System: PASS
        CAT Config: PASS
     CAT Framework: PASS
        CAT Faults: PASS
NO-GO

Exceptions:
    Ethernet
```

Use ADCP Utilities to test the Workhorse Proteus.

PC – Built-In Tests

Purpose Allow the user to view the values of sensor data used in Doppler processing and to identify the source of the data IDs.

Format PC*nnn*

Range *nnn* = 2

Description PC2 continuously displays at approximately 1 sec update the current system heading, pitch, roll, Up/Down, temperature, and pressure.

Example See below.S

```
>PC2

Press any key to quit sensor display ...

All Sensors are Internal Only.
Heading     Pitch     Roll      Up/Down Temperature Pressure
0.00        0.00      0.00      Down    24.52 C     0.00 kPa
0.00        0.00      0.00      Down    24.53 C     0.00 kPa
0.00        0.00      0.00      Down    24.52 C     0.00 kPa
0.00        0.00      0.00      Down    24.54 C     0.00 kPa
0.00        0.00      0.00      Down    24.54 C     0.00 kPa
0.00        0.00      0.00      Down    24.54 C     0.00 kPa
0.00        0.00      0.00      Down    24.53 C     0.00 kPa
0.00        0.00      0.00      Down    24.54 C     0.00 kPa
0.00        0.00      0.00      Down    24.53 C     0.00 kPa
0.00        0.00      0.00      Down    24.52 C     0.00 kPa
>
```

PD – Data Stream Select

Purpose Selects the type of ensemble output data structure.

Format PD *n*

Range *n* = 0, 27 (0=ensemble; 27=ASCII)

Default PD0

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

Description **PD0** (pd zero, not the letter o) output is a binary output that is somewhat configurable via other commands (such as WD) and can send all profile and sensor data being collected by the Workhorse Proteus. For a full description of the PD0 format, see PD0 Output Data Format. See PD27 ASCII Output Data Format when the PD27 is sent.

PS – Display System Parameters

Purpose Displays Workhorse Proteus system configuration data.

Format PS *n*

Range *n* = 0

PS0 – System Configuration Info

PS0 displays system configuration info.

```
>PS0
    Serial Number: 0
        Frequency: 307200 Hz
  Transducer Type: PISTON
       Beam Angle: 20 Degrees
    Vertical Beam: Yes

   CAT FW Version: 1.0.0.76_WS29_DEV06
    DP FW Version: 1.0.0.109
    EC FW Version: 1.0.0.58
     FPGA Version: 0x1203
   CAT BL Version: 0.0.0.0
    DP BL Version: 1.0.0.11
    EC BL Version: 1.0.0.8
      Config File: 2.0.1.10
>
```

Recorder Commands

The following paragraphs list all the WorkHorse Proteus 64GB Micro SD memory card commands. The recorder is set on/off using the CF command. During a deployment, if the memory card is full, the Proteus will stay deployed, but no more data is written to the recorder. Data will not be overwritten.

If the memory card is full, the Proteus cannot be restarted (error message = Recorder full).

Available Recorder Commands

This section lists the available 64GB Micro SD memory card commands.

```
>r?
Available Commands:

RE ----------------------- Recorder Erase (re ErAsE)
RF ----------------------- Rec Space Used (bytes), Free (bytes)
RR ----------------------- Recorder Directory
RS ----------------------- Rec Space Used (MB), Free (MB)
R? ----------------------- Display R-Command Menu
```

RE – Recorder Erase

Purpose Erases and formats the memory card to the FAT32 format.

Format RE ErAsE <volume label>

Description RE ErAsE erases and formats the memory card. This command *is* case sensitive. Use RE ErAsE < volume label > to assign a volume label. The default volume label is "NO NAME".

Use *ADCP Utilities* to download data from the Micro SD memory card. **Once erased, data is not recoverable.**

Do not format or delete files from the memory card using Windows®. This may leave hidden files on the card. Use *ADCP Utilities* to format and delete data from the memory card recorder.

Recommended Setting. Use *ADCP Utilities* to download and erase files.

Example See below.

```
>RE ErAsE erasing...
Recorder erased.
>
>RE ErAsE volLabel erasing...
Recorder erased.
>
>RE
Must use 'RE ErAsE' or 're ErAsE' to erase recorder!
use 'RE ErAsE <name>' to assign volume label
Recorder not erased.
>
```

RF – Recorder Free Space (Bytes)

Purpose Lists the amount of used and free memory card 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 = 7919571,3104440320 --- Rec space used (bytes), free (bytes)

>
```

RR – Show Recorder File Directory

Purpose Lists the files on the 64GB Micro SD memory card recorder in the style of a DOS directory listing.

Format RR

Recommended Setting. Use *ADCP Utilities* to download and erase files.

Description RR lists the files stored on the 64GB Micro SD memory card recorder in the form of a DOS directory listing.

Example: See below:

```
>rr
Recorder Directory:
Volume serial number for device #0 is ba5a-bcdb

  $$SAFE$$     <DIR>          0 01-09-48   3:02:12a rh    [     3]
  _RDI_000 000                0 05-11-21   2:01:54p r   a [     0]
  _RDI_001 000             6032 05-11-21   2:01:10p r   a [     4]
  _RDI_002 000              754 05-11-21   3:03:56p r   a [     5]
  _RDI_003 000                0 05-11-21   3:00:02p r   a [     0]
  _RDI_004 000             1508 05-11-21   3:01:50p r   a [     6]
  _RDI_005 000             1508 05-11-21   3:00:06p r   a [     7]
  _RDI_006 000             7540 05-11-21   3:02:24p r   a [     8]
  _RDI_007 000            24882 05-11-21   4:00:54p r   a [     9]
  _RDI_008 000             2262 05-11-21   4:03:34p r   a [    13]
  _RDI_009 000                0 05-11-21   4:01:00p r   a [     0]
  _RDI_010 000            16384 05-11-21   4:01:48p     a [    14]
  _RDI_011 000             4524 05-12-21   9:01:30a r   a [    16]
  _RDI_012 000            40960 05-12-21   9:01:24a     a [    17]
  _RDI_013 000           156832 05-12-21  10:02:50a r   a [    22]
  _RDI_014 000             6032 05-12-21  10:00:10a r   a [    42]
  _RDI_015 000           565500 05-12-21   2:01:30p r   a [    43]
  _RDI_016 000           401408 05-12-21   3:00:28p     a [   113]
  _RDI_017 000            64090 05-13-21  11:02:26a r   a [   162]
        B                   110 03-15-36   0:03:18a rhs   [7602176]
        _S              6619245 03-21-36   0:03:24a rhs   [7274496]
  SYSTEM~1     <DIR>          0 04-05-21   1:00:06p  hs   [  1024]
  _RDI_018 LOG                0 07-08-21   1:01:28p r   a [     0]

  Bytes used on device #0 = 7919571
Total capacity   = 15990710272 bytes
Total bytes used =     7919571 bytes in 23 files
Total bytes free = 15989342208 bytes

>
```

RS – Recorder Free Space (Megabytes)

Purpose Lists the amount of used and free 64GB Micro SD memory card recorder space in megabytes.

Format RS

Recommended Setting. Use *ADCP Utilities* to download and erase files.

Description RS lists the amount of recorder space used and free in megabytes.

Example See below

```
>rs
RS = 002,2960 ------------- REC SPACE USED (MB), FREE (MB)
>
```

Sensor Commands

The Workhorse Proteus uses the following commands for the sensors.

Available Sensor Commands

This section lists the available Sensor commands.

```
>S?
Available Commands:

SZ ----------------------- Zero Pressure Sensor
S? ----------------------- Display P-Command Menu
>
```

SZ – Zero Pressure Sensor

Purpose	Zeros the pressure sensor.
Format	SZ
Default	N/A

Use *ADCP Utilities* to zero the pressure sensor

Description This command zeros the Keller30 pressure sensor at the specific location where the Workhorse Proteus will be used.

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

```
>sz
Keller 30 Pressure was NOT zeroed ...
```

Timing Commands

These commands set the timing of various profiling functions.

Available Timing Commands

This section lists the available Timing commands.

```
>t?
Available Commands:

TE 00:10:00.00 ----------- Time Between Ensembles (hrs:min:sec.sec/100)
TP 00:00.00 -------------- Time per Ping (mm:ss.ss)
TS 25/08/28,12:32:49.15 -- Set System Date and Time (yy/mm/dd,hh:mm:ss)
T? ----------------------- Display T-Command Menu
```

TE – Time Between Ensembles

Purpose	The TE command will set the time between Ensembles for interleaved mode.
Format	TE *hh:mm:ss.ff*
Range	*hh* = 00 to 12 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TE 00:10:00.00

Recommended Setting. Use *ADCP Utilities* to set the timing commands.

Description	During the ensemble interval set by TE, the Workhorse Proteus transmits the number of pings set by the WP, BP, ZP, and VP commands. If TE = 00:00:00.00, the Workhorse Proteus starts collecting the next ensemble immediately after processing the previous ensemble.
Example	TE01:15:30.00 tells the Workhorse Proteus to collect data ensembles every 1 hour, 15 minutes, 30 seconds.

1. The Workhorse Proteus automatically increases TE if (WP x TP > TE).
2. The time tag for each ensemble is the time of the first ping of that ensemble.

TP – Time Per Ping

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	TP 00:00.00

Recommended Setting. Use *ADCP Utilities* to set the timing commands.

Description The WorkHorse Proteus interleaves individual pings within a group so they are evenly spread throughout the ensemble.

During the ensemble interval set by TE, the WorkHorse Proteus transmits the number of pings set by the WP, BP, ZP, and VP commands. TP determines the spacing between the pings. If TP = 0, the WorkHorse Proteus 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 TP 00:00.10 sets the time between pings to 0.10 second.

> The WorkHorse Proteus automatically increases TE if (WP x TP) > TE.

TS – Set Real-Time Clock

Purpose Sets the Workhorse Proteus's internal real-time clock.

Format TS *yy/mm/dd, hh:mm:ss*

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

> Recommended Setting. Use *ADCP Utilities* to set the clock.

Example TS 25/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2025.

> 1. When the Workhorse Proteus 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 Workhorse Proteus sends an error message and does not update the real-time clock.

Vertical Beam Range Commands

These commands define the criteria used to collect the vertical range data.

Available Vertical Beam Range Commands

This section lists the available Vertical Beam commands.

```
>v?
Available Commands:

VA 024 ------------------- Amplitude Threshold (0-255)
VB 0000 ------------------ Blank After Transmit (0-5000 cm)
VF 00000 ----------------- Boundary Guess (0-30000 cm)
VP 00000 ----------------- Number of Pings (0-16384)
VX 01250 ----------------- Max Search Range (10-5000 dm)
V? ----------------------- Display V-Command Menu
>
```

VA – Amplitude Threshold

Purpose	Sets the minimum value for a valid bottom or surface detection.
Format	VA *nnn*
Range	*nnn* = 0 to 255 counts
Default	VA 024

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

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

VB - Blank After Transmit

Purpose	Moves the location of vertical beam first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.
Format	VB *nnnnn*
Range	*nnnnn* = 0 to 5000 cm
Default	VB 00000

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

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

VF – Boundary Guess

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

Format VF *nnnn*

Range *nnnn* = 0, 1 to 30,000 cm (300m) (0 = automatic)

Default VF 0

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

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

VP – Number of Pings

Purpose Sets the number of vertical range pings to average together in each data ensemble.

Format VP *nnnnn*

Range *nnnnn* = 0 to 16384 pings

Default VP 0

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

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

The Workhorse Proteus interleaves vertical pings with water-track pings (see TP - Time Between Pings) with the vertical ping being the first ping in an ensemble.

If VP = zero, the Workhorse Proteus does not collect vertical data.

VX – Maximum Search Range

Purpose Limits the search range for the vertical beam.

Format VX *nnnn* decimeters (meters x 10)

Range *nnnn* = 10 to 5000 (dm)

Default VX 00450 (1200 kHz), VX 01250 (600 kHz), VX 02000 (300 kHz)

Recommended Setting. The default setting for this command is recommended for most applications. The command will accept values within the stated range, but if it is higher than the default value, the default value will be used.

Description VX sets the maximum tracking depth used by the Proteus during vertical pinging. This prevents the Proteus from searching too long, and too deep for the bottom or surface, allowing a faster ping rate when the Proteus loses track of the bottom/surface.

Water Profiling Commands

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

Available Water Profiling Commands

This section lists the available Water Profiling commands.

```
>w?
Available Commands:

WA 050 -------------------- False Target Amplitude Threshold (0-255)
WB 0 ---------------------- Bandwidth Control (0=Wide,1=Narrow)
WC 064 -------------------- Correlation Threshold (0-255)
WD 111100000 -------------- Data Out {v;c;a;p;s;*;*;*;*}
WE 2000 ------------------- Error Velocity Threshold (0-9999 mm/s)
WF 0050 ------------------- Blank After Transmit (0-9999 cm)
WG 050 -------------------- Percent Good Threshold (1-100)
WJ 1 ---------------------- Receiver Gain (0=Low, 1=High)
WM 2 ---------------------- Profiling Mode
WN 030 -------------------- Number of Depth Cells (1-255)
WP 00001 ------------------ Number of Pings (0-16384)
WS 0200 ------------------- Depth Cell Size (cm)
WT 0000 ------------------- Transmit Length (cm) (0=Cell Size)
WV 175 -------------------- Ambiguity Velocity (cm/s radial)
W? ------------------------ Display W-Command Menu
>
```

WA – False Target Amplitude Threshold

Purpose	Sets a false target (fish) filter.
Format	WA *nnn*
Range	*nnn* = 0 to 255 counts (255 disables this filter)
Default	WA 050 (processed data), WA 255 (raw data)

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

Description The Workhorse Proteus 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 Workhorse Proteus 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 the profiling bandwidth (sampling rate). Smaller bandwidths allow the Proteus 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 WB 0

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

Description See table below.

