PINNACLE 45

45 kHz

PHASED ARRAY ACOUSTIC DOPPLER CURRENT PROFILER

OPERATION MANUAL

TELEDYNE MARINE
Everywhereyoulook™

P/N 95B-6142-00 (June 2025)

https://www.teledynemarine.com

U.S. Patent No. 11,333,757

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Revision History

June 2025

- Added the connector mounting block cap O-Ring to Replacing the DR Endcap O-rings.

April 2025

- Added Using Acoustic Windows to Chapter 2.

November 2024

- Corrected Power specification on page 140 to 24 to 50VDC, was 25 to 50VDC.

October 2024

- Added leak sensor locations to page 5.
- Added replacing the O-Rings on a DR system.

September 2024

- Added Firmware and Feature updates to maintenance chapter.

February 2024

- Updated Returning Systems to the TRDI Factory, page 133 Brokerage address.
- Corrected page 63 from 30-degree beam angle to 20-degrees.

October 2023

- Updated the OL command output example.

July 2023

- Updated website address.

June 2023

- Added Velocity resolution specification.
- Added P/N to Figure 13.

March 2023

- Changed the bend radius for the pinnacle cable from 292.1 mm (11.5 in.) to 190.5 mm (7.5 inches), page 32.

January 2023

- Updated EAR statement to EAR99.
- Removed printed deployment guides – now download only.

June 2022

- Added U.S. Patent No. 11,333,757 to cover and TOC
- Updated dry-side connector part number, page 32.
- Added CE certification to Appendix B
- Modified Beam Clearance Figure 17 to include range for mooring bridle
- Added reference to deep-water buoyancy frame conversion kit

April 2022

- Add deck box specifications and outline installation drawing 96B-9148
- Add DR to SC conversion kit P/N PIN45-CONV
- Add SC to DR conversion kit P/N 75BK6127-00

November 2021

- Added section on Setting up a Pinnacle without a Pinnacle Deckbox
- Updated figure 10 and 11 wiring diagrams
- Updated Installing the Dry-Side Connector section

August 2021

- Added link to PD0Decoder
- Updated How to Contact TRDI table

October 2020

- Updated overview and assembly pictures to show new LED location and Impulse connectors
- Updated turnaround maintenance instructions
- Updated spare parts kits
- Added DR to SC and SC to DR conversion instructions
- Updated cable wiring diagrams
- Removed Glenair cables
- Updated outline installation drawing

October 2019

- Preliminary Release

Conventions Used in this Manual

Thank you for purchasing a Teledyne RD Instruments (TRDI) Pinnacle 45 kHz Phased Array Acoustic Doppler Current Profiler (ADCP). This Operation Manual is designed to help Pinnacle users to get familiar with the system. Conventions used in the Pinnacle Operation Manual have been established to help learn how to use the system quickly and easily.

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 (*Pinnacle Utilities*) and file names (*Test.txt*).

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

```
Pinnacle
Teledyne RD Instruments (c) 2019
All rights reserved.
Version: 71.0
Not Pinging
>
```

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

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 Pinnacle).

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

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

This paragraph tells the reader to use lifting aids and proper lifting techniques when moving the system.

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.

The technologies used in the Pinnacle 45 are currently under patent protection (U.S. Patent No. 11,333,757). TRDI will aggressively utilize its full rights under patent law to protect its interest in these technologies.

Chapter 1

OVERVIEW

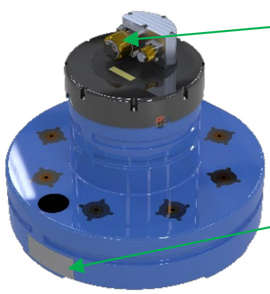
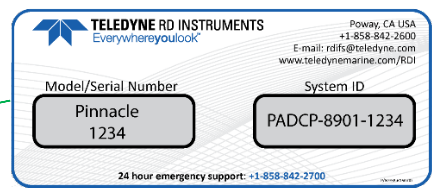
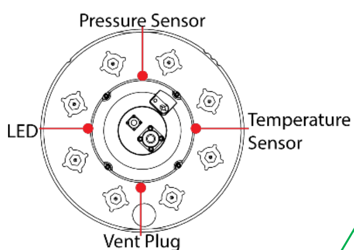
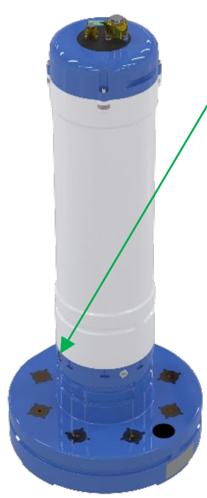
This chapter covers:

- System Overview
- Health and Environment Monitoring Features
- Computer Considerations
- Power Overview
- Setting up the Pinnacle System
- Ethernet Communications

System Overview

The Pinnacle system consists of a 45 kHz phased array transducer ADCP, cables, battery pack, flash memory card, and software. Both battery capacity and memory can be increased with upgrades for longer deployments. Use the *Pinnacle Utilities* software to confirm you have enough memory and battery capacity for your deployment. The ADCP can also be used for direct-reading current profile operation. They only require the addition of a Windows® compatible computer to configure the ADCP and to replay collected data. See the Outline Installation Drawings for dimensions and weights.

When unpacking, use care to prevent physical damage to the transducer face and connectors. The urethane face covers the transducer ceramics and provides a robust, flexible waterproof seal. Avoid setting the transducer on bumpy surfaces that may leave an indentation in the urethane or damage the urethane face.

Picture	Description
	The Power/COMs cable connects the ADCP to the computer and external power supply. When a cable is not connected, use a dummy plug to protect the connector. The product ID label shows the system serial number and System ID. 
	Vent plug is used during production to check for leaks. The Thermistor measures the water temperature. The pressure sensor measures water pressure (depth). LED status light for self-contained operations provide user feedback. Indications of deployed and ready, deployed and set for later start, error (failed BIT)
	The standard Pinnacle housing allows deployment depths to 2000 meters. Use lifting aids and proper lifting techniques when moving. Approximate weight in air:  Direct Read 105 ±2 LBS [47.6 ±.9 KG] 2X Battery Self-Contained 145 ±2 LBS [65.8 ±.9 KG] 4X Battery Self-Contained 195 ±2 LBS [88.5 ±.9 KG] The DR system includes two handles in the accessories kit. Attach the handles to the included eyebolts for lifting the system. The eyebolts can be equally spaced around the transducer. The SC systems should be lifted using a hoist and the included eyebolts. The Pinnacle electronics and transducer ceramics are mounted to the transducer head. The lines embossed on the edge of the transducer indicate beams 1 and 3. The Pinnacle electronics includes the Catalyst interface for Ethernet/serial, data storage, Doppler control and post-processing. The Self-Contained ADCP includes a longer housing to hold up to four alkaline or Lithium battery packs. TRDI specifies each alkaline battery pack to have 450 Watt-hours and each Lithium battery pack to have 1350 Watt-hours of usable energy at 0°C. Self-Contained Pinnacle ADCPs include a **removable recorder** (SD memory card) inside the battery case and is intended to be removed by the user for direct download onto a computer. Both the Self-Contained and Direct Reading Pinnacle systems include a **fixed recorder** (SD memory card) which is installed inside the electronics housing.

Direct Reading System

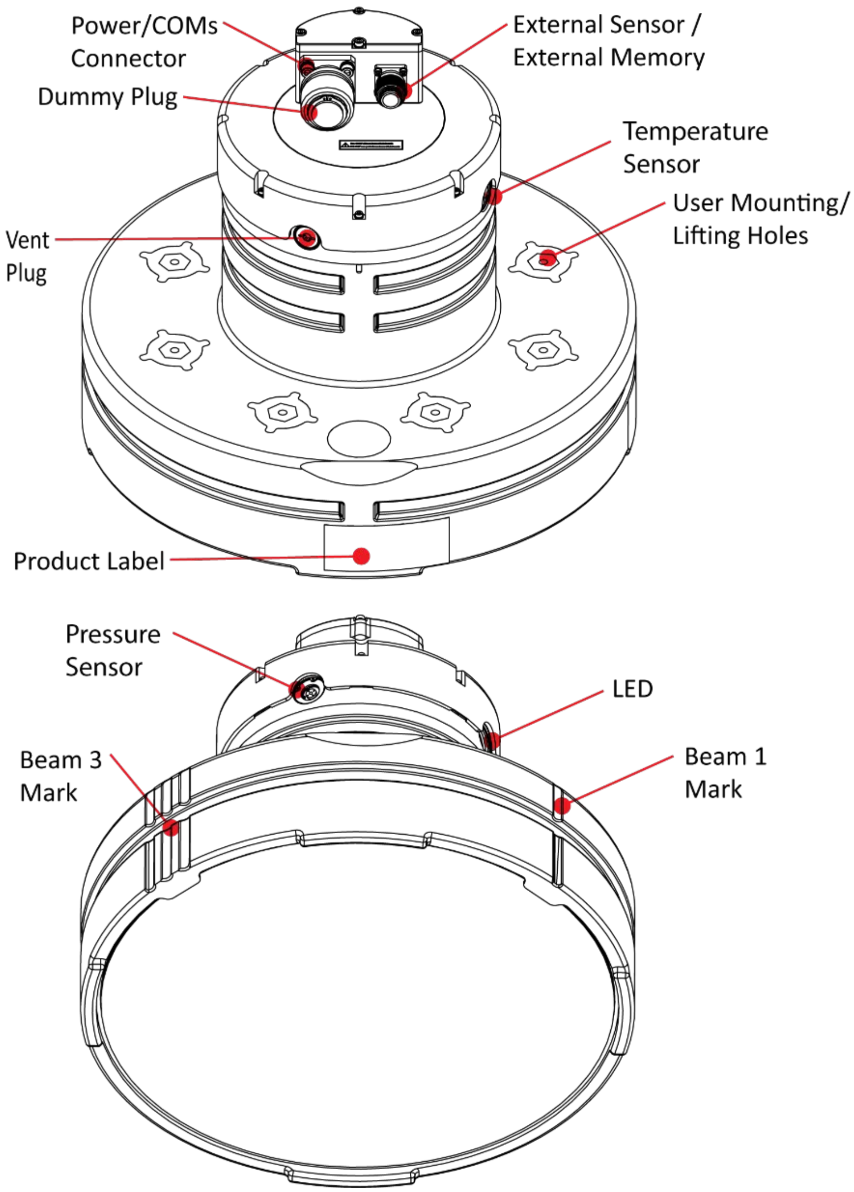


Figure 1. Direct-Reading System Overview

Lubricate the connector by placing a light amount of silicone lubricant on the female cable connector mating surfaces (rubber portion only). Silicone lubricant is included in the Spare Parts kit. **Regular lubrication is required**.

Never lift the transducer assembly by the housing or end-cap. The housing is not meant to support the weight of the transducer.

Use the handles (included in the Spare Parts kit) when moving/lifting the transducer. The handles can be readily moved around the transducer as needed.

Self-Contained System

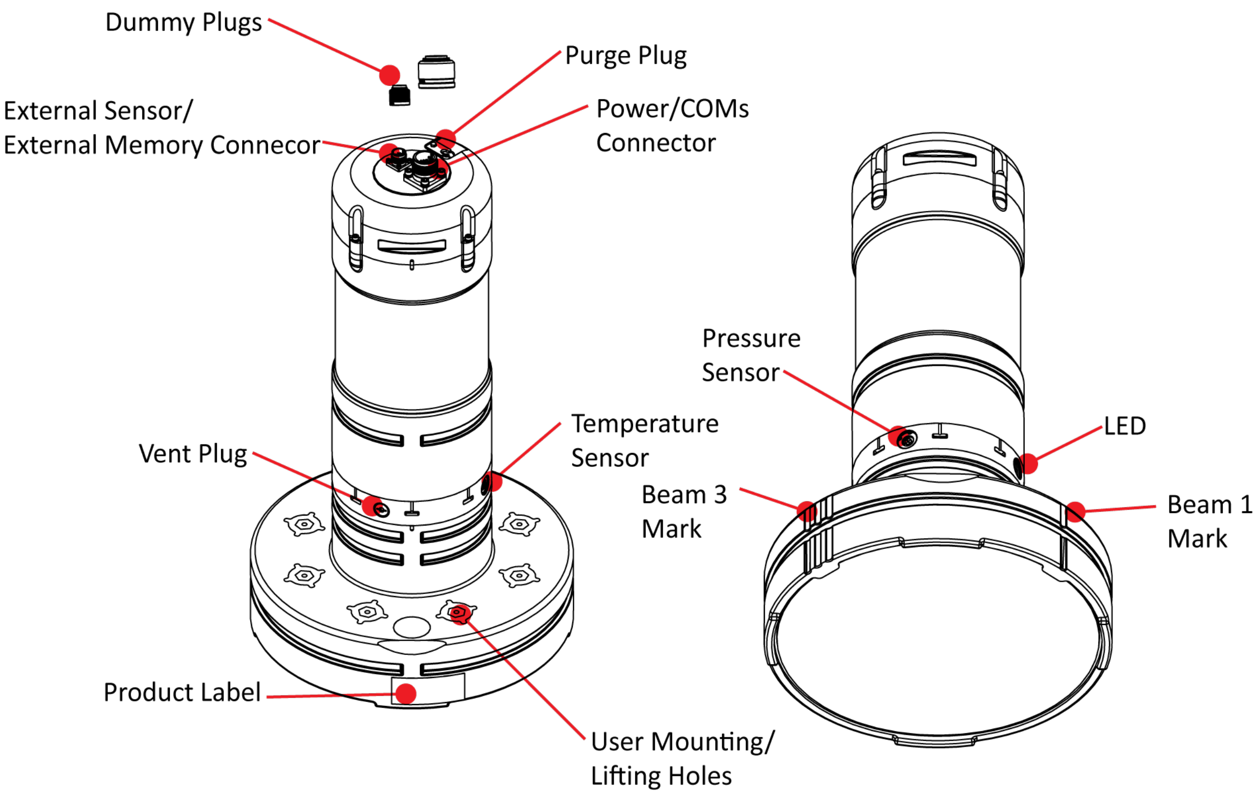


Figure 2. Self-Contained System Overview

⚠	Lubricate the connector by placing a light amount of silicone lubricant on the female cable connector mating surfaces (rubber portion only). Silicone lubricant is included in the Spare Parts kit. **Regular lubrication is required**.

⚠	Never lift the transducer assembly by the housing or end-cap. The housing is not meant to support the weight of the transducer. Use Eyebolts and plastic washers with the Pinnacle that attach to the transducer user mounting holes. These bolts should be the only thing used for lifting the transducer. The eyebolts can be readily moved around the transducer as needed.

Health and Environment Monitoring (HEM)

Health and Environment Monitoring (HEM) Sensors monitor the health of the Pinnacle system.

- **Depth-Enabled Pinging** – This feature helps to ensure that the Pinnacle product only pings when submerged. The C1 command sets the minimum pressure value that must be met before the Pinnacle system will start pinging. The user can adjust the level of sufficient immersion or disable the feature.
- **Leak Detection** – The Pinnacle detects water leaking into the system and reports this detected leakage in the PD0 output data structure. The Pinnacle also supports the PC4 and PC5 user interactive test for reporting the status of the leak sensors. There are two leak sensors; Leak Sensor A is mounted near the connector and Leak Sensor B is mounted at the transducer end of the housing.
- **Transducer Monitor** – The Pinnacle monitors the transmit voltage and current when the transmit pulse is 16 meters or greater. This information provides insight, in near real-time, to the status of the transducer and alerts the user should problems arise. This data is relayed back to the user in the PD0 output data structure.
- **Operating Time** – The Pinnacle system records the total time of operation in minutes where "operation" is defined as the time that the system ping loop is active (CS command has been sent). The record of the total awake time has a maximum value of 33,554,432 minutes, which corresponds to over 500,000 hours of operation. The value of the counter can be read as part of the PS5 command. Although the time is stored in minutes, the operating time is reported in hours with one decimal place.
- **Maximum Pressure** – The Pinnacle system monitors the pressure during operation and records the maximum pressure seen during the lifetime of the instrument. This maximum pressure is stored in non-volatile memory. The PS5 output will read N/A if no pressure was measured/recorded. Use the PS5 command to read the maximum pressure seen.
- **Pressure Cycles** – The Pinnacle system records the number of pressure cycles (dives, casts, etc.) to which a unit is exposed during operation. The number of pressure cycles seen by the system is collected while the unit is operational. A pressure cycle is defined as "pressure is greater than 40% of maximum, followed by a pressure that is less than 20% of maximum". The pressure cycle counter has a maximum value of 16,384. Use the PS5 command to read the number of pressure cycles.
- **Over Pressure** – The Pinnacle system monitors its pressure during operation and records the number of events beyond the system's maximum rated pressure value. The system pressure rating is defined as the maximum pressure rating of the installed pressure sensor. The system maintains a flag in non-volatile memory to indicate whenever the pressure exceeds 100% of the maximum rated value, this flag is set to a '1' value, and whenever pressure is less than 80% of the maximum rated value, this flag is cleared to a '0' and the over pressure cycle counter is incremented. Use the PS5 command to read the number of over pressure events seen.

If an Over Pressure event occurs or the Maximum Pressure seen has exceeded the Pinnacle's pressure sensor depth rating, TRDI advises returning the unit back to us for inspection before re-deploying.

Example PS5 output:

```
PS5
Operating time: 4327.5 hours
Maximum pressure seen: 652.378 dBar
Over-pressure events: 1
Pressure cycles: 25
```

Setting up the Pinnacle System

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

Computer and Software Considerations

The Pinnacle system includes the utility program *Pinnacle Utilities* to help set up, use, test, and deploy the Pinnacle. Use this program to "talk" to the Pinnacle and to create command files. *Pinnacle Utilities* is included on the Marine Measurements CD. For detailed information on how to use *Pinnacle Utilities*, see the help file and the Pinnacle deployment guides.

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

- Windows 10®, Windows 8®, Windows 7® Desktop, Laptop, or Netbook computer
- Screen resolution above 1024x768
- 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.

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

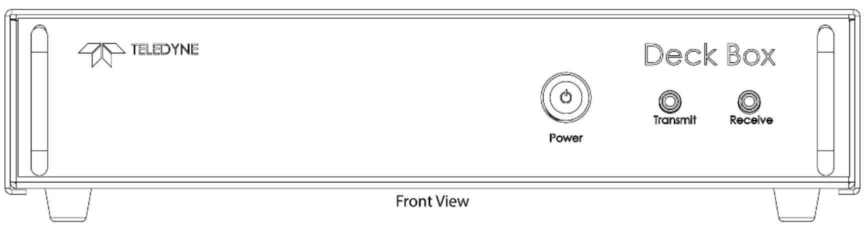
Power Overview

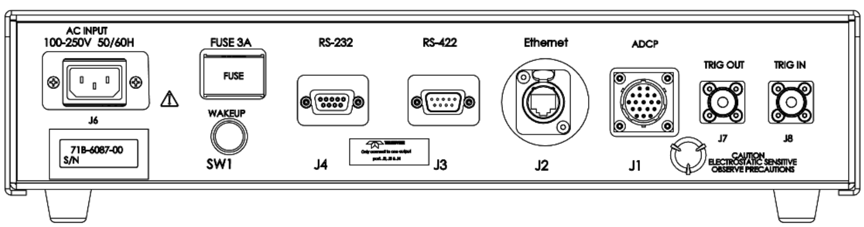
The Direct Read Pinnacle uses 24 to 50 VDC, 150 W (275 W of peak power worst case with 50 VDC input and a short underwater cable). However, the power inrush is much higher. Teledyne RD Instruments recommends using an uninterruptible power supply (UPS) system with a rated output power of at least 275 W.

> Wait approximately 30-seconds between back to back power cycles. This will ensure the electronics residual charges have been dissipated and for the Wake Logic to properly detect the next Cold Start.

Deck Box

The optional Deck Box converts AC power input into 36 VDC for the Pinnacle ADCP input power. It can convert the computer's serial interface from RS-232 to RS-422.





Power Switch – The power switch is a combination switch/circuit breaker. The LED lights when power is applied to the deck box.

LEDs

- Transmit indicates the transducer is transmitting.
- Receive indicates data transmission from the Pinnacle to the computer.

ADCP (J1) Connector – Data/Power/COM cable connects the Pinnacle transducer to the deck box.

Communications (J2, J3, and J4) Connectors – Allows deck box-to-ADCP communications in either Ethernet (J2), RS-232 on the J4 connector (< 15-meter length I/O cable), or RS-422 on the J3 connector (> 15-meter length I/O cable).

Trigger Input/Output Connectors – The Trigger Input (J8) allows the Pinnacle to be pinged by an external standard RS422 level signal. The Trigger Output (J7) is a RS422 level signal as well. See Using the Trigger In/Out for details.

Wakeup Switch – Sends a Wakeup signal to the Pinnacle ADCP for Ethernet mode.

Power In – The electronics chassis automatically scales the input voltage to the proper level. No special jumpers or switch settings are required to select the input voltage. The electronics chassis accepts input voltages of 100 to 250 VAC, 50 to 60 Hz. This input voltage is converted to 36 VDC by the chassis power supply. This is the voltage supplied to the Pinnacle ADCP.

Fuse – The deck box uses a 3A 250 VAC (slow-blow) fuse. The pull-out fuse housing holds a spare fuse and the fuse in use.

Battery Power

The Self-Contained Pinnacle ADCP includes a longer housing to hold up to four battery packs.

- Each alkaline battery pack has 450 watt-hours (Wh) of usable energy at 0 C. When fresh, the voltage is +42 VDC. When depleted, the voltage drops to 30 VDC or less.
- The optional Lithium Battery Packs can be used interchangeably in Pinnacle systems. This battery pack is assembled using lithium battery cells that provide 34 VDC with a capacity of approximately 1350 Wh of usable energy at 0°C. The battery includes a safety circuit that protects the battery and users against short circuits and provides users the ability to test the pack. The circuit also turns the battery off at its end of life, before the battery fully discharges. This happens when about 97% of the battery's capacity is depleted.

Keep in mind the following about Pinnacle battery packs:

- TRDI specifies each alkaline battery pack to have 450 Watt-hours and each Lithium battery pack to have 1350 Watt-hours of usable energy at 0°C.

  Four Alkaline Battery Packs = 1800 Watt-hours

  Four Lithium Battery Packs = 5400 Watt-hours

Before using the optional Lithium battery pack, always run the battery self-test. See Testing the Lithium Battery Pack for instructions.

Instruments with high inrush currents occasionally trigger the optional Lithium battery pack short circuit detection, which turns the battery off. If this happens, do the following:

- Connect an AC adapter or the deck box and wait for a minute and then connect the battery pack. Once the ADCP is connected, unplug the AC adapter/deck box. The ADCP will work normally after that.

- A Standard ADCP battery packs hold 28 'D-cell' alkaline batteries with a voltage, when new, of approximately 42 VDC.
- When the capacity of a battery pack is 50% used, the voltage (measured across the battery connector) falls to approximately 32 to 35 volts. However, keep in mind that this voltage is not an accurate predictor of remaining capacity.
- Transmitted power increases or decreases depending on the input voltage (within the voltage range of 20 to 50 VDC). A fresh battery provides +42 VDC. Batteries spend most of their life at a nominal voltage of +33 VDC.
- Alkaline batteries should be replaced when the voltage falls below 30 VDC (measured across the battery connector). Lithium batteries should be replaced when they fail the self-check.
- Battery packs differ from one to another.
- 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*).

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 warrant 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 Pinnacle 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 will 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.

Battery replacement induces both single and double cycle compass errors. The compass should be calibrated after replacing the battery pack.

These compass effects can be avoided by using an optional external battery pack. The optional external battery housing holds up to four batteries and can easily be replaced on-site. If the optional external battery is placed a minimum of 1 meter away from the ADCP, no compass calibration will be required.

Lithium battery packs are longer then 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 Self-Contained Pinnacle 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 module. Carefully pull it free.
3. Connect the battery pack power cable to the PWR connector (see Battery Replacement).
4. Install the end-cap (End-Cap Replacement).

Setting up the Pinnacle System

The Pinnacle system can be connected to in several ways:

- Using a Deck-Box with Serial cable
- Using a Deck-Box with Ethernet cable
- The underwater cable is sent as a pigtail and wired to the vessel (see Cabling Considerations)

Connecting the Cable/Dummy Plug

Connecting the Cable / Dummy Plug

1. Lubricate the connector by placing a light amount of silicone lubricant on the female cable connector mating surfaces (rubber portion only). Silicone lubricant is included in the Spare Parts kit. **Regular lubrication is required**.
2. Insert the connector into the receptacle, ensuring the key and pins are properly aligned.
3. Push straight in to fully seat the connector.
4. Thread the coupling ring onto the receptacle to complete the connection.

Disconnecting the Cable / Dummy Plug

Loosen the coupling ring and disconnect the cable/dummy plug with a straight outward motion. Do not twist the connector.

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

The Ethernet and Serial Deck Box underwater cables have identical connectors on both ends. Plugging in the wrong cable will not harm the system but it will result in an inability to establish communication with the Pinnacle. To help avoid this possibility, the Ethernet and Serial cables have different color shrink-wrap to match the correct adapter:

Serial = Red

Ethernet = Blue

Lubricate the connector by placing a light amount of silicone lubricant on the female cable connector mating surfaces (rubber portion only). Silicone lubricant is included in the Spare Parts kit. **Regular lubrication is required.**

Figure 3. Connecting the Data/Power/Comm Underwater Cable

Connecting the Deck Box

The optional Deck Box converts AC power input into 36 VDC for the Pinnacle input power.

To set up the Pinnacle system with a deck box:

1. Connect the underwater cable to the Deck Box and Pinnacle Power/COM connector.
2. Place or leave the dummy plug on the External Sensor/External Memory connector.
3. Attach the Deck Box to the computer's communication port. Choose one based on the underwater cable type (Serial or Ethernet):
4. Connect the Deck Box power cord to 100 to 250 VAC, 50/60 Hz.

Serial Communications

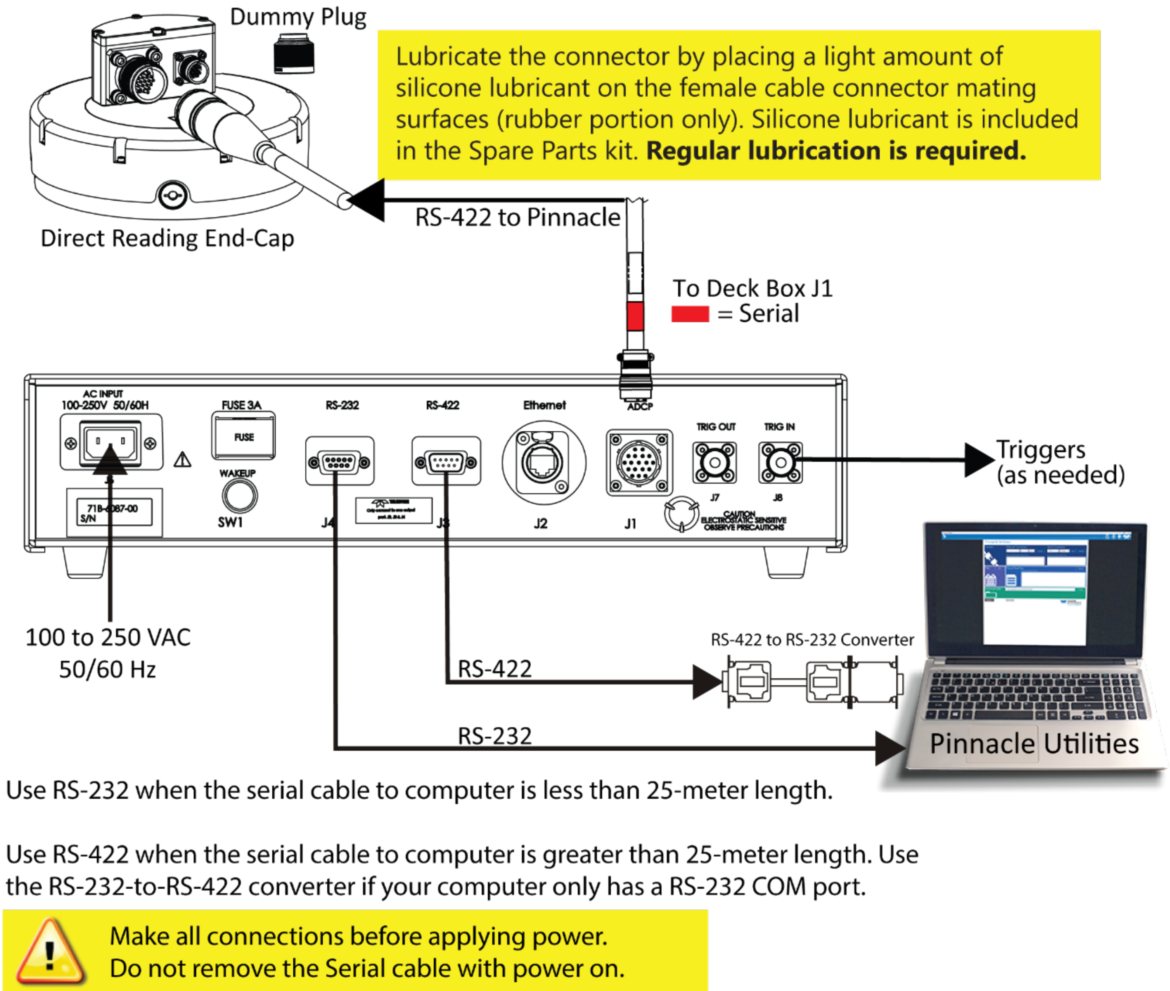


Figure 4. Pinnacle Connections with Deck Box and Serial Cable

Ethernet Communications

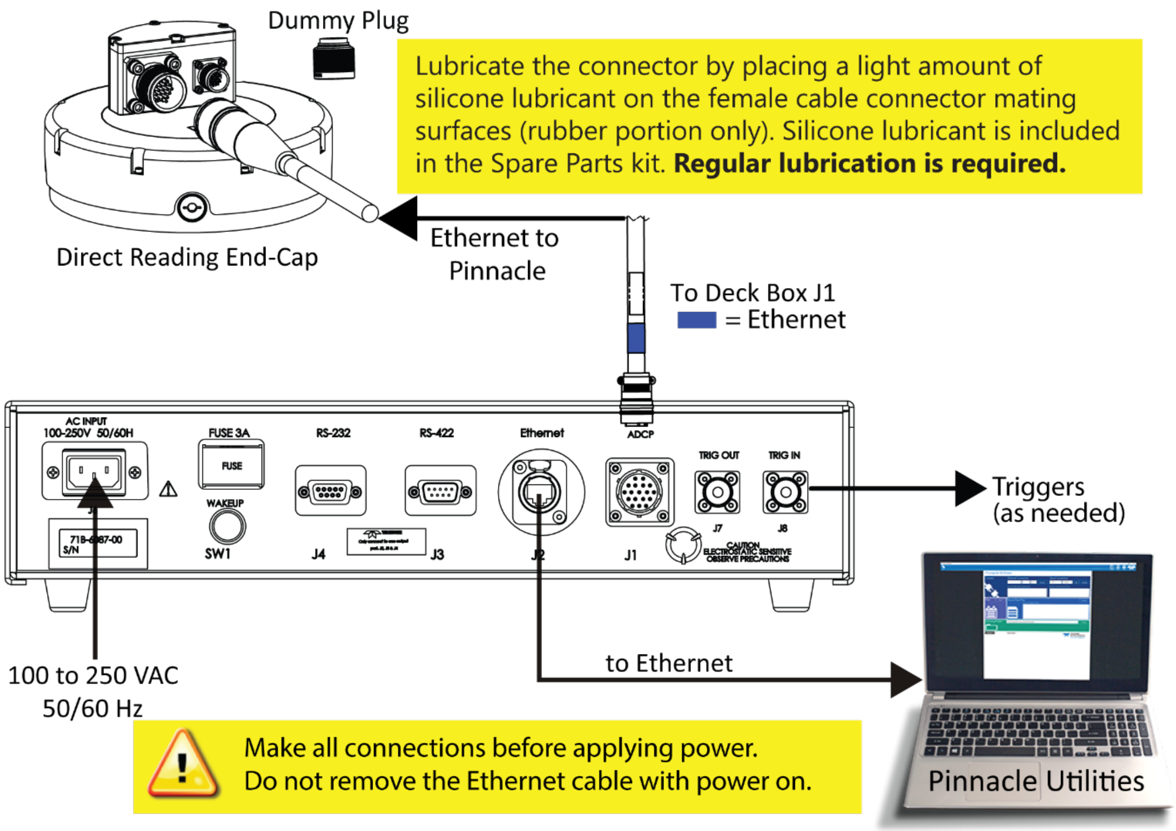


Figure 5. Pinnacle Connections with Deck Box and Ethernet Cable

Setting up a Pinnacle without a Pinnacle Deckbox

To set up the Pinnacle system without a deck box:

1. Use a 48 V Power Supply capable of supporting a continuous current draw of 5 A (or better). The Pinnacle Deckbox uses part number TDK-Lambda GWS250-48.
2. The Pinnacle is susceptible to noise on the power line, so a common mode power line choke is strongly recommended. The Pinnacle Deckbox uses part number Würth Electronik WE-CMBNC. This has been proven to work well in suppressing the ripple on the Deckbox power supply. With a different power supply some experimentation to find an optimal choke may be required.
3. The default communication is either RS422 or Ethernet (depends on cable ordered: 73B-6082 for serial and 73B-6084 for ethernet). For either cable, additional noise suppression is provided by shorting the comms shield (brown wire) connected to pin 3 to ground.
4. Pinnacle serial comms are RS422 by default, so for serial comms (cable 73B-6082, see Figure 10, page 33) then an RS422-232 converter must be supplied. Alternatively, if the cable run is less than 30 meters, then the Pinnacle can be configured to use RS232 comms by shorting the blue wire connected to Pin 11 to ground.
5. For ethernet comms (cable 73B-6084, see Figure 11, page 33) the Pinnacle should be configured to remain powered by shorting the blue wire connected to pin 9 to ground. If an ethernet system does go to sleep, it can be awakened by sending a break (hold line high for 300 msec) on the Trigger In lines (this is a differential signal on the brown wire connected to pin 5 along with the brown/white wire connected to pin 6).

Connecting to the Pinnacle

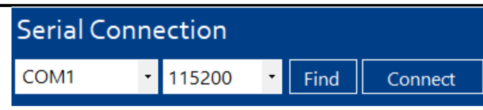
To establish communications with the Pinnacle:

1. Start the *Pinnacle Utilities* software.
2. Connect the Pinnacle deck box and apply power. Wait five seconds.
3. 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).
4. Select **New Serial Connection** or **New Ethernet Connection** depending on the underwater cable type.
5. Enter the ADCP's communication settings.

Serial Communications:

Select the **COM Port** from the drop-down list.

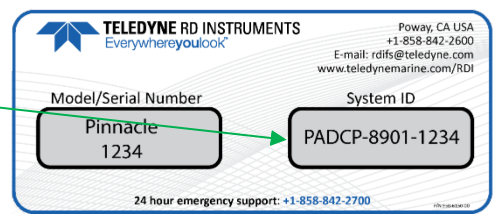
Enter 115200 for the **Baud Rate** from the drop-down list.



Ethernet TCP Communications when the PC is connected to a network:

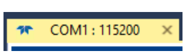
Enter the **System ID** PADCP-xxyy-nnnn as shown on the product label on the Pinnacle ADCP.

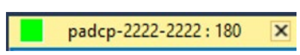
Enter the **Port Number** 180



If the PC is NOT connected to a network, see Direct to Laptop Connection.

6. Click the **Connect** button. Once connected, the main screen opens, and the session tab will show.



(Serial) or


(Ethernet)

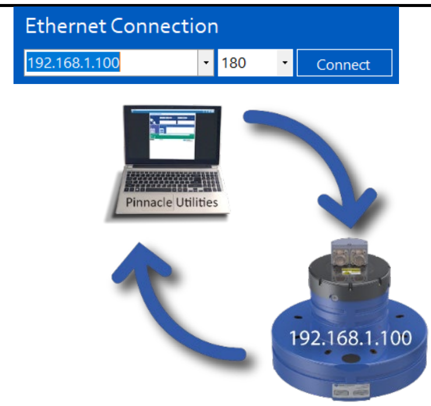
Always close the TRDI software connection to the system by clicking on the X (×) in the session tab and then power down the Pinnacle before disconnecting the Ethernet cable. If the Ethernet link drops while an active connection exists with TRDI Software, then you may need to cycle power to the Pinnacle to reconnect.

If the Pinnacle is NOT deployed it will go to sleep in five minutes if there is no activity. This is true regardless of Direct-Reading, Self-Contained, Serial COM, or Ethernet communications. The only exception is when Ethernet is connected, and a link is detected. In this case the system will NOT go to sleep.

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

Direct to Laptop Connection

Ethernet Peer-to-Peer – Pinnacle direct to laptop



With no access to a Domain Name System (DNS) server, the PC must be set up to use a peer-to-peer network connection.

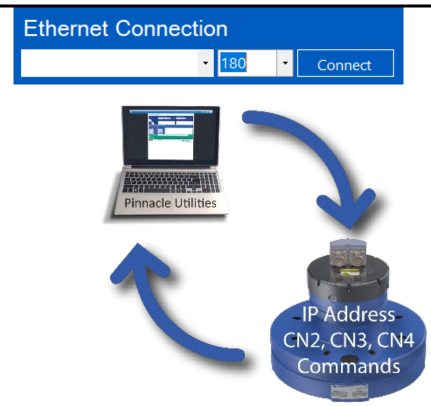
See Configure the PC for a Peer-to-Peer Network Configuration.

Create a Peer-to-Peer Network Configuration

Enter the Static **IP address** 192.168.1.100

Enter the **Port Number** 180

Ethernet Peer-To-Peer when using a subnet specific to the vehicle



First set up communication either via LAN/DHCP or Peer-to-Peer to communicate with the system.

Change the Pinnacle’s static IP address using the CN2, CN3, and CN4 commands as needed. Then connect to the system and do all comms through that channel going forward.

Enter the Static **IP address** xxx.xxx.x.xxx as configured

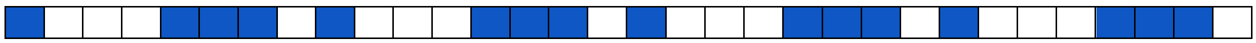
Enter the **Port Number** 180

See Configure the Pinnacle for a Specific Subnet.

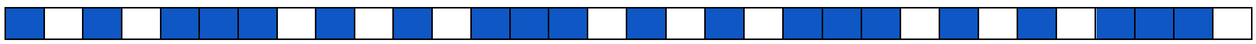
LED Indications

There is one blue LED mounted on the side of the transducer housing. The blink rates indicate the Pinnacle 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.

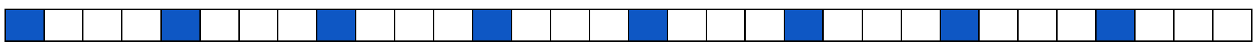
Serial Not Deployed: The Pinnacle is configured to communicate via serial channels. The pattern is 10001110 and repeats as long as the system is active. Visually (8 seconds shown):



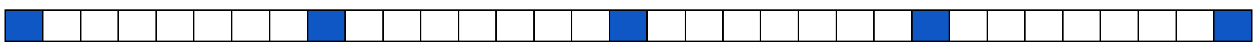
Ethernet Not Deployed: The Pinnacle is configured to communicate via Ethernet channels. The pattern is 10101110 and repeats as long as the system is active. Visually (8 seconds shown):



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

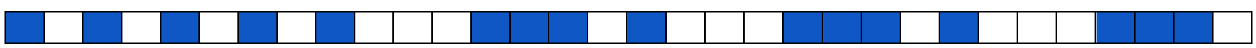


Deployed to ping in the future: The pattern is 1000000 and repeats for fifteen minutes. Visually (8 seconds shown):

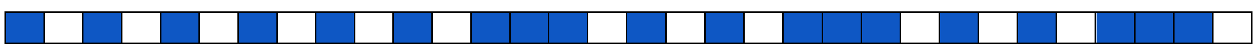


On cold-start power up, the Pinnacle runs a self-test. If the self-test passed, the pattern is 10101010 for two seconds, followed by the "not deployed" state. Visually (8 seconds shown):

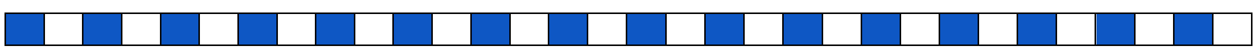
Self-Test Passed Serial:

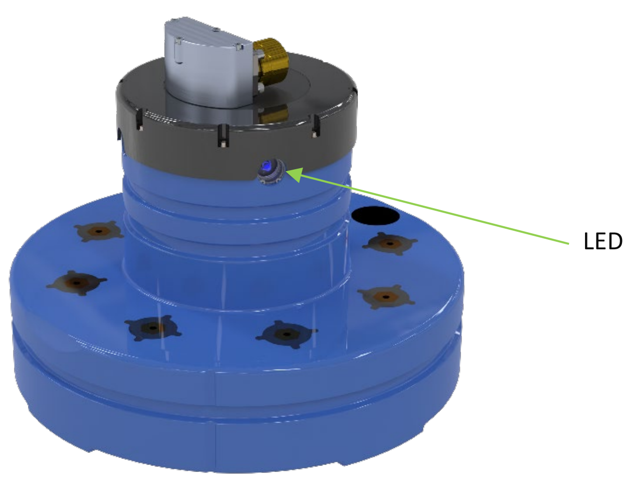


Self-Test Passed Ethernet:



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





Using Ethernet Communications

The Pinnacle includes a NetBIOS server that identifies the system by a name rather than the Static DHCP server **IP address** 192.168.1.100 address. The naming convention uses the unique system ID PADCP-xxyy-nnnn (for example PADCP-8901-1234.

Protocols:

- The Pinnacle ADCP supports a single UDP connection for data broadcast. UDP is a connection-less protocol. Therefore, UDP packets can be lost in an unreliable or highly congested network.
- The Pinnacle ADCP supports TCP for command and control.
- The Pinnacle ADCP supports TCP for data download.

Serial data download is not supported.

Using UDP Protocol

The Pinnacle uses several “scenarios” for how to interpret the IP Address field passed in from the UDP Address command:

- **Scenario 1** – If UDP should be unicast back to the same IP field as the command/control client, set the Interface IP address to all zeros (CN6 000.000.000.000:280).
- **Scenario 2** – If the UDP should be broadcast to whatever the current network subnet is, configure the Interface's IP field to all F’s (CN6 255.255.255.255:280).
- **Scenario 3** – If the UDP should be unicast to a specific IP address (presumably routable), configure the Interface IP field to that address.

Implicit in scenarios 1-3 above is that TRDI specifically disallows attempting to configure trans-subnet broadcasts. This would require visibility into and control over multiple pieces of the network architecture and will likely require a non-standard network configuration.

Scenario 1 will automatically use the IP address as the unicast address when sending data. The CN6 command can be left at its default of 000.000.000.000:280. If a user connects to the Pinnacle for command/control via TCP, then the UDP client can listen to port 280 or listen to the port and the specific Pinnacle IP address (see Figure 6, page 23 for an example). This setup works best in a statically configured network, or one using DHCP where the leases are not likely to turn over on a regular basis.

Scenario 2 is for *broadcast* UDP. When the CN6 command is configured as CN6 255.255.255.255:280, then the Pinnacle will do UDP broadcast to the *subnet*, which is determined by the Subnet (mask CN5 and static IP CN2 commands if set to static IP mode, or determined by the DHCP server in dynamic mode (CN3 command)). This enables multiple clients to all listen to port 280 and get copies of the data. Again, they can listen to just the port, or listen to the port and the specific Pinnacle IP address.

Scenario 3 lets the user explicitly configure a given IP address to send the data (CN6 is configured as *xxx.xxx.xxx.xxx:pppp*, where *xxx* is the IP address and *pppp* is the port). This will work in any IP topology (DHCP, Static, etc.) so long as the specified address is reachable from the Pinnacle subnet (it is either on the same subnet as the Pinnacle or is a routable IP address and a router is present on the network).

Use *Pinnacle Utilities* Plan function and on the toolbar, click **Commands** to view the command file. Add the CN command settings as needed in the **Custom Commands** box.

For more information, see the CN command and Fallback Operation.

Fallback Operation

When the Pinnacle 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 the Pinnacle will "fall back" to use a Static network configuration. This prevents the Pinnacle from being "unreachable" if placed on a network without a DHCP server.

When operating in this mode, the Pinnacle will use the values configured for Static networking via commands CN2, CN4, and CN5.

The CN1 command will indicate when Pinnacle is operating via the fallback configuration:

```
>cn1
Network Configuration:
Hostname:                 PADCP-1234-5678
IPv4 Address:             192.168.1.100 (Static - Fallback)
Subnet Mask:              255.255.255.0
Default Gateway:          192.168.1.1

UDP Data Destination:     0.0.0.0:280
```

To change the Pinnacle networking configuration or resume DHCP operation after it has entered the fallback mode, you must restart the Pinnacle after making and saving (CK command) the configuration changes.

Example output when a DHCP server is found:

```
>cn1
Network Configuration:
Hostname:                 PADCP-1234-5678
IPv4 Address:             10.20.230.32 (DHCP)
Subnet Mask:              255.255.255.0
Default Gateway:          10.25.230.254

UDP Data Destination:     0.0.0.0:280
```

Example output when in static mode:

```
>cn1
Network Configuration:
Hostname:                 PADCP-1234-5678
IPv4 Address:             192.168.1.100 (Static)
Subnet Mask:              255.255.255.0
Default Gateway:          192.168.1.1

UDP Data Destination:     0.0.0.0:280
```

The CN1 command changes from showing the IP address as "(Not Initialized)" when an Ethernet connection is made.

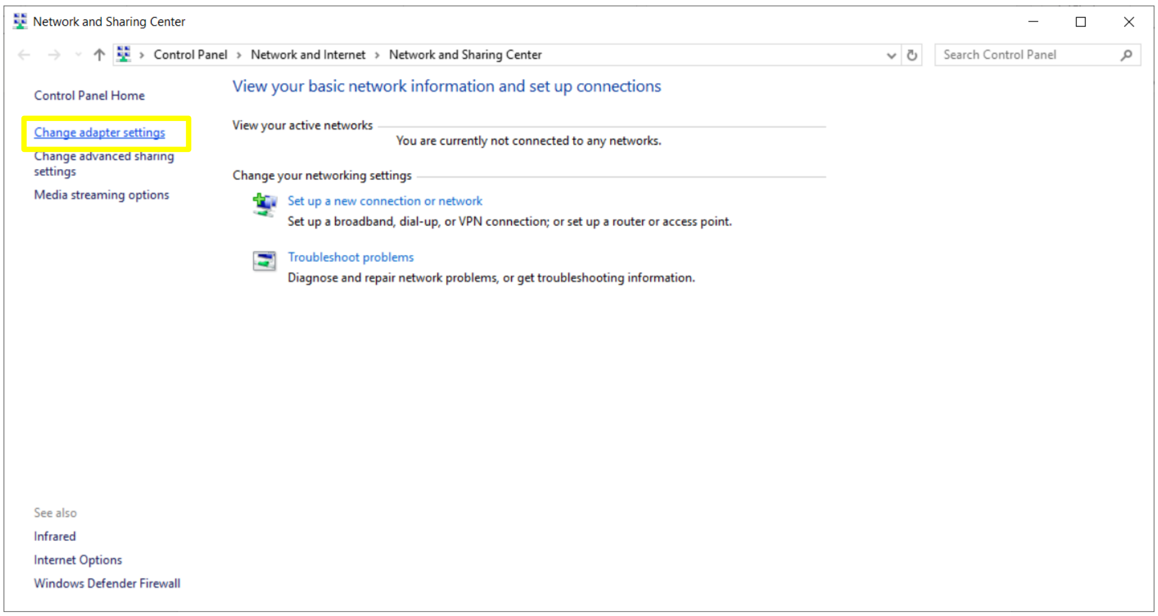
Configure the PC for a Peer-to-Peer Network Configuration

With no access to a Domain Name System (DNS) server, the PC must be set up to use a peer-to-peer network connection.

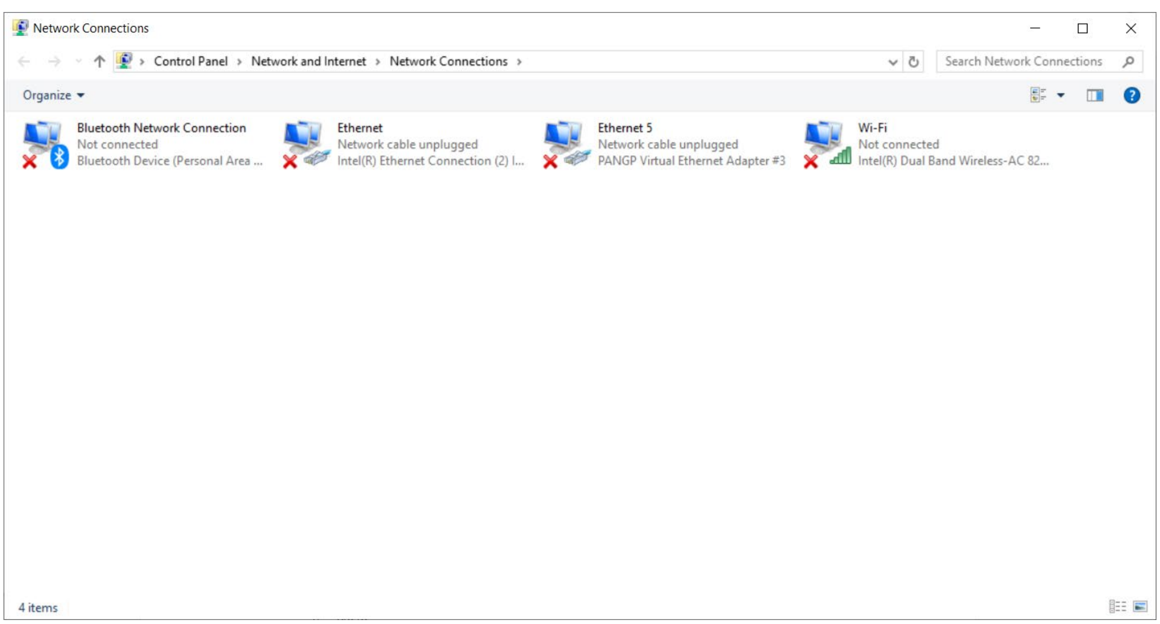
> You must have Administrator privileges on the PC.

To create a Peer-to-Peer Network:

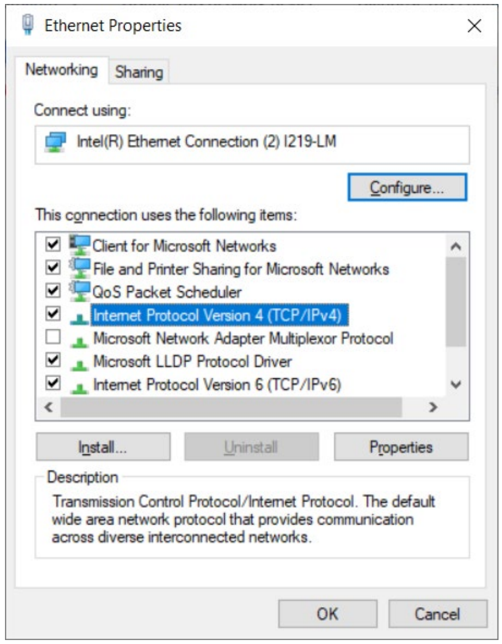
1. Connect the ethernet cable from the Pinnacle directly to the PC input (this assumes that the PC is *not* connected to a LAN).
2. Go to the PC's Control Panel, Network and Sharing Center.



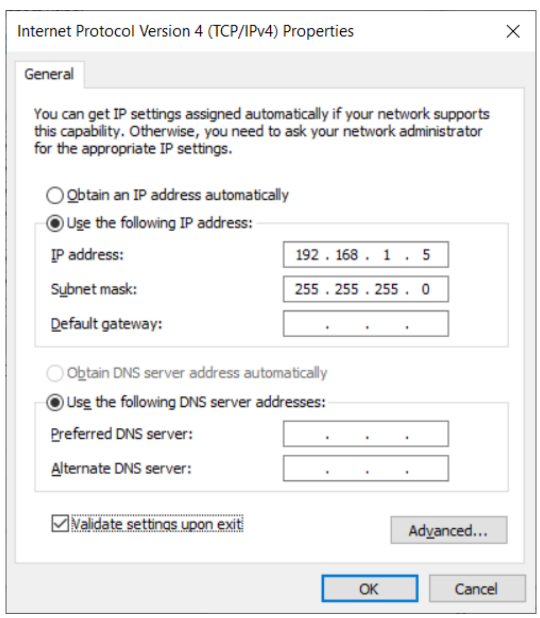
3. Click on **Change adapter settings** in the left-hand column



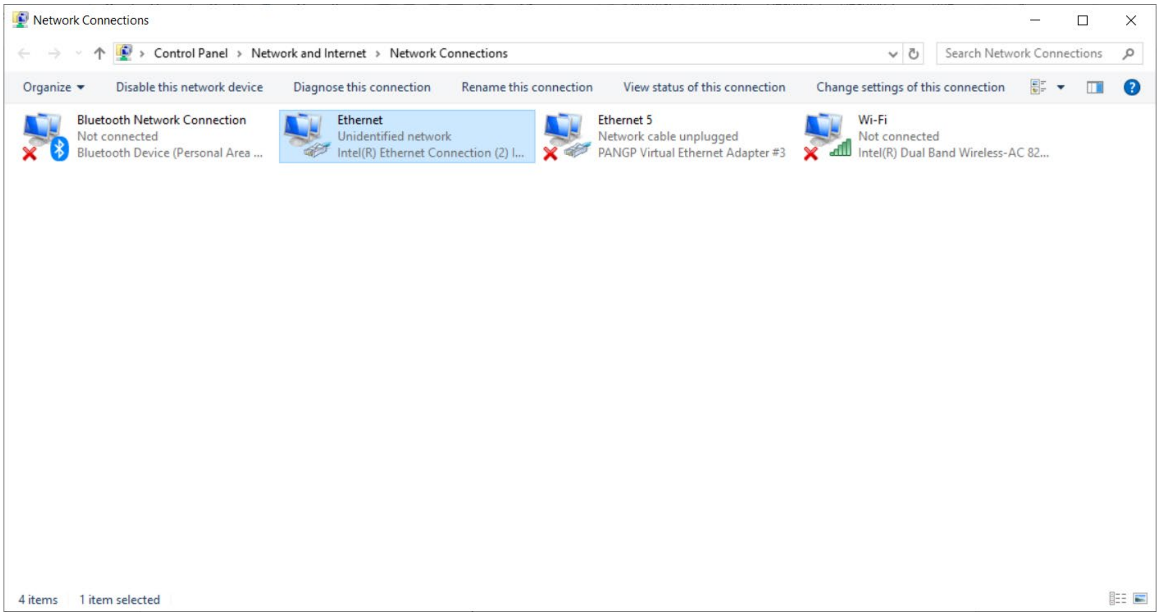
4. Select the correct ethernet port (don't select the Bluetooth or Wi-Fi port, it is a bit of a guessing game between any remaining Ethernet ports).
5. Right-click on this connection and select **Properties**. Enter your admin credentials when prompted.



6. Highlight **Internet Protocol Version 4 (TCP/IPv4)** and select **Properties**.
7. Select **Use the Following IP address** and enter the address and gateway as shown. Note that the last number here (5) 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 Pinnacle ADCP.



8. Click **OK** and then **Close**. After some time, the original screen showing no internet connections will change to show an "Unidentified network". Note that the red X on the second port is gone.



9. The peer-to-peer ethernet connection is complete. Use *Pinnacle Utilities* and connect to the Pinnacle using the ADCP's static IP address 192.168.1.100.

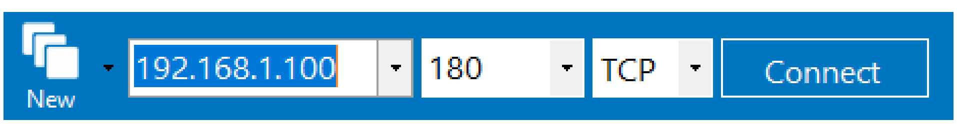
Configure the Pinnacle for a Specific Subnet

Some users will require setting up a subnet specific to their vehicle rather than using 192.168.1.xxx. To communicate with the Pinnacle in this type of system, the Pinnacle needs to be assigned a specific address within the subnet using the CN2 command.

First set up communication either via LAN/DHCP or Peer-to-Peer using the static IP address 192.168.1.100 to communicate with the Pinnacle. Once you are communicating with the system, use *TRDI Toolz* to set the CN commands as needed and save the settings as the user default.

To set a specific subnet:

1. Start *TRDI Toolz* and establish communications with the Pinnacle.



2. Send the CN1 command to see the network settings.

```
>cn1
Network Configuration:
Hostname:                    PADCP-8901-1234
IPv4 Address:                192.168.1.100
Subnet Mask:                 0.0.0.0
Default Gateway:             0.0.0.0

UDP Data Destination:        0.0.0.0:280
>
```

3. Send the CN2 command to change the Pinnacle's static DHCP server IP address. If the vessel's subnet is on 192.168.2, then send the following:

```
>cn2 192.168.2.100
Set IP to 192.168.2.100
>
```

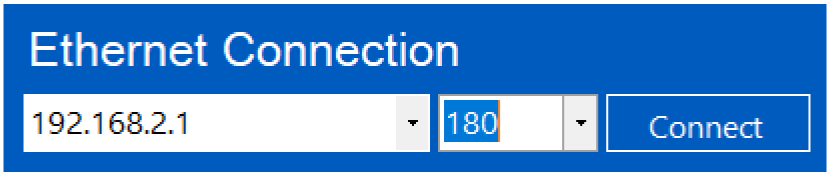
4. Send the CN3 command to change the DHCP Enable to Static.

```
>cn3 0
```

5. Send the CN4 command to set the IP Gateway.

```
>cn4 255.255.255.0
IP Gateway set to: 255.255.255.0
```

6. Send the CK command to save the settings as the user default.
7. Restart the Pinnacle by cycling the power. Wait approximately 30-seconds between back to back power cycles. This will ensure the electronics residual charges have been dissipated and for the Wake Logic to properly detect the next Cold Start.
8. Open *Pinnacle Utilities* and enter the new IP address in the box and click **Connect**. Do all comms using this IP address going forward.



Static IP Address Assignment Tips

When making static IP assignments for local devices on static networks, the address numbers should be chosen from the private IP address ranges defined by the Internet Protocol standard:

- 10.0.0.0 to 10.255.255.255
- 172.16.0.0 to 172.31.255.255
- 192.168.0.0 to 192.168.255.255

To choose and set specific static IP addresses suitable for your network, follow these guidelines.

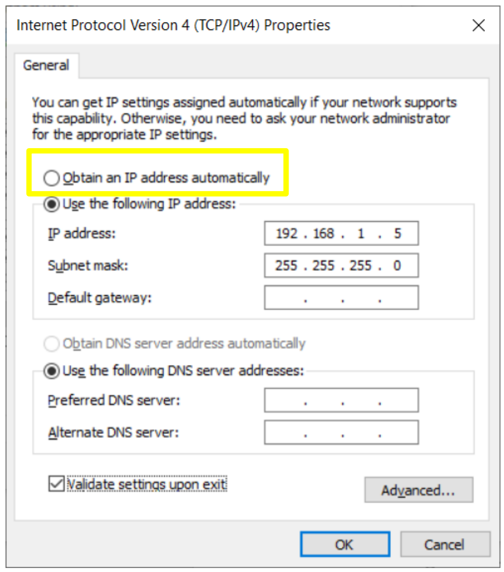
- Do not choose any addresses that end with .0 or .255. These addresses are usually reserved for use by network protocols.
- Do not choose addresses at the beginning of a private range. Addresses like 10.0.0.1, 192.168.0.1, and 192.168.0.100 are commonly used by network routers and other consumer devices.
- Don't choose an IP address that falls outside the range of your local network. For example, to support all addresses in the 10.x.x.x private range, the subnet mask on all devices must be set to 255.0.0.0. If they are not, some static IP addresses in this range do not work.

Returning the PC Back to a LAN Connection

Once the PC is configured for Peer-to-Peer communication, it will not be able to connect back to a LAN automatically. Before reconnecting to a DNS served LAN, you need to undo the Peer-to-Peer connection.

To go back to a LAN connection for the PC:

1. Return to the Network and Sharing center and repeat all the steps from Configure the PC for a Peer-to-Peer Network Configuration (you will again need admin privileges) until you reach this window:



2. This time select **Obtain an IP address automatically**.
3. Click **OK** and **Close**. When you connect the PC to a LAN, it will be rediscovered by the DNS and reconnected.

Ethernet Communications Port Settings

For ethernet systems, Pinnacle uses TCP for the command control on port 180, but data is not viewable on this port. To view data, open a second ethernet port (280) for UDP. Shown below is a screen capture of *TRDI Toolz* configured on the left for TCP command input, and on the right for the UDP data output.

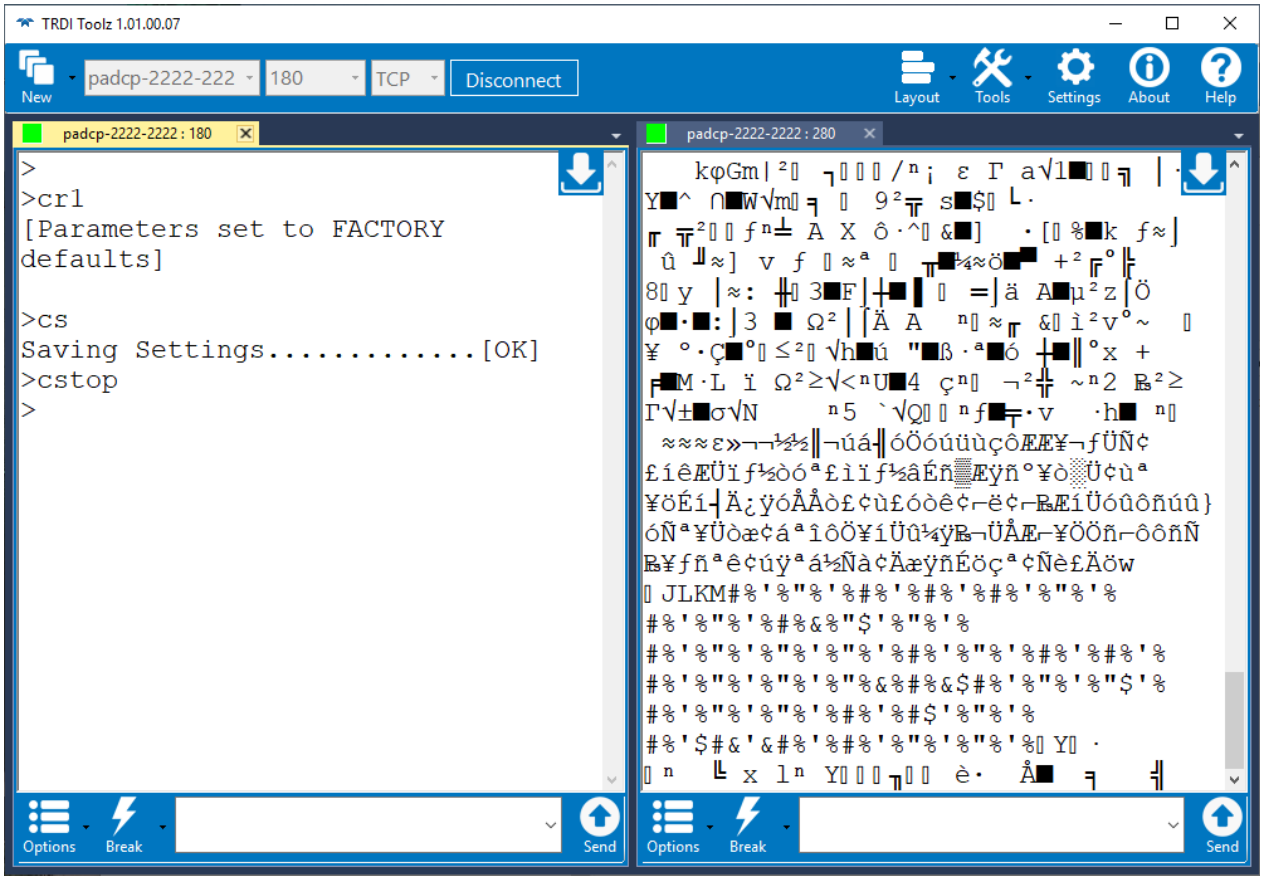


Figure 6. Viewing Raw Data with TRDI Toolz

See the *TRDI Toolz* help file for more information.

NOTES

Chapter 2

INSTALLATION

This chapter covers:

- Testing the Pinnacle System
- Mounting the Deck Box
- Mounting the transducer assemble
- How to connect/disconnect the Data/Power/COMM cable
- Cable wiring diagrams

Bench Testing the Pinnacle System

You should test the Pinnacle ADCP:

- When you first receive the system.
- Before each deployment or every six months.
- When you suspect instrument problems.
- After each deployment.

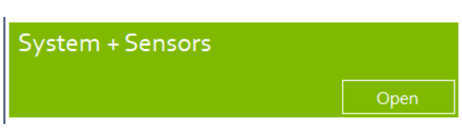
To bench test the Pinnacle:

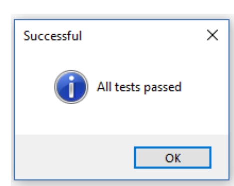
1. Interconnect the system as described in Setting Up the Pinnacle System.
2. Place the Pinnacle system in water. Use wood strips or a hoist to lift the transducer to protect the face.

> The transducer MUST be submerged in water when running the System Test. The test will fail if done in air. Only a failure with the transducer at a minimum in contact with water is a relevant test.
>
> The urethane face covers the transducer ceramics and provides a robust, flexible waterproof seal. Avoid setting the transducer directly on bumpy surfaces that may leave an indentation in the urethane or damage the urethane face. Use wood strips or a hoist to lift the transducer to protect the face (see Figure 7).

Figure 7. Testing the Pinnacle

3. Apply power to the system.
4. Start the *Pinnacle Utilities* program and connect to the Pinnacle ADCP.
5. Click **Open** on the System + Sensors box.
6. Click on the System Tests **Run** button.
7. Click **OK** at the **All tests passed** screen.





If a failure occurs, see Chapter 5 - Troubleshooting and contact TRDI support.

This test may fail if the Pinnacle is exposed to electrical interference such as that from other acoustic devices or SONARs or other electronic devices (i.e. cellphones, radios, computers, TV's, etc.). The test may also fail if the Pinnacle or its cable is exposed or installed near potential sources of EMI's such as high voltage lines like main engine cables, galley equipment, winches, engine room equipment, cranes, high voltage lighting circuit, etc.

Interference from the mentioned sources may contaminate the Pinnacle's data as well.

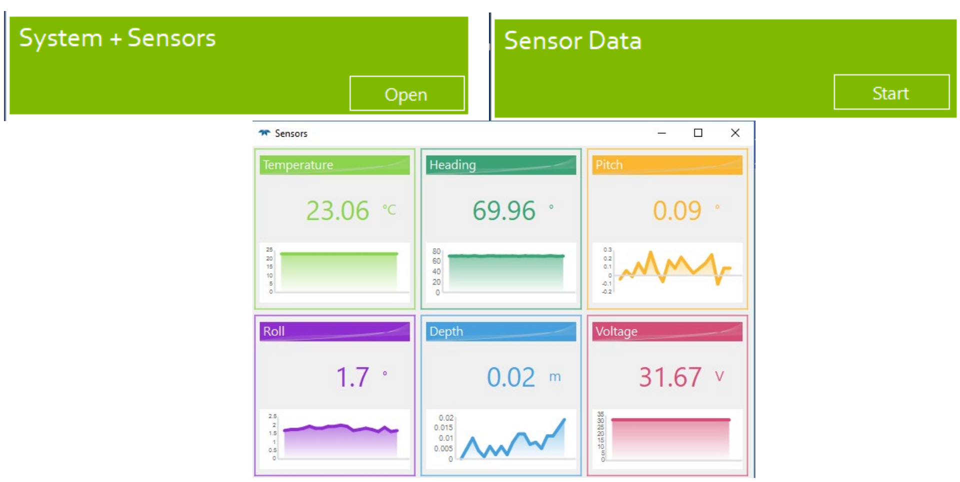
Oftentimes, a noisy (i.e. non-UPS) power supply may cause failures in this test as well.

Testing the Sensors

Verify the sensor data before each deployment.

To view the sensor data:

1. Start *Pinnacle Utilities* and connect to the Pinnacle ADCP.
2. Click **Open** on the System + Sensors box.
3. Click **Start** on the Sensor Data button.
4. To test the sensors, rotate and tilt the system and verify the Pitch and Roll sensor data is reasonable. Rotate the system clockwise and verify the heading increases. Validate the accuracy of beam 3 at 0, 90, and 180 degrees. If the heading is off by more than 2 degrees, calibrate the compass. If the pressure is not zero, use *Pinnacle Utilities* to zero the pressure sensor.
5. Click the **X** on the **Sensors** screen to exit the sensor test.

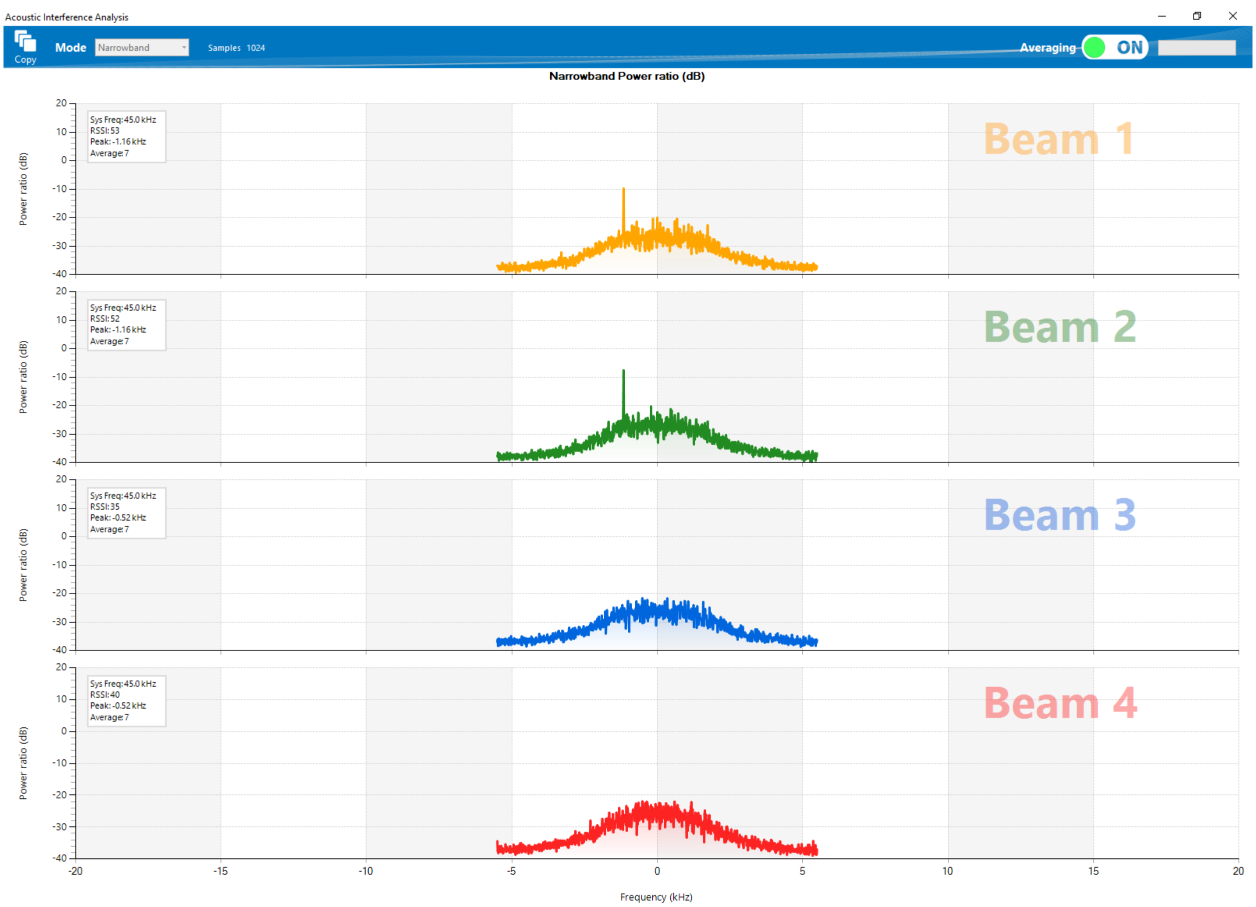


Acoustic Interference Analysis

Observation of the acoustic interference plots will provide information about interference to the Pinnacle ADCP. The *Pinnacle Utilities* software provides the user with a frequency domain plot (~100% bandwidth) of the Pinnacle's four receiver channels during a sampling interval.

To view the Acoustic Interference Analysis data:

1. Start *Pinnacle Utilities* and connect to the Pinnacle ADCP.
2. Click **Open** on the System + Sensors box.
3. Click **Start** on the Sensor Data button.
4. Use the On/Off switch to turn on or off **Averaging**.
5. Move devices that may cause interference closer to the Pinnacle transducer. Observe changes in the plots. Interference will show as large spikes.
6. Click **Copy** to create a screen capture of the Acoustic Interference screen.



It takes a few seconds for the Acoustic Interference screen to display.

Mounting the Deck Box

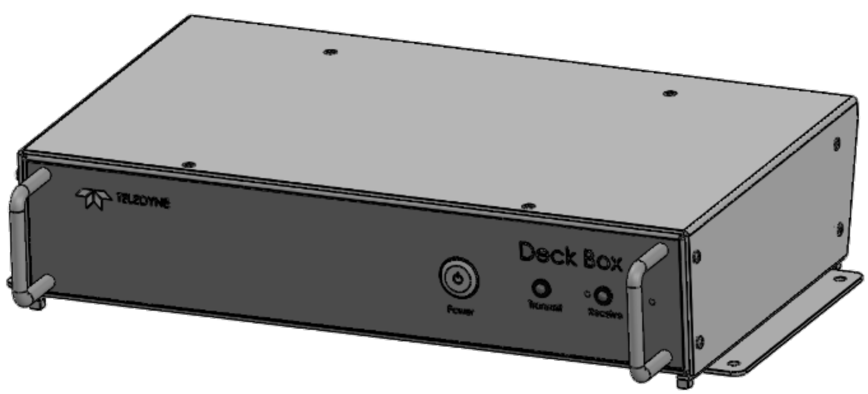
Follow the guideline below for installing the optional Deck Box assembly:

- The Power/Data/COM cable from the Deck Box to the transducer is 100 meters (328 feet) maximum, or less.
- The RS-232 communication cable from the Deck Box to the computer used to collect data is 25 meters (82 ft.) maximum. If the cable needs to be longer, use the RS-422 cable connection and a RS-422 to RS-232 converter (see Figure 4, page 11).
- The Deck Box requires 100 to 250 VAC, 50/60 Hz input. The Deck Box provides +36 VDC to the transducer.

TRDI recommends a dedicated AC circuit protected by a circuit breaker.

- The Deck Box should be mounted inside a 19" rack mount chassis or secured to a bench in a dry location.

DECKBOX SHOWN WITH OPTIONAL RACK MOUNTS



DECKBOX SHOWN WITH OPTIONAL BENCH MOUNTS

Figure 8. Deck Box

Transducer Mounting Considerations

Ideally, you want to install the transducer assembly:

- Use a mounting system that will keep the pitch and roll rate of the transducer to less than 1 degree per second. Use isolating bushings and washers when mounting the transducer to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the structure.

> Never lift the transducer assembly by the housing or end-cap. The housing is not meant to support the weight of the transducer.
>
> Use Eyebolts and plastic washers that attach to the user mounting holes. These bolts should be the only thing used for lifting the transducer. The eyebolts can be readily moved around the transducer as needed.