Table 18: Bandwidth Control

Bandwidth	Sample rate	Data variance	Profiling range
0 = Wide (25%)	High	Low	Low
1 = Narrow (6.25%)	Low	High	High

WC – Correlation Threshold

Purpose Sets the minimum threshold of water-track data that must meet the correlation criteria for profile.

Format WC *nnn*

Range *nnn* = 0 to 255 counts

Default WC 064 (processed data), WC 0 (raw data)

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

Description The Workhorse Proteus uses WC to screen water-track data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and depth cell size (WS – Depth Cell Size). The WC command sets the threshold of the correlation below, which the Workhorse Proteus flags the data as bad and does not average the data into the ensemble.

The default threshold is 64 counts. A solid target would have a correlation of 255 counts.

WD – Data Out

Purpose Selects the data types collected by the Workhorse Proteus.

Format WD *abc def ghi*

Range Firmware switches (see description)

Default WD 111 100 000 (processed data), WD 111 000 000 (raw data)

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

Description WD uses firmware switches to tell the Workhorse Proteus the types of data to collect. The Workhorse Proteus always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the Workhorse Proteus 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 for processed data) tells the Workhorse Proteus 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 Workhorse Proteus 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 WE 2000 (processed data), WD 9999 (raw data)

Description The WE command sets a threshold value used to flag water-current data as good or bad. If the Workhorse Proteus's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The WE command screens for error velocities in both beam and transformed-coordinate data. Setting the WE command to zero (WE 0000) 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 *nnnnn* = 0 to 9999 cm

Default WF 0030 (1200kHz), WF 0050 (600kHz), WF 0100 (300kHz)

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 Workhorse Proteus transmit circuits time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.

1. The distance to the middle of depth cell #1 is a function of WF, WS – Depth Cell Size, and speed of sound. The fixed leader data contains this distance.

2. Small WF values may show ringing/recovery problems in the first depth cells that cannot be screened by the Workhorse Proteus.

WG – Percent Good Threshold

Purpose Sets the minimum percentage of water-profiling pings in an ensemble that must be considered good to output velocity data.

Format WG *nnn*

Range *nnn* = 1 to 100 percent

Default WG 50

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

Description When averaging velocity bins from many pings into ensembles, this parameter will set the minimum percentage threshold for how many must be marked good to be included and marked good in the processed ensemble. The feature is intended to screen spurious velocities from the processed data that have not been sufficiently averaged.
For example: Assume this setting is enabled and set to 50%, and the ADCP is setup to averaging 100 pings in an ensemble. If the velocity in bin 60 from beam 2 is marked bad in all but a few pings, it would be marked bad in the ensemble.

WJ – Receiver Gain Select

Purpose	Allows the Workhorse Proteus to reduce receiver gain by 40 dB for profile mode.
Format	WJ *n*
Range	*n* = 0 (low), 1 (high)
Default	WJ 1

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

Description WJ0 tells the Workhorse Proteus 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.

WM – Profiling Mode

Purpose	Selects the application-dependent profiling mode used by the Workhorse Proteus.
Format	WM *n*
Range	*n* = 2
Default	WM 2

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

Description The WM command selects an application-dependent profiling mode. The chosen mode selects the types of pings transmitted. The ping type depends on how much the water-current is changing from ping-to-ping and from cell-to-cell.

WN – Number of Depth Cells

Purpose	Sets the number of depth cells over which the Workhorse Proteus collects data.
Format	WN *nnn*
Range	*nnn* = 001 to 255 depth cells
Default	WN 030

> Recommended Setting. Use *ADCP Utilities* to set the number of depth cells.

Description The range of the Workhorse Proteus is set by the number of depth cells (WN) times the size of each depth cell WS – Depth Cell Size).

> It is highly recommended to use *ADCP Utilities* to set the bin size and number of bins.
>
> The maximum number of depth cells depends on cell size value (WS). The stated maximum depth cells can be used with smaller cell sizes, and fewer depth cells can be used with larger cell sizes.

WP – Number of Pings

Purpose Sets the number of pings to average in each data ensemble.

Format WP *nnnnn*

Range *nnnnn* = 0 to 16384 pings

Default WP 1

Recommended Setting. Use *ADCP Utilities* to set the number of pings.

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

1. If WP = zero the Workhorse Proteus does not collect water-profile data.
2. The Workhorse Proteus automatically extends the ensemble interval TE – Time Per Ensemble) if (WP+BP) x TP > TE.

WS – Depth Cell Size

Purpose Selects the volume of water for one measurement cell.

Format WS *nnnn*

Range 5 to 400cm (1200 kHz), 10 to 800cm (600 kHz), 20 to 1600cm (300 kHz)

Default WS 0100 (1200 kHz), WS 0200 (600 kHz), WS 0400 (300 kHz)

Recommended Setting. Use *ADCP Utilities* to set the depth cell size.

Description The Workhorse Proteus collects data over a variable number of depth cells. The WS command sets the size of each cell in vertical centimeters.

WT – Transmit Length

Purpose Selects a transmit length different from the depth cell length (cell sampling interval) as set by the WS command (see WS – Depth Cell Size).

Format WT *nnnn*

Range *nnnn* = 0 to 3200 cm (0 = same transmit as WS)

Default WT 0000

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

Description When WT is set to zero, the transmit signal is set to the depth cell size (WS-command). This is the default setting. Setting WT allows selection of a transmit length different than the area depth cell size (sampling length).

WV – Ambiguity Velocity

Purpose Sets the radial ambiguity velocity for profile.

Format WV *nnn*

Range *nnn* = 050 to 700 cm/s

Default WV 175

> It is strongly recommended that the WV command be left at the default value of 175.

Description Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur.

The WV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam. WV is used to improve the single-ping standard deviation. The lower the value of the WV command, the lower the single-ping standard deviation.

Set the WV command based on the maximum apparent velocity (Workhorse Proteus motion plus water speed). The following formula is used to determine the setting of the WV command: WV = (Max. Apparent Vel. cm/s) * sin(beam angle) * 1.2

Be aware that the firmware will accept larger values then the default WV command; however, WV values that exceed the default values will result in collecting data with ambiguity resolving errors or completely erroneous values.

Example If the maximum expected Workhorse Proteus horizontal velocity (vessel velocity) is 250 cm/s (≈5 kt) and the maximum expected horizontal water velocity is 100 cm/s, set WV to ([250+100]*0.5*1.2=) 210 cm/s.

Vertical Profiling Commands

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

Available Vertical Profiling Commands

This section lists the available Vertical Profiling commands.

```
>z?
Available Commands:

ZB 0 --------------------- Bandwidth Control (0=Wide,1=Narrow)
ZC 064 ------------------- Correlation Threshold (0-255)
ZF 0050 ------------------ Blank After Transmit (0-9999 cm)
ZJ 1 --------------------- Receiver Gain (0=Low, 1=High)
ZN 030 ------------------- Number of Depth Cells (1-255)
ZP 00000 ----------------- Number of Pings (0-16384)
ZS 0200 ------------------ Depth Cell Size (cm)
ZT 0000 ------------------ Transmit Length (cm) (0=Cell Size)
ZV 175 ------------------- Ambiguity Velocity (cm/s radial)
Z? ----------------------- Display Z-Command Menu
```

ZB – Bandwidth Control

Purpose Sets the vertical beam profiling bandwidth (sampling rate). Smaller bandwidths allow the Proteus to profile farther, but the standard deviation is increased by as much as 2.5 times.

Format ZB *n*

Range *n* = 0 (Wide), 1 (Narrow)

Default ZB 0

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

Description See table below.

Table 19: Vertical Beam Bandwidth Control

Bandwidth	Sample rate	Data variance	Profiling range
0 = Wide (25%)	High	Low	Low
1 = Narrow (6.25%)	Low	High	High

ZC – Correlation Threshold

Purpose Sets the minimum threshold of vertical water-profile data that must meet the correlation criteria for profile.

Format ZC *nnn*

Range *nnn* = 0 to 255 counts

Default ZC 064 (processed data), ZC 0 (raw data)

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

Description The Workhorse Proteus uses ZC to screen water-profile data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and depth cell size (WS – Depth Cell Size). The ZC command sets the threshold of the correlation below, which the Workhorse Proteus flags the data as bad and does not average the data into the ensemble.

The default threshold is 64 counts. A solid target would have a correlation of 255 counts.

ZF – Blank after Transmit

Purpose Moves the location of first depth cell away from the vertical beam transducer head to allow the transmit circuits time to recover before the receive cycle begins.

Format ZF *nnnn*

Range *nnnn* = 0 to 9999 cm

Default ZF 0010 (1200kHz), ZF 0025 (600kHz), ZF 0050 (300kHz)

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

Description ZF positions the start of the first depth cell at some vertical distance from the transducer head. This allows the Workhorse Proteus transmit circuits time to recover before beginning the receive cycle. In effect, ZF 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 ZF, ZS, and speed of sound. The fixed leader data contains this distance.
2. Small ZF values may show ringing/recovery problems in the first depth cells that cannot be screened by the Workhorse Proteus.

ZJ – Receiver Gain

Purpose Allows the Workhorse Proteus to reduce receiver gain by 40 dB for profile mode.

Format ZJ *n*

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

Default ZJ 1

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

Description ZJ0 tells the Workhorse Proteus 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. ZJ1 (the default) uses the normal receiver gain.

ZN – Number of Depth Cells

Purpose	Sets the number of vertical depth cells (Bins) over which the Workhorse Proteus collects data.
Format	ZN *nnn*
Range	*nnn* = 001 to 255 depth cells
Default	ZN 030

Recommended Setting. It is highly recommended to use *ADCP Utilities* to set the bin size and number of bins.

Description	The range of the Workhorse Proteus is set by the number of depth cells (ZN) times the size of each depth cell ZS).

ZP – Number of Pings

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

Recommended Setting. Use *ADCP Utilities* to set the number of pings.

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

1. If ZP = zero the Workhorse Proteus does not collect water-profile data.
2. The Workhorse Proteus automatically extends the ensemble interval TE – Time Per Ensemble) if (ZP+BP) x TP > TE.

ZS – Depth Cell Size

Purpose	Selects the volume of water for one vertical measurement cell (Bin).
Format	ZS *nnnn*
Range	5 to 400cm (1200 kHz), 10 to 800cm (600 kHz), 20 to 1600cm (300 kHz)
Default	ZS 0100 (1200 kHz), ZS 0200 (600 kHz), ZS 0400 (300 kHz)

Recommended Setting. Use *ADCP Utilities* to set the Bin (depth cell size).

Description	The Workhorse Proteus collects data over a variable number of Bins/depth cells. The ZS command sets the size of each cell in vertical centimeters.

ZT – Transmit Length

Purpose Selects a transmit length different from the vertical depth cell length (cell sampling interval) as set by the ZS command.

Format ZT *nnnn*

Range *nnnn* = 0 to 3200 cm (0 = same transmit as WS)

Default ZT 0000

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

Description When ZT is set to zero, the transmit signal is set to the depth cell size (ZS-command). This is the default setting. Setting ZT allows selection of a transmit length different than the area depth cell size (sampling length).

ZV – Ambiguity Velocity

Purpose Sets the radial ambiguity velocity for the vertical profile.

Format ZV *nnn*

Range *nnn* = 050 to 700 cm/s

Default ZV 175

It is strongly recommended that the ZV command be left at the default value of 175.

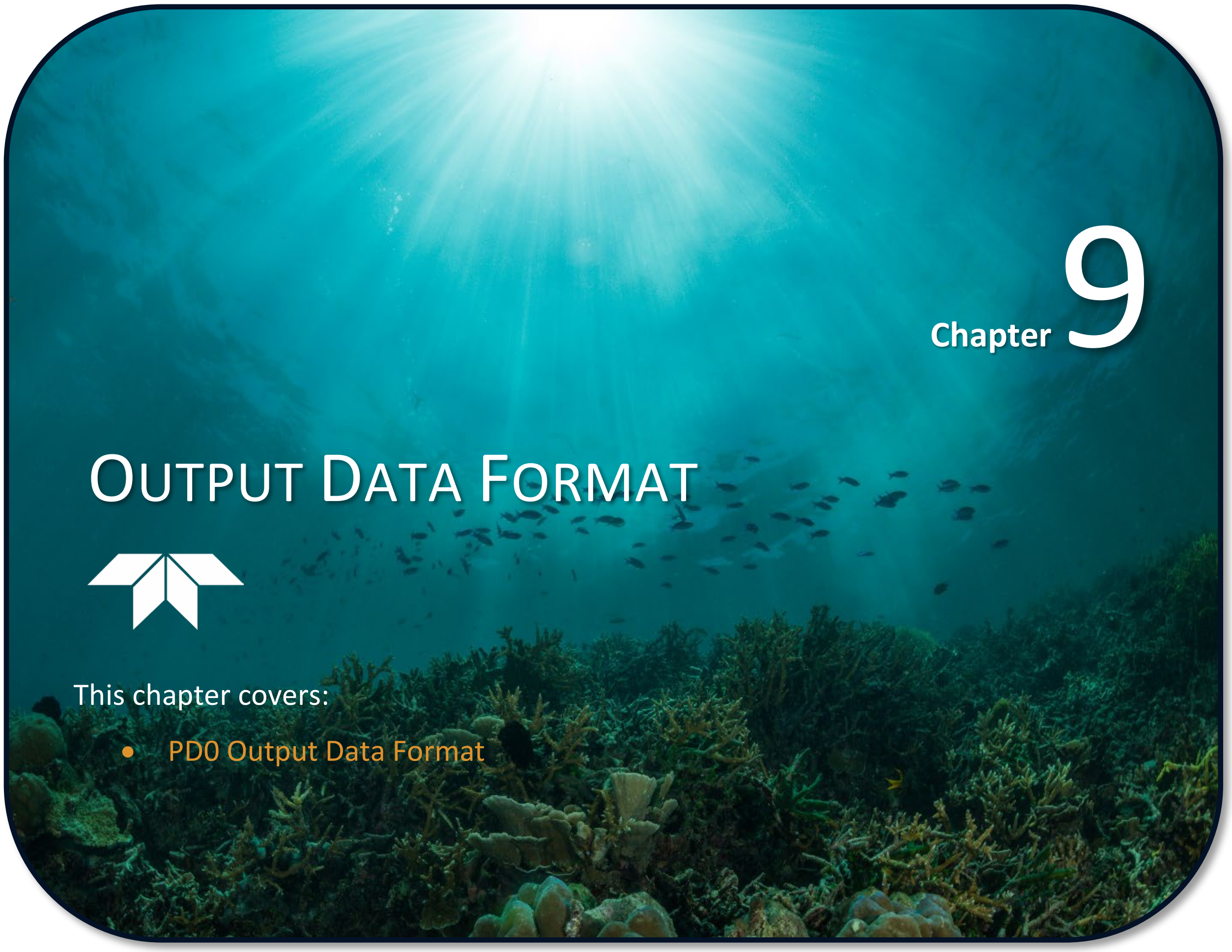
Description Set ZV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur.

The ZV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam. ZV is used to improve the single-ping standard deviation. The lower the value of the ZV command, the lower the single-ping standard deviation.

Set the ZV command based on the maximum apparent velocity (Workhorse Proteus motion plus water speed). The following formula is used to determine the setting of the ZV command: ZV = (Max. Apparent Vel. cm/s) * sin(beam angle) * 1.2

Be aware that the firmware will accept larger values then the default WV command; however, ZV values that exceed the default values will result in collecting data with ambiguity resolving errors or completely erroneous values.

Example If the maximum expected Workhorse Proteus horizontal velocity (vessel velocity) is 250 cm/s (≈5 kt) and the maximum expected horizontal water velocity is 100 cm/s, set ZV to ([250+100]*0.5*1.2=) 210 cm/s.



Chapter 9

OUTPUT DATA FORMAT

This chapter covers:

- PD0 Output Data Format

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 portal at https://tm-portal.force.com/TMsoftwareportal/s/

Binary Output

This section shows the format of all files to be created by Workhorse Proteus. Workhorse Proteus will have two processing engines. Doppler creates raw beam coordinate data that can contain broadband and/or bottom track information that is fed to Catalyst for screening, coordinate transformation and processing (screening and averaging). Raw and processed files will follow this format.

Per Figure 30 below, the PD0 message (sometimes called an "ensemble", but here we use the term "message" to avoid confusion with an ensemble of measurements) always contains a header, fixed leader, variable leader, reserved bytes, and a checksum. All other data types are optionally included in the PD0 message and may only be present in some PD0 messages output from the instrument. The PD0 messages produced by Catalyst may have additional data types added in by the Catalyst instrument – in fact this is the anticipated mode of operation for the Workhorse Proteus.

Binary Standard Output Data Buffer Format

Figure 30 below shows the general format of a PD0 message. Specific data items within the PD0 message may or may not be included (as shown) and the order of data types is not prescribed.

Output	ID (MSB LSB)	Description
Always Output	7F 7F	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	00 00	**FIXED LEADER DATA** (65 BYTES)
	00 80	**VARIABLE LEADER DATA** (79 BYTES)
Slant Beams Water Profile Data	01 00	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	02 00	**CORRELATION MAGNITUDE** (2 BYTES + 4 BYTES PER DEPTH CELL)
	03 00	**ECHO INTENSITY** (2 BYTES + 4 BYTES PER DEPTH CELL)
	04 00	**PERCENT GOOD** (2 BYTES + 4 BYTES PER DEPTH CELL)
	05 00	**STATUS** (2 BYTES + 1 BYTES PER DEPTH CELL)
Vertical Beam Range Data	41 00	**VERTICAL BEAM RANGE** (9 BYTES)
	40 03	**VERTICAL BEAM STATE** (15 BYTES)
	40 04	**VERTICAL BEAM AMPLITUDE** (650 BYTES)
Vertical Beam Profile Data	0F 01	**VERTICAL BEAM PROFILE LEADER** (40 BYTES)
	0A 00	**VERTICAL BEAM WATER VELOCITY** (2 BYTES + 2 BYTES PER DEPTH CELL)
	0B 00	**VERTICAL BEAM WATER CORRELATION MAGNITUDE** (2 BYTES + 1 BYTES PER DEPTH CELL)
	0C 00	**VERTICAL BEAM WATER ECHO INTENSITY** (2 BYTES + 1 BYTES PER DEPTH CELL)
	0D 00	**VERTICAL BEAM WATER PERCENT GOOD** (2 BYTES + 1 BYTES PER DEPTH CELL)
	0E 00	**VERTICAL BEAM WATER STATUS** (2 BYTES + 1 BYTES PER DEPTH CELL)
	06 00	**BOTTOM-TRACK** (81 BYTES)
Ping Data	11 00	**PING METADATA** (40, 76, 112, or 148 BYTES)
	11 10	**PING SENSOR DATA** (324, 340, 356, or 373 BYTES)
	59 02	**PING ATTITUDE** (29, 55, 81, or 108 BYTES)
	59 01	**ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS)** (21 BYTES)
Always Output		**RESERVED** (2 BYTES)
		CHECKSUM (2 BYTES)

Figure 30. Binary Standard Output Data Buffer Format

Some data outputs are in bytes per depth cell. As an example, the size of a PD0 message with 64 bins and including bottom track and attitude data, would be as follows:

```
44    Bytes of Header Data (6+2x19)
65    Bytes of Fixed Leader Data (fixed)
79    Bytes of Variable Leader Data (fixed)
514   Bytes of Velocity Data (2+8x64)
258   Bytes of Correlation Magnitude Data (2+4x64)
258   Bytes of Echo Intensity (2+4x64)
258   Bytes of Percent Good(2+4x64)
258   Bytes of Status(2+4x64)
81    Bytes of Bottom Track Data (fixed)
55    Bytes of Ping Attitude Data (2 ping types)
21    Bytes of AHRS Data (fixed)
2     Bytes of Reserved for TRDI Use (fixed)
2     Bytes of Checksum Data (fixed)
------------------------------------------------
1895  Bytes of data per ensemble
```

Sample PD0 from Catalyst Data

In the Workhorse Proteus system, the user always has access to the original raw PD0 data. Because of this, in the processed data files Proteus discards data items that were only used to aid in calculating the final results being displayed. Specifically, it discards the ping attitude, as those are only used to keep a record of how the solution was calculated, and the user still has access to these data items via the raw PD0 files.

For processed data files, the percent-good field is now meaningful and is now included in the data. However, the status field does not convey any information that is not already discerned by the software, so it will not be included.

```
44    Bytes of Header Data (6+2x19)
65    Bytes of Fixed Leader Data (fixed)
79    Bytes of Variable Leader Data (fixed)
514   Bytes of Velocity Data (2+8x64)
258   Bytes of Correlation Magnitude Data (2+4x64)
258   Bytes of Echo Intensity (2+4x64)
258   Bytes of Percent Good(2+4x64)
81    Bytes of Bottom Track Data (fixed)
55    Bytes of Ping Attitude Data (2 ping types)
21    Bytes of AHRS Data (fixed)
2     Bytes of Reserved for TRDI Use (fixed)
2     Bytes of Checksum Data (fixed)
------------------------------------------------
1637  Bytes of data per ensemble
```

The Workhorse Proteus ADCP outputs packets of data that will contain any or all vertical water profile data, broadband water profile data, and/or bottom track data. The Catalyst saves the raw data verbatim as received from the Doppler. The Catalyst creates an ensemble average of each water profile data type, where the ensemble size is defined by the WP, as appropriate. Bottom track data, if present, is included with the water profile data for each water profile type. Output files are named *Proc[nnn].pd0*.

Velocity Screening and Coordinate Transformations

Water profile screening

- Correlation less than a user set value (default 64 counts in most instruments) for any bin in any beam results in that velocity being marked “bad” [broadband data only].
- Fish rejection: The basic premise is that a fish is so bright that it will contaminate more than one beam. The algorithm checks for a difference in RSSI measurements for all beams at each range, and if the difference exceeds the user set value (default is 50 counts) then it marks the velocity of the **lowest** beam bad, if a second beam also has a difference exceeding the threshold, then it marks **all** beams bad at that range.

- Error Velocity: If the error velocity exceeds a user set threshold (the default is to turn it off - by setting it to 2000), then all beams at that range are marked bad.

Bottom Track Screening

- Correlation screening as above.
- Error velocity is in two phases:
  - An initial error velocity in beam coordinates.
  - A second error velocity screening as described above for water profile.
- Evaluation amplitude less than a user set value (default is 24 counts). The evaluation amplitude is a measure of the elevation of the RSSI bottom bounce compared to the background RSSI. The purpose of this screening is to help "find" the bottom – and what it accomplishes is screening out later "bounces" in water shallow enough that they can occur (that is, the sound can propagate to the bottom, bounce to the surface, and bounce back to the measurement volume before attenuating to below detection levels).
  - A "second bounce" screening based on the averaged range results of all four beams.

Transform from beam to instrument coordinates and calculation of an error velocity.

- Three beam solutions - When one bin in one beam is marked bad, a three-beam solution can be calculated by assuming that error velocity was zero.
  - Example, ev=a(Beam1+Beam2-(Beam3+Beam4), so if Beam1 is marked bad, solve 0=(Beam1+Beam2-(Beam3+Beam4) to get Beam1=Beam3+Beam4-Beam2.
  - Replace Beam1 with this value, mark the error velocity "bad" and proceed with the transformation.

Bin Mapping (done on beam velocities before rotation to ship or earth coordinates).

- Because flow is typically horizontal, a tilted instrument could be inappropriately combining bins from different depths. In traditional beam mapping, a look up table is used to substitute the measurement from the bin closest to the target depth for the one measured at that range. The Workhorse Proteus calculates each bin for re-position. There isn't just an offset applied to all bins in a beam. Aligning the bins horizontally provides a more accurate calculation of velocities in the data, which is calculated in horizontal "slices" representing a vertical profile of water velocities.

Dynamic attitude compensation

- It can take up to three seconds to make a long-range measurement, and on a moving platform the heading pitch and roll may change significantly during the measurement. This adjustment allows for using a linear interpolation of the heading, pitch, and roll (between measurements taken at the beginning and end of the measurement for each ping) to the value at the midpoint of the measurement or for each bin in the measurement (water profile only).

Conversion from instrument to ship coordinates (apply tilts, but not heading).

- This is a straightforward rotation in two dimensions (heading rotation is held zero)

Conversion from instrument to earth coordinates

- This is a straightforward rotation in all three dimensions.

Ensemble Average

- An ensemble average of the transformed data, whose length is defined by the WP and ZP commands will be created for each data type.

Header Data Format

BYTE	7	6	5	4	3	2	1	0	
1	HEADER ID (7Fh)								
2	DATA SOURCE ID (7Fh)								
3	NUMBER OF BYTES IN ENSEMBLE (EXCLUDING CHECKSUM)								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

Figure 31. Header Data Format

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

Table 20: Header Data Format

Binary Byte	Field	Description
1	HDR ID / Header ID	Stores the header identification byte (7Fh).
2	HDR ID / Data Source ID	Stores the data source identification byte (7Fh for the ADCP).
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.
5	Spare	Undefined.
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 default value of six (4 data types + 2 for the Fixed/Variable Leader data).
7,8	Address Offset for Data Type #1 / Offset for Data Type #1	This field contains the internal memory address offset where the 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).
9,10	Address Offset for Data Type #2 / Offset for Data Type #2	This field contains the internal memory address offset where the 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).
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 ADCP will store information for data type #3 through data type #n. Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Types #3-n begin (first byte of ensemble is Binary Byte) #1).

Fixed Leader Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	FIXED LEADER ID 0000							00h	LSB
2								00h	MSB
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	RESERVED								
8									
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS								
11	NUMBER OF PINGS								LSB
12									MSB
13	DEPTH CELL LENGTH								LSB
14									MSB
15	BLANK AFTER TRANSMIT								LSB
16									MSB
17	SIGNAL PROCESSING MODE								
18	BROAD BANDWIDTH PROFILING WATER CORRELATION THRESHOLD								
19	NUMBER CODE REPS								
20	RESERVED								
21	ERROR VELOCITY MAXIMUM								
22									
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS {TP}								
26	COORDINATE TRANSFORMATION {EX}								
27	HEADING ALIGNMENT {EA}								LSB
28									MSB
29	HEADING BIAS {EB}								LSB
30									MSB
31	SENSOR SOURCE {EZ}								
32	SENSORS AVAILABLE								

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
33	BIN 1 DISTANCE								LSB
34									MSB
35	XMIT PULSE LENGTH								LSB
36									MSB
37	RESERVED								
38									
39	FALSE TARGET THRESH								
40	RESERVED								
41	TRANSMIT LAG DISTANCE								LSB
42									MSB
43	RESERVED								
↓									↓
54									
55	INSTRUMENT SERIAL NUMBER								LSB
56									
57									
58									MSB
59	JANUS BEAM ANGLE								
60	RESERVED								
61	PINGS PER ENSEMBLE SETTING								
62									
63	SYSTEM FREQUENCY								LSB
64									
65									MSB

Figure 32. Fixed Leader Data Format

Fixed Leader data as shown in Table 21 below refers to the non-dynamic ADCP data that only changes when you change certain commands. Fixed Leader data also contain hardware information. The ADCP always sends Fixed Leader data as output data (LSBs first). See Command Descriptions for detailed descriptions of commands used to set these values.