- Away from protrusions that reflect energy. Allow for a reflection-free clearance of 15° around each beam (see Pinnacle Beam Clearance Area).
- Away from other acoustic/sonar devices, especially those operating at the same frequency (or harmonic) of the Pinnacle.
- Mount the transducer 30 meters below or away from the bubble layer created by the thrusters. 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 Pinnacle profiling range.
- Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the Pinnacle.

There are two methods of mounting the Pinnacle:

- Use a clamp that grips the circumference of the housing groove.
- Use the mounting holes on the transducer. See the Outline Installation Drawings for dimensions.

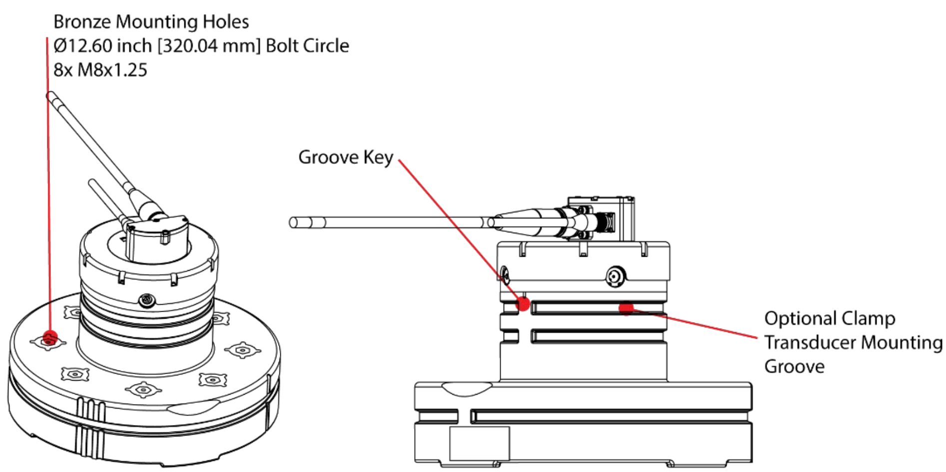


Figure 9. Transducer Mounting Methods

> Your Pinnacle transducer housing is made of bronze that is over-molded with urethane.
>
> Use isolating bushings and washers on the user mounting holes when mounting the transducer to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the structure.

Cabling Considerations

Two cables connect to the Pinnacle Direct Reading system and Deck Box. Use care when routing these cables through bulkheads, deck plates, cable runs, and watertight spaces. Make allowances in cable length and engineering design plans for cable routing. **Use strain relief on all cables.**

The user must provide adequate strain relief for all cables on the transducer and deck box.

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 side-load stress to the connector. Do not exceed the bend radius of the cables.

Secure the cables to the mounting structure in such a manner that the cables do not move or vibrate.

If the connector breaks or cracks due to movement, vibration, or side-load stress, the Pinnacle system may flood.

Use caution when connecting or un-mating the cable to the transducer to avoid damage to the connector hardware.

Under all circumstances, the intrusion of water or any other foreign matter into the connector contact area must be avoided, since this may result in permanent damage to the connector and may render the Pinnacle inoperable.

The Power/Data/COMM underwater cable conducts 36VDC 8.4A from the Deck Box to the transducer. You MUST shut off and Lock and Tag the circuit breaker when raising or lowering the Pinnacle.

Common practice on oil rigs when lowering the Pinnacle is to use wire ties to attach the Power/Data/COMM cable to the rig. Do not tighten the wire ties so they damage the cable jacket in any way.

When removing the wire ties, use medium sized wire cutters; do not use a knife. This prevents cutting into the cable jacket, causing expensive and avoidable repairs.

Lubricate the connector by placing a light amount of silicone lubricant on the female cable connector mating surfaces (rubber portion only). Silicone lubricant is included in the Spare Parts kit. **Regular lubrication is required.**

Power/Data/COM Underwater Cable

The Power/Data/COM cable connects the transducer assembly to the Deck Box. This cable is typically pulled through the vessel inside of conduits that may be unable to accommodate the dry-end connector. To facilitate installation through conduits, the cable can be provided without the dry-end connector installed (pigtail). Once the cable has been pulled through the vessel, the dry end connector is installed. The pigtail version cable connector is delivered in a bag with the associated pins, backshell, and hardware for installation at the customer site (see Installing the Dry-Side Connector).

Available Cables:

- 73B-6082-xxx Cable, RS422/RS232, Serial, Pinnacle (see Figure 10)
- 73B-6084-xxx Cable, Ethernet, Pinnacle (see Figure 11)

The Pinnacle transducer POWER/ SERIAL COMM/ETHERNET COMM/TRIGGER connector part number is MKS(W)-519-CCP (CONN, FEMALE, METAL KEY WET PLUGGABLE, 2 #16X 17 #20, IMPULSE).

The dry side connector is IPT06J14-18PF11 (CONN, PLUG, STRAIGHT, SHELL SIZE 14, 18#20, Glenair).

The Ethernet and Serial Deck Box cables have identical connectors on both ends. Plugging in the wrong cable will not harm the system but it will result in an inability to establish communication with the Pinnacle. To help avoid this possibility, the Ethernet and Serial cables have different color shrink-wrap to match the correct adapter:

Serial = Red

Ethernet = Blue

The Power/Data/COMM cables have the following specifications:

- Minimum bend radius
    - 190.5 mm (7.5 inches)
- Typical cable OD = 14.3 mm (0.564 in.)
- Depth Rating = 200 m (656 ft.)

The cable must be routed such that:

- It does not have kinks or sharp bends.
- It can easily be replaced if it fails.

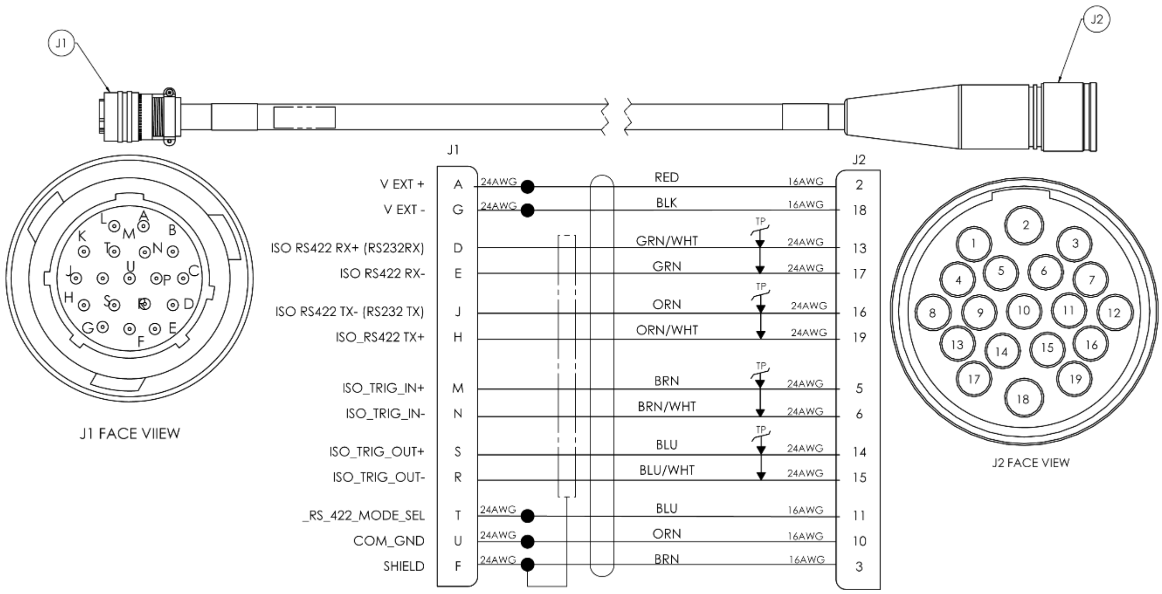


Figure 10. Power/Data/COM Cable, Deck Box, RS422/RS232 73B-6082-xxx

TP = Twisted Pair

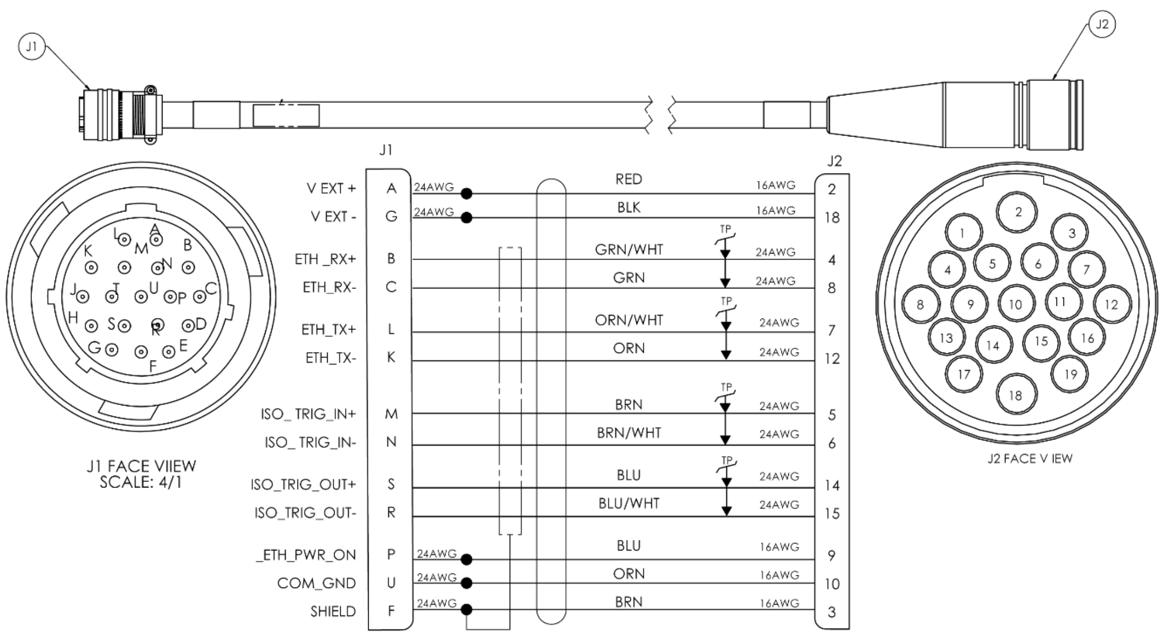


Figure 11. Power/Data/COM Cable, Deck Box, Ethernet 73B-6084-xxx

TP = Twisted Pair

External Sensor /External Memory Cable

This cable is used to connect external sensors.

PIN #	RT SIGNAL	SC SIGNAL
1	SENSOR 2 RS232 RX	SENSOR 2 RS232 RX
2	SENSOR 1 RS232 TX	SENSOR 1 RS232 TX
3	SENSOR 2 RS232 TX	SENSOR 2 RS232 TX
4	SENSOR ISO GND	SENSOR ISO GND
5	SENSOR 1 RS232 RX	SENSOR 1 RS232 RX
6	REMOVEABLE MEMORY	NC
7	REMOVEABLE MEMORY	NC
8	REMOVEABLE MEMORY	NC
9	REMOVEABLE MEMORY	NC
10	REMOVEABLE MEMORY	NC
11	REMOVEABLE MEMORY	NC
12	REMOVEABLE MEMORY	NC

Figure 12. External Sensor/External Memory Cable

The External Sensor /External Memory Cable connector part number is MKS(W)-3XL12-FCR (IMPULSE).

Use the dummy plug to protect the connector if the cable is not connected.

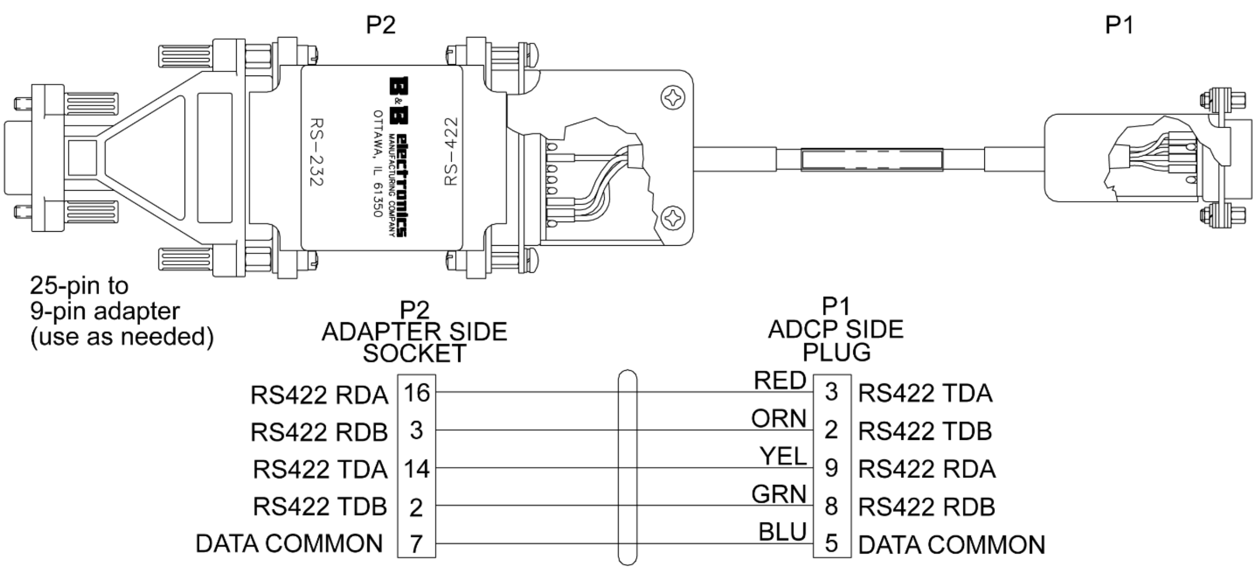


Figure 13. RS-422 to RS-232 Converter - 73B-6000-00

Deck Box RS-232 Serial Communication Cable

The provided wiring diagram and pin-out description below provides the information necessary to connect a host computer to the Pinnacle Deck Box with a minimum of conductors. Off-the-shelf cables may provide more than these minimum connections but must follow as a minimum the schematics depict below. The serial communication connectors are located on the rear panel of the Deck Box.

Deck Box RS-232 (J4) Deck Box Signals

DB9 connector (J4) side	Signal Name
2	Tx
3	Rx
5	GND

Cable must be less than 25 meters in length

Deck Box RS-422 (J3) Deck Box Signals

DB9 connector (J3) side	Signal Name
Pin 9	Tx+
Pin 8	Tx-
Pin 2	Rx-
Pin 3	Rx+
Pin 5	GND

Deck Box Ethernet (J2) Signals

Pin number on RJ45 cable	Signal name
2	Tx-
1	Tx+
3	Rx+
6	Rx-

Using the Trigger In/Out

The Pinnacle receives a signal across the external trigger pins/contacts whose voltage conform to RS-422 standards. The voltage output signal levels are derived from two lines, TX+ and TX-. For logic high, TX+ is set to standard RS422 levels and TX- is set to 0 volts. To transmit logic low, TX+ is set to 0 volts and TX- is set to + standard RS422 levels. The trigger functions over 50-meters of 20AWG cable and requires a minimum trigger input pulse width of greater than 100uS.

Triggers are differential, not TTL. This is to support triggering over long cable runs. Using a 422/TTL converter may be required to support triggering for customers without deck boxes.

Trigger Overview

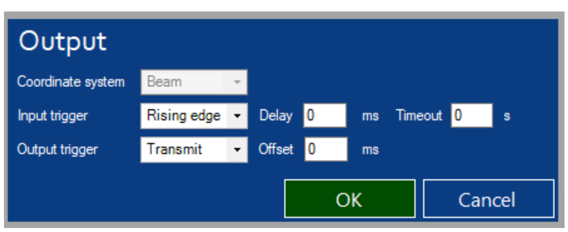
The Pinnacle is intended to operate in some applications where it will need to be coordinated with other acoustic sensors.

Oil & gas, surface applications: A Pinnacle ADCP oriented downward (though often slanted to avoid risers) is commonly paired with one or more horizontal ADCPs to fill the water profile gap between the 1st good bin and the surface. These ADCP's may need triggering to sequence the pinging to avoid acoustic interference. The desired functionality is direct synchronization between these ADCPs, which is sometimes called master/slave triggering in TRDI ADCPs. Due to internal latency in our ADCP and/or in the other device being triggered, synchronizing events is facilitated by time offsets in triggering.

Vessel mount applications: A Pinnacle ADCP mounted on a moving vessel is used to take a moving water profile. The ADCP generally requires bottom track to remove boat velocity from the water profile velocity. This application may use triggering to orchestrate many acoustic sensors to avoid acoustic interference. One example is using the Kongsberg Synchronization Unit, which would require the sensor to accept a trigger-in. Another example is in coordination with a hydrophone or other listening device, where the ADCP would need to send a trigger out to instruct a hydrophone not to listen during a ping.

To configure the Trigger In/Out:

1. Start *Pinnacle Utilities*.
2. On the start screen, click **Plan** and select a Wizard template.
3. Click the **Change** button on the Output tab.



- **Input trigger** – Choose between **Off**, **Rising edge**, and **Level high**. If needed, enter a **Delay** and **Timeout** value.
- **Output trigger** – Choose between **Off**, **Duration of Transmit and Receive**, and **Duration of Transmit**.

4. Save the command file. The CX and #CO commands will be included in the command file.

Level Signal Cycling

If level signals are to be used as a trigger between the Pinnacle and another instrument, the CX command controls the trigger in functionality and the #CO command controls the trigger out functionality.

Trigger Input:

The CX command is used to specify all discreet trigger-in parameters.

Example:

CX <enable> <mode> <delay> <timeout>

where:

<enable>	1 = enable, 0 = disable
<mode>	1 = rising-edge, 0 = level-high
<delay>	Added milliseconds from trigger to ping.
<timeout>	milliseconds to wait before giving up on trigger.

Input triggers will not be processed until the system is awake and ready to ping; i.e. when it has completed its pre-ping setup. If a trigger signal arrives before the system is ready for it, it will be ignored. After the system is ready to ping, if input triggering is enabled, then Pinnacle will bypass the wait for the scheduled ping time according to TE/TP and will instead wait for a trigger. Therefore, the ping schedule will automatically align itself to the trigger pulses provided that they are reasonably close to the TE/TP schedule, or if TE and TP are both zero. If a timeout occurs while waiting for a trigger, then the trigger mode will be turned off, and pinging will resume according to the TE/TP schedule.

Triggers work best when sleep is disabled. On Trigger In this is done most easily by simply setting TP and TE to zero. On Trigger Out there is a balance that must be set between setting TE to zero and with a TP setting small enough (less than 5 seconds) and specifically disabling sleep (CL0). See the CL command.

Trigger Output:

The #CO command is used to specify all trigger-out parameters.

Example:

#CO <enable> <duration> <offset>

where:

<enable>	1 = enable, 0 = disable
<duration>	1 = Transmit + Receive, 0 = Transmit
<offset>	milliseconds from trigger to ping, in the range [-10 to +10].

Manual Ping Cycling

Manual ping cycling (ping on receipt of a defined serial prompt) is controlled by the CF command. The firmware has serial ping and ensemble triggering enabled by the CF command and triggered by serial command:

- The CF manual *ensemble* triggering will require a tab or CS (enter) to start the ensemble. After the ensemble (and data output, if appropriate) the firmware will return to the command prompt.
- The CF manual *ping* triggering will show a < prompt and wait for a character (a space, tab, carriage return, line feed) to execute that ping.

The Pinnacle will have a longer response time versus previous products since the Catalyst must receive this command and forward it to the Doppler.

General Mounting Considerations

Use the following sections to help locate the best possible location for the Pinnacle system.

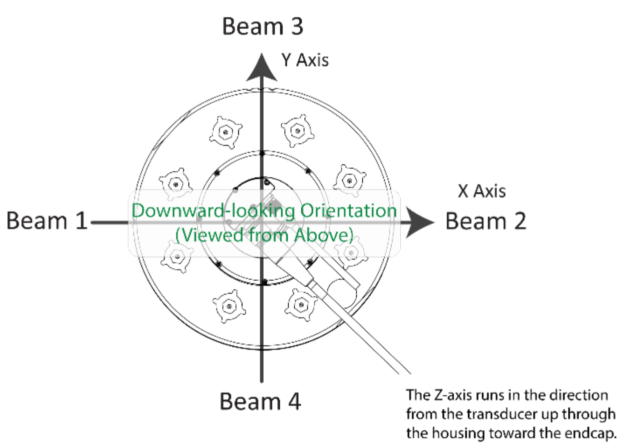
Beam Coordinate Systems

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

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

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

Instrument Coordinates. (X, Y, Z) Instrument Coordinates are selected by the EX01xxx command. This set of axes is always oriented the same relative to the transducer head. Looking at the end view of the housing, the transducers are labeled clockwise in the order 3-2-4-1 (Figure 14). When you look at the face of the transducer head, the transducers are labeled clockwise in the order 3-1-4-2. The X-axis lies in the direction from transducer Beam 1 towards transducer Beam 2 and the Y-axis lies in the direction from transducer Beam 4 towards transducer Beam 3. The Z-axis lies along the axes of symmetry of the four beams, pointing away from the water towards the housing. The internal compass is mounted so that when the X-Y plane is level, the compass measures the orientation of the Y-axis relative to magnetic north.



The PD0 output data format velocities:

- If the flow (or a component thereof) is towards Beam 3 and away from beam 4, then the Y velocity is negative.
- If the flow (or a component thereof) is towards Beam 2 and away from beam 1, then the X velocity is negative.
- If the flow (or a component thereof) is going towards the face of a Pinnacle, then Z is positive.

Figure 14. X, Y, and Z Velocities

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

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

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

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

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

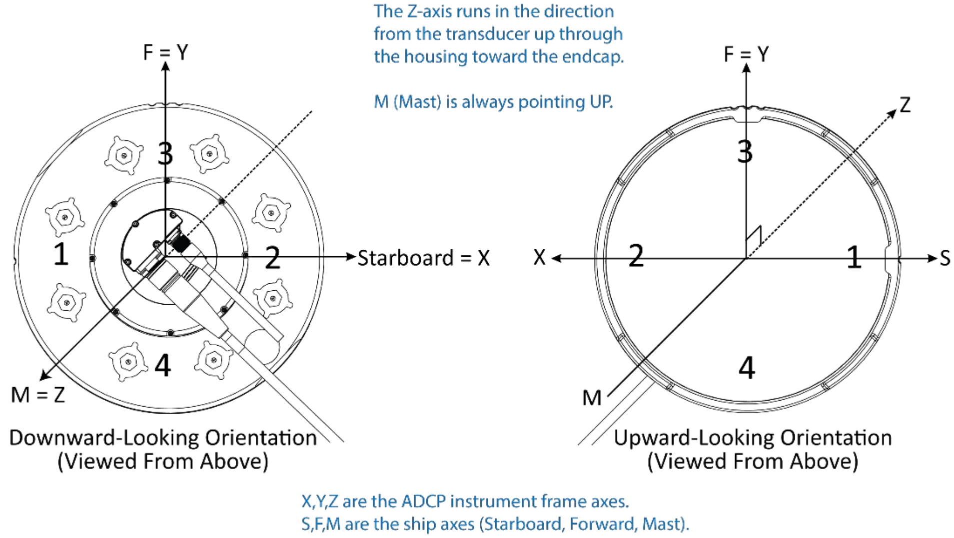


Figure 15. Pinnacle Coordinate Transformation

The importance of the ship axis is that the attitude angles (pitch, roll, and heading) measure the orientation of the ship axes relative to the earth axes, regardless of up/down orientation. The sense of internal sensors Tilt 1 (pitch) and Tilt 2 (roll) is positive for counterclockwise tilts respectively about the S and F axes, using the right-hand rule (see Figure 16).

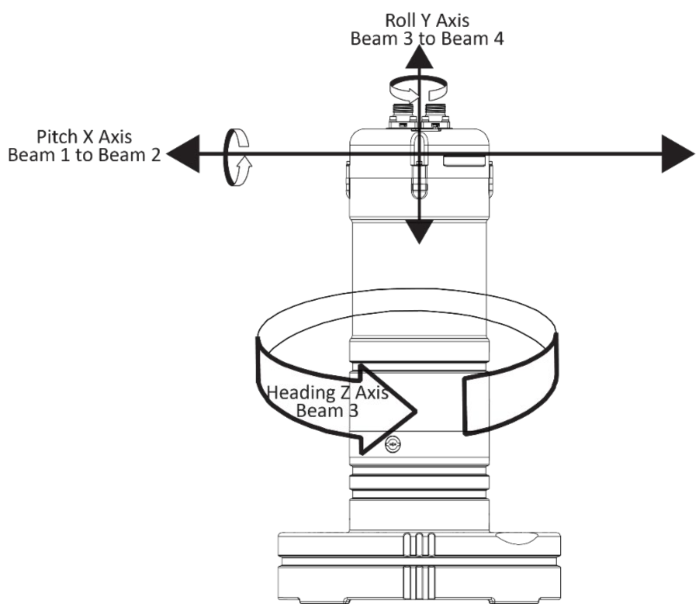


Figure 16. Pinnacle Pitch and Roll

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

Ringing

The Pinnacle 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 metal of the transducer beam itself and other items in the water.

The energy from the side lobes will excite the metal of 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. TRDI refers to this as "ringing."

If the Pinnacle 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 Pinnacle. The ringing causes bias to the velocity data.

All Pinnacles "ring" for some amount of time. Therefore, each Pinnacle requires a blanking period (time of no data processing) to keep from processing the ringing energy. Each Pinnacle frequency has a different typical ringing duration. The typical ringing period for Pinnacle systems is 16 meters. These typical ringing values are recommended as the minimum setting for all Pinnacles using default setups. It should be noted, on some installations the effects of ringing will last longer than the recommended settings above.

For more information, see the WF command.

Acoustic Isolation

Acoustic isolation from other acoustic devices on the rig is necessary. You can do this using the following techniques.

- Mount the other acoustic devices as far apart as possible.
- Make sure neither the main lobes nor the side lobes of the acoustic devices point at the transducers, including acoustic reflections.
- Devices with same center frequency or harmonics of the Pinnacle will interfere with the Pinnacle data (bias the data).

Pinnacle Beam Clearance Area

All ADCPs transmit signals into the water and receive the echoes backscattered from this transmission. This transmission is done in a relatively narrow beam width. Normally, the scattering is from life forms and other objects or discontinuities in the water column within this beam width (also referred to as the "main lobe"). All transducers, however, do have sidelobes. This means that a small amount of the transmitted energy falls outside of the main lobe. The transducer is designed to minimize these sidelobes and the effect in open water is that the sidelobes have no appreciable influence on the measurements that an ADCP makes.

Situations do arise, however, where very large backscattering (other than the normal scatterers), can occur in either the main beam or in the sidelobe areas. Examples are structures, cables, other instruments, etc. In these situations, the user has to take care to make sure that these scatterers do not interfere with the normal operation of the ADCP or has to be aware of the consequences if they do interfere.

This section contains guidelines of how to best mount the transducer in adverse situations and what can be expected if an object is in either the main lobe or the sidelobe of any given transducer beam. It also recommends a "clearance zone". This is an area that we recommend keeping clear of potentially large scatterers.

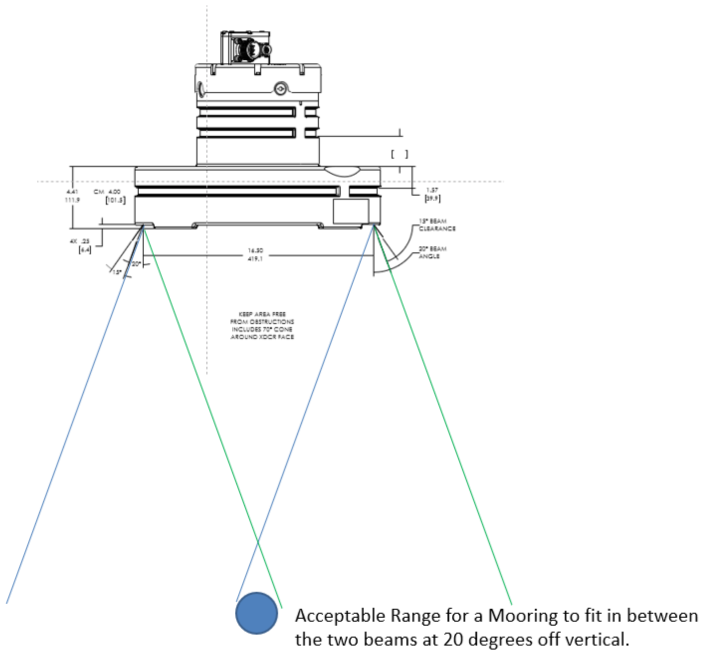


Figure 17. Beam Clearance Area

> It is OK to have an object in front of the phased array if it is out of the "near field" where the phased array beams are still forming.

Table 1: Beam Widths

System Type and Frequency (kHz)	Estimated One-Way Beam Width (degrees)
Pinnacle 46.08 kHz	3.2

> The values shown above are the approximate one-way beam widths to the –3dB points on the beam. In general, these values should be doubled in determining the width of the main beam.

The following information illustrates the recommended clearance zone (the area outside of the main beam to be clear of objects) on each individual beam. The drawings at this point are only showing a single beam. The single beam descriptions are the same no matter if the beam is created by an individual single beam or if the beam is created by the phased array transducer (as in Figure 17).

Figure 18 shows the Main Beam and the spreading of the main beam width. Beam spreading is a geometric cause for echo attenuation as a function of range (for more information, see the ADCP Principles of Operation; A Practical Primer). Beam spreading is represented as a logarithmic loss in echo intensity with increasing range, where echo intensity is measured in dB. In linear units, the echo intensity decreases proportional to the range squared. ADCPs are made to minimize the beam spreading.

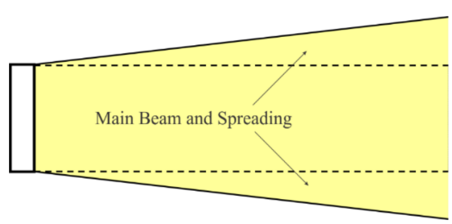


Figure 18. View of Main Beam Spreading

Figure 19 shows the Main Beam and the "Clearance Zone" (area to keep free of objects) around the Main Beam. The edge of the clearance zone is 15 degrees out from the main beam (an additional 11 degrees farther out from the main beam spreading).

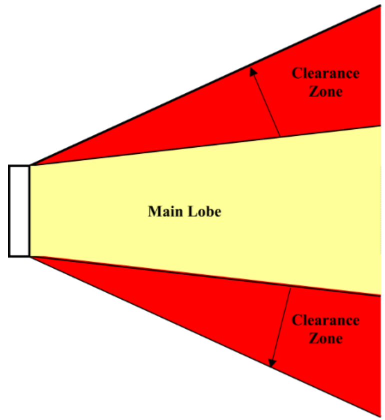


Figure 19. View of Clearance Zone Width

In Figure 18 and Figure 19 we have represented the beam width and the recommended clearance zone around each beam. In some cases, however, it may not be possible to avoid having objects in the clearance zone.

How much of a problem is an object in the clearance zone? The answer to that question depends on the size of the object and if the object appears inside or outside of the main beam width of the system. The following figures will illustrate what you must avoid and what issues might arise if you have an object inside the clearance zone.

Never allow an object to be inside of the main beam width of the system. Objects inside the main beam width are blocking the main lobe, creating beam distortion, and as a result, the entire water profile may be affected. Any object in this area can bias the ADCP measurement for the bin the object appears in, the bin before the object, and all bins for the entire profile.

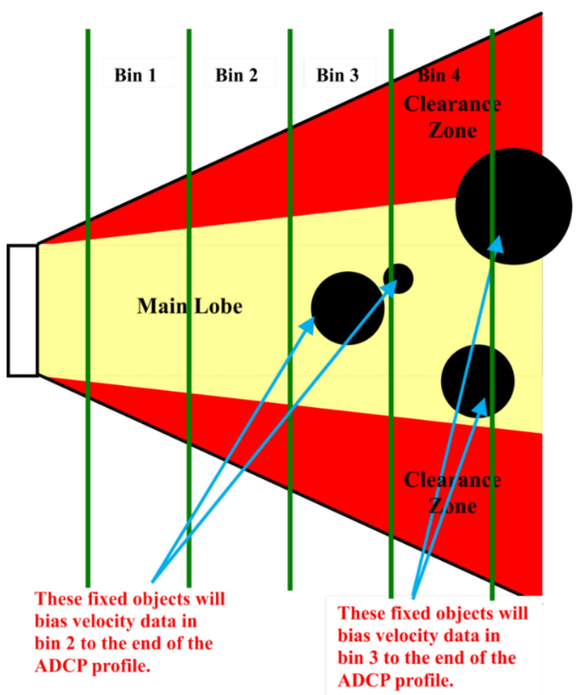


Figure 20. Profile Bias Caused by Objects in the Main Beam

An object inside the clearance zone, but not in the main beam, will bias the velocity estimate in the depth cell that the object corresponds to. Additionally, it can also bias the depth cells on each side of the depth cell shown. The amount of bias will depend on the size of the object and its reflective energy compared to that of the water. The next figures illustrate the expected bias depending on the size of the object.

In Figure 21 we show a relatively small object located inside the clearance zone of bin three. Here it is expected that bin three will be biased but bins two and four may only be biased slightly. However, it is not possible to determine that and so the recommendation is to flag bins two and four as suspect and not use them.

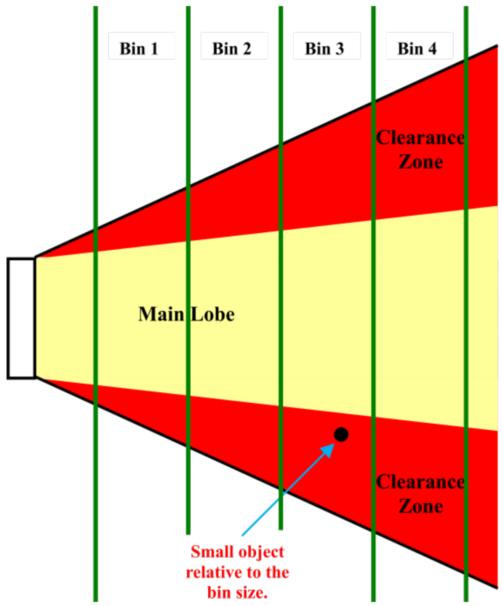


Figure 21. Small Object Biasing a Single Bin and the Adjoining Bins

In Figure 22 we show a relatively large object located inside the clearance zone of bin two and bin three. Here it is expected that bins one through four will be biased, with bins two and three being more biased than the bins one and four. Once again, it is not possible to determine how biased bins one and four are so the recommendation is to flag bins one and four as suspect and not use them.

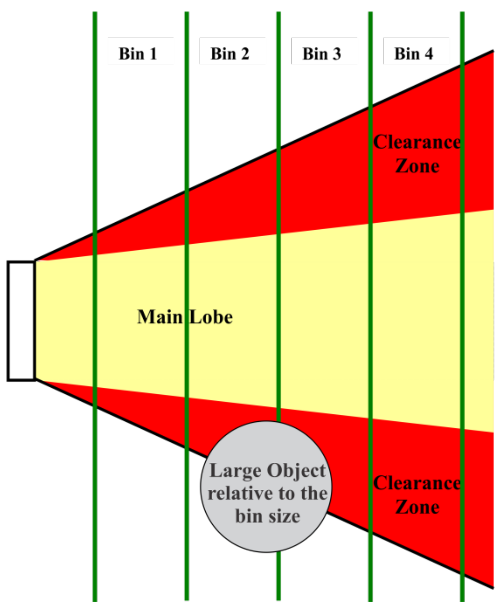


Figure 22. Large Object Biasing Two Bins and the Adjoining Bins

Installing a Vessel Mount System

Read these steps before doing them. In general, follow them in the order listed. Some may differ for your installation, so modify them as necessary. Some can be done simultaneously (e.g., hardware installation and software loading). If you have problems or questions, contact TRDI.

1. On receipt of the system, read the Deployment Guide and check that you have all of the Pinnacle equipment.
2. Before installing the system, test the transducer right out of the shipping container.
   a) Load the *Pinnacle Utilities* software on the computer's hard drive.
   b) All power to the system DISCONNECTED.
   c) Review Power Overview.
   d) Connect the Power/Data/COM Cable from the transducer to the Deck Box.
   e) Connect the RS-232 or RS-422 serial or Ethernet communication cable from the computer to the Deck Box.
   f) Connect power to the Deck Box and apply power to the system.
   g) Test the system.
3. Prepare the system for installation. Disconnect all power to the system. Disconnect all interface cables.

When power is removed, or a cable is disconnected, the transducer Capacitor Bank voltage will discharge in approximately 0.5 seconds. However, the voltage of the Capacitor Bank after discharge will remain at 4 to 5 volts DC for an extended period. While this voltage level poses no safety risk, do not short the contacts of the transducer Data/Power/COM connector or to expose them to water; contact degradation may result.

The Pinnacle Deck Box is powered by 90 ~ 120 VAC or 220 ~ 240 VAC, 7A, 47 ~ 63Hz. Always shut off and tag the circuit breaker when disconnecting cables.

4. Review Transducer Mounting Considerations. Install the transducer head and electronics.
5. Review Computer Considerations. Install the computer and Deck Box.
6. Review Cabling Considerations. As necessary, route and connect the following cables:

- Transducer Power/Data/COM cable.
- Communication cable

The user must provide adequate strain relief for all cables on the transducer and transducer.

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 side-load stress to the connector. Do not exceed the bend radius of the cables.

Secure the cables to the mounting structure in such a manner that the cables do not move or vibrate.

If the connector breaks or cracks due to movement, vibration, or side-load stress, the Pinnacle system may flood.

Use caution when mating or un-mating the cables to the transducer and/or Pinnacle transducer to avoid damage to the connector hardware.

Under all circumstances, the intrusion of water or any other foreign matter into the connector contact area must be avoided, since this may result in permanent damage to the connector and may render the Pinnacle inoperable.

Lubricate the connector by placing a light amount of silicone lubricant on the female cable connector mating surfaces (rubber portion only). Silicone lubricant is included in the Spare Parts kit. Regular lubrication is required.