Table 21: Fixed Leader Data Format

Binary Byte	Field	Description
1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word 0000. LSB is sent first.
3	fv / CPU F/W Ver.	Contains the version number of the CPU firmware.
4	fr / CPU F/W Rev.	Contains the revision number of the CPU firmware.
5,6	Sys Cfg / System Configuration	This field defines the ADCP hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows. Note: Refer to [1] for full definition of possible value for these fields; the list below defines only the values that are to be used in the Workhorse Proteus ADCP. LSB BITS 7 6 5 4 3 2 1 0 - - - - - 1 1 1 FREQ SPECIFIED IN BYTES 61-63 - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - SENSOR CONFIG #1 - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 1 20° BEAM ANGLE - - - - 0 0 - - RESERVED 0 1 0 0 - - - - 4-BEAM JANUS CONFIG
7	Reserved	Reserved for TRDI Use
8	Reserved	Reserved for TRDI Use
9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The ADCP needs only three beams to calculate water-current velocities. The fourth beam provides an error velocity that determines data validity. If only three beams are available, the ADCP does not make this validity check. The Percent-Good Data Format has more information.
10	Number of Cells	Contains the number of depth cells over which the ADCP collects data, as set by the WN. Scaling: LSD = 1 depth cell; Range = 1 to 255 depth cells
11,12	Pings Per Ensemble	Contains the number of (broadband) pings which have been screened and averaged to generate this measurement in the PD0 message. This is always set to 1 for single ping data (i.e. all messages from Doppler to Catalyst). Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
13,14	Depth Cell Length	Contains the length of one depth cell, as set by the WS. Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)
15,16	Blank after Transmit	Contains the blanking distance used by the ADCP to allow the transmit circuits time to recover before the receive cycle begins, as set by the WF. Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
17	Signal Processing Mode	If the profile ping was a broadband ping then it will show 1.
18	Broad Bandwidth Profiling Water Correlation Threshold	If the profile ping was a broadband ping, then byte 18 is the value of WC.
19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse. If this header is associated with narrowband data, this value is set to zero. Scaling: LSD = 1 count; Range = 0 to 255 counts

Table 21: Fixed Leader Data Format

Binary Byte	Field	Description
20	Reserved	Reserved
21,22	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 ADCP flags all four beams of the affected bin as bad. Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s
23 24 25	Minutes Seconds Hundredths	These fields contain the amount of time between ping groups in the ensemble (where a “ping group” is a single broadband ping and/or a single bottom track ping, and/or vertical range, and or vertical profile). The time reported is TP.

26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX - Coordinate Transformation). These firmware switches indicate how the Ocean Surveyor 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`

27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (EA - Heading Alignment). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
29,30	EV / Heading Bias	Contains a correction factor for electrical/magnetic heading bias (EV - Heading Bias). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees

31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ - Sensor Source). These firmware switches indicate the following.
		`Field     Description`
		`1xxxxxxx = calculates EC from ED, ES, and ET`
		`x1xxxxxx = uses ED from depth sensor`
		`xx1xxxxx = uses EH from transducer heading sensor`
		`xxx1xxxx = uses EP from transducer pitch sensor`
		`xxxx1xxx = uses ER from transducer roll sensor`
		`xxxxx1xx = uses ES from conductivity sensor`
		`xxxxxx1x = uses ET from transducer temp sensor`
		NOTE: If the field = 0, or if the sensor is not available, the ADCP uses the manual command setting. If the field = 1, the 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 ADCP only displays a 0 (manual) or 1 (int/ext sensor).

32	SA / Sensors Avail	This field reflects what sensors are available.
		`Field     Description`
		`x1xxxxxx = calculates EC 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 from conductivity sensor`
		`xxxxxxx1 = uses ET from transducer temp sensor`

33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first depth cell (bin). This distance is a function of depth cell length (WS), the profiling mode (WM), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)

Table 21: Fixed Leader Data Format

Binary Byte	Field	Description
35,36	Xmit pulse length	This field, set by the WT-command for broadband data, contains the length of the transmit pulse. When the 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 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)
37,38	Reserved	Reserved for TRDI Use
39	False Target Threshold	Contains the threshold value used to reject data received from a false target, usually fish, as set by the WA command. Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
40	Reserved	Reserved for TRDI Use
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
43-54	Reserved	Reserved for TRDI use
55-58	Serial #	Instrument serial number
59	Beam Angle	Beam angle – set at constant value of 20 for Workhorse Proteus.
60	Reserved	Reserved for TRDI use
61,62	Pings Per Ensemble Setting	Contains the number of (broadband or narrowband) pings which comprise an ensemble of pings, as set by the WP command. Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
63-65	System Frequency	System frequency, in Hz

Variable Leader Data Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
1	VARIABLE LEADER ID 80h	LSB
2	00h	MSB
3	ENSEMBLE NUMBER	LSB
4		MSB
5	SYSTEM DATE YEAR	
6	MONTH	
7	DAY	
8	SYSTEM TIME HOUR	
9	MINUTE	
10	SECOND	
11	HUNDREDTHS	
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

<table>
<tr><th rowspan="2">BYTE</th><th colspan="8">BIT POSITIONS</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>29</td><td colspan="8" rowspan="3">RESERVED</td></tr>
<tr><td>30</td></tr>
<tr><td>31</td></tr>
<tr><td>32</td><td colspan="8">HEADING STANDARD DEVIATION</td></tr>
<tr><td>33</td><td colspan="8">PITCH STANDARD DEVIATION</td></tr>
<tr><td>34</td><td colspan="8">ROLL STANDARD DEVIATION</td></tr>
<tr><td>35</td><td colspan="8">RESERVED</td></tr>
<tr><td>36</td><td colspan="8">ADC CHANNEL 1</td></tr>
<tr><td>37</td><td colspan="8" rowspan="6">RESERVED</td></tr>
<tr><td>38</td></tr>
<tr><td>39</td></tr>
<tr><td>40</td></tr>
<tr><td>41</td></tr>
<tr><td>42</td></tr>
<tr><td>43</td><td colspan="8" rowspan="6">RESERVED</td></tr>
<tr><td>44</td></tr>
<tr><td>45</td></tr>
<tr><td>46</td></tr>
<tr><td>47</td></tr>
<tr><td>48</td></tr>
<tr><td>49</td><td colspan="8" rowspan="3">PRESSURE DATA</td></tr>
<tr><td>↓</td></tr>
<tr><td>52</td></tr>
<tr><td>53</td><td colspan="8" rowspan="3">PRESSURE STANDARD DEVIATION</td></tr>
<tr><td>↓</td></tr>
<tr><td>56</td></tr>
<tr><td>57</td><td colspan="8">RESERVED</td></tr>
<tr><td>58</td><td colspan="8" rowspan="3">Y2K TIME</td></tr>
<tr><td>↓</td></tr>
<tr><td>65</td></tr>
<tr><td>66</td><td colspan="8">RESERVED</td></tr>
<tr><td>67</td><td colspan="8">HEALTH STATUS</td></tr>
</table>

BYTE	7	6	5	4	3	2	1	0	
68	LEAK A COUNT								LSB
69									MSB
70	LEAK B COUNT								LSB
71									MSB
72	TX VOLTAGE								LSB
73									MSB
74	TX CURRENT								LSB
75									MSB
76	TRANSDUCER IMPEDANCE								LSB
77									MSB
78	PING NUMBER								LSB
79									MSB

Figure 33. Variable Leader Data Format

Variable Leader data refers to the dynamic ADCP data (from clocks and sensors) that change with each ping. The ADCP always sends Variable Leader data as output data (LSBs first). See Command Descriptions for detailed descriptions of commands used to set these values.

Table 22: Variable Leader Data Format

Binary Byte	Field	Description
1,2	VID / Variable Leader ID	Stores the Variable Leader identification word 0080. LSB is sent first.

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.`

5 6 7 8 9 10 11	RTC Year RTC Month RTC Day RTC Hour RTC Minute RTC Second RTC Hundredths	These fields contain the time from the ADCP's real-time clock (RTC) that the current data ensemble began. The TS-command (TS - Set System Date and Time) initially sets the clock. The ADCP does account for leap years. If the PD0 message contains multiple variable leaders, then each variable leader shall contain a unique time stamp, with the time stamp representing the time of the water profile ping represented by that leader.
12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3 and 4) "rolls over." This allows ensembles up to 16,777,215. See Ensemble Number field above.
13,14	BIT Result	This field contains the results of the Workhorse Proteus's Built-in Test function. A zero code indicates a successful BIT result. See Table 23, page 159 for a list of error codes.

Table 22: Variable Leader Data Format

Binary Byte	Field	Description
15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC - Speed of Sound). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s
17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED - Depth of Transducer). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
19,20	EH / Heading	Contains the ADCP heading angle (EH - Heading Angle). This value may be a manual setting or a reading from a heading sensor. Heading will include the heading bias (EB – Heading Bias) correction. For example, if PC2 displays the heading as 319 degrees and a user enters EB1600 (16 degrees), then the heading in the variable leader will be 335 degrees. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees
21,22	EP / Pitch (Tilt 1)	Contains the ADCP pitch angle (EP - Pitch and Roll Angles). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -179.00 to +180.00 degrees
23,24	ER / Roll (Tilt 2)	Contains the ADCP roll angle (ER - Roll (Tilt 2)). This value may be a manual setting or a reading from a tilt sensor. For up-facing ADCPs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing ADCPs, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -60.00 to +60.00 degrees
25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES - Salinity). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 50 ppt
27,28	ET / Temperature	Contains the temperature of the water at the transducer head (ET - Temperature). 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
29 - 31	Reserved	Reserved
32	HDG STD	Heading Standard Deviation
33	Pitch STD	Pitch Standard Deviation
34	Roll STD	Roll Standard Deviation
35-42	Reserved	Reserved

35	ADC Channel 0	These fields contain the outputs of the Analog-to-Digital Converter (ADC). The ADC channels in the Workhorse Proteus are defined as follows:
		`ADC Channel 0 Reserved`
		`ADC Channel 1 Input Voltage (deci-Volts with 24 VDC offset)`
		`ADC Channel 2 Reserved`
		`ADC Channel 3 Reserved`
		`ADC Channel 4 Reserved`
		`ADC Channel 5 Reserved`
		`ADC Channel 6 Reserved`
		`ADC Channel 7 Reserved`
		TBD

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 - 48	Reserved	Reserved for TRDI use.
49-52	Pressure Data	Pressure in decaPascals
53-56	Pressure STD	Pressure Standard Deviation
57	Reserved	Reserved for TRDI use.
58	Y2K Century	Upper 2 digits of the year
59	Y2K Year	Lower 2 digits of the year, identical to location 5 of variable leader

Table 22: Variable Leader Data Format

Binary Byte	Field	Description
60	Y2K Month	Locations 60-65 are identical to locations 6-11, respectively.
61	Y2K Day	
62	Y2K Hour	
63	Y2K Min	
64	Y2K Sec	
65	Y2K HSec	
66	Reserved	Reserved for TRDI use.

67	HEM Status	Contains the leak sensor flags and flags to indicate whether the transmit voltage, transmit current, and transducer impedance have been updated. These update flags are set when the measurement is made, and cleared after each ensemble output.
		`BITS 07 06 05 04 03 02 01 00`
		`* * * * * * * 1 Leak sensor A leak detected`
		`* * * * * * 1 * Leak sensor A open circuit`
		`* * * * * 1 * * Leak sensor B leak detected`
		`* * * * 1 * * * Leak sensor B open circuit`
		`* * * 1 * * * * Tx voltage updated`
		`* * 1 * * * * * Tx current updated`
		`* 1 * * * * * * Transducer impedance updated`

68-69	Leak A Count	Raw A/D reading, in counts, for leak sensor A.
70-71	Leak B Count	Raw A/D reading, in counts, for leak sensor B.
72-73	Tx Voltage	Voltage delivered to transducer during transmit. Scaling: LSD = 0.001 volt (Value set to 0xFFFF if a valid reading is not available.)
74-75	Tx Current	Current delivered to transducer during transmit. Scaling: LSD = 0.001 ampere (Value set to 0xFFFF if a valid reading is not available.)
76-77	Transducer Impedance	Measured impedance of transducer, calculated by dividing voltage by current. Scaling: LSD = 0.001 ohm (Value set to 0xFFFF if a valid reading is not available or for any reading greater than 65.535 ohms. NOTE that the Workhorse Proteus transducer is expected to have an impedance in the range of 300 ohms, which is beyond the limits of this field, so its value will routinely be set to 0xFFFF and the user will need to calculate impedance by dividing voltage by current.)
78-79	Ping Number	The ensemble ping sequence number for single ping samples. Reports 1 for the first ping sample of the ensemble and increments for each ping sample until the end of the ensemble. If the PD0 contains averaged pings then this value will be set to 0.

Table 23. Workhorse Proteus's Built-in Test Error Codes

The BIT Results are part of the Variable Leader Data Format, bytes 13 and 14.