7. Configure *Pinnacle Utilities* (see the *Pinnacle Utilities* help file and Chapter 3 of this manual).
8. Re-test the system.

Using Acoustic Windows

Installation of an ADCP in a vessel is done in many ways, but typically the ADCP transducer is mounted inside of a sea chest or well. The opening of the sea chest or well can be open to the ocean or it can be covered by an *acoustic window*.

An acoustic window is a covering that can seal the opening of the sea chest but still allow the acoustic signal (both transmit and received signals) to be transferred through the window. The type, thickness, orientation, and other installation issues of the acoustic window are important to understand. If the wrong material is used or the wrong installation used, then the performance obtained by the ADCP will be severely limited.

Background - Should I use an Acoustic Window?

Like any vessel-mount, acoustic system, the performance of the ADCP is sensitive to acoustic noise. For best performance, the transducer is mounted in its own well, recessed in the vessel hull, with an opening slightly larger than the transducer. An Acoustic Window, mounted across the well opening, is required to isolate the transducer face from flow noise, as the vessel moves through the water. Acoustic windows (or simply windows) can produce overall performance improvements in vessel-mounted ADCPs through the following advantages.

Advantages

- Well will not fill with air bubbles caused by the ship moving through the surface water.
- Flow noise is reduced.
- 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.

Although these advantages are important, it should be known that if the wrong window is used or if the window is not installed properly then the following disadvantages are possible.

Disadvantages

- The range of the ADCP can be reduced because the window 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. Applying sound absorbing material on the well walls may dampen the ringing.
- The transmit signal could be reflected off of the window and back into the other beams.

However, even though there are disadvantages possible our experience has shown that when the correct window is used, and it is properly installed that the window advantages are far more important. The remainder of this Application Note will focus on how to choose the window for your vessel, how to mount the window, how to maintain the window, and any other associated concerns when using a window.

What Window should I use?

While we cannot claim to understand every window, we do believe that we can recommend a material that will work. We have developed a simple model for an acoustic window made from polycarbonate material. Over the past two decades we have obtained feedback from customers that have allowed us to prove the model is a fair estimation of what to expect for performance. Polycarbonate was chosen because it can provide enough strength for most installations, is readily available in most countries, it has been shown to last a long time (over seven years in some installations), and it can be used on all ADCP models (Narrow-Band *(NB)*, BroadBand *(BB)*, WorkHorse *(WH)*, and Ocean Surveyor *(OS)*).

The type of ADCP model is very important when choosing a window. The bandwidth of the acoustic signal from the ADCP must be maintained. Different window materials have different losses over a band of frequencies. As an example, the Ocean Surveyor/Observer ADCP uses a bandwidth of 6% or 1% about the system's center frequency. A BroadBand or WorkHorse ADCP uses a bandwidth of 25% or 6% about the system's center frequency. The material polycarbonate has a fairly uniform loss about these frequency bandwidths.

It should be noted that we have no knowledge about the variability of polycarbonates. And so, the acoustic model that we run is for a particular polycarbonate manufactured by Zelux. This is a window-grade, polycarbonate and has a high tensile strength (~9000psi) to resist cracking.

Even when choosing this particular window, it is important to choose the proper thickness of window material. A window will absorb sound and reduce the range of the ADCP. Therefore, we always recommend using the thinnest window possible. However, depending on your application a thicker material may be necessary. The following table indicates the expected loss (two-way) of polycarbonate at different frequencies and thickness.

Table 2: Expected Loss for ADCPs with 30 Degree Beam Angle

Frequency (kHz)	Thickness mm (in.)	One-way loss @ 0°,20°,40°C (dB)			Two-way loss @ 0°,20°,40°C (dB)			Expected Loss in Range (meters)
38	76.2 (~3.0)	2.7	2.6	2.3	5.4	5.2	4.6	173
38	63.5 (~2.5)	3.0	2.9	2.5	6.0	5.8	5.0	192
38	50.8 (~2.0)	2.9	3.2	2.9	5.8	6.4	5.8	205
38	***38.1 (~1.5)***	***1.4***	***1.2***	***1.0***	***2.8***	***2.4***	***2.0***	***90***
38	25.4 (~1.0)	2.9	3.3	3.3	5.8	6.6	6.6	211
38	**19.1 (~0.75)**	**1.0**	**0.9**	**0.8**	**2.0**	**1.8**	**1.6**	**64**
38	12.7 (~0.5)	5.3	5.8	5.6	10.6	11.6	10.2	371
38	9.5 (~0.375)	1.8	1.8	1.8	3.6	3.6	3.6	115
38	6.4 (~0.25)	0.7	0.7	0.6	1.4	1.4	1.2	45
75	76.2 (~3.0)	4.2	4.3	3.8	8.4	8.6	7.6	138
75	63.5 (~2.5)	3.9	4.0	3.5	7.8	8.0	7.0	128
75	50.8 (~2.0)	3.6	3.6	3.0	7.2	7.2	6.0	115
75	38.1 (~1.5)	2.7	2.6	2.3	5.4	5.2	4.6	83
75	25.4 (~1.0)	3.1	3.3	2.9	6.2	6.6	5.8	106
75	***19.1 (~0.75)***	***1.4***	***1.2***	***1.0***	***2.8***	***2.4***	***2.0***	***45***
75	12.7 (~0.5)	3.1	3.5	3.3	6.2	7.0	6.6	112
75	**9.5 (~0.375)**	**1.0**	**0.8**	**0.7**	**2.0**	**1.6**	**1.4**	**32**
75	6.4 (~0.25)	5.9	6.3	5.5	11.8	12.6	11.0	202
150	50.8 (~2.0)	5.0	5.2	4.6	10.0	10.4	9.2	83
150	38.1 (~1.5)	4.2	4.4	3.8	8.4	8.8	7.6	70
150	25.4 (~1.0)	3.6	3.6	3.0	7.2	7.2	6.0	58

Frequency (kHz)	Thickness mm (in.)	One-way loss @ 0°,20°,40°C (dB)			Two-way loss @ 0°,20°,40°C (dB)			Expected Loss in Range (meters)
150	***19.1 (~0.75)***	***2.7***	***2.6***	***2.3***	***5.4***	***5.2***	***4.6***	***43***
150	12.7 (~0.5)	3.1	3.3	2.9	6.2	6.6	5.8	53
150	**9.5 (~0.375)**	**1.4**	**1.2**	**1.0**	**2.8**	**2.4**	**2.0**	**22**
150	6.4 (~0.25)	3.2	3.6	3.3	6.4	7.2	6.6	58
300	25.4 (~1.0)	5.0	5.2	4.5	10.0	10.4	9.0	42
300	19.1 (~0.75)	4.2	4.3	3.8	8.4	8.6	7.6	34
300	12.7 (~0.5)	3.6	3.6	3.0	7.2	7.2	6.0	29
300	***9.5 (~0.375)***	***2.7***	***2.6***	***2.3***	***5.4***	***5.2***	***4.6***	***22***
300	6.4 (~0.25)	2.9	3.4	3.2	5.8	6.8	6.4	27

TRDI's recommended thickness is in **blue bold**. TRDI's recommended maximum thickness is in ***red italic and bold*** in the above table. All other items will result in poor overall performance or a loss in range that most customers find unreasonable.

One-way insertion loss curves for all items above in **bold** (TRDI's recommended thickness) are found in Appendix A of this application note. All other plots are available from TRDI upon request.

Note all of the losses and expected ranges are estimated and some of the assumptions we make may not be true in your installation. However, based on several actual installations the values shown have proven to be good estimations. Your actual loss may be higher or lower than what is shown.

Table 3: Expected Loss for ADCPs with 20 Degree Beam Angle

Frequency (kHz)	Thickness mm (in.)	One-way loss @ 0°,20°,40°C (dB)			Two-way loss @ 0°,20°,40°C (dB)			Expected Loss in Range (meters)
38	76.2 (~3.0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	63.5 (~2.5)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	50.8 (~2.0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	***38.1 (~1.5)***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***
38	25.4 (~1.0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	**19.1 (~0.75)**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
38	12.7 (~0.5)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	9.5 (~0.375)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	6.4 (~0.25)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
75	76.2 (~3.0)	3.1	3.2	2.8	6.2	6.4	5.6	102
75	63.5 (~2.5)	2.7	2.8	2.6	5.4	5.6	5.2	90
75	50.8 (~2.0)	2.6	2.6	2.3	5.2	5.2	5.6	90
75	38.1 (~1.5)	2.0	2.0	1.8	4.0	4.0	3.6	64
75	25.4 (~1.0)	2.2	2.1	1.8	4.4	4.2	3.6	70
75	***19.1 (~0.75)***	***0.9***	***0.9***	***1.0***	***1.8***	***1.8***	***2.0***	***32***
75	12.7 (~0.5)	2.8	2.9	2.4	5.6	5.8	5.4	93
75	**9.5 (~0.375)**	**1.0**	**0.9**	**0.8**	**2.0**	**1.8**	**1.6**	**32**
75	6.4 (~0.25)	4.2	3.7	2.7	8.4	7.4	5.4	134
150	50.8 (~2.0)	3.6	3.8	3.4	7.2	7.6	6.8	61
150	38.1 (~1.5)	3.1	3.2	2.8	6.2	6.4	5.6	51
150	25.4 (~1.0)	2.6	2.6	2.3	5.2	5.2	4.6	42
150	***19.1 (~0.75)***	***2.0***	***2.0***	***1.8***	***4.0***	***4.0***	***3.6***	***32***
150	12.7 (~0.5)	2.2	2.1	1.8	4.4	4.2	3.6	35

Frequency (kHz)	Thickness mm (in.)	One-way loss @ 0°,20°,40°C (dB)			Two-way loss @ 0°,20°,40°C (dB)			Expected Loss in Range (meters)
150	**9.5 (~0.375)**	**0.9**	**0.9**	**0.9**	**1.8**	**1.8**	**1.8**	**14**
150	6.4 (~0.25)	2.9	2.9	2.3	5.8	5.8	5.6	46
300	25.4 (~1.0)	3.6	3.8	3.4	7.2	7.6	6.8	30
300	19.1 (~0.75)	3.1	3.2	2.8	6.2	6.4	5.6	26
300	12.7 (~0.5)	2.6	2.6	2.3	5.2	5.2	4.6	21
300	***9.5 (~0.375)***	***2.0***	***2.0***	***1.8***	***4.0***	***4.0***	***3.6***	***16***
300	6.4 (~0.25)	2.2	2.1	1.8	4.4	4.2	3.6	18

Table 4: Expected Loss for Pinnacle45 with 20 Degree Beam Angle and Polycarbonate Window

Frequency (kHz)	Thickness mm (in)	One Way loss @ 0°, 20°,40°C (dB)			Two Way loss @ 0°, 20°,40°C (dB)			Expected Loss in Range (meters)
45	76.2 (~3.0)	2.2	2.3	2.2	4.4	4.6	4.4	128.8
45	63.5 (~2.5)	2.1	2.0	1.7	4.2	4.0	3.4	117.6
45	50.8 (~2.0)	2.1	2.2	2.0	4.2	4.4	4.0	123.2
45	***38.1 (~1.5)***	***1.4***	***1.5***	***1.7***	***2.8***	***3.0***	***3.4***	***95.2***
45	25.4 (~1.0)	2.4	1.8	1.1	4.8	3.6	2.2	134.4
45	**19.1 (~0.75)**	**1.0**	**1.3**	**1.7**	**2.0**	**2.6**	**3.4**	**95.2**
45	12.7 (~0.5)	2.6	1.8	1.2	5.2	3.6	2.4	145.6
45	9.5 (~0.375)	2.2	2.4	2.8	4.4	4.8	5.6	156.8
45	6.4 (~0.25)	0.9	0.9	0.8	1.8	1.8	1.6	50.4

TRDI's recommended thickness is in **blue bold**. TRDI's recommended maximum thickness is in ***red italic and bold*** in the above table. All other items will result in poor overall performance or a loss in range that most customers find unreasonable.

One-way insertion loss curves for all items above in **bold** (TRDI's recommended thickness) are found in Insertion Loss. All other plots are available from TRDI upon request.

Note all of the losses and expected ranges are estimated and some of the assumptions we make may not be true in your installation. However, based on several actual installations the values shown have proven to be good estimations. Your actual loss may be higher or lower than what is shown.

Are there any Other Windows that I can consider?

TRDI has only limited experience with other materials. As a result, there is not much information we can provide about other materials. However, we can state that different materials will behave differently, depending on both the frequency and bandwidth of the acoustic ADCP signal. The absorption curves of various materials have significant amplitude fluctuations with frequency, which can change in both frequency and amplitude with changes in temperature.

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.

- The life of the material must also be considered as well as its overall strength. We have had customers design their own windows out of Kevlar. They required Kevlar because they required a material that was very strong both for temperature and for strength against heavy seas, objects in the water, and striking the bottom or ice. Kevlar can provide this strength without having to be very thick thus minimizing loss.
- Kevlar windows have been successfully built and used by two different institutes (Monterey Bay Aquarium Research Institute (MBARI) in the United States, and the Institut National des Sciences de l'Univers (INSU) in France. The procedure to build the window is not known by TRDI. The properties of the Kevlar windows are not well understood and so a lot of experimentation with different thickness windows was required before these customers were satisfied with the Kevlar window.
- INSU used a graduate student, Roche Frederic in 1997, to perform a study to determine the best thickness and composite of Kevlar to provide a window for a BB VM150kHz ADCP. The report states that the material KEVLAR K49 made with Resine Vinylester ATLAC 580 was used. The following French company produced this material:

  Brest-Composite Industrie
  124 Rue Auatole Frauce
  29200 – Brest, France
  Tel: 02-98-05-19-09
  Fax: 02-98-34-06-02

TRDI only knows that this single window was produced for INSU and does not know of any others who are using this material. It is TRDI's understanding that the above-mentioned company can produce the Kevlar window but cannot give the acoustic properties required to determine the losses through the window. 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 material.

Acoustic Window Installation

In Table 1 and Table 2 we provided the recommended window material and thickness. In this section we will provide installation recommendations. Installation of the window must be done properly so that the best performance is possible. The following discussion is broken into sections so that each point can be considered individually.

What should the Window Shape be?

The window should be smooth without cracks or deformities. Typically, the window is round and of a diameter that is large enough to clear all four beams. To determine the proper diameter of the window see Conceptual Transducer Well Design.

The acoustic window should be flat and parallel to the transducer mounting plate. This will result in a constant angle of 20 or 30 degrees (depending on the transducer beam angle) to the transducer on both the inside and outside window face.

Dome shaped windows have been used successfully. 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.

Can I Add Strengthening to the Window?

Adding a strengthening member across the window is not recommended because this can cause similar behavior as a cracked window (see If I find that the Window is Damaged Can I Keep Operating the ADCP?) or can actually block the acoustic transmit and receive signals.

How do I Secure the Window to the Well Opening?

We recommend that a steel ring around the outside of the window be used because you do not want the screw heads to come in direct contact with the window material as it may crack under the strain.

It is recommended that window be designed so that the ring will sit flush with the entire window face as shown in the Figure 1. Flat headed bolts or recessed bolts should be used. All of these will maintain a smooth surface around the entire window and will prevent any chance for cavitation (see Do I Need to Worry About Air Bubbles When Using a Window? for more information).

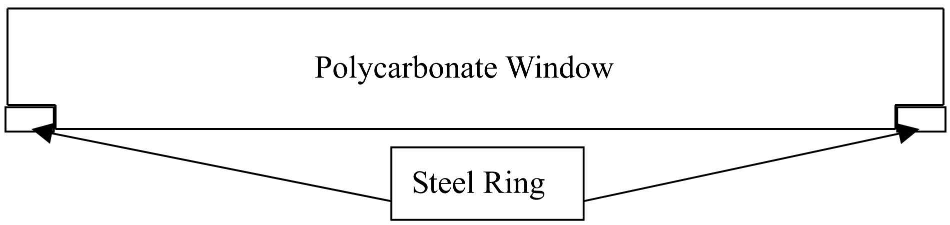


Figure 23. Conceptual Drawing of an Acoustic Window with Mounting Ring

Do not thread the holes in the polycarbonate window. Use bolt through holes spaced evenly around the window. The number of bolts through holes (typically 16 to 24 holes) should be enough to prevent leakage and will provide equal pressure on the window to prevent cracking.

The bolt circle should be located a distance from the edge of the window that is a minimum of twice the diameter of the bolt through holes, see Figure 2.

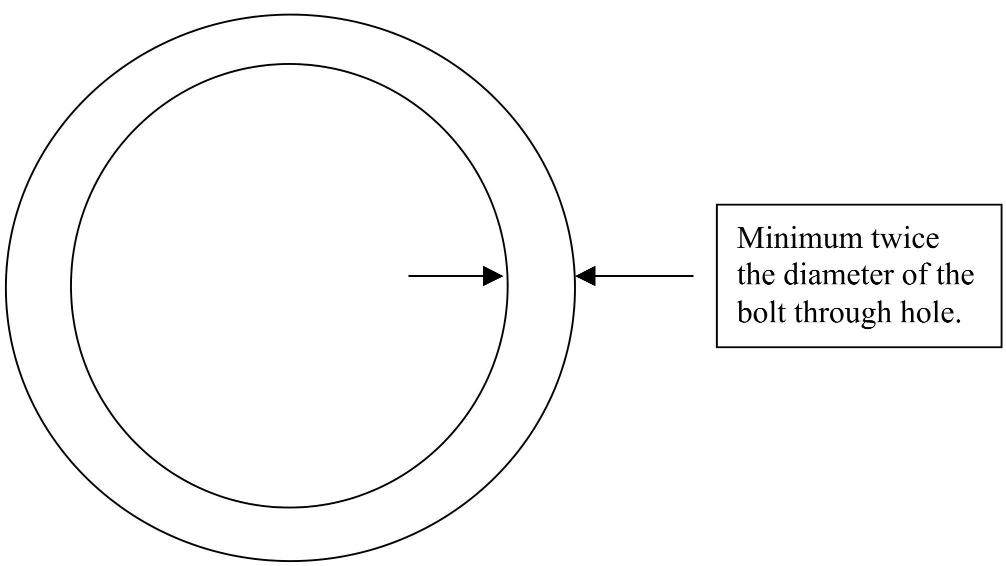


Figure 24. Location of the Window Bolt Hole Circle Diameter

How to Prevent the Window from Cracking When Going into Dry Dock?

Using as thin a window as possible may mean that the window will not be able to support the water inside the sea chest when the vessel goes into dry dock. This means that you must either be sure to have a way to drain the sea chest prior to going into dry dock or allow a way for the water to drain out of the sea chest during dry dock. The former must be done as part of the sea chest design and the latter can be accomplished by placing holes in the window face.

The holes in the window face will allow water to freely flow in and out of the well. However, drilling holes in the window will increase your chances of flow noise, air bubbles in sea chest, corrosion, bio-fouling, and will make the sea chest non-hydrostatic. The bio-fouling will require that you have regular transducer inspections and cleanings. If you make the sea chest non-hydrostatic then in heavy seas the window can crack as it flexes from wave slamming. Dave Taylor Model Basin has measured slamming pressures as high as 300 psi with durations of a few milliseconds. If the sea chest behind the window is hydrostatic, no pressure gradient will exist across the window and no substantial deflections will occur.

With those considerations in mind you may still want to drill holes in the window. Ideally, the holes should be outside the circumference of the array since the entire array is used to form the beams. If the holes are inside the array circumference and are a fraction of a wavelength, such as $\lambda/20$ or smaller, then the effect these holes may have on distorting the beam pattern should be small. If the holes are larger than $\lambda/20$ but not more than $\lambda/10$, then the number of holes should be only a few and ideally are randomly distributed. Holes larger than $\lambda/10$ should be outside the array circumference.

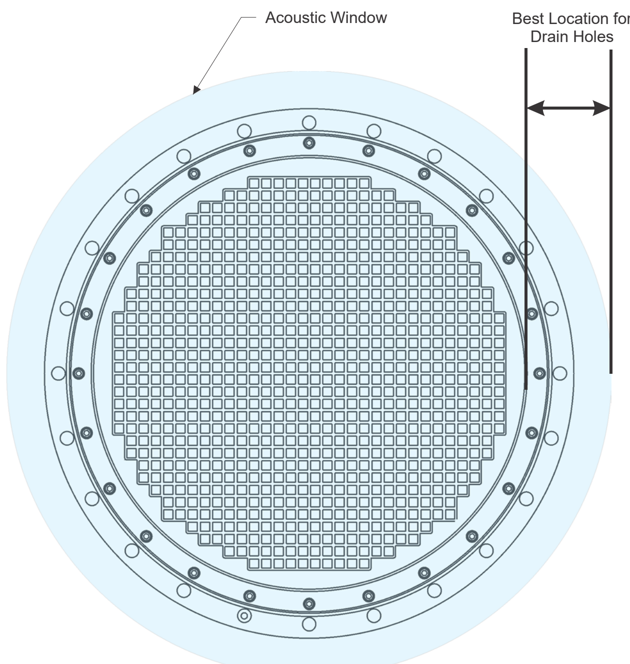


Figure 25. Ideal Drain Hole Locations

How Much Space should I Have between the Window and Transducer?

Never allow the transducer to touch the window. Separation is good for reducing the strength of the multiple fields of flow noise. However, we must limit the separation to prevent the reflection of a beam off of the window into another beam. This causes cross talk between the beams.

Therefore, with all ADCP models and frequencies the recommended distance between the transducer and the inside face of the window should be between 6.4mm to 12.7mm. This will ensure that there is no cross talk between beams and will provide adequate spacing to reduce flow noise. See Conceptual Transducer Well Design for more sea chest design issues.

What Other Issues should be Considered When Using an Acoustic Window?

Once you decide to use a window there are many issues that no longer are a worry but there are other new issues you do need to worry about. This section will outline each of these items and the issues related to them.

What Fluid Should I Fill the Sea Chest With?

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% fresh-water 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 veloci-ties on a Phased Array Transducer.

You will have to perform post processing on the data sets from the NarrowBand (NB), BroadBand (BB), and WorkHorse (WH) ADCPs. The NB, BB, and WH ADCPs 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.

How Much Fluid Should I Use in the Sea Chest?

The transducers must be completely immersed in water. No air should be in front of the transducers and the pressure within the sea chest should be adjusted to keep the window from bowing in and out, and thereafter, the volume should be kept constant.

Should I Use Absorption Material When Using a Window?

The window causes some of the transmit signal to reflect back into the well due to the difference in imped-ance between the window and the water. When the transmit signal is reflected in the well it becomes trapped and this results in what is called ringing. To keep from processing this signal, the blanking of the ADCP will have to be increased.

However, in extreme cases, ringing can last a period that will cause the first 50 to 100 meters of data to be unusable. Therefore, a sound absorbing material should be used inside the sea chest to minimize the effects of sound ringing within the sea chest. The material should be a minimum of one wavelength thick (include the sound speed of the absorbing material when calculating the size of a wavelength). Approximate wavelengths of sound in seawater are given below in Table 4. Using standard neoprene wet suit material has been found to work well with 75 and 150 kHz frequency ADCPs.

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

Frequency (kHz)	Wavelength (mm)
38	40
75	20
150	10
300	5

Do I Need to Worry About Corrosion When Using a Window?

Corrosion is always possible. However, our transducers are made of a material that has shown to corrode very little over time when the above precautions are met. There is nothing that you can do to protect the transducer from corrosion. However, if the well is covered with a window and then filled with freshwater corrosion is can be further minimized. You should inspect the transducer regularly for signs of corrosion.

Note, never attach any anodes directly to the transducer head. Additional anodes or impressed voltage systems can cause the urethane to separate from the transducer (cathodic disbondment) or cause the material of the transducer to break down. Standard anode protection used for the ship should be installed outside of the well of the transducer head. Mounting of ship's standard anode protection outside of the transducer well will typically not cause any problems.

Do I Need to Worry About Air Bubbles When Using a Window?

All vessels create air bubbles in the water as the ship moves through the water. Ships with a deep draft or a non-flat bottom have fewer problems with bubbles. If you are using a window, these bubbles will still be present. If the window is sealed, then this air will not fill the sea chest. However, if the window is not sealed then air can fill the sea chest. You must make sure to vent air from the sea chest periodically if there is a possibility that air will become trapped in your sea chest.

To avoid air bubbles from getting into the front of the window you should mount the transducers below or away from the bubble layer. The flow layer is usually within the first two feet below the waterline. Bubbles can be trapped in this layer. Mounting the transducer head amid ship on the fore-to-aft centerline may help. Another technique is to divert the bubble layer so it flows around the transducers. A fairing around the sea chest can help with this, but care must be taken so that you do not cause cavitation.

Do windows Improve Flow Noise Problems?

Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the ADCP. A window reduces the coupling of flow noise to the transducer. This is because of the gap filled with fluid between the inside of the window face and the transducer faces attenuates the flow noise. By reducing flow noise, you are increasing the signal to noise ratio. The higher the signal to noise ratio is, the better (stronger) the returned signal will appear. This will result in better data reception and longer ranges.

What Maintenance is required when using Windows?

In general, a window provides protection to the transducer from the most common sources of problems such as bio fouling and corrosion. However, the window can still become covered with bio fouling or could become damaged. The following section discusses these issues.

How Often Should I Inspect the Window?

Since the growth of mussels, barnacles, and other bio fouling occurs on all vessels, the window should be inspected and cleaned by divers on a regular interval. This interval should be often enough to prevent the growth of anything on the window and to allow inspection for damage to the window. It is recommended that this interval be at least once per year but may be required more often in areas that have heavy bio-fouling growth.

When inspecting the window, you should inspect for bio-fouling growth, cracks, damage, for air pockets, and for mud on the inside of the window. We have seen cases where the inside of the well became filled with mud. The mud entered through a crack in the window and where the holes were drilled in the window. Bio fouling should be cleaned off, air should be purged from the sea chest, and mud should be removed from the sea chest.

If I find that the Window is Damaged Can I Keep Operating the ADCP?

In general, any window that is cracked or is damaged so that it is not smooth should be replaced as soon as possible.

A window that is damaged causes a problem with the acoustic transmission. The exact problem or problems seen because of this damage will vary depending on where the break is and the way a beam would strike the damage. All windows have losses because of an impedance difference to the water inside the well and outside the well. There are also losses that are built up in the window. An important loss is due to the shear wave that is created as our acoustic signal passes through the window at an angle. This shear wave traps sound in the thickness of the window as the acoustic signal tries to pass through the window. If the window has a crack in it then the window can cause this trapped energy to bounce in all directions rather than remain trapped in the window. Depending on the size of the crack, the location of the crack, and what the window does around the crack this reflected energy may even go into other beams.

Regrettably, there is no way to predict on what can happen as a crack will have a strange pattern to it. A single beam or all four beams may be affected. However, in either case it is enough to know that a crack in the window is very bad and will cause the energy that is transmitted and received in a beam to be deflected at strange angles.

Additionally, cracks can cause the window to have a rough surface. This can result in cavitation around the window. Cavitation results in air being trapped near the crack. This air can cause energy to be reflected back into the transducer well instead of traveling through the water.

Does the Use of a Window Effect My Warranty?

The use of a window has no impact on warranty. The window is primarily an aid to optimal performance. A window isolates the transducer face from flow noise when the vessel is moving and provides protection from bio fouling. These all increase the performance and reliability of the transducer. The window will also absorb some of the transmitted and returned signals. This will have an adverse effect on performance. However, when the proper window is used this adverse effect is minimal compared to the benefits of using a window. TRDI cannot be responsible for the acoustic design of the vessel, but that design and the installation of our transducer certainly can adversely affect the ADCP system performance.

Insertion Loss

The following section contains insertion (one-way) loss graphs for each of the ADCP frequencies at each transducer beam angle at 0°C. These graphs are provided as an example of the expected insertion loss.

The main beam of each ADCP system at its maximum bandwidth is displayed as the red line on each graph (the sin X/X is represented by the smaller bumps in red). The minimum and maximum frequencies used on the X-axis of the graph were chosen so that this bandwidth would be approximately centered on the graph.

The blue line represents the expected loss across this bandwidth of frequencies for this thickness of polycarbonate. The Y-axis of each graph represents the expected insertion loss. See the example below for descriptions.

Uniform Ave. IL represents the entire average insertion loss over the entire frequency (X-axis) shown. The Weighted Ave. IL represents the average insertion loss over the bandwidth of the ADCP frequency. The Weighted Ave. IL is used to complete Table 1 and Table 2 of this document.

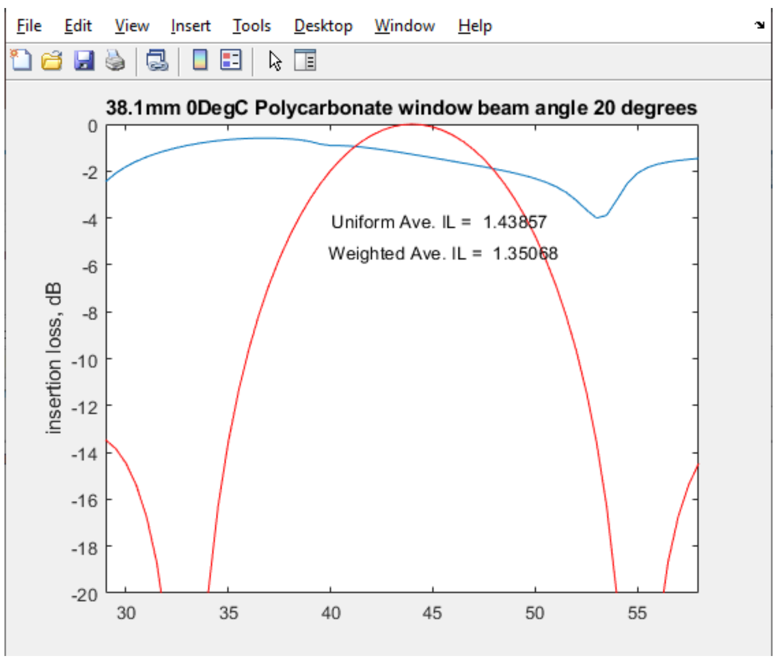


Figure 26. **45kHz Insertion Loss (one-way) with a 38.1mm window at 0°C**

Conceptual Transducer Well Design

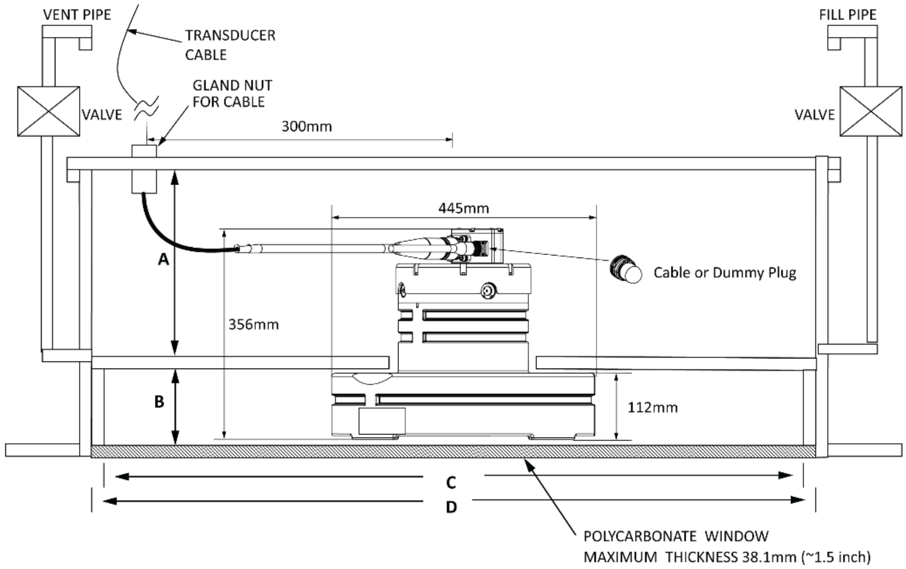


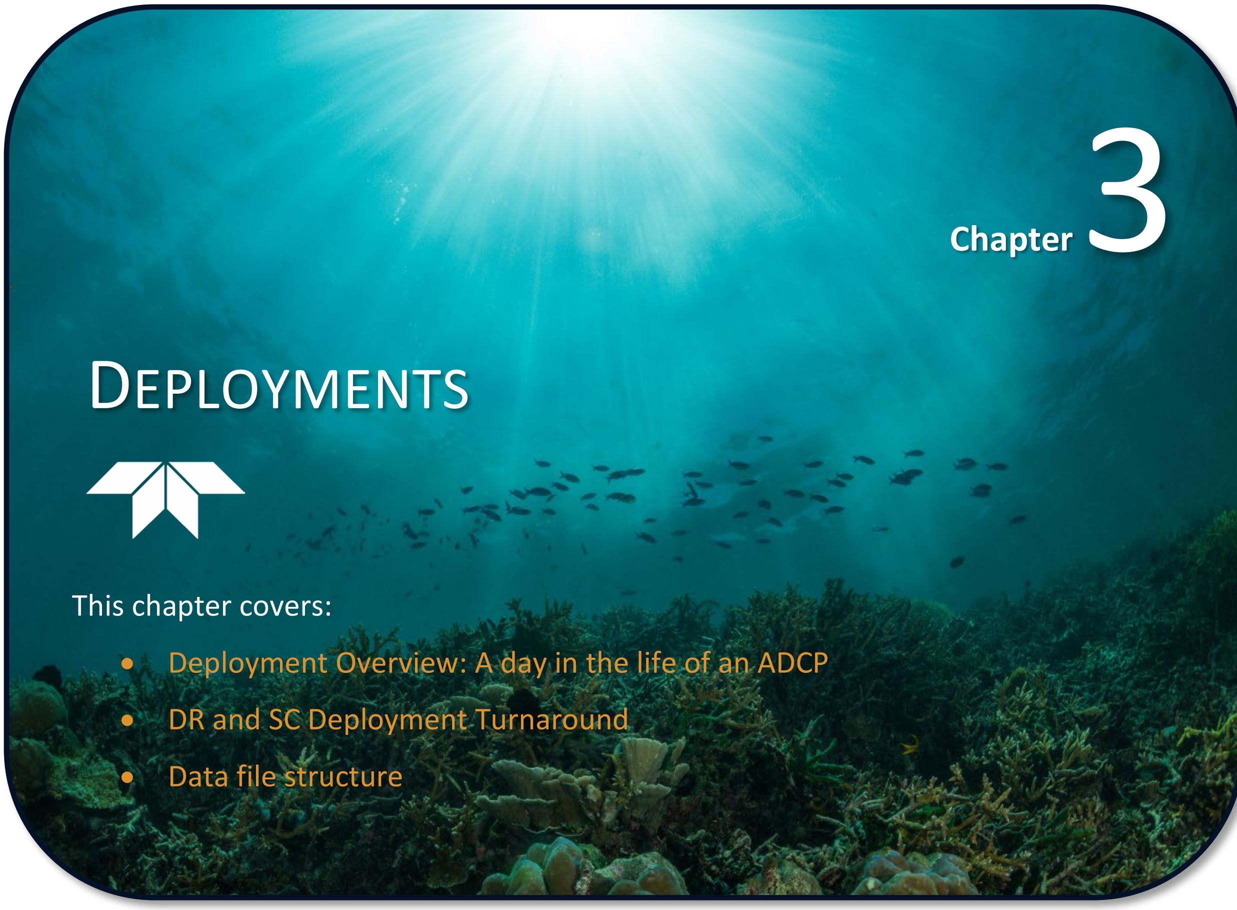
Figure 27. Underneath Vessel Mounting – Pinnacle45 Transducer

Dimension Letter	Option 1 Minimum Dimension	Option 2 Maximum Dimension
A	422mm	422mm
B	115mm	118.3mm
C	498mm	534.4mm
D	600mm	635mm

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 listed minimum and maximum dimensions are recommendations based on maintaining the clearance for the transducer as well as providing the smallest well possible.
5. 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.
6. Inserts in the transducer housing mounting holes may be used to provide additional isolation from vessel.
7. The walls of the well should be coated with a material to absorb reflected sound in the well. Material such as 3mm wet suit material glued to the inside well walls is satisfactory for this purpose.
8. 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.
9. Window thickness should not exceed 38.1 mm of Polycarbonate material. Thinner Polycarbonate window is OK.
10. Window faces should be parallel to the transducer face to within 2 degree for best performance; angle should never exceed 5 degrees.

NOTES



Chapter 3

DEPLOYMENTS

This chapter covers:

- Deployment Overview: A day in the life of an ADCP
- DR and SC Deployment Turnaround
- Data file structure

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. Pinnacle 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.

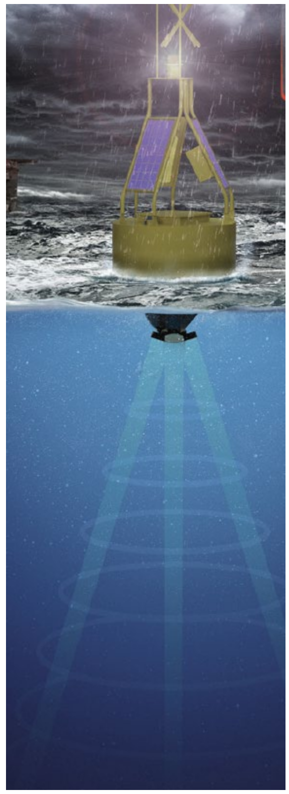
Deployment on surface buoy looking down

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
  - Data on Ethernet port
- Self-Contained Operations:
  - CS command sent, system to ping immediately
  - CS command sent, system set to start at later time

Surface buoy is deployed off the stern of the ship and the mooring line run through the davit of the crane – usually an A-Frame on the back of the ship. Line is paid out while the ship steams away from the surface buoy to keep separation. Additional instruments and flotation may be attached to the mooring line by stopping the payout at intervals decided by the mooring designer. This is a complicated procedure involving an able-bodied seaman controlling the crane who is in communication with the person in charge of the mooring and one or more spotters helping ensure the davit remains clear for the line to pay through. The line is grabbed and pulled in for each attachment to be made by one or two people, while others are tasked with mounting the instruments and flotation. There is a lot of heavy equipment moving around, and several people involved in keeping everything and everybody safe. The mooring line needs to be paid in and out quite a bit during this process, especially for heavy instruments. The line is paid out and pulled to the instrument on the deck. The instrument is mounted, and the line pulled back in to lift it clear of the deck. Spotters are critical during the lift because the crane could pull the instruments right off they reach the davit, or even worse, the line could part. Stuff does get dropped and/or banged around; it is a moving vessel. When the mooring has been completely populated an anchor is attached, usually with a dual acoustic release. The ship steams to where the mooring is to be placed and the anchor is dropped, pulling all of the instruments down one by one behind it.