Error Code	Description
AB_NO_ERR = 0x00,	No Error
AB_POST_FAULT_DSC = 0x01,	DSC Fault
AB_POST_FAULT_DPMRAM = 0x02,	MRAM Fault
AB_POST_FAULT_SDRAM = 0x03,	SDRAM Fault
AB_POST_FAULT_DPEEPROM = 0x04,	DPEEPROM Fault
AB_POST_FAULT_RTC = 0x05,	RTC Init Fault
AB_FAULT_RTC = 0x06,	RTC General Fault
AB_FAULT_ENSBUF_STARTUP_INIT_FAULT = 0x07,	Ens Buffer Startup init failure
AB_FAULT_RTC_LOW_BATT = 0x0b,	RTC Low Battery
AB_FAULT_HWCFG_INIT_FAULT = 0x0c,	Hw Config initialization fault
AB_FAULT_DSC_CLK_NOT_LOCKED = 0x10,	DSC FPGA Fault Register 0x0001
AB_FAULT_DSC_REG_FILE_SCK_ADC = 0x11,	DSC FPGA Fault Register 0x0002
AB_FAULT_DSC_REG_FILE_DSP = 0x12,	DSC FPGA Fault Register 0x0004
AB_FAULT_DSC_REG_FILE_ADC = 0x13,	DSC FPGA Fault Register 0x0008
AB_FAULT_DSC_RAW_RD_EMPTY = 0x14,	DSC FPGA Fault Register 0x0010
AB_FAULT_DSC_RAW_WR_FULL = 0x15,	DSC FPGA Fault Register 0x0020
AB_FAULT_DSC_FILTER = 0x16,	DSC FPGA Fault Register 0x0040
AB_FAULT_DSC_OUTSTORE_RD_EMPTY = 0x17,	DSC FPGA Fault Register 0x0080
AB_FAULT_DSC_OUTSTORE_WR_FULL = 0x18,	DSC FPGA Fault Register 0x0100
AB_FAULT_DSC_OVER_TEMP = 0x19,	DSC FPGA Fault Register 0x0200
AB_FAULT_DSC_INPUT_FIFO_FULL = 0x1A,	DSC FPGA Fault Register 0x0400
AB_FAULT_DSC_TX = 0x1B,	DSC FPGA Fault Register 0x0800
AB_FAULT_DSC_QSPI_OP_ERROR = 0x1C,	DSC FPGA Fault Register 0x1000
AB_FAULT_DSC_QSPI_FIFO_RD_EMPTY = 0x1D,	DSC FPGA Fault Register 0x2000
AB_FAULT_DSC_CFG_FLASH_RD_ERR = 0x1E,	DSC FPGA Fault Register 0x4000
AB_FAULT_DSC_CFG_FLASH_WR_ERR = 0x1F,	DSC FPGA Fault Register 0x8000
AB_FAULT_VOLTAGE_OUT_OF_RANGE = 0x20,	VIN out of range when measured (not necessarily when pinging)
AB_FAULT_VOLTAGE_READ_ERROR = 0x21,	VIN ADC read error
AB_FAULT_VOLTAGE_DESCR_ERROR = 0x22,	VIN bad descriptor
AB_FAULT_VOLTAGE_3V3_READ_ERROR = 0x23,	3V3 ADC read error
AB_FAULT_VOLTAGE_3V3_DESCR_ERROR = 0x24,	3V3 ADC bad descriptor
AB_FAULT_VOLTAGE_PARAM_ERROR = 0x25,	Voltage NULL return pointer
AB_FAULT_XMIT_INHIBIT_LOW_VOLTS = 0x30,	Vin too low for transmit at ping time
AB_FAULT_XMIT_INHIBIT_HIGH_VOLTS = 0x31,	Vin too high for transmit at ping time
AB_FAULT_XMIT_DISABLED = 0x32,	Transmit disabled by command
AB_FAULT_XMIT_LIMIT = 0x33,	Transmitted length limited
AB_CDI_FAILURE = 0x38,	Catalyst-Doppler Interface failure
AB_CDI_XFER_FAILURE = 0x39,	Catalyst-Doppler data transfer failure
AB_CDI_BUFF_FAILURE = 0x3A,	Catalyst-Doppler data buffer failure
AB_OUT_QUEUE_ERR = 0x3B,	Output queue error
AB_EDI_FAILURE = 0x3C,	EC-Doppler Interface failure
FIFO Read Faults	
AB_FIFO_NOBUFFER= 0x42,	Ran out of buffers for FIFO unload
AB_FIFO_BUFF_INIT_ERR = 0x43,	Can't add buffer to buffer pool
Trigger Faults	
AB_FIFO_TRIGIN_FAULT= 0x48,	Trigger-in fault (e.g. timeout)
HPR Faults	
AB_HPR_INIT_FAIL= 0x50,	AHRS Init failure
AB_HPR_START_FAIL = 0x51,	AHRS Start failure
AB_HPR_DATA_OOB = 0x52,	AHRS data out of bounds
AB_HPR_COM_FAIL = 0x53,	AHRS communication failure
AB_HPR_STOP_FAIL= 0x54,	AHRS Stop failure
AB_HPR_MEM_ALLOC_FAIL = 0x55,	AHRS memory allocation failure
AB_HPR_MTX_FAIL = 0x56,	AHRS Mutex lock/unlock failure
AB_HPR_EVT_FAIL = 0x57,	AHRS Event wait/signal failure
AB_HPR_GEN_FAIL = 0x58,	AHRS General fault
Pressure/Temp Sensor Faults	
AB_PRESS_COMM_FAIL= 0x60,	Pressure sensor communication failure.
AB_PRESS_GEN_FAIL = 0x61,	Pressure sensor general failure.
AB_PRESS_STATUS_FAIL= 0x62,	Pressure sensor status failure.
AB_PRESS_UNK_ERROR= 0x63,	Pressure sensor unknown error.
AB_PRESS_READ_FAIL= 0x64,	Pressure sensor read failure.
AB_TEMP_FAIL= 0x65,	Temperature sensor failure.
AB_TEMP_NOCONNECT = 0x66,	Temperature sensor not connected.
AB_PRESS_OVER_MAX = 0x67,	Pressure sensor max rating exceeded.
Memory Failures	
AB_MTX_FAIL = 0x70,	Mutex Lock/unlock failure
AB_EVT_FAIL = 0x71,	Event wait/signal failure
AB_PTR_NULL = 0x72,	Unexpected Null pointer
AB_QUE_FAIL = 0x73,	Queue failure
HEM Faults	
AB_HEM_WRITE_T_FAIL = 0x82,	Failed to update HEM data in nvmem.

Error Code	Description
AB_HEM_WRITE_P_FAIL = 0x83,	Failed to update HEM data in nvmem.
AB_HEM_READ_T_FAIL= 0x84,	Failed to read HEM data from nvmem.
AB_HEM_READ_P_FAIL= 0x85,	Failed to read HEM data from nvmem.
AB_HEM_OPTIME_OVR = 0x87,	Operating time over max.
AB_HEM_PRESS_OVR= 0x88,	Pressure reading over sensor limit.
AB_HEM_LEAK_1 = 0x89,	Leak detected in sensor 1.
AB_HEM_NOCONN_1 = 0x8C,	Leak sensor 1 disconnected.
AB_HEM_LEAK_1_RD_FAIL = 0x8D,	Leak sensor 1 read failure.
Scheduler, ping timing, ens buffer	
AB_DP_FAULT_SCHED_INV_STATE = 0x90,	Scheduler Invalid State
AB_DP_FAULT_SCHED_DEP_RESTART = 0x91,	Scheduler Deployment Restart
AB_DP_FAULT_LATE_PING = 0x92,	late Ping
AB_DP_FAULT_UNSUPPORTED_NB_FREQ = 0xE3,	NB ping aborted due to unsupported sysFreq
AB_DP_FAULT_MEMORY = 0xE5,	Memory pointer error
AB_DP_FAULT_OOB = 0xE6,	Out-of-Bounds error
AB_DP_FAULT_START_PING = 0xE7,	Ping start error
AB_DP_FAULT_PING_WAIT_EVT_FAIL = 0xE8,	Ping Wait for Data Event failed
AB_DP_FAULT_PING_FIFO = 0xE9,	Ping FIFO failure
AB_DP_FAULT_BOTDET_FISH = 0xEA,	Bottom detect fish screen failed a beam
AB_DP_FAULT_BOTDET_BOUNCE = 0xEB,	Bottom detect 2nd bounce screen failed a beam
AB_DP_FAULT_BOTDET_FAIL = 0xEC,	Bottom detect failed to find >2 good beams.
AB_DP_FAULT_COR_FAIL = 0xED,	Beam failed correlation threshold test.
AB_DP_FAULT_VEL_OVR = 0xEE,	Using manual override velocities
AB_DP_FAULT_NVMEM_FAILURE = 0xEF,	Bottom ping nonvol memory error (bottom track disabled)
AB_DP_FAULT_SCHED_EVT_DESCR = 0xF0,	Scheduler - Bad Event descriptor
AB_DP_FAULT_SCHED_EVT_ERR = 0xF1,	Scheduler - Event error
AB_DP_FAULT_SCHED_TRIG_EVT_ERR = 0xF2,	Scheduler - trigger event create failure
AB_DP_FAULT_SCHED_PING_EVT_ERR = 0xF3,	Scheduler - ping event wait error
AB_DP_FAULT_SCHED_EVT_RESET_ERR = 0xF4,	Scheduler - Event reset error
AB_DP_FAULT_PING_EVT_ERR = 0xF6,	Ping event wait error
AB_DP_FAULT_TIMER = 0xF7,	Timer read error
AB_DP_FAULT_IQ_EVT_SET = 0xFA,	IQ data event set error
AB_DP_FAULT_FPGA_IND_FAULT = 0xFB,	FPGA indicates fault
AB_DP_FAULT_WDREG_ERR = 0xFE,	Watchdog registration error
AB_DP_FAULT_WDRPT_ERR = 0xFF	Watchdog reporting error

Velocity Data Format

BYTE	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID							00h	LSB
2								01h	MSB
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 255 CELLS)								↓
2035	DEPTH CELL #255, VELOCITY 1								LSB
2036									MSB
2037	DEPTH CELL #255, VELOCITY 2								LSB
2038									MSB
2039	DEPTH CELL #255, VELOCITY 3								LSB
2040									MSB
2041	DEPTH CELL #255, VELOCITY 4								LSB
2042									MSB

Figure 34. Velocity Data Format

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

The 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 ADCP scales velocity data in millimeters per second (mm/s). A value of -32768 (8000h) indicates bad velocity values.

Table 24: Velocity Data Format

Binary Byte	Field	Description
1,2	Velocity ID	Stores the velocity data identification word 0100. LSB is sent first.
3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2. See above.
7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3. See above.
9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4. See above.
11-2042	Cells 2 - 255 (if used)	These fields store the velocity data for depth cells 2 through 255 (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 Format

	BIT POSITIONS								
BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	DEPTH CELL #1, FIELD #4								
7	DEPTH CELL #2, FIELD #1								
8	DEPTH CELL #2, FIELD #2								
9	DEPTH CELL #2, FIELD #3								
10	DEPTH CELL #2, FIELD #4								
↓	(SEQUENCE CONTINUES FOR UP TO 255 BINS)								↓
1019	DEPTH CELL #255, FIELD #1								
1020	DEPTH CELL #255, FIELD #2								
1021	DEPTH CELL #255, FIELD #3								
1022	DEPTH CELL #255, FIELD #4								

Figure 35. Correlation Magnitude, Echo Intensity, Percent Good and Status Format

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

Correlation magnitude data for Broad Bandwidth ensembles give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The ADCP represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target).

Table 25: Correlation Magnitude Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the correlation magnitude data identification word 0200. LSB is sent first.
3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam #4. See above.
7-1022	Cells 2 - 255 (if used)	These fields store correlation magnitude data for depth cells 2 through 255 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

The echo intensity scale factor is approximately 0.60 to 0.65 dB per ADCP count. The ADCP does not directly check for the validity of echo intensity data.

Table 26: Echo Intensity Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the echo intensity data identification word 0300. LSB is sent first.
3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam #4. See above.
7-1022	Cells 2 – 255 (if used)	These fields store echo intensity data for depth cells 2 through 255 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

The percent-good data field is a data-quality indicator that reports the percentage (0 to 100) of good data collected for each depth cell of the velocity profile. The setting of the EX-command (Coordinate Transformation) determines how the 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:			
xxx**00**xxx	Beam	BEAM 1	BEAM 2	BEAM 3	BEAM 4

EX-Command	Coordinate System	Velocity 1	Velocity 2	Velocity 3	Velocity 4
		Percentage Of:			
xxx**01**xxx xxx**10**xxx xxx**11**xxx	Instrument Ship Earth	3-Beam Transformations (note 1)	Transformations Rejected (note 2)	More Than One Beam Bad In Bin	4-Beam Transformations

Note 1. Because one beam failed due to amplitude or correlation threshold.

Note 2. Because the error velocity threshold was exceeded.

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the ADCP uses all four beams to calculate the orthogonal and error velocities. As the echo returns from far away depth cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the ADCP to reject some of its depth cell data. This causes the ADCP to calculate velocities with three beams instead of four beams. When the ADCP does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further depth cell, the ADCP rejects all cell data because of the weak echo. As an example, let us assume depth cell 60 has returned the following percent-good data.

```
FIELD #1 = 50, FIELD #2 = 5, FIELD #3 = 0, FIELD #4 = 45
```

If the EX-command was set to collect velocities in BEAM coordinates, the example values show the percentage of pings having good solutions in cell 60 for each beam based on the Low Correlation Threshold (WC command). Here, beam 1=50%, beam 2=5%, beam 3=0%, and beam 4=45%. These are neither typical nor desired percentages. Typically, you would want all four beams to be about equal and greater than 25%.

On the other hand, if velocities were collected in Instrument, Ship, or Earth coordinates, the example values show:

Field 1 – Percentage of good 3-beam solutions – Shows percentage of successful velocity calculations (50%) using 3-beam solutions because the correlation threshold (WC command) was not exceeded.

Field 2 – Percentage of transformations rejected – Shows percent of error velocity (5%) that was less than the WE command setting. WE has a default of 5000 mm/s. This large WE setting effectively prevents the ADCP from rejecting data based on error velocity.

Field 3 – Percentage of more than one beam bad in bin – 0% of the velocity data were rejected because not enough beams had good data.

Field 4 – Percentage of good 4-beam solutions – 45% of the velocity data collected during the ensemble for depth cell 60 were calculated using four beams.

Table 27: Percent-Good Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the percent-good data identification word 0400. LSB is sent first.
3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
4	Depth cell 1, Field 2	Stores percent-good data for depth cell #1, field 2. See above.
5	Depth cell 1, Field 3	Stores percent-good data for depth cell #1, field 3. See above.
6	Depth cell 1, Field 4	Stores percent-good data for depth cell #1, field 4. See above.
7-1022	Depth cell 2 – 255 (if used)	These fields store percent-good data for depth cells 2 through 255 (depending on the WN-command), following the same format as listed above for depth cell 1.

Table 28: Status Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the Status data identification word 0500. LSB is sent first.
3	Depth cell 1, Field 1	Stores Status data for depth cell #1, field 1. See above.
4	Depth cell 1, Field 2	Stores Status data for depth cell #1, field 2. See above.
5	Depth cell 1, Field 3	Stores Status data for depth cell #1, field 3. See above.
6	Depth cell 1, Field 4	Stores Status data for depth cell #1, field 4. See above.
7-1022	Depth cell 2 – 255 (if used)	These fields store Status data for depth cells 2 through 255 (depending on the WN-command), following the same format as listed above for depth cell 1.