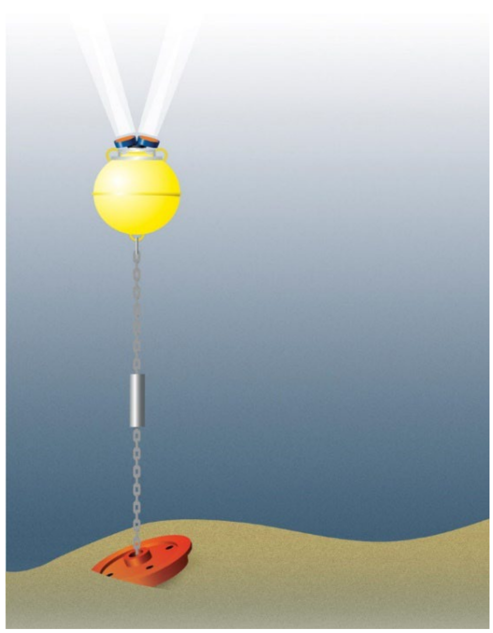


In the classic, surface use case, the ADCP is mounted in a load cage and integrated into a surface buoy. It is typically powered by 12V batteries (marine deep-discharge batteries) which are recharged by solar cells.

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

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

For an instrument the size of a Pinnacle, 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 like the deep-water buoyancy frame conversion kit https://deepwaterbuoyancy.com/buoy-conversion-kit-teledyne-rdi-pinnacle-adcp/. If the mooring line is parted, and there are inductive communications planned for instruments below the Pinnacle, 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.

Bottom mount, near an offshore platform

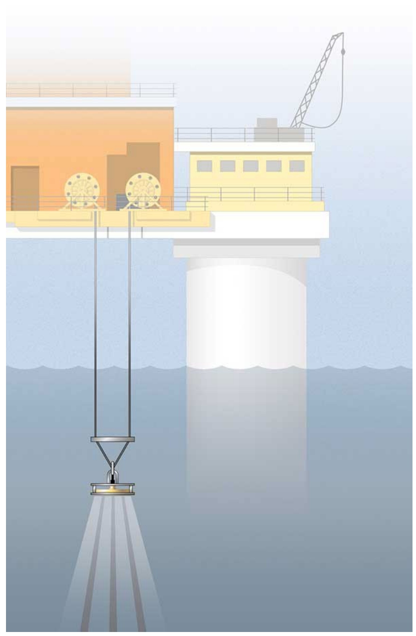
This is different because the oil companies generally prefer not to use a vessel if they can avoid it. Instead they will “swim” the instrument plus mount down with the rig’s ROV and deploy it as far as they can from the underwater infrastructure (which is usually not very far). There are several things that come into play that are different about this:

- The mount is minimalist – there is not much to worry about in the way of trawling and such, and the ROV can go get it so you don’t need elaborate recovery kit.
- The instrument and mount will often have flotation strapped to it to make the ROV’s job easier.
- They often will try to “split” beams to get around the riser. The 20 degree off-vertical angle of the Pinnacle will help with this. Use the lines on the outside rim of the transducer to identify beams 1 and 3.
- If they cannot avoid the infrastructure, then they will point one beam right at and turn that beam off using the #CM command. Use the lines on the outside rim of the transducer to identify beams 1 and 3.

Oil and Gas

Ideally, you want to install the transducer assembly:

- Suspended over the side of the rig.
- Use a mounting system that will keep the pitch and roll rate of the transducer to less than 1 degree per second. Use isolating bushings and washers when mounting the transducer to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the structure.



Direct-Reading Turnaround

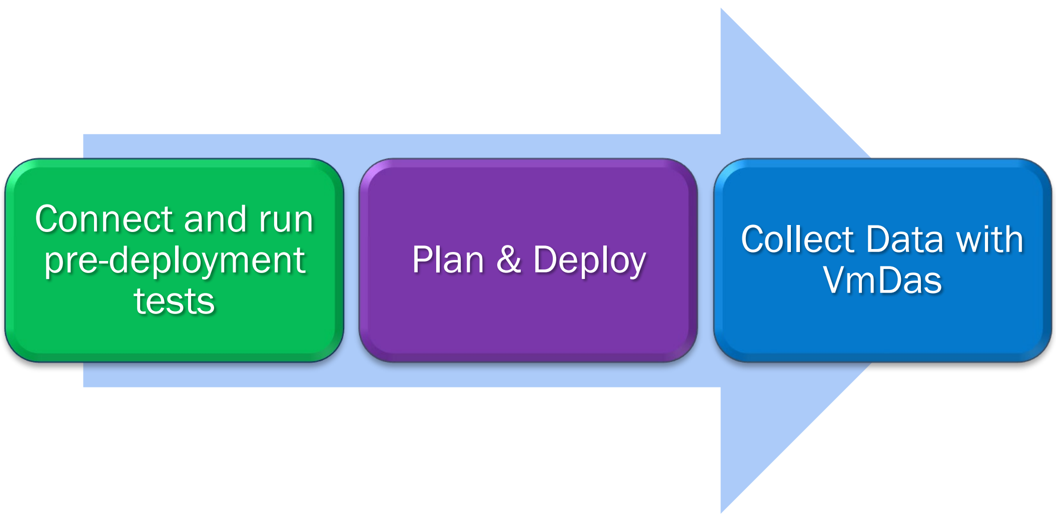
Direct-Read deployments in real time collect, view, and process data collected using the *VmDas* software that is included as part of the Pinnacle Utilities software.

The typical Direct-Reading deployment involves the following tasks:

1. Connect to the Pinnacle ADCP using *Pinnacle Utilities*. Use *Pinnacle Utilities* to run the pre-deployment tests.
2. Plan a vessel-mount deployment.
3. Click the **Deploy** button on *Pinnacle 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 DR system type and Vessel Mount wizard, no data is recorded to the Pinnacle's internal recorder. Data is recorded to the *Pinnacle Utilities* working folder.

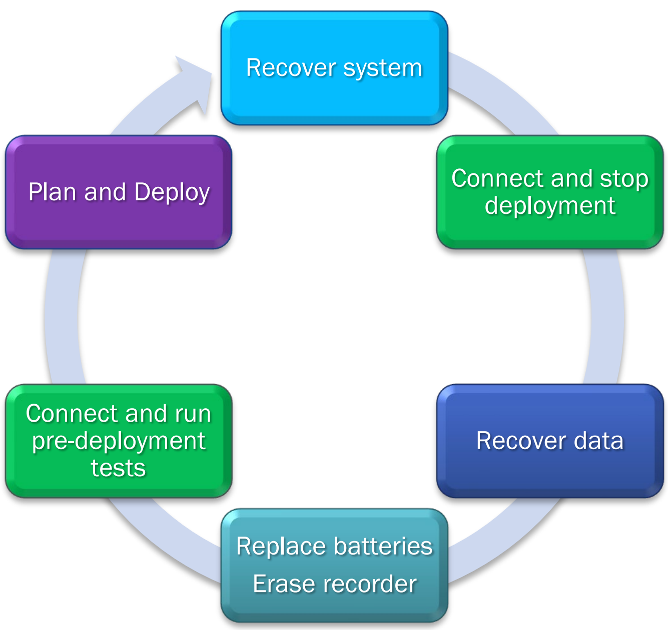
For information on Direct-Reading deployments, see the *Pinnacle Utilities* help file and the DR Deployment Guide. For information on *VmDas*, see the VmDas User's Guide.

Self-Contained Turnaround

The Pinnacle Self-Contained 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 typical turn-around involves the following tasks:

1. Recover the Pinnacle ADCP to the deck of the support vessel.
2. Connect to the Pinnacle ADCP using *Pinnacle Utilities* to stop the deployment. On connecting, the software will provide the status of the fixed and removable recorders.
3. Remove the end-cap and manually dismount the removable recorder (SD memory card) from the Replaceable Memory Housing and transfer the data to the laptop (see the *Pinnacle Utilities* help file and the SC Deployment Guide).
    - Use a microSD card reader to download all the data directly to a computer for maximum download speeds.
4. Replace the batteries and the removable recorder (with either a new SD card or the existing one).
    - It is recommended that all data is downloaded and verified before both the removable recorder and the fixed recorder are erased.
5. Close the self-contained module and reconnect to the Pinnacle ADCP using *Pinnacle Utilities* to run the pre-deployment tests.
6. Plan the deployment and redeploy the Pinnacle ADCP.



Self-Contained data is viewed, processed, and played back using *Pinnacle Utilities*.

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

Data File Structure

The file system is compatible with Microsoft Windows 7 or later; i.e. the removable recorder (SD memory card) can be inserted into a Windows PC and the contents of the card can be browsed and copied without the need for further software.

> ⚠ Renaming, editing, or deleting any files may cause a loss of data.

Folder Structure Overview

The folder structure is shown, with a sample set of data files, in the figure below.

```
[Filesystem root]
│
├───$$SAFE$$ [Hidden when viewed on SafeFAT system]
│       [Journal files]
│
└───Data
    │   MetaData.json
    │
    ├───Calibrations
    │       PADCP-8901-0101-Compass-20181210T094054.cal
    │       PADCP-8901-0101-Compass-20190103T173212.cal
    │       PADCP-8901-0101-Compass-20190213T081245.cal
    │
    ├─── PADCP-8901-0101-20181210T095812
    │       MetaData.json
    │       PADCP-8901-0101-Compass-20181210T094054.cal
    │       SystemConfig.txt
    │       DataFileQA.log
    │       Raw001.pd0
    │       Raw002.pd0
    │       Raw003.pd0
    │       Raw004.pd0
    │       Proc001.pd0
    │
    ├─── PADCP-8901-0101-20190103T180405
    │       MetaData.json
    │       PADCP-8901-0101-Compass-20190103T173212.cal
    │       SystemConfig.txt
    │       DataFileQA.log
    │       Raw001.pd0
    │       Raw002.pd0
    │       Raw003.pd0
    │       Raw004.pd0
    │       Raw005.pd0
    │       Proc001.pd0
    │       Proc002.pd0
    │
    └─── PADCP-8901-0101-20190213T095012
            MetaData.json
            PADCP-8901-0101-Compass-20190213T081245.cal
            SystemConfig.txt
            DataFileQA.log
            Raw001.pd0
            Raw002.pd0
            Proc001.pd0
```

Root-level Folders

As shown in the figure above, the root file system contains two top-level folders:

- The journal folder **$$SAFE$$**, which is automatically created by the SafeFAT file system and is a hidden folder when viewed on SafeFAT.
- A folder titled **Data** which contains all Pinnacle data.

Data Folder

The **Data** folder contains only two files at its lowest level, plus a collection of subfolders as follows:

- A file **Metadata.json**, which contains metadata about the system deployment.
- A subfolder titled **Calibrations** contains log files for all calibrations performed.
- Each system deployment has its own subfolder, which contains all the data files relevant to that deployment.

Calibrations Subfolder

The **Calibrations** folder contains a log file for each system calibration performed. Each log file will be named with the following naming convention:

[SystemID]-[Device]-[ISODate].cal

Where:

- **[SystemID]** is the unique ID of the Pinnacle system, **PADCP-xxyy-nnnn**.
- **[Device]** is the name of the device being calibrated (for example **Compass**).
- **[ISODate]** is the date and time in ISO8601 format **YYYYMMDDThhmmss** (4-digit year, 2-digit month, 2-digit day, the letter **T**, 2-digit hour in 24-hour format, 2-digit minute, 2-digit second).

Deployment Subfolders

The **Data** folder contains one subfolder for each deployment of the system. The deployment subfolder will be named with the following naming convention:

[SystemID]-[ISODate]

Where:

- **[SystemID]** is the unique ID of the Pinnacle system, **PADCP-xxyy-nnnn**.
- **[ISODate]** is the date and time in ISO8601 format YYYYMMDDThhmmss (4-digit year, 2-digit month, 2-digit day, the letter **T**, 2-digit hour in 24-hour format, 2-digit minute, 2-digit second).

Each deployment folder will contain the following files and subfolders:

- A file **Metadata.json** containing deployment metadata describing the deployment details. The contents of this file are written by and defined by the *Pinnacle Utilities* software.
- For each calibrated device (nominally just the compass, in the future there may be others) the folder will contain a copy of the most recent calibration file prior to the start of the deployment.
- The log of the system configuration (system setup per user commands): **SystemConfig.txt**
- The data file QA log: **DataFileQA.log**
- One or more data files of raw PD0 data, named **Raw[nnn].pd0**, where nnn is a sequence number for the files.

- One or more data files of post-processed PD0 data, named **Proc[nnn].pd0**, where nnn is a sequence number for the files.

Metadata File

One of the key features of the Pinnacle file system is the metadata file that is provided for each deployment. The metadata file provides:

- A means for users to provide a custom name to their deployments.
- A means for users to provide additional information about the deployment, for example:
  - A free-text description of the deployment: location, conditions, and similar information
  - Latitude/longitude information.
  - Any other desired information (other equipment present, batteries used, et cetera).
- The ability to provide the above information using characters (such as Chinese or Japanese) that require an extension beyond the standard ASCII character set.

Data Quality File

A simple log file is generated that contains the following:

- First Ensemble Number, date & time
- Last Ensemble Number, date & time
- # of Valid Ensembles
- # of Missing Ensembles.
- # of Ensembles with BIT result other than zero or Error Status Word set to non-zero.
- Leak sensor status
  - If no leak sensor errors occurred, this line item is not displayed.
  - Open circuit detected; log: "Leak Detector A/B Not Found" (where A/B indicates which of the two leak detectors), date and time of first occurrence, and/or
  - Leak detected; log "Leak Detected on Leak Detector A/B" (where A/B indicates which of the two leak detectors), date and time of first occurrence.
- A count of any write failures received during the deployment. This combined with file size information, can help the user make decisions on how to proceed if the two memories mis-match. Note, if no write errors occurred then this line is not displayed.

> This log file is generated on the Fixed SD card, and is included with files that are transferred to the replaceable memory when the deployment is ended. This file relates to the Catalyst memory and should be taken only as representative of the replaceable memory files to the extent that the two files are the same.

System Config File

When the Pinnacle system is deployed, it creates a file **SystemConfig.txt** in the deployment folder. This file is a plain ASCII text file, containing the following information:

- Any Doppler configuration settings created by the Plan portion of *Pinnacle Utilities*.
- Any averaging configuration settings created by the Plan portion of *Pinnacle Utilities*.

- Any settings configured by the user in two letter commands through terminal window or created by the Plan portion of *Pinnacle Utilities*.

Sample SystemConfig.txt file

The sample given here is an example of a configuration as created by *Pinnacle Utilities*; it is only an example and not a prescription. The **SystemConfig.txt** file can be whatever is generated by the *Pinnacle Utilities* Plan module.

```
TB 0 00:00.00 00:00.00 00:00:00.00  Burst Configuration
TE 01:00:00.00 ---------- Time Between Ensembles
TP 00:04.00 ------------- Time Between Ping Groups
TO 100 ------------------ Ping Type Order, 0=none, 1=NB, 2=BB, 3=BT
WF 1000 ----------------- Blanking Distance (cm) [0-500]
WN 050 ------------------ Number of Bins [1-255]
WS 1600 ----------------- Bin Size (cm) [400-6400]
WP 000 ------------------ Number of Pings [0-999]
NF 1600 ----------------- Blanking Distance (cm)
NN 040 ------------------ Number of Bins [0-128]
NS 3200 ----------------- Bin Size (cm)
NP 150 ------------------ Number of Pings
BP 0 -------------------- Number of BT Pings in ensemble [0-999]
```

File and Folder Creation and Manipulation

Initial state of a freshly formatted memory card

- The file system contains the root directories **$$SAFE$$** (automatically created and managed by the SafeFAT file system) and **Data**.

When the compass or another device is calibrated

- A new file is written to the **Calibrations** folder. This file contains the calibration data and is given a filename containing the system ID, device being calibrated, and calibration date/time.

When a system is prepared for deployment

- *Pinnacle Utilities* stores all user information related to the deployment in the metadata file **MetaData.json** in the root **Data** directory.

When a deployment is started (deployed)

- A new folder is created within the **Data** directory. The folder name consists of a system ID and the deployment date / time.
- The metadata file **MetaData.json** is copied into the deployment folder.
- A new, empty metadata file **MetaData.json** is created in the base **Data** folder.
- The most recent calibration files for each device are copied from the **Calibrations** folder into the deployment folder.
- The system configuration (commands used to configure the system for deployment, or a structured data file describing the system setup) is written to a file **SystemConfig.txt** in the deployment folder.

During the deployment

- Raw PD0 is written / appended into the deployment folder in file **Raw001.pd0**, and may be split across multiple files.
- Processed PD0 data is written / appended to one or more PD0 files **Proc001.pd0**, **Proc002.pd0**, etc.

- Analysis of PD0 data integrity is performed and written / appended to file **DataFileQA.log**.
- System messages and faults are written / appended to **SystemLog.txt** and **FaultLog.txt**, respectively.

When a deployment is stopped

- Writes to all data and log files are completed and finalized.
    - Raw PD0 data files
    - Processed PD0 data files
    - DataFileQA.log

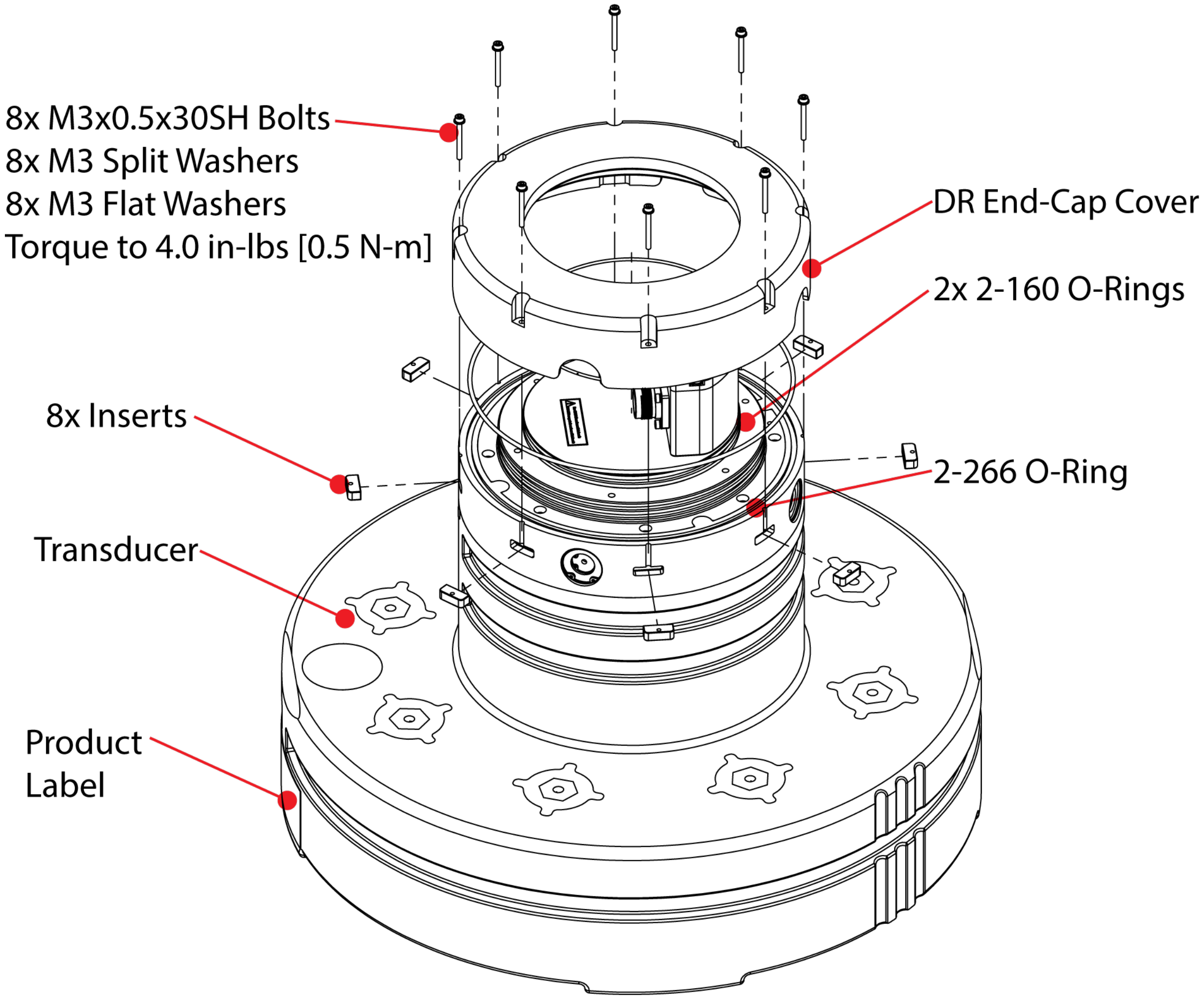
Chapter 4

MAINTENANCE

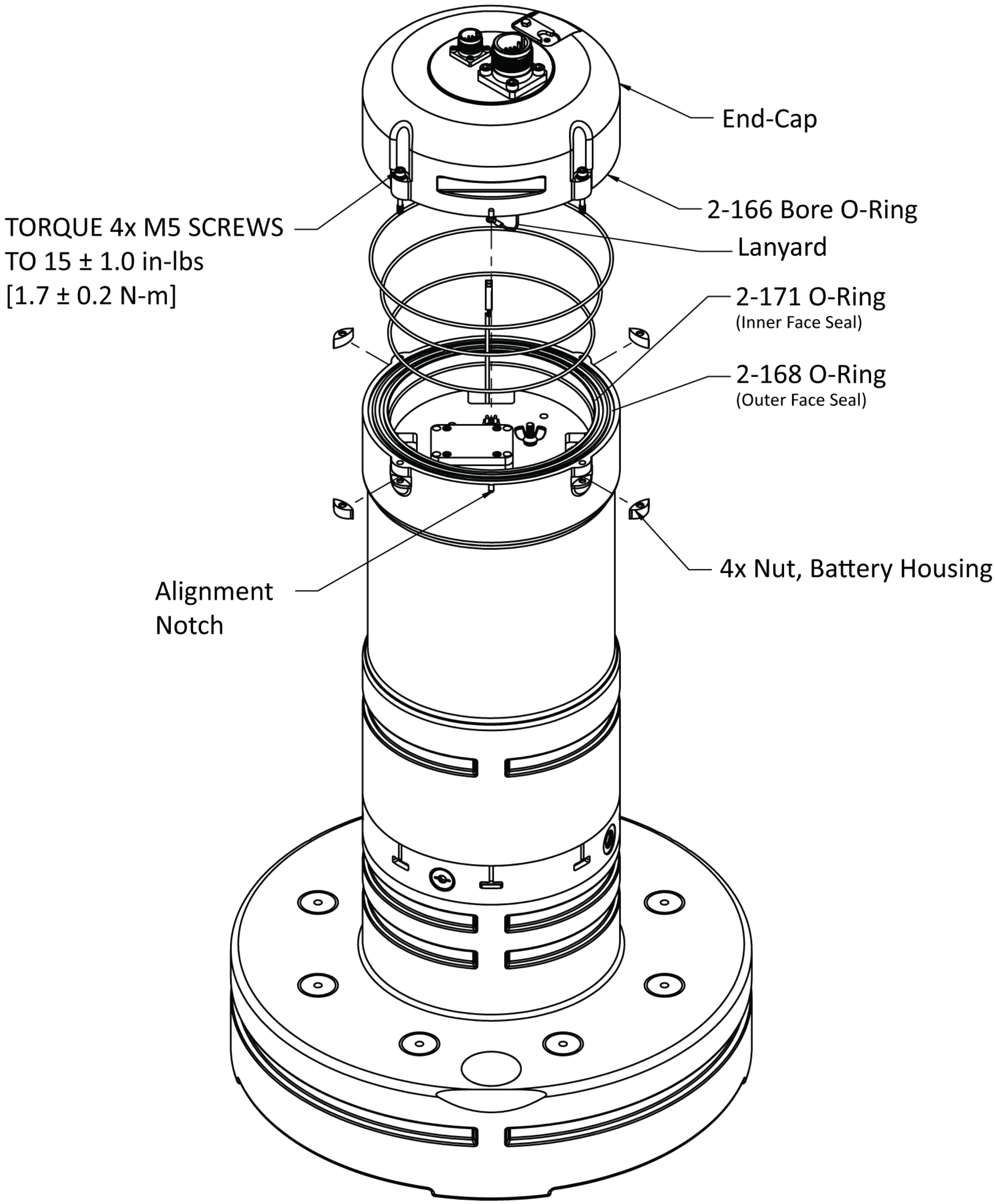
This chapter covers:

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

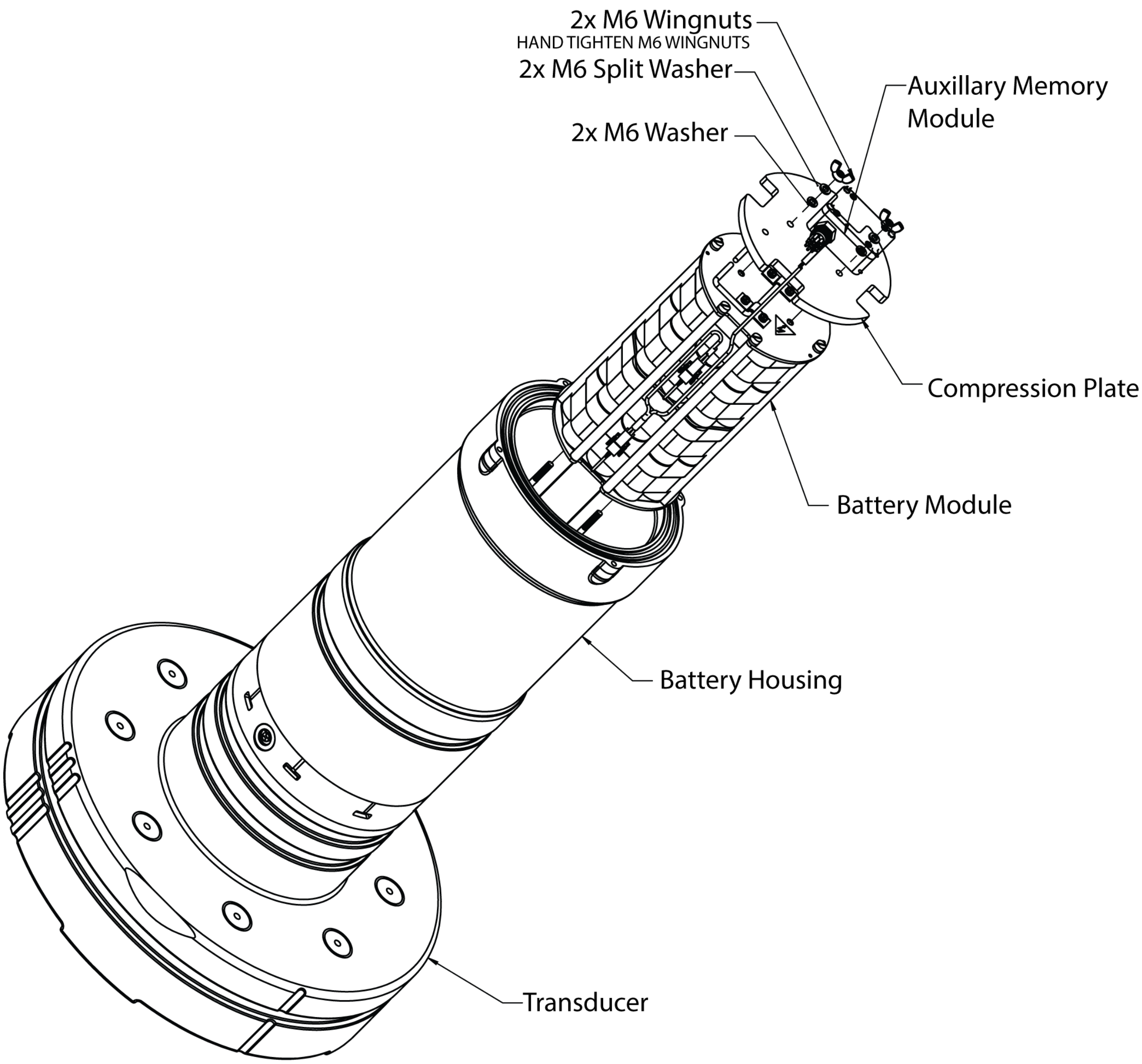
Part Location Drawings



Replace all O-rings every two to three years maximum.



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 Pinnacle Self-Contained batteries, the end-cap is removed. Replace the end-cap O-rings each time the end-cap is removed.



2x M6 Wingnuts
HAND TIGHTEN M6 WINGNUTS
2x M6 Split Washer
2x M6 Washer
Auxillary Memory Module
Compression Plate
Battery Module
Battery Housing
Transducer

Spare Parts Kits

The following tables show the spare parts included with the system.

Table 6. Direct-Reading Pinnacle Spare Parts Kit P/N 75BK6114-00

Part Number	Part Description	Quantity
3040T13	EYEBOLT, M8X1.25, 16MM THREAD LG, STEEL	4
5020	SILICONE LUBRICANT, 4-PACK	1
5503A38	L-KEY, HEX, 2.5MM	1
71B-6092-00	HANDLES, W/ CARABINERS, PINNACLE	2
84Z-6000-00	TOOL BAG, CANVAS	1
97Z-6145-00	O-RING, 2-160, EPDM	2
97Z-6166-00	O-RING, 2-266, DURO 70, EPDM	2
M3WASHSMOD	WASHER, FLAT, 6MM OD, 316 SST	16
M3WASHSPL	WASHER, SPLIT LOCK, 316SST	16
M3X0.5X30SH	SCREW, SOCKET HEAD SST	16

Table 7. Self-Contained Pinnacle Spare Parts Kit P/N 75BK6124-00

Part Number	Part Description	Quantity
84Z-6000-00	TOOL BAG, CANVAS	1
5020	SILICONE LUBRICANT, 4-PACK	2
9557K209	O-RING,2-171, EPDM, A70, STREAM RESISTANT	2
97Z-6035-00	O-RING, 2-165, DURO 70, EPDM	4
97Z-6036-00	O-RING, 2-166, 70 DURO, EPDM	2
97Z-6038-00	O-RING, 2-168, DURO 70, EPDM	2
97Z-6166-00	O-RING, 2-266, DURO 70, EPDM	2
9557K123	O-RING, 2-031 EPDM	4
97Z-6012-00	O-RING, 2-017, DURO 70, EPDM	4
97Z-6010-00	O-RING,2-015, DURO 70, EDPM	4
M4X0.7X10HHN	SCREW, HEX HEAD NYLON	4
5522A26	SOCKET EXTENSION, 24" LENGTH, 3/8" DRIVE	1
9170008	L-KEY, 4MM, HEX, BALLPOINT	1
3040T13	EYEBOLT, M8X1.25, 16MM THREAD LG, STEEL	4
54185A22	HEX BIT, 4MM, BALL, 3/8" DRIVE	1
DES2	DESICCANT, SEALED BAG,1/3 UNIT	4
T18S	TIE WRAP	4

Replaceable Parts

Use the following table to order replacement parts:

Table 8: Pinnacle Replaceable Parts

Description	Part number	Where used
Alkaline Battery Pack Kit (includes 1 battery, desiccant, and 2 rubber bands)	757K6051-00	
Battery Pack, Lithium, 1500-Watt Hours, WH	TLP-83131/I/BE1A	Self-Contained Housing
Memory Card, Micro SDHC,32GB, CLASS 10, UHS CLASS 1	SFSD032GN3BM1TO-I-HG-2B1	

Turnaround Maintenance

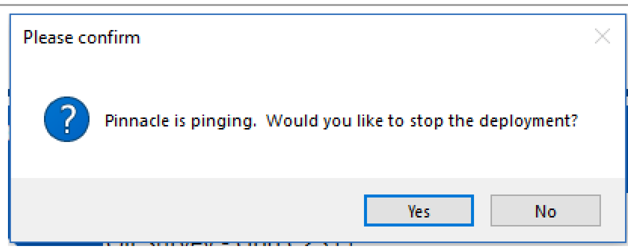
Before a Pinnacle SC system is installed into its deployment environment, or when it has been removed from its deployment environment and/or mounting structure to be serviced, use *Pinnacle Utilities* software to download data or clear memory.

For information on starting a deployment, erasing the recorder, viewing and exporting data, see the *Pinnacle Utilities* help file and the SC Deployment Guide.

Stopping a Deployment

The deployment must be stopped before downloading data or before opening the self-contained module and dismounting the removable recorder (SD memory card). This is necessary, and standard best practice to ensure that the recorder is not being accessed at the time of dismount.

To stop the deployment:

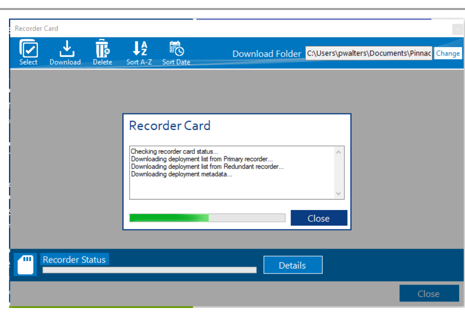


Start *Pinnacle Utilities* and connect to the Pinnacle ADCP.

Click **Yes** to stop the deployment.

Note that if you select **No**, Pinnacle Utilities will disconnect from the ADCP and continue the deployment.

If you can not connect to the system, see Downloading SC Data Using a Card Reader.



Upon connecting to the Pinnacle and stopping the deployment, the Pinnacle will ensure that all data is written and finalized. For example, if data still exists in the Doppler output buffer, that buffer will be flushed, processed, and written to the recorders.

Pinnacle Utilities software will then compare the files on the fixed recorder and the removable recorder (SD memory cards) to provide immediate feedback to the user. Verify both recorder cards match.

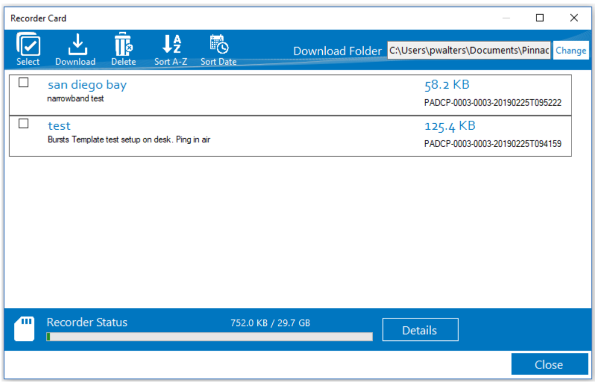
Downloading Data Files

To download data via Ethernet:

Start *Pinnacle Utilities* and connect to the Pinnacle ADCP via Ethernet.

Click the Recorder Card **Show** button to Manage/Download the recorder.

The recorder card screen will open.



Pinnacle Utilities will display a list of deployments on the instrument.

Use the **Select** Button to select all (click again to select none) or select the checkbox to select deployment(s) for download.

Click the **Change** button to set the Working folder location.

Click the **Download** button to start to download all checked/selected deployments. The progress bar shows the progress in percent, time remaining, and bytes downloaded/total bytes.

Removing the SC End-Cap

To gain access to the batteries and replaceable memory, the end-cap must be removed.

Tools and Equipment Required:

Tools / Equipment	Comments / Where Used
7mm wrench or adjustable wrench	Purge plug removal / installation
4mm hex key	Endcap bolts installation / removal
Silicone lubricant	O-ring lubricant
2.5mm hex key	Auxiliary Memory bolts installation / removal
Flathead screwdriver	Battery Case opening / closing

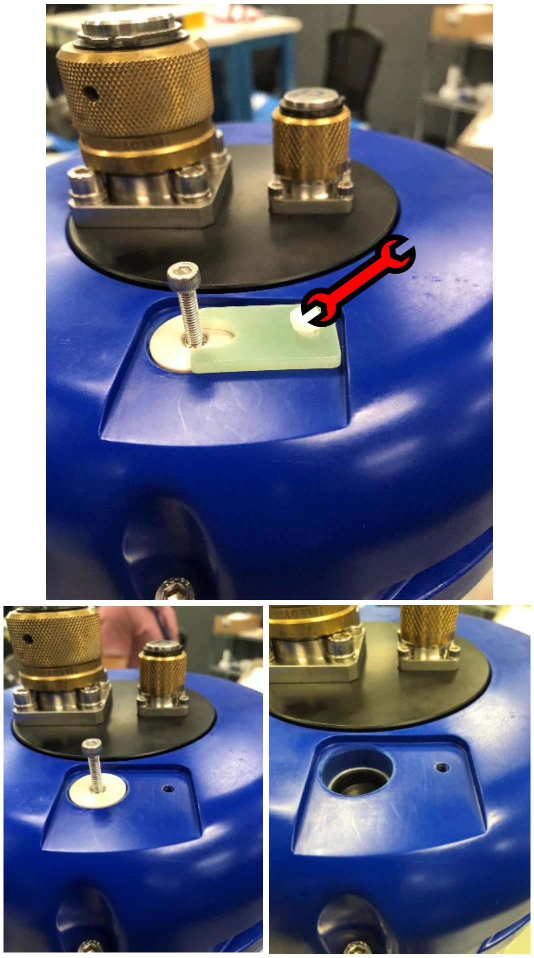
Before opening the instrument, stop the deployment.

Caution label on housing near 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.

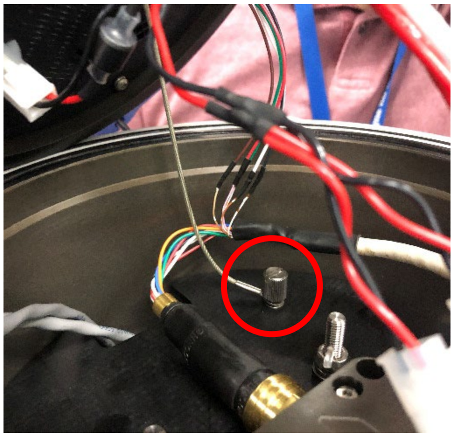
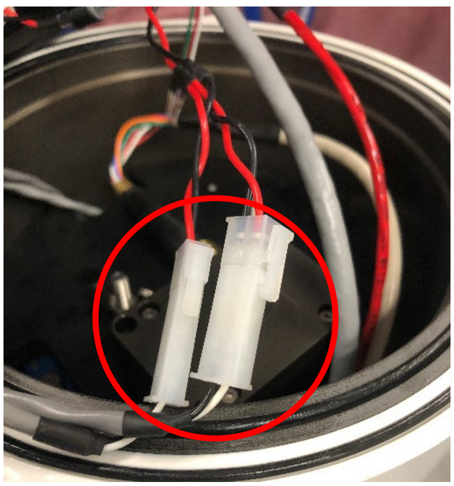
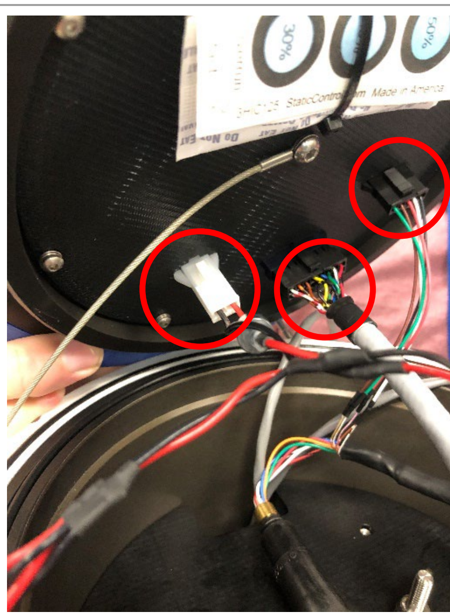
Remove the purge plug

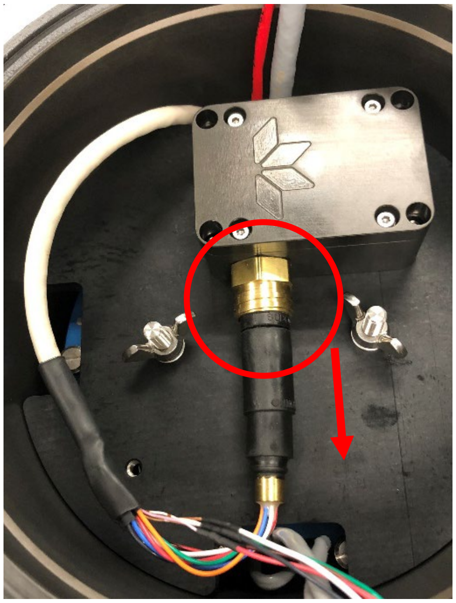


1. Remove any external power to the Pinnacle.
2. Remove the Power/Data/COM cable. Do not allow debris or moisture to enter the contacts of the connector. Install the dummy plugs to protect the connectors.
3. Thread a M4 bolt into the insert on the purge plug.
4. Use a 7mm wrench or adjustable wrench to loosen the nylon hex head bolt to remove the purge plug keeper.
5. Remove the purge plug by pulling up vertically.

End-Cap Removal

1. Use a 4mm hex key to loosen the four captive M5 bolts holding the endcap onto the housing.
2. Using the two handle cutouts in the sides of the endcap, gently lift the endcap off the housing vertically just enough to disconnect the cables. The end cap is attached to the electronics by four cables and a safety tether.

	3. Release the safety tether by undoing the thumbscrew on the compression plate.
	4. Disconnect the two battery cables first.
	5. Disconnect the 2-pin Molex connector from the SC endcap. 6. Disconnect the 16-pin Molex connector from the SC endcap. 7. Disconnect the 5-pin Molex connector from the SC endcap.



8. Disconnect the 8-pin connector from the auxiliary memory module.

The endcap is now free from the housing and can be set aside.

Replacing the Batteries

The Pinnacle Self-Contained systems use battery packs to provide power (four or two battery cores). Alkaline battery pack cores should be replaced when the voltage falls below 30 VDC (measured across the battery pack core connector). Lithium batteries should be replaced when the self-test shows a continuous red LED.

Battery replacement induces both single and double cycle compass errors. Compass calibration is available, but not required. Raw ISM data is stored for post-correction to remove magnetic influences.

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

Test the new alkaline battery pack voltage by measuring across the battery connector. The voltage should be +42 VDC for a new battery pack. Verify the battery is within the Warning date.

Test a Lithium battery pack using the self-test safety circuit.

Do NOT mix alkaline and Lithium battery cores.

The Lithium packs are too large to fit inside the battery modules; they can be installed directly inside the housing without using the battery modules. The compression plate holds them in place. This works well because the lithium battery packs are light. They are 60% less weight than an alkaline pack.

Testing the Lithium Battery Pack

The optional Lithium battery pack includes a safety circuit that turns the battery off at its end of life, before the battery fully discharges. This happens when about 97% of the battery's capacity is depleted. The circuit also protects the battery and users against short circuits and provides users the ability to test the pack. When the battery detects a short circuit, it waits about 300 us, and then it turns itself off. A red LED on the circuit indicates when it detects a short. The circuit monitors the load across the battery and as soon as the load is removed, it displays the results of its self-test.

Before installing the Lithium battery pack run the self-test by shorting the battery's pins with a bent paperclip. The LED display lasts approximately 10 seconds and indicates the battery status:

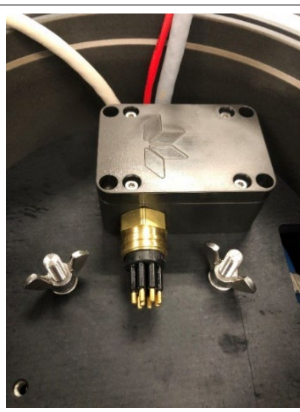
- A continuous green LED tells you the battery is new.
- A flashing green LED tells you the battery has been used but can still power an ADCP.
- A continuous red LED tells you the battery has been disconnected at its end of life and cannot be used any more.
- If there is no LED light at all, the circuit is defective, and you should not use the battery.

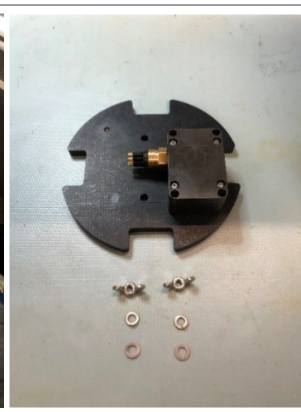
You should run the self-test when you receive new lithium battery packs. This way, there is time to replace defective batteries before you deploy. You should also run the self-test just before installing the battery.

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.

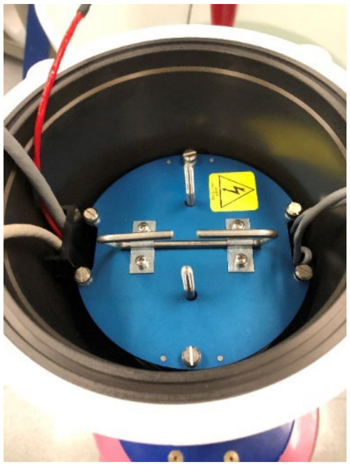
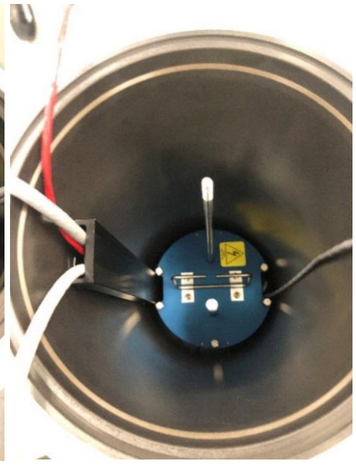
The optional Lithium battery packs are restricted to Cargo Aircraft Only since 1 January 2015. Do NOT return Pinnacle system with the optional Lithium battery pack installed.

Removing the Battery Modules





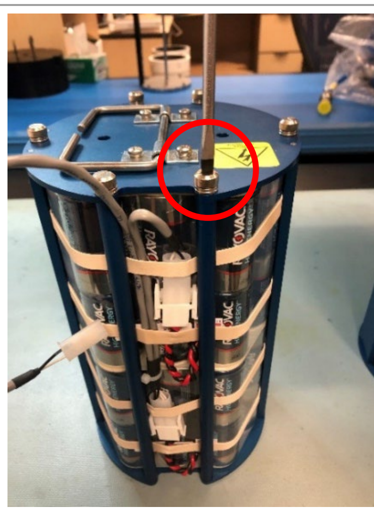
1. Loosen the wingnuts on the compression plate and remove all the hardware. Set aside the two M6 wing nuts, two M6 Split Washers, and two M6 washers.
2. Remove the compression plate and auxiliary memory module by lifting vertically over the rods.

3. Use the handle to lift the upper battery module out of the housing.
4. Use the handle to lift the lower battery module out of the housing.

Systems with two batteries will only have the upper battery module and a shorter housing.

Replacing the Battery Cores

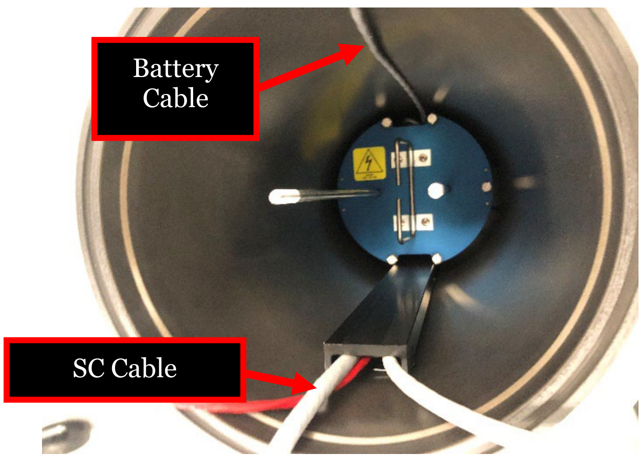


1. Loosen the six captive bolts on the top of the battery cage using a flat head screwdriver.
2. Remove the battery cage lid by lifting vertically off the alignment dowel pins.

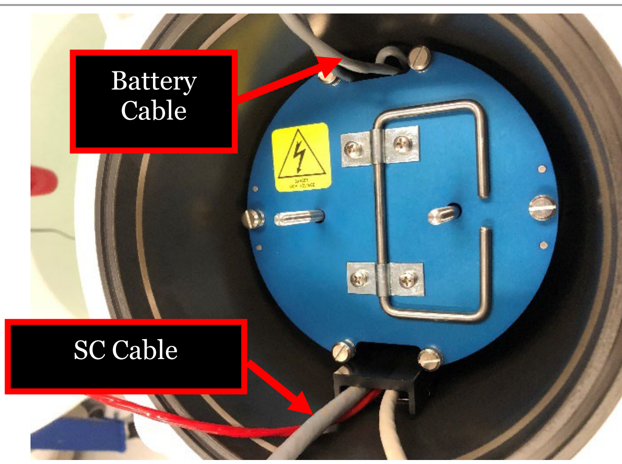

3. Unplug the cable from the batteries and remove the cable by threading it through the rubber bands.
4. Remove the depleted batteries.

5. Install the new batteries into the cage.
6. Plug the cable into the batteries. Route cable behind the rubber bands to secure it out of the way.
7. Align the battery cage lid with the dowel pins and push down until firmly seated.
8. Secure the battery cage lid with the six captive bolts. Tighten in a star pattern and torque to 6 in-lbs [0.68 N-m].
9. Repeat steps 3 to 10 for the second battery module.

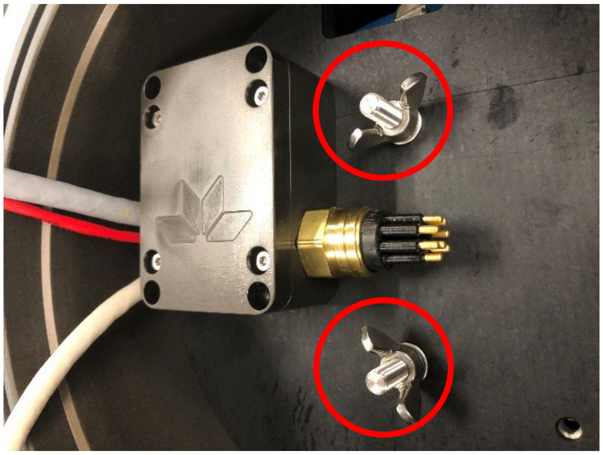
Installing the Battery Modules



1. Align the lower battery pack with the two rods and the battery cable on the opposite side of the SC cable guide.
2. Lower into the housing until it reaches the bottom.
3. Fold the handle down to either side.
4. Hold or secure the battery cable at the top so it doesn't fall into the housing.

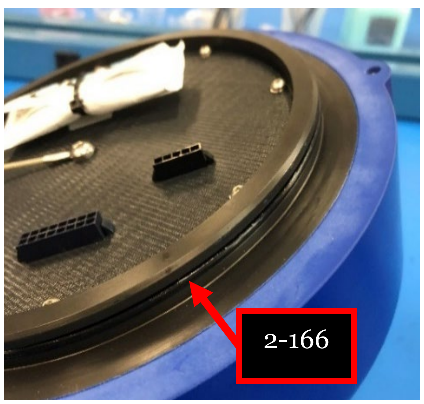


5. Align the upper battery pack with the two rods and the battery cables on the opposite side of the SC cable guide.
6. Lower into the housing until it sits flat on the other battery pack.
7. Fold the handle down to either side.



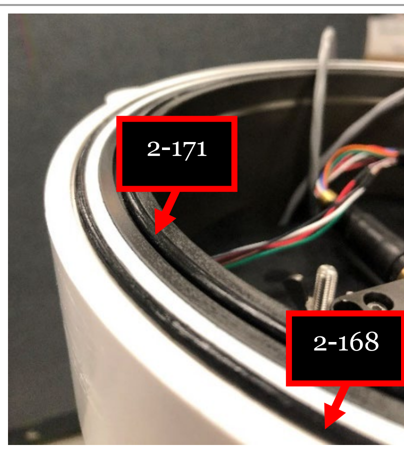
8. Align and lower the compression plate over the top of the batteries.
9. Secure with two M6 wing nuts, two M6 split-washers, and two M6 washers.
10. Hand tighten the wingnuts.

Installing the End-Cap

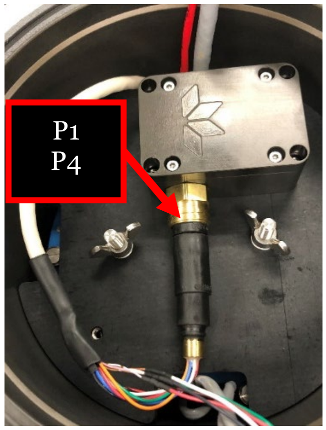


1. Prepare the O-ring surfaces and grooves on the SC endcap and SC housing by cleaning with IPA and ensuring they are free of any dust or particles.
2. Inspect the O-rings for any damage. Ensure they are free of any dust or particles. Replace the O-rings if needed.
3. Lubricate the 2-166 O-ring with silicone lubricant and install into the bore seal groove on the SC Endcap.

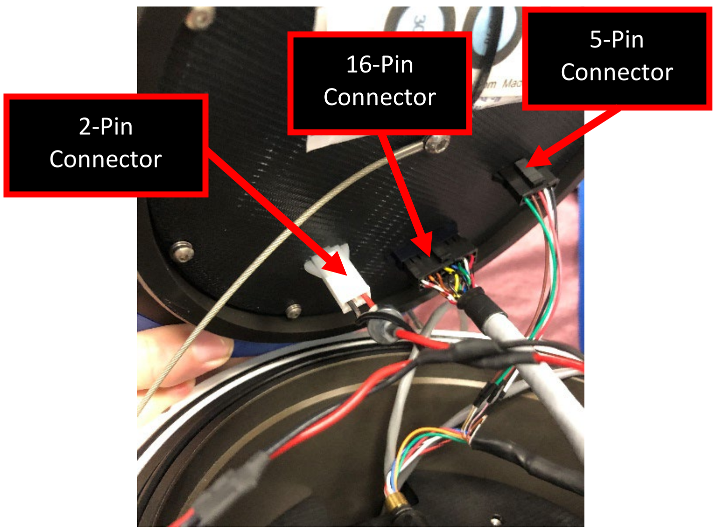
TRDI always recommends using new O-rings.



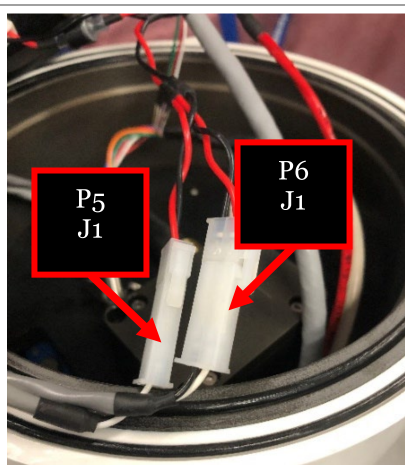
4. Lubricate the 2-171 O-ring with silicone lubricant and install into the inner face seal groove on the SC Housing.
5. Lubricate the 2-168 O-ring with silicone lubricant and install into the outer face seal groove on the SC housing.



6. Plug P4 on the SC Cable into P1 on the Auxiliary Memory Module. Route the cables around the module as shown.

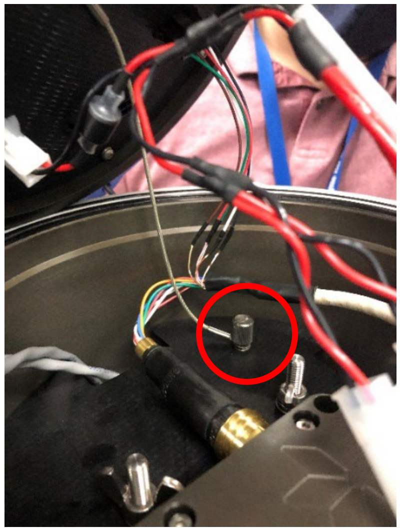


7. Connect the 2-pin Molex connector to the SC endcap.
8. Connect the 16-pin Molex connector to the SC endcap.
9. Connect the 5-pin Molex connector to the SC endcap.



10. Plug the two J1 connectors from the battery packs into P6 and P5 on the SC Cable.

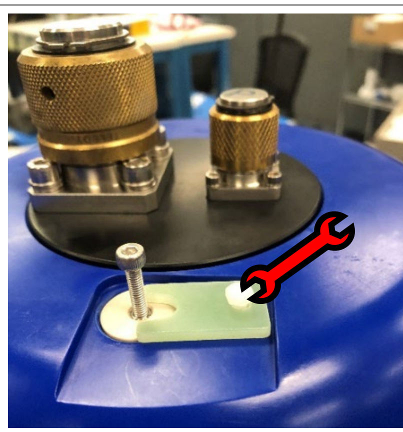
Plugging in the batteries will power the instrument. This is indicated by the LED on the RT Endcap beginning to flash. If you are not testing or deploying the instrument right away, leave these connectors unplugged.



11. Secure the safety tether with the captive screw to the base plate. Hand-tighten the thumb screw.

12. Align the notches on the top of the housing and the endcap and rest the endcap on the housing.
13. Ensure that no cables are being pinched. Push the endcap down until fully seated and the holes are aligned.
14. Tighten the captive hardware with a 4mm hex key. Torque to 15 ± 1.0 in-lbs [1.7 ± 0.2 N-m].

Installing the Purge Plug

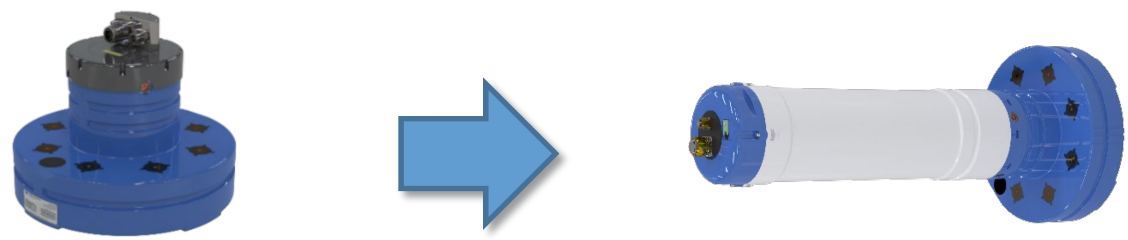


1. Inspect the purge plug O-rings and replace if necessary (2-015 and 2-017 O-rings).
2. Lubricate the O-rings with silicone lubricant.
3. Install the purge plug back into the SC Endcap.
4. Secure the purge plug keeper with the Nylon M4 hex head bolt. Torque 2.5 ± 0.5 in-lbs [0.3 ± 0.1 N-m].
5. Remove the M4 bolt.

Converting Between DR and SC

The Pinnacle ADCP supports a modular design that can be field converted between Self-Contained (SC) and Direct-Read (DR) configurations. The Self-Contained version includes a removable recorder (SD memory card) in the battery module that needs to communicate with the electronics inside the Direct-Read module.

DR to SC



Tools and Equipment Required:

Table 9. PIN45-CONV CONVERSION KIT, RT TO SC, PINNACLE

Sales Part No	Description
75BK6128-00	KIT, PINNACLE 45 KHZ, CONVERSION, RT TO 4X BATT SC
MRDI1178	CASE, SHIPPING, PINNACLE SC
75BK6124-00	KIT, TOOLS AND SPARES, PINNACLE, SELF CONTAINED

User Supplied:

Tools / Equipment	Comments / Where Used
2.5mm hex key	Cover ring bolts removal (included with DR spare parts kit)
Wire cutters or equivalent	Cut cable tie loose ends
Socket wrench with 3/8” drive	Use with 4mm Hex Bit Socket Extension Tool
7mm wrench or adjustable wrench	Purge plug removal / installation

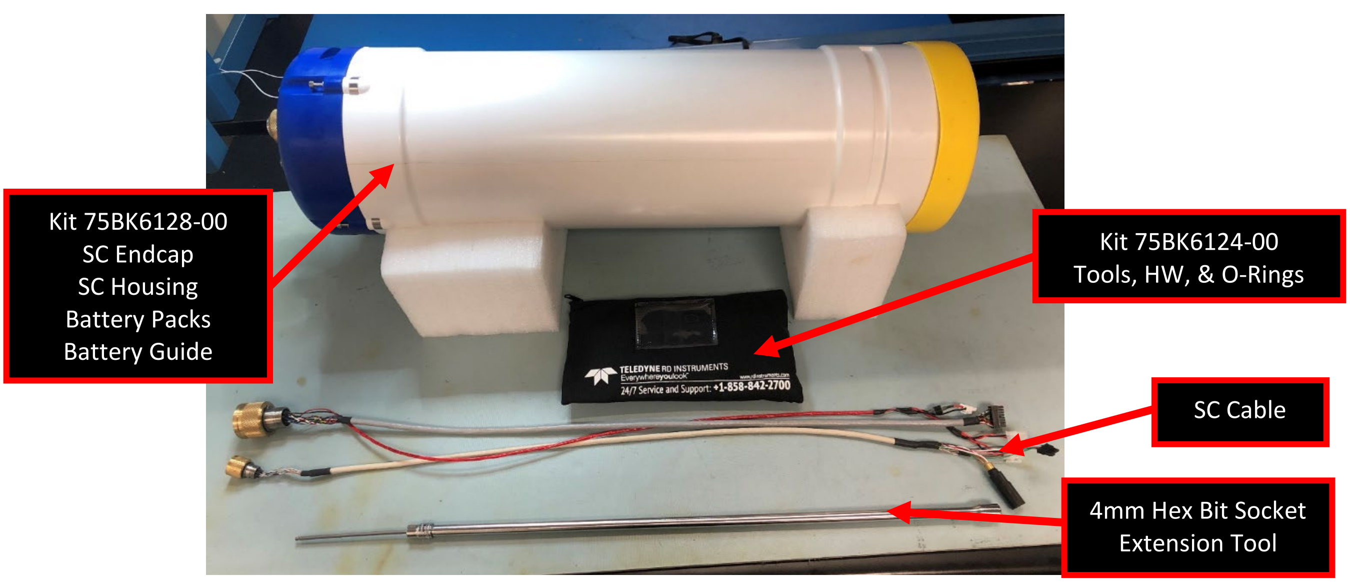
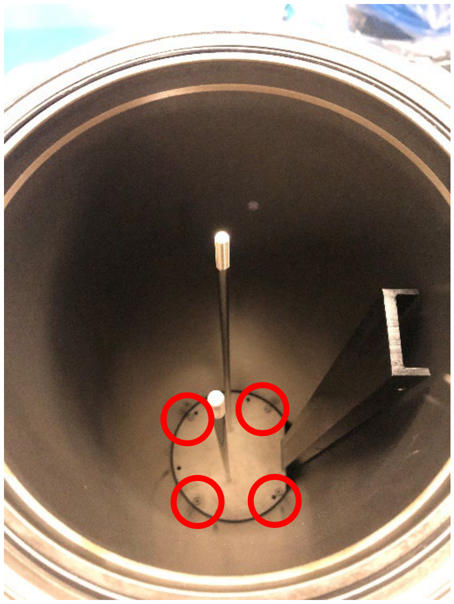


Figure 28. Self-Contained Module (Shipping Configuration)

	Disassemble the SC module from the shipping configuration into individual components: 1. Remove the Purge Plug 2. Remove the End-Cap 3. Remove the Battery Modules 4. Use the socket extension with the 4mm hex key to loosen the four captive bolts inside the housing. 5. Carefully lift the battery guide vertically out of the housing.

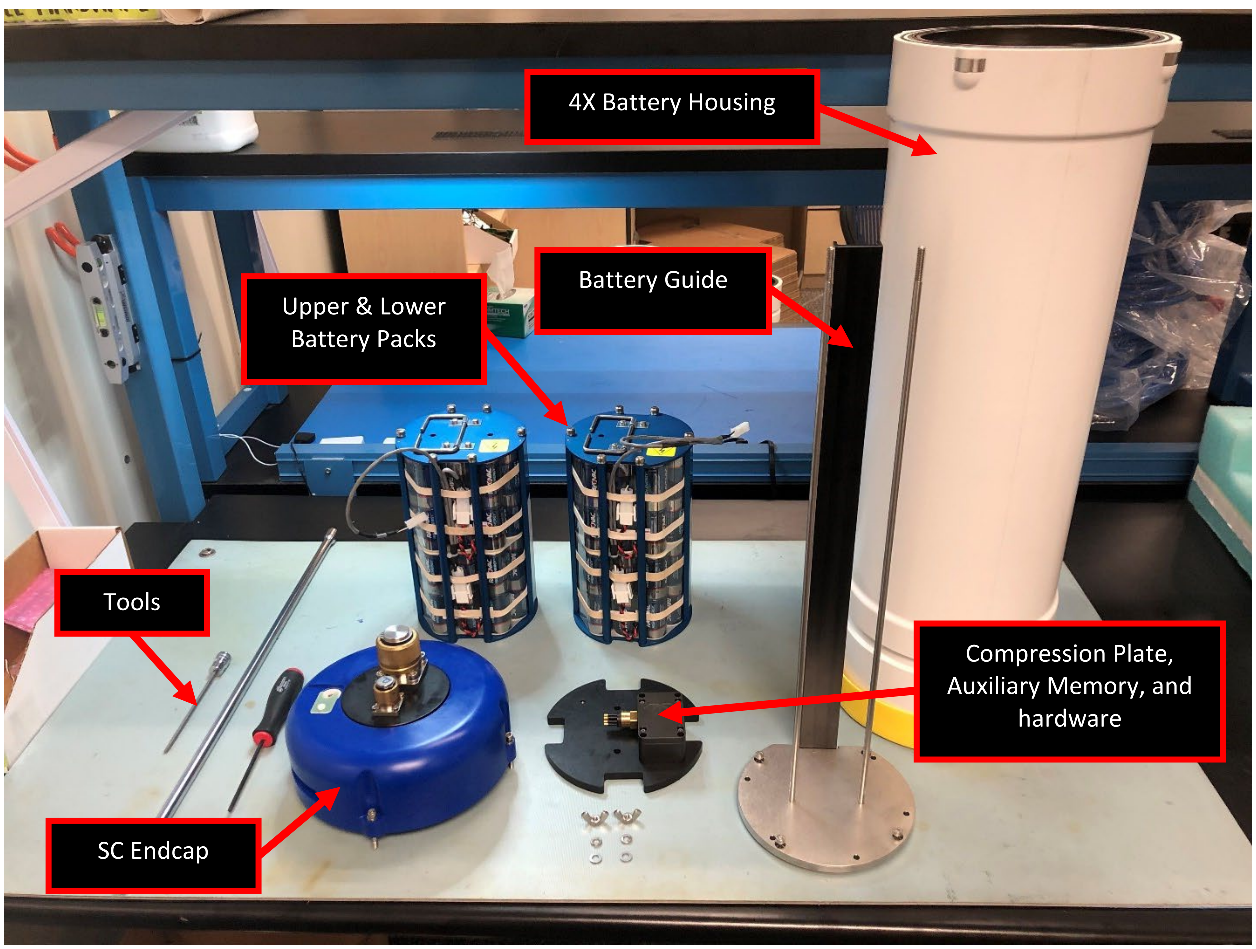


Figure 29. Self-Contained Module (ready to be installed onto the Base Instrument)

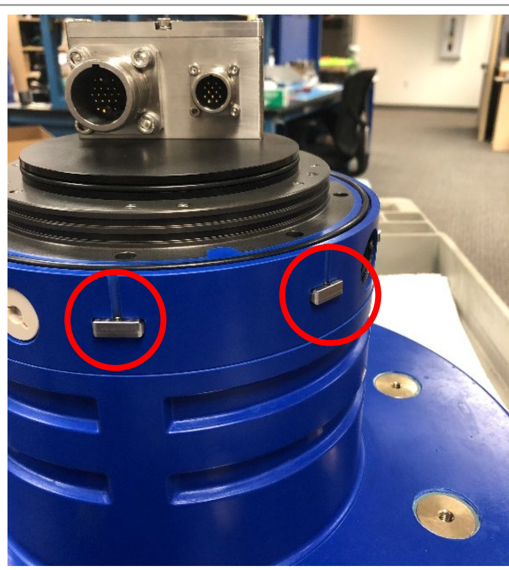
Conversion Procedure

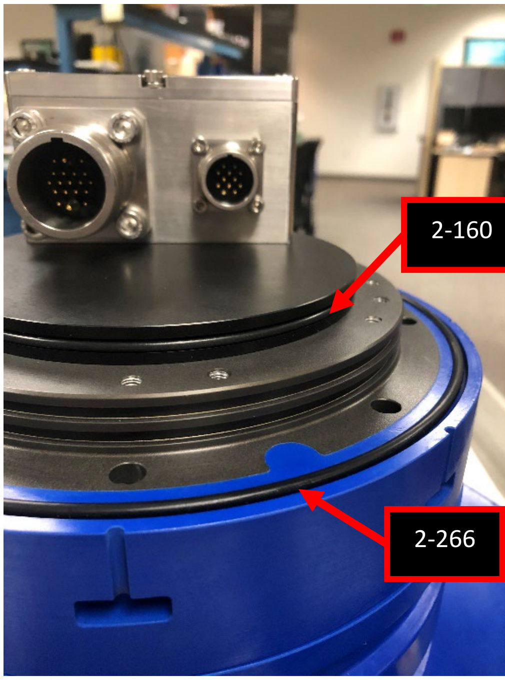
Caution label on housing near DR end-cap

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.

Cover Ring Removal

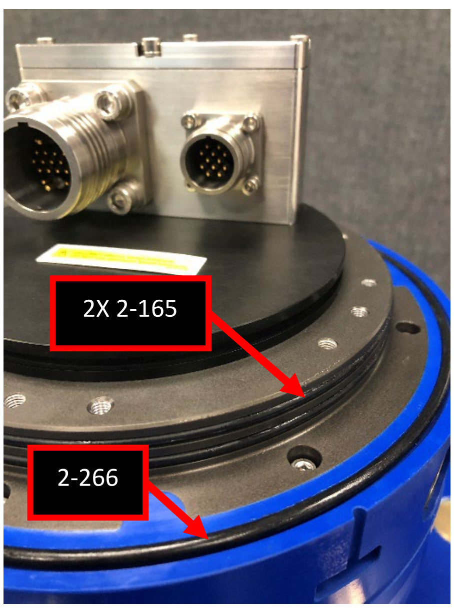
	1. Use a 2.5mm hex key to loosen the eight M3 bolts around the cover ring. Loosen evenly in a star pattern. 2. Remove eight M3X0.5X30SH bolts, eight M3 split-washers, and eight M3 washers and set aside. 3. Lift the cover ring vertically to remove.

	4. Collect the eight nut inserts and set aside.



5. Remove the 2-160 O-ring from the bore seal groove on the Delrin isolator on the DR Endcap.
6. Remove the 2-266 O-ring from the face seal groove on the DR Endcap.

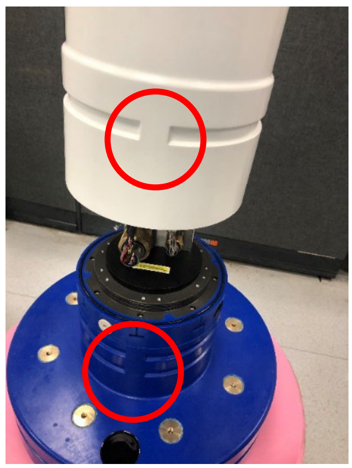
Housing Installation



1. Prepare the O-ring surfaces and grooves on the DR Endcap and SC Housing by cleaning with IPA and ensuring they are free of any dust or particles.
2. Inspect the O-rings for any damage. Ensure they are free of any dust or particles.
3. Lubricate the two 2-165 O-rings with silicone lubricant and install into the bore seal grooves on the DR endcap.
4. Lubricate one 2-266 O-ring with silicone lubricant and install into the face seal groove on the DR endcap.

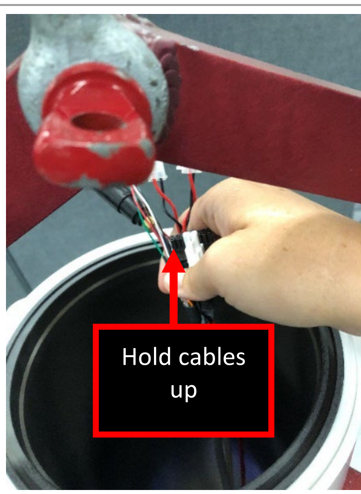
TRDI always recommends using new O-rings.

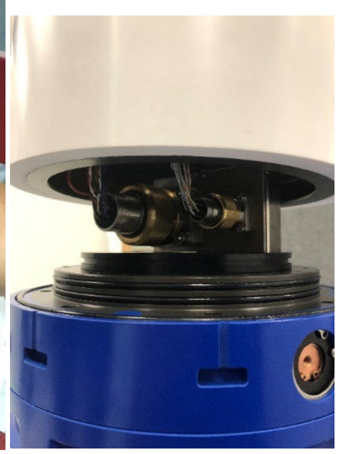

5. Connect the SC Cable (73B-4015-01) to the connectors on the DR endcap.
6. Plug P19 on the SC Cable into the 19-pin connector on the DR Endcap. Ensure that the key is aligned and then twist the locking sleeve in a clockwise direction until the connector is fully engaged.
7. Plug P12 on the SC Cable into the 12-pin connector on the DR Endcap. Ensure that the key is aligned and then twist the locking sleeve in a clockwise direction until the connector is fully engaged.

8. Lift the SC housing and position over the DR Endcap on the base instrument.
9. Visually align the notches on the external grooves features and slowly lower the housing down onto the DR Endcap.

Using a hoist to lift the housing will allow for more control to position and lower the housing onto the endcap slowly. This will also allow for easy inspection of the O-rings and cables as the housing is lowered to make sure they aren't pinched.



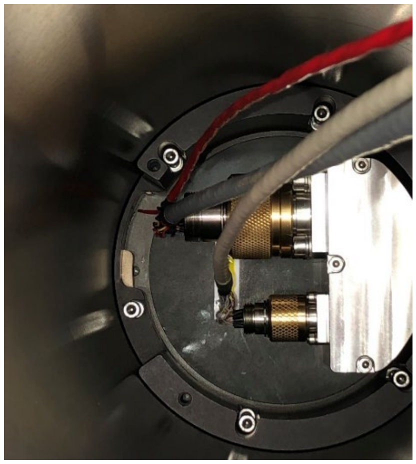


10. Feed the cable up through the housing.

Ensure that the cables are held straight up to prevent them from being pinched as the housing is lowered.

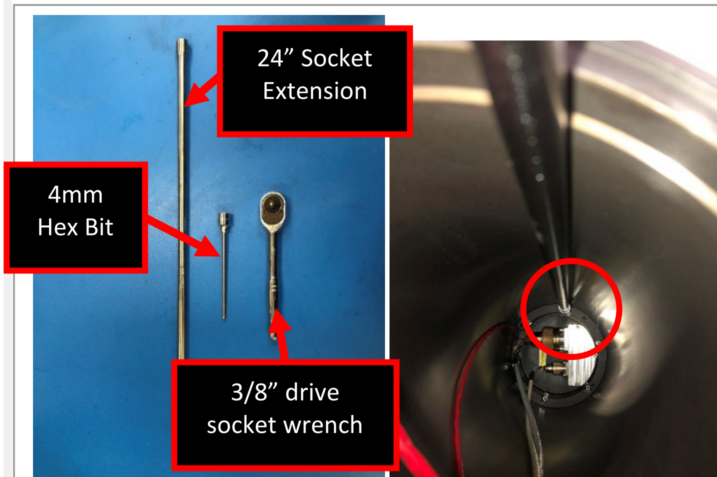
Inspect the housing as it is very slowly lowered onto the endcap to make sure that bore seal O-rings are not pinched.

Lubricate the sealing surface inside of the housing to allow the housing to slide onto the endcap easier.