Vertical Beam Range Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VERTICAL BEAM RANGE ID 41 00h								LSB 00h
2									MSB 41h
3	EVAL AMP								
4	RSSI AMP								
5	Altitude * 1000 (mm)								
6									
7									
8									
9	STATUS								

Figure 36. Vertical Beam Range Format

Table 29: Vertical Beam Range Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam data identification word (00 41h).
5-6	3	Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo.
7-8	4	RSSI Amp	Contains the RSSI value for the sample at the middle of the bottom echo.
9-16	5-8	Range to Bottom	Contains the vertical beam range to the bottom. Scaling: LSD = 1 mm; Range = 0 to 100000 mm.
17-18	9	Status	Contains flags, defined as follows: <d7:d3> Reserved <d2> Gain setting: 0 = LowGain; 1 = HighGain <d1:d0> Status: 00 = Range invalid; 01 = Range valid from w-filter 10 = Range valid from leading-edge filter

Only present when there is a vertical range to report.

Vertical Beam State Format

	BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0	
1	VERTICAL BEAM STATE LEADER ID 4003h								LSB 03
2									MSB 40
3	nCodeElements								
4									
5	CPE								
6	SPE								
7	CodeReps								
8									
9	XmtBins								
10									
11	Bottom Blank Bins								
12									
13	First Rssi Bin								
14									
15	Samples Per Meter * 1000								
16									
17									
18									

Figure 37. Vertical Beam State Format

the Vertical Beam State (0x4003) might not exist in the final released product as it is an internal engineering format and probably should not be published.

Table 30: Vertical Beam State Format

Binary Byte	Field	Description
1-2	ID Code	Stores the vertical beam state data identification word (4003h).
3	nCodeElements	
5	CPE	
6	SPE	
7 - 8	CodeReps	
9 - 10	XmtBins	
11 - 12	Bottom Blank Bins	
13 - 14	First Rssi Bin	
15 - 18	Samples Per Meter * 1000	

Vertical Beam Amplitude Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
1	VERTICAL BEAM AMPLITUDE LEADER ID 4004h	LSB 04
2		MSB 40
3	nRssiBins	
4		
5	RssiBinLen	
6		
7	MaxBin	
8		
9	MaxAmp	
10	Amp[0]	
11	Amp[1]	
12	Amp[2]	
↓	↓	↓
649	Amp[639]	
650	Amp[640]	

Figure 38. Vertical Beam Amplitude Format

Table 31: Vertical Beam Amplitude Format

Binary Byte	Field	Description
1,2	ID Code	Stores the vertical beam amplitude data identification word (4004h).
3 - 4	nRssiBins	Contains the number of Receiver Signal Strength Indicator (RSSI) bins
5 - 6	RssiBinLen	
7 - 8	MaxBin	
9	MaxAmp	
10 - 650	Amp[0] to Amp[640]	

Vertical Beam Profile Leader Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	VERTICAL BEAM PROFILE LEADER ID								LSB 01
2									MSB 0F
3	NUMBER OF BINS								
4									
5	NUMBER OF PINGS PER ENSEMBLE								
6									
7	BIN SIZE								
8									
9	DISTANCE TO BIN 1 MIDDLE								
10									
11	RESERVED								
12									
13	TRANSMIT LENGTH								
14									
15	LAG LENGTH								
16									
17	NUMBER OF CODE ELEMENTS TRANSMITTED								
18									
19	RESERVED								
↓									↓
40									

Figure 39. Vertical Beam Profile Leader Format

Table 32: Vertical Beam Profile Leader Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile leader identification word (0x0F01h)
5-8	3,4	# Bins	Stores the number of bins (ZN – Vertical Beam Number of Bins). Scaling: LSD = 1 bin; Range = 1 to 200 bins
9-12	5,6	Ping/ensemble	Stores the number of pings to average together in each ensemble (ZP – Vertical Beam Number of Pings). If ZP = 0, the Proteus does not collect vertical beam profile data. Scaling: LSD = 1 ping; Range = 0 to 999 pings
13-16	7,8	Bin size	Stores the vertical beam profile bin size (cm) (ZS – Vertical Beam Bin Size) Scaling: LSD = 1 cm; Range 2 to 500 cm
17-20	9,10	Distance to bin 1 middle	Contains the distance to the middle of bin 1. The distance to the middle of bin 1 is determined by: blank + (xmtLength + lagLength + binSize)/2. Blank and bin size are affected by the speed of sound; xmt length and lag use a fixed speed of sound value. ZF – Vertical Beam Blanking Distance determines blank. ZS – Vertical Beam Bin Size determines bin size, which also determines xmt length, unless the ZT xmt override is used. ZV – Vertical Beam Ambiguity Velocity determines lag length by setting the ambiguity velocity. Scaling: LSD = 1 centimeter; Range = 0 to 500 cm
21-24	11-12	Reserved	Reserved
25-28	13-14	Xmit length	Stores the vertical beam Transmit Length in cm. Scaling: LSD = 1 centimeter; Range = 2 to 500 cm
29-32	15-16	Lag length	Lag Length in cm. The lag is the time period between sound pulses. This is varied as required by the Proteus.
33-36	17-18	# Code elements	Contains the number of code elements in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
37-160	19-40	Reserved	Reserved

Vertical Beam Profile Velocity Data Format

BYTE	7/S	6	5	4	3	2	1	0	
1	VERTICAL BEAM PROFILE VELOCITY ID 0A00								LSB 00
2									MSB 0A
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 200 CELLS)								↓
401	DEPTH CELL #200, VELOCITY 1								LSB
402									MSB

Figure 40. Vertical Beam Profile Velocity Data Format

Table 33: Vertical Beam Profile Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the vertical beam profile velocity identification word (LSB=00, MSB=0A).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
8-804	5-402	Cells 2 – 200 (if used)	These fields store the velocity data for depth cells 2 through 200 (depending on the setting of the ZN – Vertical Beam Number of Bins command). These fields follow the same format as listed above for depth cell 1.

Vertical Beam Profile Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #2, FIELD #1								
↓	(SEQUENCE CONTINUES FOR UP TO 200 CELLS)								↓
202	DEPTH CELL #200, FIELD #1								

See Table 34 through Table 37 for a description of the fields.

Figure 41. Vertical Beam Profile Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

Table 34: Vertical Beam Profile Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile correlation magnitude data identification word (LSB=00, MSB=0B).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store correlation magnitude data for depth cells 2 through 200 for all four beams. These fields follow the same format as listed above for depth cell 1.

Table 35: Vertical Beam Profile Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the vertical beam profile echo intensity data identification word (LSB=00, MSB=0C).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store echo intensity data for depth cells 2 through 200 for all four beams. These fields follow the same format as listed above for depth cell 1.

Table 36: Vertical Beam Profile Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile percent-good data identification word (LSB=00, MSB=0D).
5,6	3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store percent-good data for depth cells 2 through 200, following the same format as listed above for depth cell 1.

Table 37: Vertical Beam Profile Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile status data identification word (LSB=00, MSB=0E).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, field 1. 1=good, 0=bad
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store status data for depth cells 2 through 200, following the same format as listed above for depth cell 1.

Bottom-Track Data Format

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	BOTTOM-TRACK ID 00h								LSB
2	06h								MSB
3	BOTTOM-TRACK # OF PINGS {BP}								LSB
4									MSB
5	RESERVED								LSB
6									MSB
7	BT CORR MAG MIN {BC}								
8	BT EVAL AMP MIN {BA}								
9	RESERVED								
10	BOTTOM TRACK MODE {BM}								
11	ERROR VELOCITY MAXIMUM {BE}								
12									
13 ↓ 16	RESERVED								↓
17	BEAM#1 BT RANGE								LSB
18									MSB
19	BEAM#2 BT RANGE								LSB
20									MSB
21	BEAM#3 BT RANGE								LSB
22									MSB
23	BEAM#4 BT RANGE								LSB
24									MSB
25	BEAM#1 BT VEL								LSB
26									MSB
27	BEAM#2 BT VEL								LSB
28									MSB
29	BEAM#3 BT VEL								LSB
30									MSB

BYTE#	BIT POSITIONS 7 6 5 4 3 2 1 0	
31	BEAM#4 BT VEL	LSB
32		MSB
33	BEAM#1 BT CORR.	
34	BEAM#2 BT CORR.	
35	BEAM#3 BT CORR.	
36	BEAM#4 BT CORR.	
37	BEAM#1 EVAL AMP	
38	BEAM#2 EVAL AMP	
39	BEAM#3 EVAL AMP	
40	BEAM#4 EVAL AMP	
41 ↓ 70	RESERVED	↓
71	BT MAXIMUM DEPTH {BX}	LSB
72		MSB
73	BM#1 RSSI AMP	
74	BM#2 RSSI AMP	
75	BM#3 RSSI AMP	
76	BM#4 RSSI AMP	
77	GAIN	
78	(*SEE BYTE 17)	MSB
79	(*SEE BYTE 19)	MSB
80	(*SEE BYTE 21)	MSB
81	(*SEE BYTE 23)	MSB

Figure 42. Bottom-Track Data Format

This data is output only if the BP-command is >0.

The LSB is always sent first. See Command Descriptions for detailed descriptions of commands used to set these values.

Table 38: Bottom-Track Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the bottom-track data identification word 0600. LSB is sent first.
3,4	BP / BT # Pings	Stores the BP-command (see BP - Bottom-Track Pings). If BP = zero, the ADCP does not collect bottom-track data. The ADCP automatically extends the ensemble interval (TE) if BP x TP > TE.
5,6	Reserved	Reserved
7	BC / BT Corr Mag Min	Stores the minimum correlation magnitude value (BC - Correlation Threshold). Scaling: LSD = 1 count; Range = 0 to 255 counts
8	BA / BT Eval Amp Min	Stores the minimum evaluation amplitude value (BA - Amplitude Threshold). Scaling: LSD = 1 count; Range = 1 to 255 counts
9	Reserved	Reserved – always 0
10	BM/BT Mode	Stores the bottom-tracking mode (BM-command).
11,12	BE/BT Err Vel Max	Stores the error velocity maximum value (BE - Error Velocity Threshold). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
13–16	Reserved	Reserved
17-24	BT Range / Beam #1-4 BT Range	Contains the two lower bytes of the vertical range from the 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
25-32	BT Velocity / Beam #1-4 BT Vel	The meaning of the velocity depends on the EX command setting (EX - Coordinate Transformation). 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: Stbd, Fwd, Upward, Error d) Earth Coordinates: East, North, Upward, Error
33-36	BTCM / Beam #1-4 BT Corr.	Contains the correlation magnitude in relation to the sea bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
37-40	BTEA / Beam #1-4 BT Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo. Scaling: LSD = 1 count; Range = 0 to 255 counts
41-70	Reserved	Reserved
71,72	BX / BT Max. Depth	Stores the maximum tracking depth value (BX - Maximum Tracking Depth). Scaling: LSD = 1 decimeter; Range = 80 to 9999 decimeters
73-76	RSSI/Bm #1-4 RSSI Amp	Contains the Receiver Signal Strength Indicator (RSSI) value in the center of the bottom echo as determined by each beam. Scaling: LSD = ≈ 0.45 dB per count; Range = 0 to 255 counts
77	GAIN	Contains the Gain level for shallow water.
78-81	BT Range MSB / Bm #1-4	Contains the most significant byte of the vertical range from the 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

Ping Metadata Format

As described in Figure 43 below, this data type can be 40, 76, 112, or 148 bytes long depending on whether one, two, three, or four ping types are included in the current PD0 message. Ping ID, 1= BT (Bottom Track), 2 = BBP (Broadband Profile), 4 = VBR (Vertical Beam Range), 5 = VBP (Vertical Beam Profile). ID = 3 is reserved.

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	PING METADATA ID 1100						00h		LSB
2							11h		MSB
3	Number of records (one for each ping type)								LSB
4									MSB
5–8	Record Count LSW								
9–12	Record Count MSW								
13–16	Burst Count LSW								
17–20	Burst Count MSW								
21	listTotCount								
22	numEnsInBurst								
23	listID								
24	ensNumber								
25	evtTotCount								
26	evtID								
27–28	evtSeqCount								

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0	
29 – 37	Ping Time								
38	Ping type								
39 – 40	SPARE								
41 ↓ 76	Ping Metadata #2								↓
77 ↓ 112	Ping Metadata #3								↓
113 ↓ 148	Ping Metadata #4								↓

Figure 43. Ping Metadata Data Format

Table 39: Ping Metadata Data Format

Byte	Field	Description
1,2	Ping Metadata ID	Stores the Ping Metadata identification word (LSB=00, MSB=11).
3, 4	Number of records	Number of records. Data repeated for each ping up to 4.
		Ping Metadata #1
5 – 8	Record Count LSW	Record Count LSW
9 - 12	Record Count MSW	Record Count MSW
13 - 16	Burst Count LSW	Burst Count LSW
17 - 20	Burst Count MSW	Burst Count MSW
21	listTotCount	List Total Count
22	numEnsInBurst	Number of Ensembles In Burst
23	listID	List ID
24	ensNumber	Ensemble Number
25	evtTotCount	Event Total Count
26	evtID	Event ID
27 - 28	evtSeqCount	Event Sequence Count
29 - 30	PingTime.msec	Ping Time msec
31 - 32	PingTime.year	Ping Time year
33	PingTime.mon	Ping Time month
34	PingTime.mDay	Ping Time Day
35	PingTime.hour	Ping Time hour
36	PingTime.min	Ping Time minutes
37	PingTime.sec	Ping Time seconds
38	PingType	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
39 - 40	Spare	Spare
		Ping Metadata #2
41 – 44	Record Count LSW	Record Count LSW
45 – 48	Record Count MSW	Record Count MSW
49 – 52	Burst Count LSW	Burst Count LSW
53 – 56	Burst Count MSW	Burst Count MSW
57	listTotCount	List Total Count
58	numEnsInBurst	Number of Ensembles In Burst
59	listID	List ID
60	ensNumber	Ensemble Number
61	evtTotCount	Event Total Count
62	evtID	Event ID
63 – 64	evtSeqCount	Event Sequence Count
65 – 66	PingTime.msec	Ping Time msec
67 – 68	PingTime.year	Ping Time year
69	PingTime.mon	Ping Time month