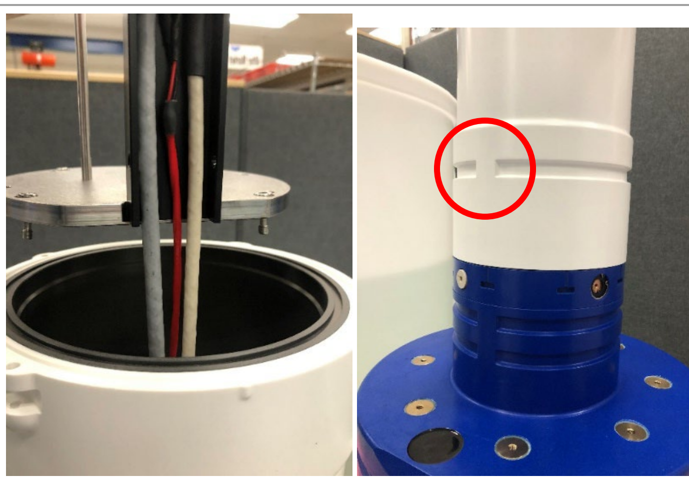
11. Once the housing is fully seated on the Base Instrument, rotate until the external notches and the captive hardware inside are aligned.

Use a flashlight to illuminate the inside of the housing to visually confirm that the captive hardware is aligned with the mounting holes.

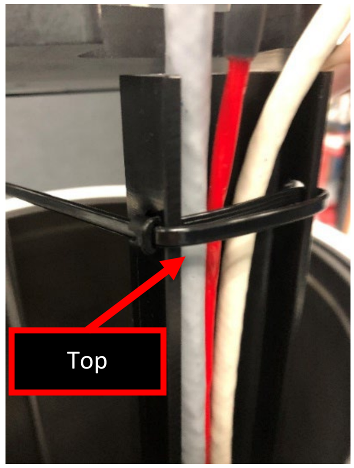


12. Use the 4mm hex bit, socket extension, and socket wrench to tighten the six captive M5 bolts inside the housing.
13. Tighten in a star pattern.
14. Torque to 15.0 ± 1.0 in-lbs [1.7 ± 0.2 N-m].

Battery Guide Installation



1. Hold or secure the SC Cables at the top of the housing.
2. Lift the battery guide above the SC housing and align the cable guide with the external notches on the groove feature.

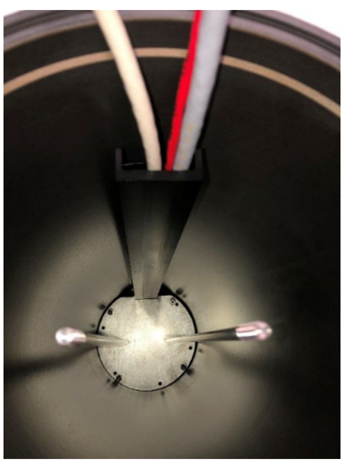


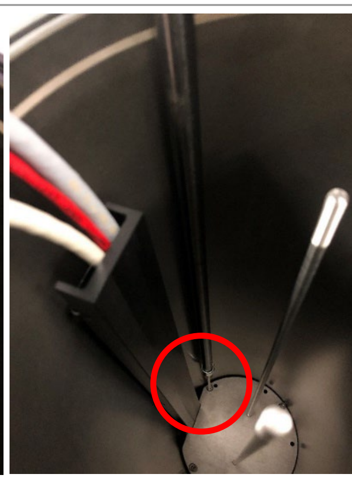
3. Feed the cables along the cable guide as the battery guide is lowered into the housing.
4. Secure the cables in place in three places with cable ties using the holes at the bottom, middle, and top of the cable guide.

Use two people to install the battery guide into the housing. One person will hold and lower the battery guide and the second person will manage the cables and secure with cable ties as the guide is lowered.

Secure the cables in between the cable tie and the cable guide.

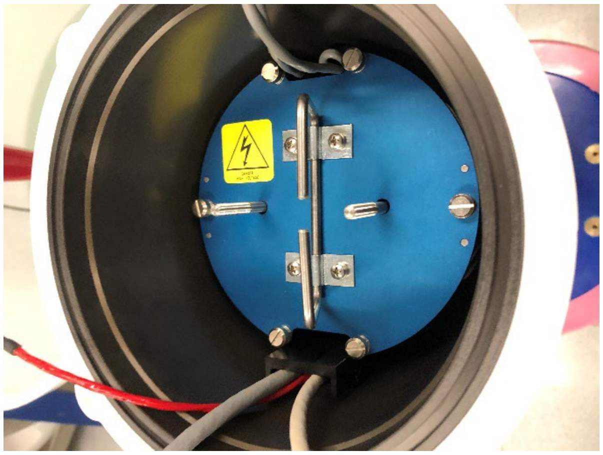
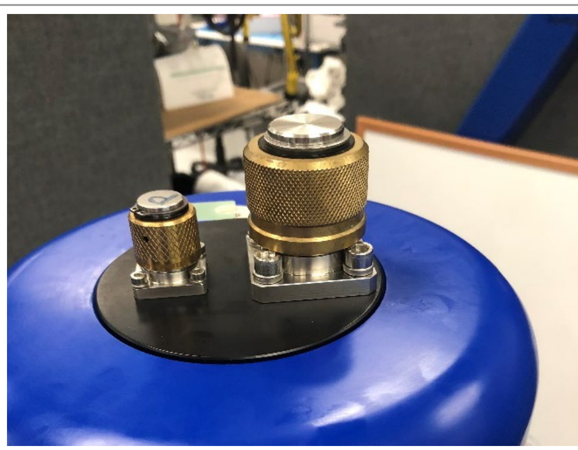
Move the cable tie around to the side of the cable guide so that it is out of the way of the housing as the battery guide is lowered.



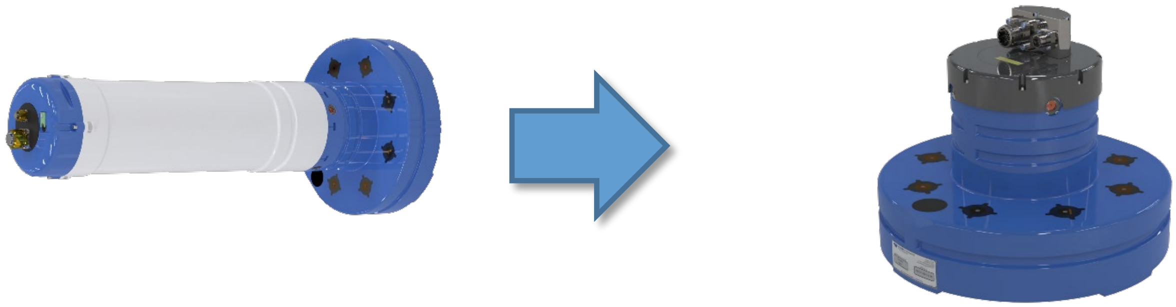


5. Once the battery guide is lowered into the housing, align the captive hardware with the mounting holes.
6. Use the socket extension for the 4mm hex key to tighten the four captive M5 bolts inside the housing. Torque to 15.0 ± 1.0 in-lbs.

Final Assembly to SC Configuration

	1. Install the battery modules.
	2. Install the compression plate over the top of the batteries.
	3. Install the end-cap. 4. Install the purge plug. 5. Connect to the system using *Pinnacle Utilities* to test and configure the system for a SC deployment. 6. Install the MKS-500-SCP dummy plug onto the 19-pin connector. Hand tighten the dummy plug. 7. Install the MKS-3XL00-SCP dummy plug onto the 12-pin connector. Hand tighten the dummy plug.

SC to DR



Tools and Equipment Required:

Table 10. 75BK6127-00 KIT, CONVERSION, SC TO RT, PINNACLE

Part Number	Part Description	Quantity
81B-1247-00	COVER, END JOINT, DIRECT READ, PINNACLE, VERSION 2	1
81B-4318-00	NUT, COVER RING, PINNACLE, DIRECT READ	8
M3X0.5X30SH	SCREW, SOCKET HEAD SST (3 sets)	24
M3WASHSMOD	WASHER, FLAT, 6MM OD, 316 SST (3 sets)	24
M3WASHSPL	WASHER, SPLIT LOCK, 316SST (3 sets)	24
97Z-6166-00	O-RING, 2-266, DURO 70, EPDM	3
97Z-6145-00	O-RING, 2-160, EPDM	3
5020	SILICONE LUBRICANT	2
5503A38	L-KEY, HEX, 2.5MM MCMASTER-CARR	1
84Z-6000-00	TOOL BAG, CANVAS	1
CAPYELLOW	CAP,XDCR,YELLOW,VINYL9 IDX 1.75 CAL SEALING	1

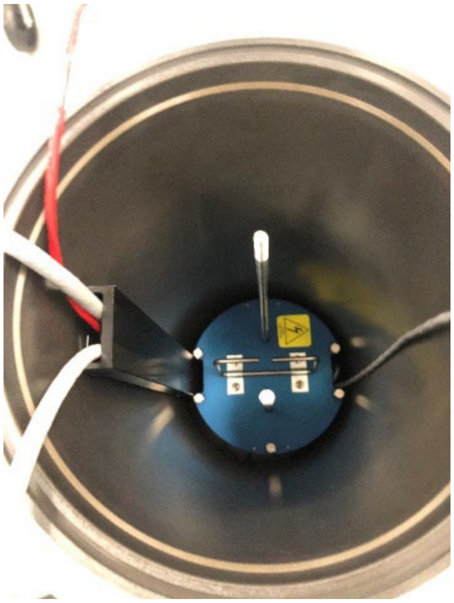
Provided in 75BK6124-00 KIT, TOOLS AND SPARES, PINNACLE, SELF CONTAINED:

Tools / Equipment	Comments / Where Used
24" socket extension w/ 3/8" drive	Housing and cable guide installation / removal
4mm hex bit w/ 3/8" drive	

User provided tools:

Tools / Equipment	Comments / Where Used
7mm wrench or adjustable wrench	Purge plug removal / installation
4mm hex key	Endcap bolt removal (included with SC spare parts kit)
Socket wrench with 3/8" drive	Housing and cable guide installation / removal
Wire cutters or equivalent	Cut cable ties

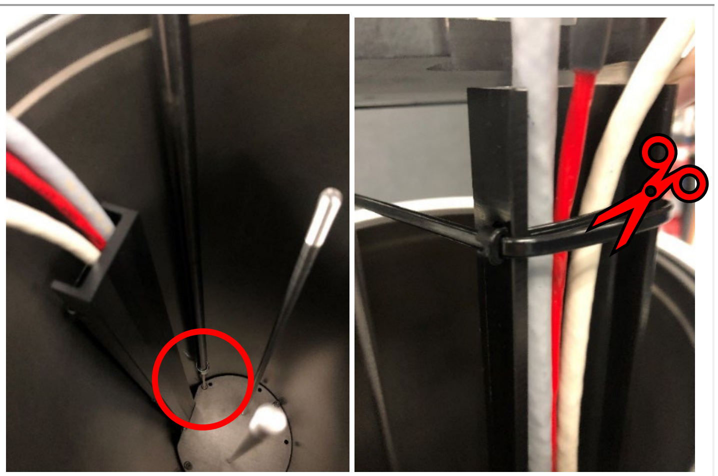
Conversion Procedure



Disassemble the SC module from the DR system:

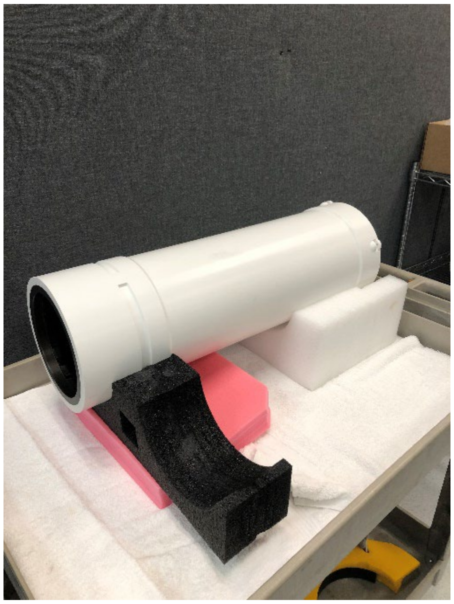
1. Remove the Purge Plug
2. Remove the End-Cap
3. Remove the Battery Modules

Battery Guide Removal



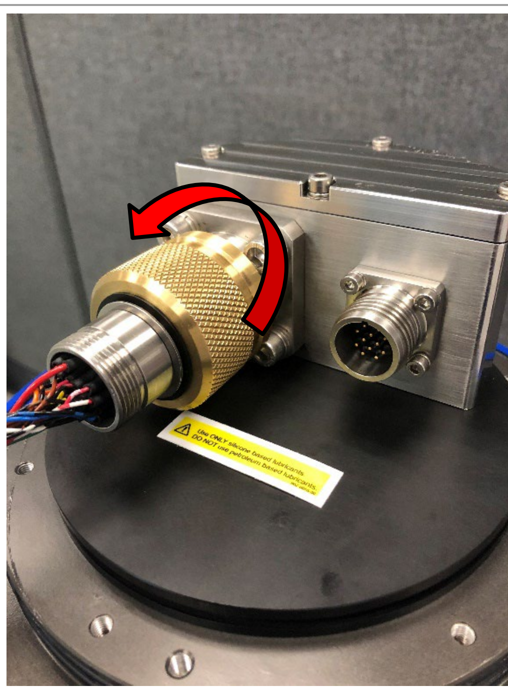
1. Use the socket extension with the 4mm hex key to loosen the four captive M5 bolts inside the housing.
2. Slowly lift the battery guide vertically out of the housing
3. Cut each of the 3 cable ties holding the cables in place as the battery guide is slowly lifted.

Housing Removal



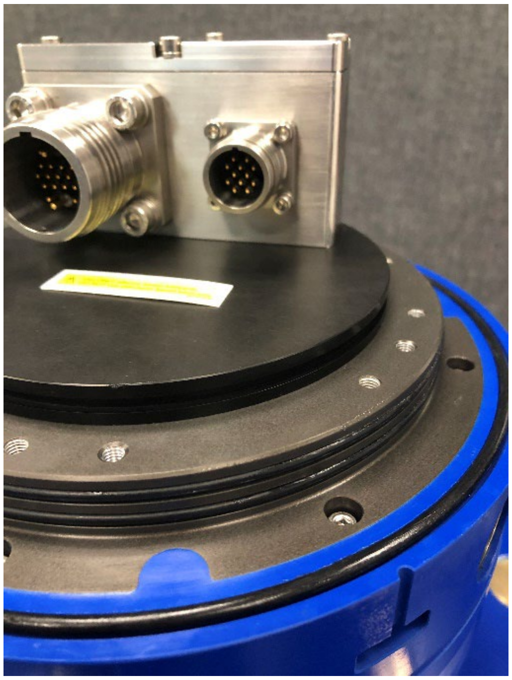
1. Use the 4mm hex bit, socket extension, and socket wrench to loosen the six captive M5 bolts inside the housing.
2. Slowly lift the housing up vertically over the connector block.
3. Carefully set the housing aside on a clean and padded surface to protect the O-ring grooves and sealing surfaces on both ends of the housing.

Use a crane or two people to lift the housing. The housing is heavy, and this will help protect the O-ring surfaces and anodize from damage.

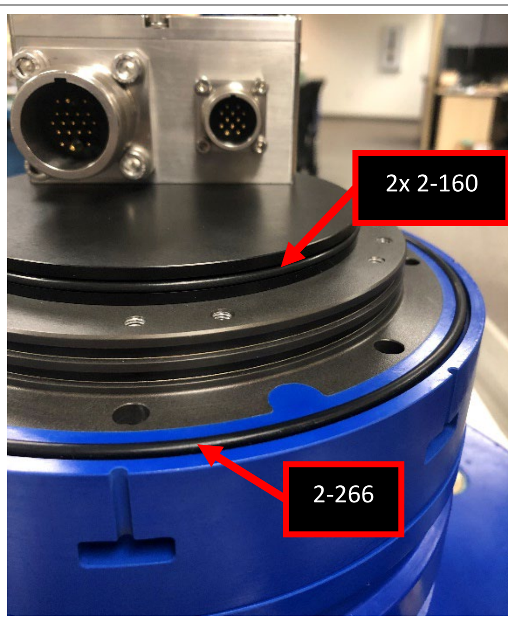


4. Disconnect the 12-pin connector on the SC cable by turning the knurled bronze locking sleeve in a counter-clockwise direction.
5. Disconnect the 19-pin connector on the SC cable by turning the knurled bronze locking sleeve in a counter-clockwise direction.

Cover Ring Installation

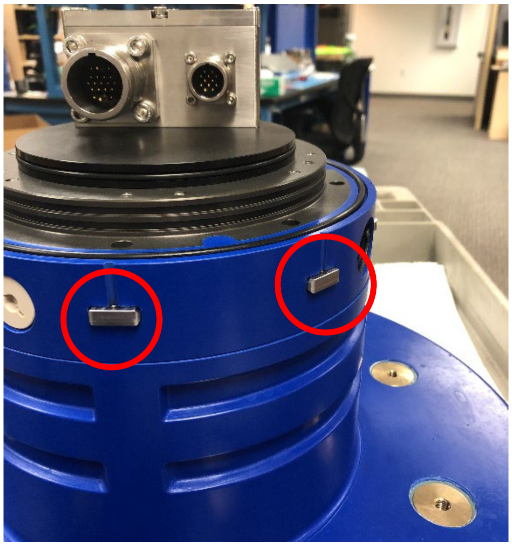


1. Remove the two 2-165 bore seal O-rings from the RT Endcap.
2. Remove the one 2-266 face seal O-ring from the RT Endcap.



3. Prepare the O-ring surfaces and grooves on the RT Endcap and cover ring by cleaning with IPA and ensuring they are free of any dust or particles.
4. Lubricate two 2-160 O-rings with silicon lubricant and install into the bore seal groove on the Delrin Isolator.
5. Lubricate one 2-266 O-ring with silicon lubricant and install into the face seal groove on the RT Endcap.

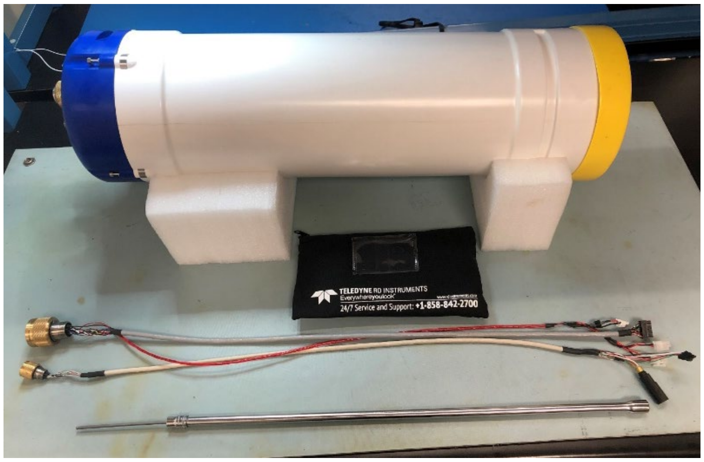
TRDI always recommends using new O-rings.



6. Install the eight nut inserts into the slots around the RT Endcap. Ensure the hole is aligned with the notch in the side of the endcap.

7. Align the four notches in the cover ring with the four port holes around the circumference of the RT Endcap.
8. Push down the cover ring until it is fully seated and the Delrin isolator on the RT Endcap is flush with the cover ring.
9. Secure with eight M3X0.5X30SH bolts, eight M3 split washers, and eight M3 flat washers using a 2.5mm hex key. Tighten in a star pattern and torque to 4.0 ± 0.5 in-lbs (0.5 ± 0.1 N-m).
10. Connect to the system using *Pinnacle Utilities* to test and configure the system for a DR deployment.

SC Module Storage



The SC Module can be stored partially assembled to keep the loose parts together:

1. Install the battery guide.
2. Install the battery modules and compression plate.
3. Install the end-cap.
4. Reinstall the purge plug, purge plug keeper, and nylon M4 hex head bolt onto the endcap.
5. Protect the seal surfaces on the open end of the housing using a silicone cover or other clean and soft material.

Periodic Maintenance

Periodic maintenance helps maintain the Pinnacle system so it is ready for a deployment. Use Table 4 if you need to order replacement parts.

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

Maintenance Schedule

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

Table 11: Visual Inspection Criteria

Item	TRDI Recommended Period
Transducer Beams	The urethane coating is important to Pinnacle 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 cup. 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 face for dents, chipping, peeling, urethane shrinkage, hairline cracks and damage that may affect watertight integrity or transducer operation. Remove biofouling as soon as possible. **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 Pinnacle Self-Contained batteries, the end-cap is removed. Replace the end-cap O-rings each time the end-cap is removed. **All O-rings should be replaced every two to three years maximum.**
Housing and End Cap	Inspect for damage and replace as needed before each deployment. Inspect the urethane on the end-cap, housing, and transducer assemblies for scratches, cracks, abrasions, or other damage. **Be critical in your judgment; the useful life of the Pinnacle depends on it.**
Hardware (bolts, etc.)	Check all bolts, washers and split washers for signs of corrosion before each deployment. **TRDI recommends replacement after every deployment or every year whichever is longer. Damaged hardware should never be used.**
Purge Plug	The purge plug is included with Self-Contained Pinnacle systems end-caps. This plug is a safety valve and is designed to push out of the system to ensure that there is not excessive pressure inside the system when removing the end cap. **Replace the plug O-Rings every two to three years.**
Cables and Connectors	Check the end-cap I/O connector for cracks or bent pins **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**. Check the Deck Box connectors on the rear panel for cracks or bent pins **before each connection**. Repair of the Deck Box connectors should only be done by TRDI.

Transducer Inspection

Based on experience, TRDI knows that ***most*** systems need to have the urethane inspected after two to three years of field use. Many users are not familiar with the early signs of urethane failure. The primary damage to the urethane is from bio-fouling and long exposure to the water and sun. Damage occurs on the surface of the urethane and at the edge where the urethane bonds to the cup. By returning the system every two to three years, TRDI can inspect it for early signs of urethane failure and repair it through our Refurbishment Service. At the same time, TRDI will make any necessary upgrades to boards, assemblies, and firmware. If the Refurbishment Service is not needed, TRDI can upgrade the system as part of one of our Inspection Services. Proper care, general maintenance, and this routine service period ensures that the Pinnacle system lasts for a minimum of 10 years with no loss in performance.

Never set the transducer face on a rough surface; always use wood strips to protect the urethane face.

Removing Biofouling

If there is heavy fouling or marine growth, the transducer faces may need a thorough cleaning to restore acoustic performance.

To remove foreign matter and biofouling:

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

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

2. Barnacles do not usually affect Pinnacle operation, but TRDI does recommend removal of the barnacles to prevent water leakage through the transducer face. Lime dissolving liquids such as Lime-Away® break down the shell-like parts. Scrubbing with a medium stiffness brush usually removes the soft-bodied parts. Do NOT use a brush stiffer than a hand cleaning brush. Scrubbing, alternated with soaking in Lime-Away®, effectively removes large barnacles.

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

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

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

Prevention of 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 all vessel-mounted deployments 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 ADCP. Therefore, you should take steps to prevent biofouling during shallow water deployments. The best-known way to control biofouling is cleaning the transducer faces often. However, in many cases this is not possible; then use antifouling paint.

Antifouling Paint Recommendations

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. It should be understood that applying a coating may reduce the measurement range of the Pinnacle (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 sensor, 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.

Do not block the pressure sensor port. The sensor port is a small hole in the center of the copper cover (see Pressure Sensor Maintenance). During anti-fouling paint application, tape-off the hole. Once the anti-fouling paint has cured, remove the tape.

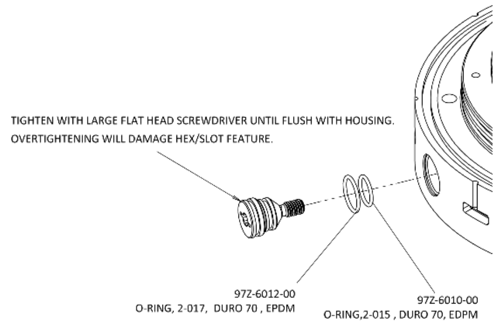
This means that the sensor port is not fully protected from bio fouling. Even though the sensor cover is surrounded by the antifouling paint, bio fouling may still build up on the copper cover and eventually clog the sensor port. However, most organisms do not seem to find the small amount of unpainted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

Vent Plug Inspection & Replacement

The Helium Vent plug is used by TRDI to test for leaks in Pinnacle systems. This plug is also a safety valve and is designed to ensure that there is not excessive pressure inside the system when removing the Direct-Reading end cap. Replace the Helium plug O-Rings every two to three years.

To replace the Helium plug O-rings:

1. Use a large flat head screwdriver to remove the plug.
2. Replace and lubricate the two O-rings.
3. Use a large flat head screwdriver to install the plug. Take care not to damage the hex feature by overtightening.



Replacing the Desiccant

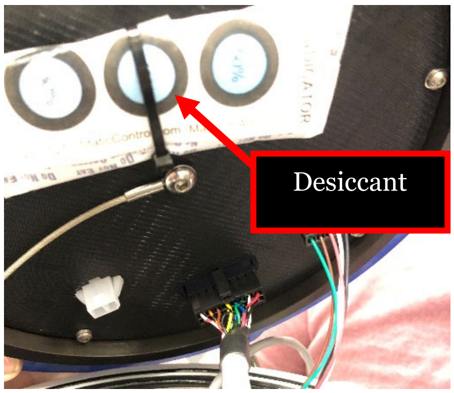
Desiccant bags are used to dehumidify the Self-Contained housing interior. The factory-supplied desiccant lasts several years at specified Pinnacle/Observer deployment depths and temperatures. Remember that desiccant rapidly absorbs moisture from normal room air.

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

If the Self-Contained housing has been opened, the desiccant should be replaced.

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.

To replace the desiccant:



1. Remove the Purge Plug
2. Remove the End-Cap
3. Remove the desiccant pack and dispose. Always use fresh desiccant once the end-cap is removed.
4. Remove the new desiccant bag from the airtight aluminum bag.
5. Remove the old desiccant bag and install a new one. Use a zip-tie to hold the desiccant bag in place.

Cleaning the Pressure Sensor Port

To read the water pressure, water must be able to flow through the copper cover on the pressure sensor. The tiny holes in the cover may at times become blocked. Use the following procedure and Figure 25 to clean the cover. Replace the pressure sensor O-ring every two to three years.

To clean the pressure sensor port:

1. Remove the retaining ring to remove the cover and O-ring.
2. Gently flush the pressure sensor cavity with fresh water (deionized water if available) to remove all dirt and grit.
3. Gently clean out the holes in the copper cover with a needle.
4. Lubricate and replace the O-ring.
5. Install the copper cover into the pressure sensor. Reinstall the retaining clip.

> Do not attempt to clean the surface of the pressure sensor. The diaphragm is very thin and easy to damage.
>
> If the pressure sensor surface looks corroded or is bowed outward, then contact TRDI for servicing. Do not attempt to remove the pressure sensor. It is not replaceable in the field.

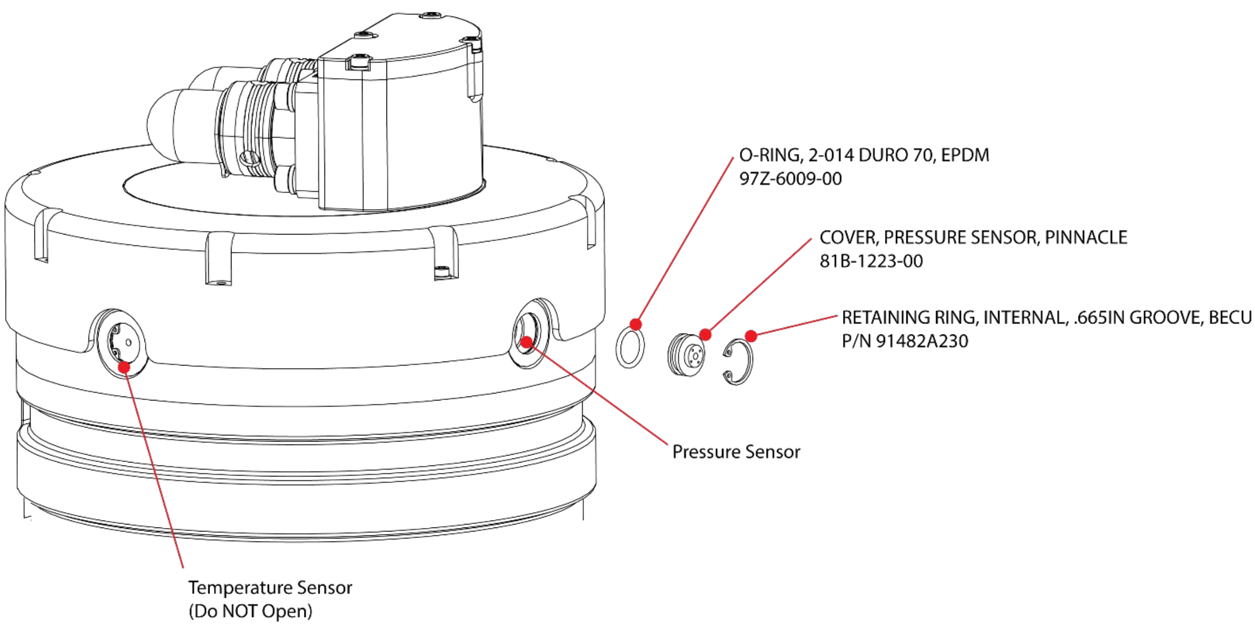


Figure 30. Cleaning the Pressure Sensor Port

Replacing the DR Endcap O-rings

The O-Rings on the DR End-Cap should be replaced every two to three years maximum.

Required parts:

Part Number	Part Description	Where used
5020	SILICONE LUBRICANT, 4-PACK	Use on all O-rings
97Z-6035-00	O-RING, 2-165, DURO 70, EPDM	Endcap
97Z-6166-00	O-RING, 2-266, DURO 70, EPDM	Cover and endcap
97Z-6145-00	O-RING, 2-160, DURO 70, EPDM	Cover
97Z-6012-00	O-RING, 2-017, DURO 70, EPDM	Vent plug
97Z-6010-00	O-RING,2-015, DURO 70, EDPM	Vent plug
97Z-6148-00	O-RING, 2-142, DURO 70, EPDM	Connector block cap
DES2	DESICCANT, SEALED BAG,1/3 UNIT	Inside endcap
T18S	TIE WRAP	As needed for desiccant and endcap cables

Cover Ring Removal

1. Remove the eight M3 screws, flat washers, and split washers.
2. Remove the eight nut inserts around the Endcap.
3. Carefully lift off the cover.
4. Remove the 2-160 and 2-266 O-rings.

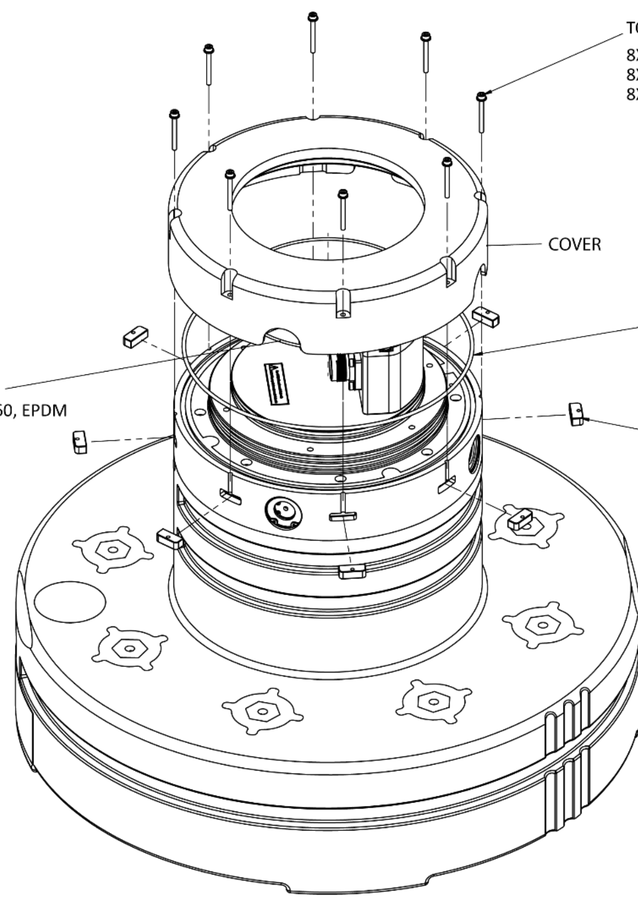


Figure 31. DR Cover Ring Removal

Endcap Removal

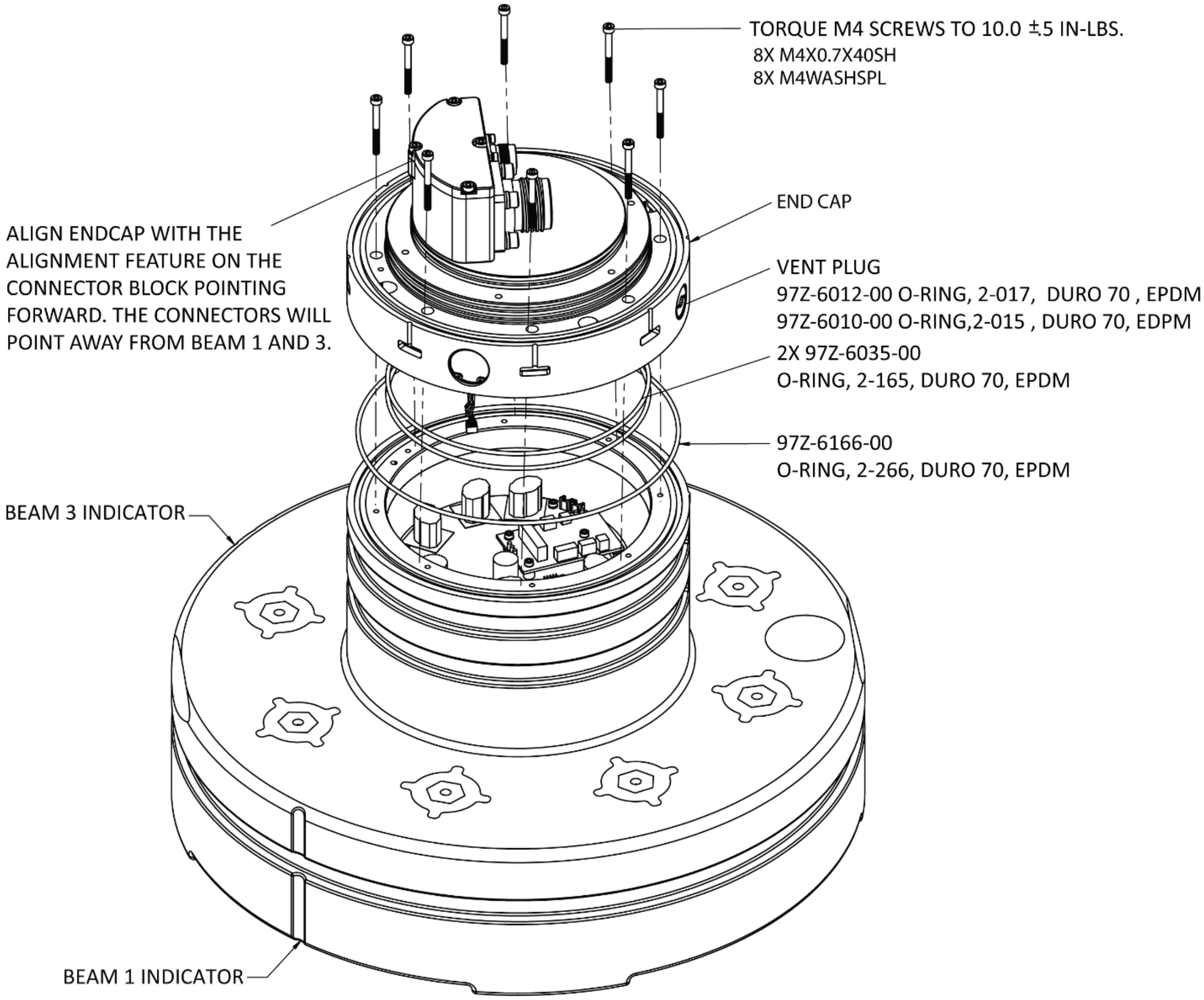


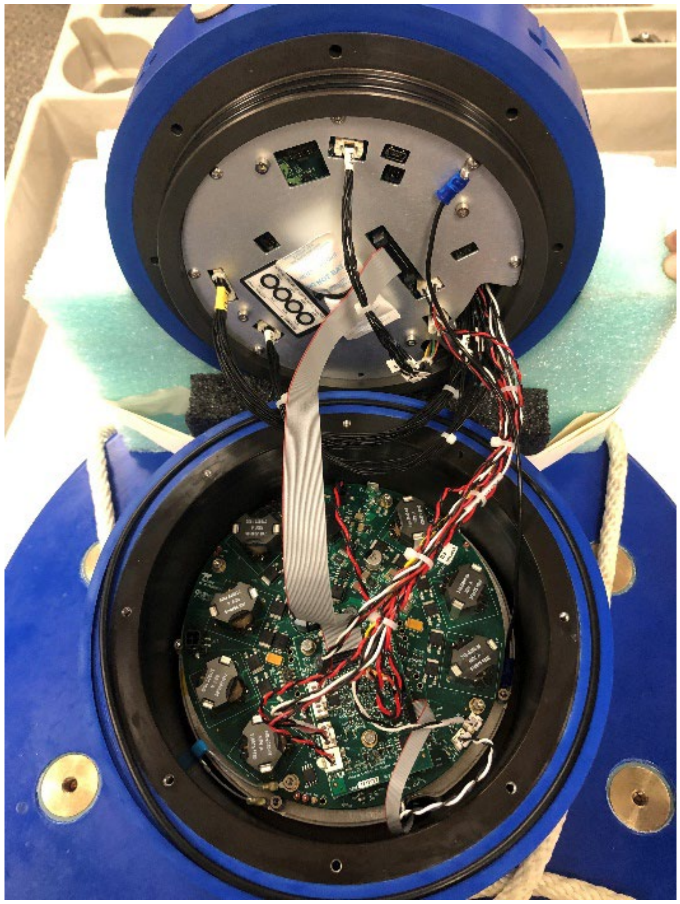
Figure 32. DR Endcap Removal

1. Using a large flat head screwdriver, remove the vent plug.

Removing the vent plug will make it easier to open and close the endcap.