Table 39: Ping Metadata Data Format

Byte	Field	Description
70	PingTime.mDay	Ping Time Day
71	PingTime.hour	Ping Time hour
72	PingTime.min	Ping Time minutes
73	PingTime.sec	Ping Time seconds
74	PingType	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
75 – 76	Spare	Spare
		Ping Metadata #3
77 – 80	Record Count LSW	Record Count LSW
81 – 84	Record Count MSW	Record Count MSW
85 – 88	Burst Count LSW	Burst Count LSW
89 – 92	Burst Count MSW	Burst Count MSW
93	listTotCount	List Total Count
94	numEnsInBurst	Number of Ensembles In Burst
95	listID	List ID
96	ensNumber	Ensemble Number
97	evtTotCount	Event Total Count
98	evtID	Event ID
99 – 100	evtSeqCount	Event Sequence Count
101 – 102	PingTime.msec	Ping Time msec
103 – 104	PingTime.year	Ping Time year
105	PingTime.mon	Ping Time month
106	PingTime.mDay	Ping Time Day
107	PingTime.hour	Ping Time hour
108	PingTime.min	Ping Time minutes
109	PingTime.sec	Ping Time seconds
110	PingType	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
111 – 112	Spare	Spare
		Ping Metadata #4
113 – 80	Record Count LSW	Record Count LSW
117 – 84	Record Count MSW	Record Count MSW
121 – 88	Burst Count LSW	Burst Count LSW
125 – 92	Burst Count MSW	Burst Count MSW
129	listTotCount	List Total Count
130	numEnsInBurst	Number of Ensembles In Burst
131	listID	List ID
132	ensNumber	Ensemble Number
133	evtTotCount	Event Total Count
134	evtID	Event ID

Table 39: Ping Metadata Data Format

Byte	Field	Description
135 – 136	evtSeqCount	Event Sequence Count
137 – 138	PingTime.msec	Ping Time msec
139 – 140	PingTime.year	Ping Time year
141	PingTime.mon	Ping Time month
142	PingTime.mDay	Ping Time Day
143	PingTime.hour	Ping Time hour
144	PingTime.min	Ping Time minutes
145	PingTime.sec	Ping Time seconds
146	PingType	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
147 – 148	Spare	Spare

Ping Sensor Data

As described in Figure 44 below, this data type can be 324, 340, 356, or 372 bytes long depending on whether one, two, three, or four ping types are included in the current PD0 message. Ping ID, 1= BT (Bottom Track), 2 = BBP (Broadband Profile), 4 = VBR (Vertical Beam Range), 5 = VBP (Vertical Beam Profile). ID = 3 is reserved.

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	PING sensor data ID 1110						10h		LSB
							11h		MSB
3 4	nPings								
5	Ping1 type ID								
6	List Index								
7	Event Index								
8	Ping1 Xducer Type (0=PA, 1=Piston)								
9	Ping1 Water Temperature (.01 deg C)								
13	Ping1 Pressure (0.001 KPa)								
17	Ping1 Pressure Sensor Bridge Temperature (0.01 deg C)								
21	Ping1 Pressure Depth (cm)								
25	HPR Quaternion [0] (* 1e6)								

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0
29	HPR Quaternion [1] (* 1e6)							
33	HPR Quaternion [2] (* 1e6)							
37	HPR Quaternion [3] (* 1e6)							
41	accel_x (* 1e6)							
45	accel_y (* 1e6)							
49	accel_z (* 1e6)							
53	mag_x (* 1e6)							
57	mag_y (* 1e6)							

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0	
61	mag_z (* 1e6)								
65	sosW (cm/s)								
69	Salinity (ppt)								
71 72	Thermistor ADC counts [0..65535]								
73 ↓ 140	Ping2 type ID ↓								↓
141 ↓ 208	Ping3 type ID ↓								↓
209 ↓ 276	Ping4 type ID ↓								↓
277 ↓ 284	Ping Type #1 VTX/ITX								
285 ↓ 292	Ping Type #2 VTX/ITX								
293 ↓ 300	Ping Type #3 VTX/ITX								
301 ↓ 308	Ping Type #4 VTX/ITX								

BYTE#	BIT POSITIONS 7	6	5	4	3	2	1	0
309 ↓ 324	ADC Counts, VIN, 3V3 - Ping Type #1							
325 ↓ 340	ADC Counts, VIN, 3V3 - Ping Type #2							
341 ↓ 356	ADC Counts, VIN, 3V3 - Ping Type #3							
357 ↓ 373	ADC Counts, VIN, 3V3 - Ping Type #4							

Figure 44. Ping Sensor Data Format

Table 40: Ping Sensor Data Format

Byte	Field	Description
1,2	Ping Sensor ID	Stores the vertical beam profile status data identification word (LSB=10, MSB=11).
3, 4	nPings	Number of pings. Data repeated for each ping up to 4.
		Ping Type #1
5	Ping1 type ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
6	Ping1 List Index	Ping1 List Index
7	Ping1 Event Index	Ping1 Event Index
8	Ping1 Xducer Type	Ping1 Xducer Type (0=PA, 1=Piston)
9 – 12	Ping1 Water Temperature	Ping1 Water Temperature (.01 degC)
13 – 16	Ping1 Pressure	Ping1 Pressure (0.001 KPa)
17 – 20	Ping1 Bridge Temperature	Ping1 Pressure Sensor Bridge Temperature (0.01 degC)
21 – 24	Ping1 Pressure Depth	Ping1 Pressure Depth (cm)
25 – 28	HPR Quaternion [0]	HPR Quaternion [0] (* 1e6)
29 – 32	HPR Quaternion [1]	HPR Quaternion [1] (* 1e6)
33 – 36	HPR Quaternion [2]	HPR Quaternion [2] (* 1e6)
37 – 40	HPR Quaternion [3]	HPR Quaternion [3] (* 1e6)
41 – 44	Acceleration x	accel_x (* 1e6)
45 – 48	Acceleration y	accel_y (* 1e6)
49 – 52	Acceleration z	accel_z (* 1e6)
53 – 56	Magnitude x	mag_x (* 1e6)
57 – 60	Magnitude y	mag_y (* 1e6)

Table 40: Ping Sensor Data Format

Byte	Field	Description
61 – 64	Magnitude z	mag_z (* 1e6)
65 – 68	Speed of Sound	sosW (cm/s)
69 – 70	Salinity	Salinity (ppt)
71 – 72	Thermistor ADC counts	Thermistor ADC counts [0..65535]
		Ping Type #2
73	Ping2 type ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
74	Ping2 List Index	Ping2 List Index
75	Ping2 Event Index	Ping2 Event Index
76	Ping2 Xducer Type	Ping2 Xducer Type (0=PA, 1=Piston)
77 – 80	Ping2 Water Temperature	Ping2 Water Temperature (.01 degC)
81 – 84	Ping2 Pressure	Ping2 Pressure (0.001 KPa)
85 – 88	Ping2 Bridge Temperature	Ping2 Pressure Sensor Bridge Temperature (0.01 degC)
89 – 92	Ping2 Pressure Depth	Ping2 Pressure Depth (cm)
93 – 96	HPR Quaternion [0]	Ping2 HPR Quaternion [0] (* 1e6)
97 – 100	HPR Quaternion [1]	Ping2 HPR Quaternion [1] (* 1e6)
101 – 104	HPR Quaternion [2]	Ping2 HPR Quaternion [2] (* 1e6)
105 – 108	HPR Quaternion [3]	Ping2 HPR Quaternion [3] (* 1e6)
109 – 112	Acceleration x	Ping2 accel_x (* 1e6)
113 – 116	Acceleration y	Ping2 accel_y (* 1e6)
117 – 120	Acceleration z	Ping2 accel_z (* 1e6)
121 – 124	Magnitude x	Ping2 mag_x (* 1e6)
125 – 128	Magnitude y	Ping2 mag_y (* 1e6)
129 – 132	Magnitude z	Ping2 mag_z (* 1e6)
133 – 136	Speed of Sound	Ping2 sosW (cm/s)
137 – 138	Salinity	Ping2 Salinity (ppt)
139 – 140	Thermistor ADC counts	Ping2 Thermistor ADC counts [0..65535]
		Ping Type #3
141	Ping3 type ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
142	Ping3 List Index	Ping3 List Index
143	Ping3 Event Index	Ping3 Event Index
144	Ping3 Xducer Type	Ping3 Xducer Type (0=PA, 1=Piston)
145 – 148	Ping3 Water Temperature	Ping3 Water Temperature (.01 degC)
149 – 152	Ping3 Pressure	Ping3 Pressure (0.001 KPa)
153 – 156	Ping3 Bridge Temperature	Ping3 Pressure Sensor Bridge Temperature (0.01 degC)
157 – 160	Ping3 Pressure Depth	Ping3 Pressure Depth (cm)
161 – 164	HPR Quaternion [0]	Ping3 HPR Quaternion [0] (* 1e6)
165 – 168	HPR Quaternion [1]	Ping3 HPR Quaternion [1] (* 1e6)
169 – 172	HPR Quaternion [2]	Ping3 HPR Quaternion [2] (* 1e6)

Table 40: Ping Sensor Data Format

Byte	Field	Description
173 – 176	HPR Quaternion [3]	Ping3 HPR Quaternion [3] (* 1e6)
177 – 180	Acceleration x	Ping3 accel_x (* 1e6)
181 – 184	Acceleration y	Ping3 accel_y (* 1e6)
185 – 188	Acceleration z	Ping3 accel_z (* 1e6)
189 – 192	Magnitude x	Ping3 mag_x (* 1e6)
193 – 196	Magnitude y	Ping3 mag_y (* 1e6)
197 – 200	Magnitude z	Ping3 mag_z (* 1e6)
201 – 204	Speed of Sound	Ping3 sosW (cm/s)
205 – 206	Salinity	Ping3 Salinity (ppt)
207 – 208	Thermistor ADC counts	Ping3 Thermistor ADC counts [0..65535]
		Ping Type #4
209	Ping4 type ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
210	Ping4 List Index	Ping4 List Index
211	Ping4 Event Index	Ping4 Event Index
212	Ping4 Xducer Type	Ping4 Xducer Type (0=PA, 1=Piston)
213 – 216	Ping4 Water Temperature	Ping4 Water Temperature (.01 degC)
217 – 220	Ping4 Pressure	Ping4 Pressure (0.001 KPa)
221 – 224	Ping4 Bridge Temperature	Ping4 Pressure Sensor Bridge Temperature (0.01 degC)
225 – 228	Ping4 Pressure Depth	Ping4 Pressure Depth (cm)
229 – 232	HPR Quaternion [0]	Ping4 HPR Quaternion [0] (* 1e6)
233 – 236	HPR Quaternion [1]	Ping4 HPR Quaternion [1] (* 1e6)
237 – 240	HPR Quaternion [2]	Ping4 HPR Quaternion [2] (* 1e6)
241 – 244	HPR Quaternion [3]	Ping4 HPR Quaternion [3] (* 1e6)
245 – 248	Acceleration x	Ping4 accel_x (* 1e6)
249 – 252	Acceleration y	Ping4 accel_y (* 1e6)
253 – 256	Acceleration z	Ping4 accel_z (* 1e6)
257 – 260	Magnitude x	Ping4 mag_x (* 1e6)
261 – 264	Magnitude y	Ping4 mag_y (* 1e6)
265 – 268	Magnitude z	Ping4 mag_z (* 1e6)
269 – 272	Speed of Sound	Ping4 sosW (cm/s)
273 – 274	Salinity	Ping4 Salinity (ppt)
275 – 276	Thermistor ADC counts	Ping4 Thermistor ADC counts [0..65535]
		VTX/ITX Byte offset, X = (NPINGS * 68) + 5
277 – 280	VTX (float Volts)	Ping1 VTX
281 – 284	ITX (float Amps)	Ping1 ITX
285 – 288	VTX (float Volts)	Ping2 VTX
289 – 292	ITX (float Amps)	Ping2 ITX

Table 40: Ping Sensor Data Format

Byte	Field	Description
293 – 296	VTX (float Volts)	Ping3 VTX
297 – 300	ITX (float Amps)	Ping3 ITX
301 – 304	VTX (float Volts)	Ping4 VTX
305 – 308	ITX (float Amps)	Ping4 ITX
		ADC Counts, VIN, 3V3 - Byte offset, Y = (NPINGS * 8) + X
309 – 310	VTX ADC Counts	Ping Type #1 VTX ADC Counts
311 – 312	ITX ADC Counts	Ping Type #1 ITX ADC Counts
313 – 314	VIN ADC Counts	Ping Type #1 VIN ADC Counts
315 – 316	3V3 ADC Counts	Ping Type #1 3V3 ADC Counts
317 – 320	VIN Volts * 1000.0	Ping Type #1 VIN Volts * 1000.0
321 – 324	3V3 Volts * 1000.0	Ping Type #1 3V3 Volts * 1000.0
325 – 327	VTX ADC Counts	Ping Type #2 VTX ADC Counts
327 – 328	ITX ADC Counts	Ping Type #2 ITX ADC Counts
329 – 330	VIN ADC Counts	Ping Type #2 VIN ADC Counts
331 – 332	3V3 ADC Counts	Ping Type #2 3V3 ADC Counts
333 – 3336	VIN Volts * 1000.0	Ping Type #2 VIN Volts * 1000.0
337 – 340	3V3 Volts * 1000.0	Ping Type #2 3V3 Volts * 1000.0
341 – 342	VTX ADC Counts	Ping Type #3 VTX ADC Counts
343 – 344	ITX ADC Counts	Ping Type #3 ITX ADC Counts
345 – 346	VIN ADC Counts	Ping Type #3 VIN ADC Counts
347 – 348	3V3 ADC Counts	Ping Type #3 3V3 ADC Counts
349 – 352	VIN Volts * 1000.0	Ping Type #3 VIN Volts * 1000.0
353 – 356	3V3 Volts * 1000.0	Ping Type #3 3V3 Volts * 1000.0
357 – 358	VTX ADC Counts	Ping Type #4 VTX ADC Counts
359 – 360	ITX ADC Counts	Ping Type #4 ITX ADC Counts
361 – 362	VIN ADC Counts	Ping Type #4 VIN ADC Counts
363 – 364	3V3 ADC Counts	Ping Type #4 3V3 ADC Counts
365 – 368	VIN Volts * 1000.0	Ping Type #4 VIN Volts * 1000.0
369 – 373	3V3 Volts * 1000.0	Ping Type #4 3V3 Volts * 1000.0

Ping Attitude Data Format

This data type encodes the movement of the heading, pitch, and roll during the ping for the various ping types. This data type is produced by the Doppler engine and consumed by the Catalyst.

As described in Figure 45 below, this data type can be 29, 55, 81, or 108 bytes long depending on whether one, two, three, or four ping types are included in the current PD0 message. Ping ID, 1= BT (Bottom Track), 2 = BBP (Broadband Profile), 4 = VBR (Vertical Beam Range), 5 = VBP (Vertical Beam Profile). ID = 3 is reserved.

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	PING ATTITUDE DATA ID 0x5902							02	LSB
2								59	MSB
3	Ping Count (n)								
4	Ping ID								
5	HPR Valid flag								
6	Ping1 Heading (0.001 deg)								LSB
7									
8									
9									MSB
10	Ping1 Pitch (0.001 deg)								LSB
11									
12									
13									MSB
14	Ping1 Roll (0.001 deg)								LSB
15									
16									
17									MSB
18	Ping1 Heading Rate (0.001 deg/sec)								LSB
19									
20									
21									MSB
22	Ping1 Pitch Rate (0.001 deg/sec)								LSB
23									
24									
25									MSB
26	Ping1 Roll Rate (0.001 deg/sec)								LSB
27									
28									
29									MSB

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
↓	(Sequence Continues up to n = 4 Ping Types)								↓
30	Ping2 type ID								
31 ↓ 55	Ping Type #2								
56	Ping3 type ID								
57 ↓ 81	Ping Type #3								
82	Ping4 type ID								
83 ↓ 108	Ping Type #4								

Figure 45. Ping Attitude Data Format

The number of Ping Types varies based on the setting of the WP, BP, ZP, and VP commands.

Ping Attitude data refers to the dynamic ADCP data (from heading, pitch, and roll sensors) that change with each ping. The ADCP will output Attitude data as output data (LSBs first). See Command Descriptions for detailed descriptions of commands used to set these values.

Table 41: Ping Attitude Data Format

Byte	Field	Description
1,2	Ping Attitude ID	0x5902
3	Ping Count	Number of Pings reported.
		Ping Type #1
4	ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
5	Data Valid Flag	1 if data is valid, 0 if invalid
6-9	Heading	Stores the Heading value for the first ping reported. LSB = 0.001 degrees.
10-13	Pitch	Stores the Pitch value for the first Ping Type recorded. LSB = 0.001 degrees.
14-17	Roll	Stores the Roll value for the first Ping Type recorded. LSB = 0.001 degrees.
18-21	Heading Rate	Stores the Heading Rate value for the first Ping Type recorded. LSB = 0.001 degrees per second.
22-25	Pitch Rate	Stores the Pitch Rate value for the first Ping Type recorded. LSB = 0.001 degrees per second.
26-29	Roll Rate	Stores the Roll Rate value for the first Ping Type recorded. LSB = 0.001 degrees per second.
		Ping Type #2
30	ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
31	Data Valid Flag	1 if data is valid, 0 if invalid
32-35	Heading	Stores the Heading value for the second ping reported. LSB = 0.001 degrees.
36-39	Pitch	Stores the Pitch value for the second Ping Type recorded. LSB = 0.001 degrees.

Table 41: Ping Attitude Data Format

Byte	Field	Description
40-43	Roll	Stores the Roll value for the second Ping Type recorded. LSB = 0.001 degrees.
44-47	Heading Rate	Stores the Heading Rate value for the second Ping Type recorded. LSB = 0.001 degrees per second.
48-51	Pitch Rate	Stores the Pitch Rate value for the second Ping Type recorded. LSB = 0.001 degrees per second.
52-55	Roll Rate	Stores the Roll Rate value for the second Ping Type recorded. LSB = 0.001 degrees per second.
		Ping Type #3
56	ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
57	Data Valid Flag	1 if data is valid, 0 if invalid
58-61	Heading	Stores the Heading value for the third ping reported. LSB = 0.001 degrees.
62-65	Pitch	Stores the Pitch value for the third Ping Type recorded. LSB = 0.001 degrees.
66-69	Roll	Stores the Roll value for the third Ping Type recorded. LSB = 0.001 degrees.
70-73	Heading Rate	Stores the Heading Rate value for the third Ping Type recorded. LSB = 0.001 degrees per second.
74-77	Pitch Rate	Stores the Pitch Rate value for the third Ping Type recorded. LSB = 0.001 degrees per second.
78-81	Roll Rate	Stores the Roll Rate value for the third Ping Type recorded. LSB = 0.001 degrees per second.
		Ping Type #4
82	ID	Ping ID, 1= BT, 2 = BBP, 4 = VBR, 5 = VBP
83	Data Valid Flag	1 if data is valid, 0 if invalid
84-88	Heading	Stores the Heading value for the fourth ping reported. LSB = 0.001 degrees.
89-92	Pitch	Stores the Pitch value for the fourth Ping Type recorded. LSB = 0.001 degrees.
93-96	Roll	Stores the Roll value for the fourth Ping Type recorded. LSB = 0.001 degrees.
97-100	Heading Rate	Stores the Heading Rate value for the fourth Ping Type recorded. LSB = 0.001 degrees per second.
101-104	Pitch Rate	Stores the Pitch Rate value for the fourth Ping Type recorded. LSB = 0.001 degrees per second.
105-108	Roll Rate	Stores the Roll Rate value for the fourth Ping Type recorded. LSB = 0.001 degrees per second.

AHRS Data format

This contains the full heading, pitch, roll, and magnetometer data captured during the ping.

BYTE	7	6	5	4	3	2	1	0	
1	AHRS ID							01h	LSB
2								59h	MSB
3	Data Valid Flag								
4	X ACCELEROMETER READING								LSB
5									
6									
7									MSB
8	Y ACCELEROMETER READING								LSB
9									
10									
11									MSB
12	Z ACCELEROMETER READING								LSB
13									
14									
15									MSB
16	X MAGNETOMETER READING								LSB
17									MSB
18	Y MAGNETOMETER READING								LSB
19									MSB
20	Z MAGNETOMETER READING								LSB
21									MSB

Figure 46. AHRS Data Format

Table 42: AHRS Data Format

Binary Byte	Field	Description
1,2	AHRS ID	Stores the AHRS data identification word 0x5901
3	Valid Flag	Flags whether data was received from AHRS and recorded
4-7	Acc_X1	Stores the x-axis accelerometer reading
8-11	Acc_Y1	Stores the y-axis accelerometer reading
12-15	Acc_Z1	Stores the z-axis accelerometer reading
16,17	Mag_X1	Stores the x-axis magnetometer reading
18,19	Mag_Y1	Stores the y-axis magnetometer reading
20,21	Mag_Z1	Stores the z-axis magnetometer reading

The AHRS calibration routine is expecting all these values to be floats (or scaled integers, i.e. the resolution is higher than pure integer values), except for the magnetometer readings, where it is expecting an INT32.

Reserved BIT Use

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

Figure 47. Reserved BIT Use

Table 43: Reserved for TRDI Format

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

Checksum Data Format

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

Figure 48. Checksum Data Format

Table 44: Checksum Data Format

Binary Byte	Field	Description
1,2	Checksum Data	This field contains a modulo 65536 checksum. The ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum.

PD27 ASCII Output Data Format

The Proteus sends this data format only when the CV1 command is sent through a 2-letter command. PD27 outputs ensemble data as formatted text. A new-line character terminates each line. Two new-line characters terminate an ensemble. Both the water column and bottom tracking velocity data are referenced to the Proteus (not removing speed over ground).

PD27 data is only for serial output. If you select CV1, the Proteus will output human readable PD27 ASCII data out the serial port and record single ping PD0 data format to the internal memory card.

Line # 1 System Timing, Attitude and Setup

$RDSA,PD27,SN,ENS#,YYMMDD,HHmmss.hh,PP.PP,RR.RR,HHH.HH,SD.PP,SD.RR,SD.HH,TT.TT,SS,DD.D,CCCC.C,1STB, WS,WP,WN, BM,BP,EX,BBB,XX

where:

$RDSA,PD27	PD27 identifier
SN	System serial #
ENS#	Ensemble number (NOTE: 1 ensemble/second 2,592,000 ens/month hence 7 sig digits)
YYMMDD	Year, month, day
HHmmss.hh	hour, minute, second and hundredths of seconds
PP.PP	Average Pitch in degrees
RR.RR	Average Roll in degrees
HHH.HH	Average Heading in degrees
SD.PP,SD.RR,SD.HH	Standard Deviation of Pitch, Roll and Heading in Degrees.
TT.TT	Average Temperature in C
SS	Average Salinity in parts per thousand (ppt)
DD.D	Average Depth of transducer face in meters
CCCC.C	Average Speed of sound in meters per second
1STB	Range to first Cell (cm)
WS	Cell Size (cm)
WP	Number Water Velocity pings per ensemble
WN	Number Water Velocity Cells
BM	Bottom Tracking Mode
BP	Number of bottom tracking pings/ensemble
EX	Coordinate frame where x varies depending on the coordinate frame that was identified when the system was deployed (EB-Beam, EI-XYZ, ES-Ship, EE-Earth)
BBB	Built-in Test (BIT) result code (not HEX),
XX	Checksum

Example output:

```
$RDSA,PD27,778899,3,250212,132153.00,0.02,-0.05,5.11,0.00,0.00,0.00,23.4,35,0.0,1530.0,197,100,1,5,8,1,EE,493*45
_
```

Line # 2 Bottom-Track, Velocity Data

$RDBX, SN,ENS#,BSPEED,BDIR,BE,BN,BU,BERR,BR1,BR2,BR3,BR4,BA1,BA2,BA3,BA4,BC1,BC2,BC3,BC4,S,*XX

where:

$RDBX	Identifier
SN	Serial #
ENS#	Ensemble number
BSPEED	Bottom Tracking Derived speed mm/s
BDIR	Bottom Tracking Derived direction in tenths of degrees (ADCP movement towards)
BE	Bottom Tracking Derived East (u-axis) velocity data in mm/s (+ = ADCP movement to east)
BN	Bottom Tracking Derived North (v-axis) velocity data in mm/s (+ = ADCP movement to north)
BU	Bottom Tracking Derived Upward (w-axis) velocity data in mm/s (+ = ADCP movement to surface)
BERR	Error velocity in mm/sec
BR1-4	Bottom range in cm for Beams 1-4
BA1-4	Amplitude (Strength of bottom return) for beams 1-4 (Counts)
BC1-4	Bottom correlation for beams 1-4 (Counts)
S	Status of velocity data (G = good, B = bad)
XX	Checksum

Example output:

```
$RDBX,778899,3,-32768,0,-32768,-32768,-32768,-32768,783,384,757,855,1,1,1,1,33,19,46,31,B*BC
```

Line # 3 Current Profile with Echo and Correlation Data - to Number Bins+3

$RDWX,SN,ENS#,BN,WSPEED,WDIR,WE,WN,WU,WERR,WA1,WA2,WA3,WA4,WC1,WC2,WC3,WC4,S,*XX

where:

$RDWX	Identifier
SN	Serial #
ENS#	Ensemble number
BN	Bin Number
WSPEED	Water speed (mm/s)
WDIR	Water direction in tenths of degrees (Current Flowing towards)
WE	East (u-axis) velocity data in mm/s (+ = Current flowing to east)
WN	North (v-axis) velocity data in mm/s (+ = Current to north)
WU	Upward (w-axis) velocity data in mm/s (+ = Current “up”)
WERR	Error velocity in mm/sec
WA1-4	Water profile amplitude for beams 1-4 (Counts)
WC1-4	Water profile correlation for beams 1-4 (Counts)
S	Status of velocity data (G = good, B = bad)
XX	Checksum

Example output for 5 bins (in the air with all screening off):

```
$RDWX,778899,5,1,2196,23728,-1848,-1187,343,-2529,49,47,47,48,30,29,34,7,G*E6
$RDWX,778899,5,2,1732,16761,372,-1692,-97,2801,49,47,47,48,30,29,34,7,G*4B
$RDWX,778899,5,3,1788,30429,-1477,1007,-821,-836,49,47,47,48,30,29,34,7,G*AF
$RDWX,778899,5,4,810,33995,-278,761,177,1632,49,47,47,48,30,29,34,7,G*F5
$RDWX,778899,5,5,3475,22736,-2556,-2354,-175,-78,49,47,47,48,30,29,34,7,G*B0
```

Appendix A

NOTICE OF COMPLIANCE

This chapter covers:

- 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 will 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 45.

CE

This product complies with the following European Community Directives:

- Electromagnetic Compatibility Directive 2014/30/EU and EN61326-1-2013
- Low Voltage Electrical Equipment Directive 2014/35/EU
- Restriction on Hazardous Substances (RoHS) Directive 2011/65/EU

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 Marine USA	**Teledyne Marine 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

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 45. 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)
换能器装配件 Transducer Assy.	X	O	O	O	O	O
接收机电路板 Receiver PCB	O	O	O	O	O	O
声纳波束形成电路板 Beamformer PCB	O	O	O	O	O	O
罗盘装配件 Compass Assy. *	O	O	O	O	O	O
底座装配件 End-Cap Assy.	X	O	O	O	O	O
机架装配件 Chassis Assy.	X	O	O	O	O	O
功率装配件 Power Assy.	X	O	O	O	O	O
换能器接口电路板 Transducer Intfc PCB	O	O	O	O	O	O
数据输入输出电路板 Data I/O Intfc PCB	O	O	O	O	O	O
外接电缆 External Cables	X	O	O	O	O	O
水下专用电缆 Underwater Cable	X	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.