2. Remove the eight M4 screws, flat washers, and split washers.
3. Have one person lift the endcap as another person disconnects the cables between the endcap and top circuit board. There is just enough cable length to tip the endcap towards Beam 3 and Beam 1. Use a large foam block to help support the endcap. Secure the Endcap into the fixture using rope, zip ties, or tape.
4. Attach an earth-grounded wrist strap.

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



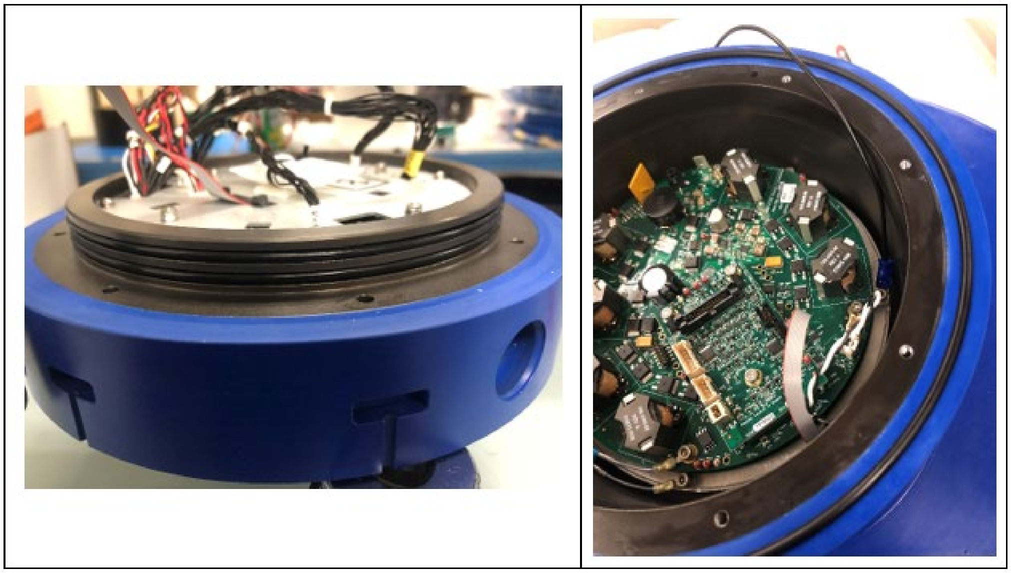
If the endcap is not fully secured, it could fall during assembly. The anodize or sealing surfaces on the endcap or mounting plate could be damaged in the event of a fall.

The endcap is heavy - a person could be injured if the endcap were to fall. Additionally, if the endcap were to move or fall with the cables plugged in, the connectors on the cables and boards could be damaged.

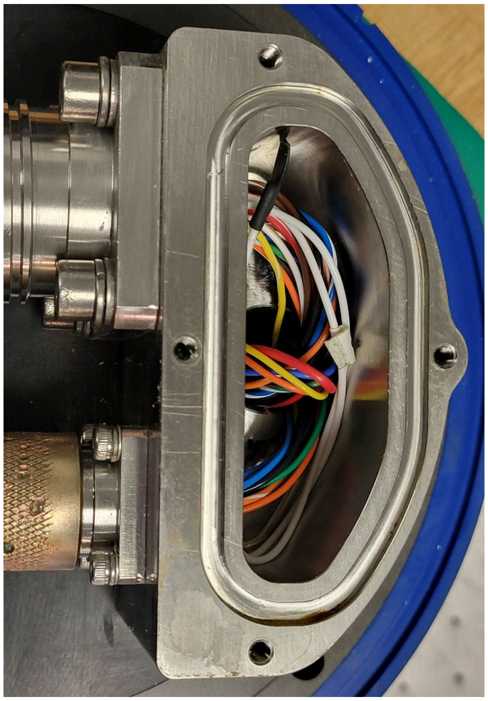
Use a large foam block to help support the endcap. Secure the Endcap into the fixture using rope, zip ties, or tape.

O-Ring Replacement

1. Prepare the O-ring surfaces and grooves on the endcap and mounting plate by cleaning with IPA and ensuring they are free of any dust or particles.
2. Lubricate the 2-165 O-rings and install into the bore seal grooves on the endcap.
3. Lubricate the 2-266 O-ring and install into the face seal groove on the XDCR mounting plate.

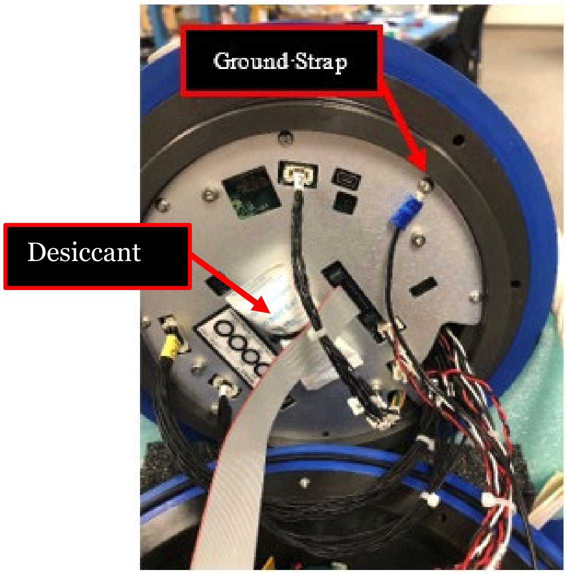


4. Remove the four connector block cap screws. Prepare the O-ring surfaces and grooves on the mounting block by cleaning with IPA and ensuring they are free of any dust or particles.
5. Lubricate the 2-142 O-ring and install into the face seal groove on the connector mounting block. Tighten the screws to 11 IN-LBS (1.24 N.m).

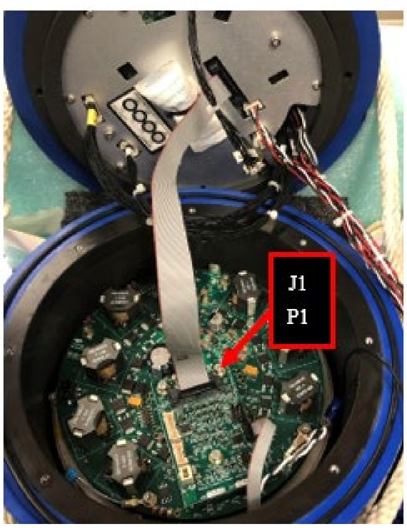


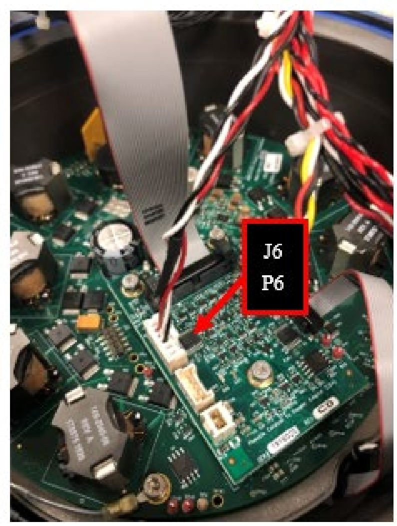
Reconnect the Cables

1. Hold the DR Endcap so that when the endcap is placed onto the mounting plate the connectors point away from Beam 1 and Beam 3. Ensure the cables are neatly bundled and none of them are strained. If cable ties need to be cut and repositioned to better bundle the cables, replace them with new cable ties.
2. Install the ground strap into one of the Catalyst shield mounting holes. The ring terminal should sit between the flat washer and the Catalyst shield.
3. Replace the desiccant bag and zip tie it to the Catalyst shield.



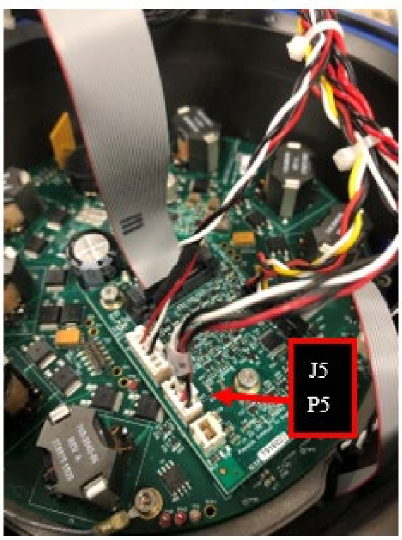
4. Plug P1 on the Catalyst / Doppler comm ribbon cable into J1 on the CDA board.
5. Plug P3 on the pressure sensor cable into J4 on the CDA board.
6. Plug P6 on the Catalyst / Doppler comm cable into J6 on the CDA board.

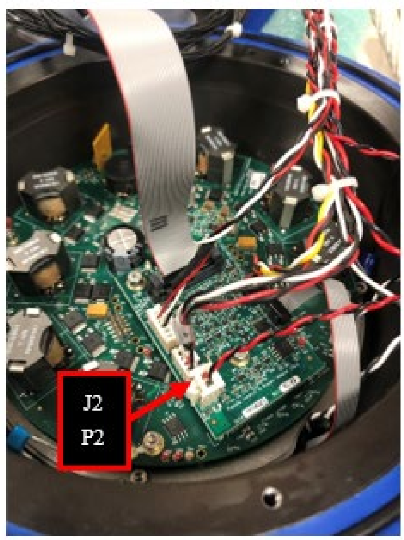


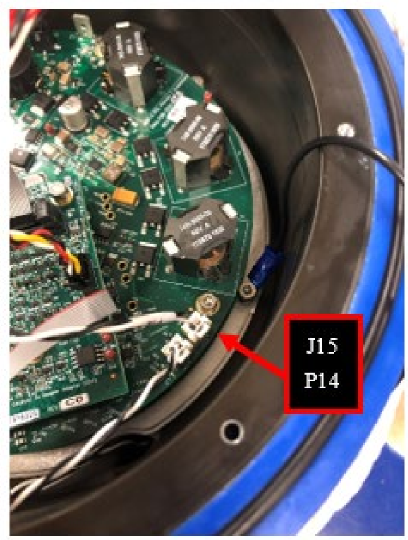


7. Plug P11 from the connector block cable into J11 on the PTX board.

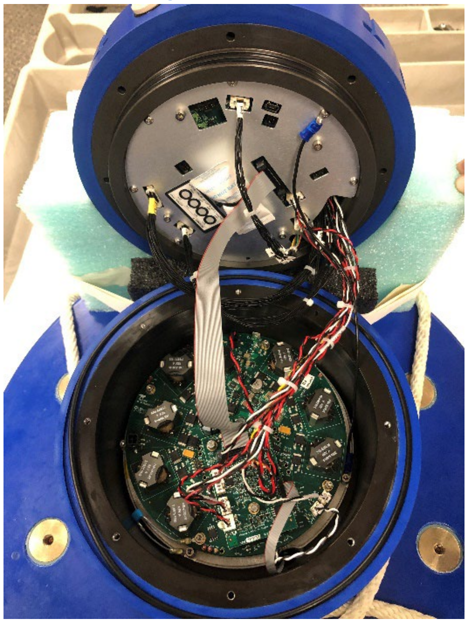
8. Plug P5 on the 1-Wire / Temp / LED / Leak Sensor cable into J5 on the CDA board.
9. Plug P2 on the Catalyst / Doppler power cable into J2 on the CDA board.
10. Plug P14 on the 1-Wire / Temp / LED / Leak Sensor cable into J15 on the PTX board.

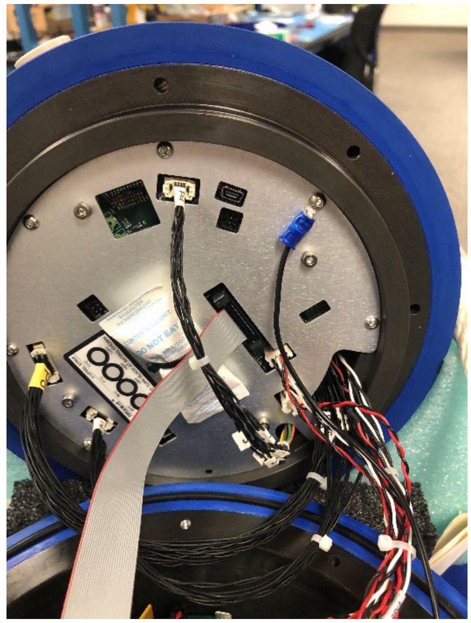






Close the Endcap

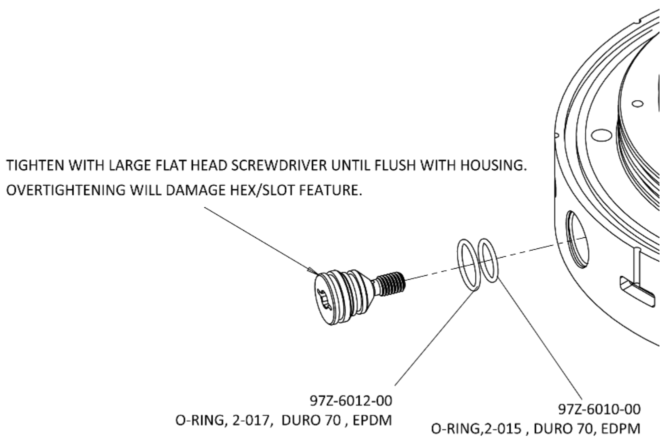




1. Slowly lower the endcap onto the mounting plate. Check to make sure that all wires are completely inside the housing and will not be pinched.
2. Ensure the endcap connectors point away from Beam 1 and Beam 3.
3. Push down the endcap while ensuring that the bore seal O-rings are not being pinched or cut.
4. Secure the endcap with the M4 hardware called out on Figure 27. Torque to 10.0 ± 0.5 in-lbs.

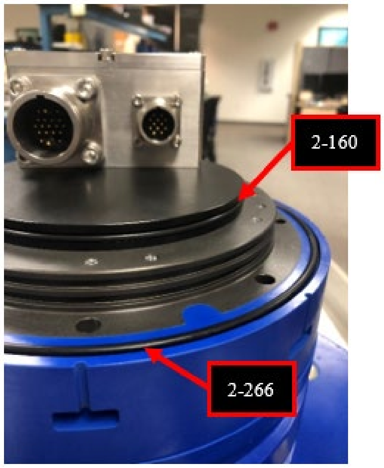
Install the Vent Plug

1. Prepare the O-ring surfaces and grooves on the vent plug by cleaning with IPA and ensuring they are free of any dust or particles.
2. Lubricate the O-rings and install into the bore seal grooves on the vent plug.
3. Re-install the vent port using a large flathead screwdriver. Tighten until it is flush with the endcap circumference. Overtightening will damage the hex/slot feature in the PEEK vent port.



Install the Endcap Cover

1. Prepare O-ring surfaces and grooves on the cover ring and direct read endcap by cleaning with IPA and ensuring they are free of any dust or particles.
2. Lubricate a 2-266 O-ring and install into the face seal groove on the direct read endcap.
3. Lubricate a 2-160 O-ring and install into the bore seal groove on the isolator on the direct read endcap.



4. Install the eight nut inserts into their grooves on the direct read endcap with the threaded hole facing up.
5. Slide the cover ring over the connector block and align the cutouts with the four ports around the direct read endcap circumference.
6. Press the cover ring down over the nut inserts until firmly seated. Secure with the M3 hardware shown in Figure 26. Using a 2.5mm hex key, tighten the M3 hardware in a star pattern to 4.0 ±0.5 in-lbs.

Installing Firmware Updates

Teledyne RD Instruments firmware is accessed via https://tm-portal.force.com/TMsoftwareportal.

To install a firmware upgrade:

1. Download the Pinnacle firmware. Save the file to the computer and unzip the file if needed. The file name will be *Pinnacle_xxxx.bin* format where *xxxx* = firmware version.
2. Start *Pinnacle Utilities* and connect to the Pinnacle ADCP.
3. Click **Update** on the Firmware Update box. Locate the firmware file and click **Open**.
4. Click **OK**. Verify the new firmware version on the system box.

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

Installing Feature Upgrades

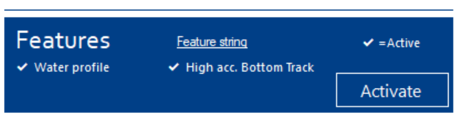
The feature upgrades are used to install additional capabilities in a Pinnacle system. Feature upgrades can be sent by TRDI's Customer Service via a *Pinnacle Utilities *.feature* file.

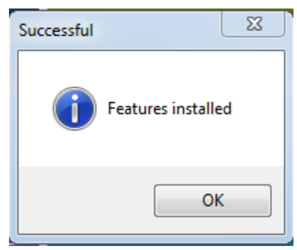
> Features can only be activated or deactivated when connected to the Pinnacle and require a Feature file (**.feature*) that is tied to the ADCP's serial number. Click on **Feature string** to send a copy of the serial number to TRDI.
>
> Contact your local sales representative if you are interested in upgrading your system.
>
> Features ordered with the system are installed by TRDI.
>
> Save the **.feature* file in a folder that has full read/write permissions. For example, if you save the file to the AppData folder, you may get a file load error.

> Many feature upgrades require the latest firmware version to be installed in your Pinnacle ADCP. If you need to update the firmware, do this before installing the feature upgrade.

To install a Feature file upgrade:

1. Start *Pinnacle Utilities* and connect to the Pinnacle ADCP.
2. Click **Activate** on the Features box. Locate the feature file and click **Open**.
3. Click **OK**. Verify the new features installed show a check mark.





Compass Calibration

The compass calibration is a sequence of rotations and tilts used to correct for distortions in the earth's magnetic fields caused by permanent magnets or ferromagnetic materials near the ADCP. These magnetic field distortions, if left uncorrected, will create errors in the heading data from the Pinnacle ADCP.

> A compass calibration should be conducted at each measurement location, and whenever the mounting fixture or ancillary equipment such as batteries are changed or rearranged.

To achieve the best possible field calibration of the compass, the compass calibration should be performed:

- In a "magnetically clean" environment, i.e. in an area free from stray magnetic fields (electronics, power lines, etc.) and magnetic materials such as iron.
- As close as possible to the actual deployment site (so that during calibration the instrument is measuring a magnetic field intensity and dip angle that are as close as possible to the as-deployed environment)
- With a large variety of instrument orientations (ideally tilting the instrument by 15 degrees or more during orientation).

- TRDI recommends that if you are having trouble calibrating the Pinnacle ADCP compass that you move the system and/or ensure the area around the system is clear of electrical equipment and ferrous materials.

In an oil & gas environment, it is typically impossible to meet the first two requirements above. Oil fields are full of metal structures that preclude “magnetically clean”. Even in standard oceanography, for example a deep-water deployment in the open ocean, it is not possible to meet both requirements because any location reasonably near the deployment site is aboard a ship, which will be a decidedly magnetically dirty environment. Therefore, the customer typically must choose between calibrating a long way away from the deployment site, use the factory default calibration, or to use the Post Calibration Processing option that is available when downloading and reviewing data.

See the Reviewing Data section in the Pinnacle Utilities help file for more information on how to use the compass Post Calibration.

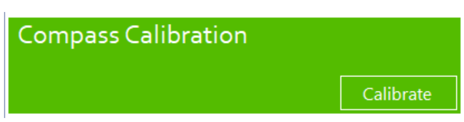
The SC systems should be lifted using a hoist and the included eyebolts.

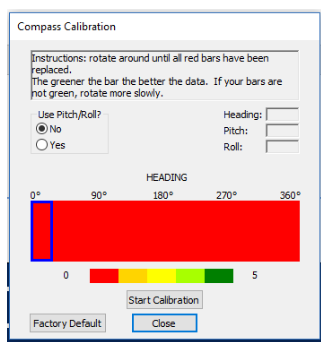
Compass calibration stands are not required to calibrate the Pinnacle compass, but they do make it much easier and increase the calibration accuracy. Calib Designs is one source for calibration stands. Contacting this company is done with the knowledge that Teledyne RD Instruments is not recommending them, but only offering this as a source for the stand.

http://www.calibdesigns.com/index.html

To calibrate the compass:

1. Go outside, away from magnetic materials.
2. Start *Pinnacle Utilities* and connect to the Pinnacle ADCP.
3. Click Compass Calibration, **Calibrate** button.



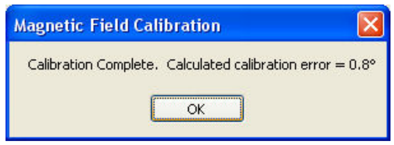


4. Click **No** for **Use Pitch/Roll**. This calibration requires two rotations (one for calibration and one for verification).
5. Press the **Start Calibration** button to start.
6. As you rotate the Pinnacle ADCP, the bars will change color. The Blue bar indicates where you are in the rotations.

- Green – Good
- Light Green – Acceptable
- Yellow – Within parameters (one or two yellow bars for the entire rotation is OK)
- Orange – Unacceptable - Rotate slower!

- Red – Not measured

7. When the first rotation(s) are complete, click **OK** on the message box to continue with the verification samples.
8. When the second rotation is complete, click **OK** on the message box. The calibration error should be less than 2 degrees.



9. If the compass calibration fails after repeated attempts, use the **Factory Default** button. This will use the factory calibration of the compass module itself as it was shipped from the vendor, not a system level calibration at the time of manufacture at TRDI. This calibration will not take into consideration variables such as magnetic fields from batteries or mounting fixtures. The assumption is a factory calibration may be better than a failed field calibration result.

Installing the Dry-Side Connector

Use the following instructions to install the dry-side connector on the Power/Data/COM cable (see Figure 10 and Figure 11).

Equipment Needed:

Tools/Equipment	Comments
Soldering iron	
Wire cutter	Support 14 to 24 AWG
Wire stripper	Support 14, 18 AWG, and 24AWG
Measuring tape	
Multimeter	
Heat Shrink Tubing	

To install the dry end cable connector:

1. Carefully remove the cable jacket and shield 0.5 inches from the dry end of the cable. Slide on a 76.2 mm (3 inch) length of heat shrink tubing. Using a heat gun, shrink the tubing around the end of the cable. Add a second layer of heat shrink tubing to strengthen the cable.
2. Strip back the individual wire ends of the cable approximately 0.2 inches long using a wire stripper.
3. Connect the cable shield (copper braid shield over the 24AWG CAT5 bundle) to J1-F.
4. Solder 24 AWG wire to the 16 AWG conductors on the J1 end of the cable. Cover solder joint with heat shrink tubing.
5. Solder the wire onto the pin. Solder the pins from the center of the connector and work your way out. This makes it less likely to bend or break the wires off the pins.
6. Connect the cable clamp. Ensure the cable clamp will grip the cable's polyurethane jacket (covered with the two layers of heat shrink tubing), not the single wires. Loosely twist the connector to take up some of the slack before installing the back shell and strain relief.

Checking the Wiring:

After the connector is installed, use a multi-meter to confirm that the connector has been wired properly by performing an end-to-end continuity and adjacent pin isolation check.

1. Confirm that no pins in the dry-end connector are shorted. Check for >two Mohms of resistance between each of the dry-end pins.
2. Check the continuity of the associated dry-end pin to the wet-end of the cable using a multi-meter.

NOTES

Chapter 5

TROUBLESHOOTING

This chapter covers:

- Pre-Deployment test
- Testing the system with TRDI Toolz
- Contacting TRDI Support

Ethernet Link Lost

TRDI always recommends closing the *Pinnacle Utilities* or *TRDI Toolz* connection to the system by clicking on the X (×) in the session tab and then power down the Pinnacle 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 Pinnacle to reconnect.

Exceptions

- If the software is exited or the connection to the Pinnacle is closed but the Pinnacle 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 Pinnacle system (both Doppler and Catalyst) will go to sleep (see System Wake Up).
- If the software connection is not closed and the Pinnacle is still powered when the ethernet cable is unplugged, you have approximately one minute to reconnect before a power cycle is required.

System Wake Up

With the entire system asleep (both Doppler and Catalyst), if power is cycled (power off, wait 30 seconds, power on), the Doppler will boot successfully, but the Catalyst will not boot. This is because the discharge rate on V_{in} is very slow (about 7.5 minutes). The Pinnacle can be booted successfully by:

- Connect with Pinnacle Utilities (serial connection)
- Issuing a BREAK using TRDI Toolz or
- Power cycling a second time (power off, wait 30 seconds, power on)

DHCP Network Connection

Problem: Cannot connect to the Pinnacle using the Pinnacle's NetBIOS Hostname/System ID.

Solution: A DHCP server will give the Pinnacle 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**.

Data Loss

For Direct-Reading applications, there are some non-default settings combinations that can result in data loss in real-time output when pinging as-fast-as-possible without stopping. When the bin size is set smaller than the default and/or the bin count is larger than the default, combined with the lowest supported serial output rate (9600 baud), data loss may occur. The recommended (conservative) ping spacing is listed in Table 11, page 166. Faster ping rates may work depending on setting specifics but should be verified before deployment. For more information, see the CB – Serial Port Control, TE – Time Per Ensemble, WN – Number of Depth Cells, and WS – Depth Cell Size commands.

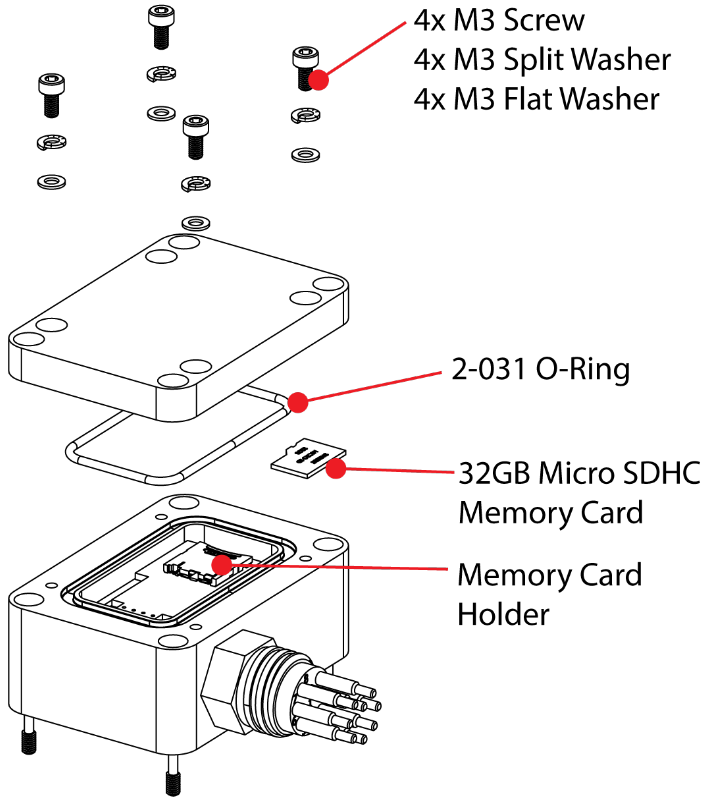
Downloading SC Data Using a Card Reader

Typically, the deployment is stopped, and the memory is downloaded using *Pinnacle Utilities*. If the batteries are depleted or a system error prevented connecting to the system, then removing the Micro SDHC card and using a card reader is another way of recovering data.

To remove the auxiliary memory module:

1. Remove the Purge Plug.
2. Remove the End-Cap.
3. Loosen the wingnuts on the compression plate and remove all the hardware. Set aside the two M6 wing nuts, two M6 Split Washers, and two M6 washers.
4. Remove the compression plate and auxiliary memory module by lifting vertically over the rods.

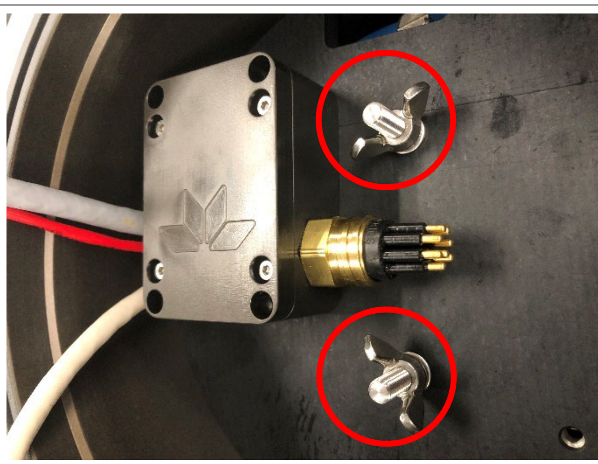
The auxiliary memory module should be opened on a bench. Dropping any hardware down the side of the 4X battery housing would likely require disassembly of the SC battery modules to retrieve.



To open the auxiliary memory module:

1. Open the auxiliary memory module by loosening the four M3 captive bolts on the lid using a 2mm hex key. Set the lid aside.
2. Remove the O-ring and keep in a safe place until ready to install the cover.
3. Open the lid on the memory card holder and slide the memory card out.
4. Use a USB memory card reader to save the files to a computer.
5. Install the 32GB memory card in the memory card holder.
6. Clean and inspect the O-ring groove. Be sure the groove is free of foreign matter, scratches, indentations, corrosion, and pitting.
7. Inspect the 2-031 O-ring for damage, wear, or dust and debris. Replace if needed. Ensure the O-ring is lubricated with silicone lubricant.
8. Install the lid onto the housing, ensuring the O-ring is fully seated in the groove. Torque the four M3 captive bolts to 4.0 ± 0.2 in-lbs [0.5 N-m].

The first few SC shipments do not have the captive M3 hardware.

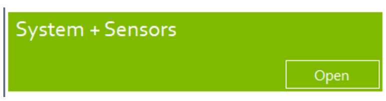


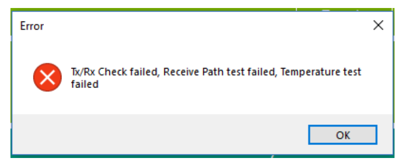
To close the system:

1. Align and lower the compression plate over the top of the batteries.
2. Secure with two M6 wing nuts, two M6 split-washers, and two M6 washers.
3. Hand tighten the wingnuts.
4. Install the end cap.
5. Install the purge plug.

Pre-Deployment Test Troubleshooting

The following tests are run when the System Tests are run using *Pinnacle Utilities* or receiving the PA command.






```
pa

RAM test................PASS
ROM test................PASS
Tx/Rx Check.............FAIL
Receive Path test.......FAIL
RTC test................PASS
UART test...............PASS
Compass test............PASS
Temperature test........FAIL
Pressure test...........PASS
Ping Order (TO) Test....PASS

NO-GO
```

Always run the PA test with the transducer beams submerged in water. The test may fail in air and if so, is not relevant. Only a failure with the transducer at a minimum in contact with water is a relevant test. If possible, run at least one PA test on the deployment site.

RAM Tests (This is based on the PT12 Test)

- Pass is defined as a writing and reading back address in the RAM.
- Fail is defined if the values differ.

ROM Test (This is based on the PT13 Test)

- Pass is defined as a test of the flash ROM by comparing the CRC of the data in ROM with the CRC value stored in FLASH.
- Fail is defined if the values differ.

Transmit/Receive Test (This is based on the PT3 Test)

- PASS is defined based on the results from a PT3 test:
    - PT3 test results in PASS on all four beams in H-Gain, N-BW for the Threshold on lag 7 and RSSI Noise floor
    - WARN if either of these results do not obtain a PASS, with the test result for the failed beam(s) reported. User discretion is advised if the test does not pass. Recommend further testing the system.

Real Time Clocks

- PASS is defined as the two Real Time Clocks (RTCs) have been set to the same time.
- FAIL is defined as the two RTCs have not been set to the same time, with the failure (or appropriate fault code) displayed

Fixed Data Memory

- PASS is defined as the MicroSD card on the Catalyst is present and functioning.
- WARN is defined as the MicroSD card on the Catalyst is not present or not functioning. In the event of a WARN, the instrument is capable of deploying (for example, a Direct Read real time system with external storage planned). A self-contained system with functioning removable memory may be deployed, but this is a desperation play.

Removable Data Memory. This memory is only available on units configured for Self-Contained deployments.

- PASS is defined as the MicroSD card on the removable memory is present and functioning.
- WARN is defined as the MicroSD card on the removable memory is not present or not functioning. The operator is warned of this failure, but the instrument is capable of deploying in the event of a WARN. A self-contained system with functioning fixed memory may be deployed, but this is a desperation play.

Redundant Data Memory. This test should only be run a system that is configured to have both fixed and removable memory (self-contained).

- PASS is defined as:
    - PASS obtained on both Fixed and Removable Memory tests.
    - File structure matches exactly on both cards.
- WARN is defined as:
    - PASS only obtained on Fixed or Removable Memory tests. This is desperation time, if one card is functioning it might be worth deploying without the redundant memory.
    - File structure does not match exactly on both cards. In this case, the mismatch should serve as a reminder that something might be amiss (removable memory erased, and fixed memory not erased to match).
- FAIL is defined as:
    - Neither the fixed or removable memory card tests PASS.

Internal Communications

- PASS is defined as
    - Doppler and Catalyst two-way communication is verified.
    - Doppler and Catalyst wake/sleep line functionality is verified.

- FAIL is defined as either of the above tests not obtaining a PASS, with the failure (or appropriate fault code) displayed.

Sensors

- PASS is defined as all sensors (pressure, temperature and ISM) are present and functioning.
- WARN is defined as any one of these sensors not present or not functioning, with the failing sensor identified. For example, the user has the option of deploying with set parameters (using appropriate command (ET, EH, ED, etc.) if the sensor is failing.

Battery Capacity – for units configured for self-contained deployments

- PASS is defined as the battery voltage indicating a fresh battery with a voltage reading of >= 39 VDC.
- WARN is defined as having 28 VDC <= battery voltage < 39 VDC (indicates the batter pack has some prior use). Multiple short deployments on a single set of batteries is acceptable.
- FAIL is defined battery voltage reading of < 28 V.

Ping Order (TO) Test

- PASS is defined as:
    - The TO command supports the WP, NP, BT setup. The TO command sets ping order, it also turns on/off aspects of the data acquisition. TO is a three-digit number, and the digits can be 1 (narrowband), 2 (broadband) or 3 (bottom track). This test ensures that if, for example WP is not zero, that one of the digits in TO command is set to “2”.
    - That the WP/NP settings are consistent with burst/interleaved deployment plans. If the first digit of TB is 0 (not burst), then WP *must* equal NP.
- WARN is defined as a PASS on first item above, but not PASS on the second item above.
- FAIL is defined as not passing on item 1 above. If the TO command is not properly configured, you will not get the data you expect.

Testing the System with TRDI Toolz

If something failed in the pre-deployment test, use the PA command and repeat the test several times rotating the unit by 90 degrees for each test. By doing so, it may be determined that the failure is directional and most likely due to the external environment. Please be sure to log the results by pressing <F3> when using *TRDI Toolz* to communicate with the system.

Failures might be observed if:

- Other magnetic or acoustic devices or high current system are near the unit,
- The Pinnacle is exposed to electrical interference such as that from other acoustic devices or SONARs or other electronic devices (i.e. cellphones, radios, computers, TV's, etc.).
- The Pinnacle or its cable is exposed or installed near potential sources of EMI's such as high voltage lines like main engine cables, galley equipment, winches, engine room equipment, cranes, high voltage lighting circuit, etc.
- Oftentimes, a noisy (i.e. non-UPS) power supply could cause failures in this test as well.

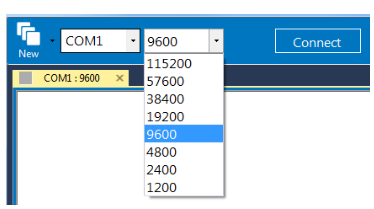
Strategy if failure is found in the BIT tests:

- Power down these devices and remove or move the suspect systems at least three meters away during diagnostic testing.
- Re-run the PT300 command and log the data for about 30 seconds to 1 minute.
- Modify the log file by adding a note as of what has been done prior to a PT300 test such as: "Turning 300KHz Sonar off" for instance.

Always run the PA test with the transducer beams submerged in water. The test may fail in air and if so, is not relevant. Only a failure with the transducer at a minimum in contact with water is a relevant test. If possible, run at least one PA test on the deployment site.

To establish communications with the Pinnacle using TRDI Toolz:

1. Connect the system and apply power. Place the transducer in a few inches of water. Use wood strips to lift the transducer to protect the face.
2. Start the *TRDI Toolz* software.
3. Select **New Serial Connection**.
4. Enter the ADCP's communication settings. Select the **COM Port** the serial cable is connected to and set the 115200 **Baud Rate** from the drop-down lists.



115200 Baud is the Pinnacle default.

5. Click the **Connect** button. Once connected, the button will change to **Disconnect**.
6. Click the **Break** ( ) button. From the **Break** button drop down menu, select **Hard Break** (Soft Break is the default for *TRDI Toolz* and will need

to be changed each time the software is started). The wakeup banner will display in the terminal window.

```
Break Detected: Yes

Pinnacle
Teledyne RD Instruments (c) 2019
All rights reserved.
Version: 71.0
>
```

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

For help on using *TRDI Toolz*, click the Help icon.

Diagnostic Tests

Compare future tests to the diagnostic test results. If large changes have occurred, check to see if changes have been made to the installation (i.e. a new sonar device installed, the Pinnacle Power/Data/COM cable was moved). Changes in the test results do not necessarily mean that the system is failing, but do require further investigation.

Communications Test

Send the following commands to the Pinnacle system using *TRDI Toolz*:

```
CR1
PS0
PT3
```

Pinnacle Utilities Test Results

This section shows an example of the printout after running the performance and test commands.

Do not place the transducer within three feet of a computer monitor. Monitors are a major source of electronic interference.

Display System Parameters

This tells the Pinnacle to display specific information about your system. For example:

```
Pinnacle
Teledyne RD Instruments (c) 2019
All rights reserved.
Version: 71.0.1.33 INT

Not Pinging
>

>ps0
   Serial Number:  0
       Frequency:  44000 Hz
 Transducer Type:  PHASEDARRAY
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
   Vertical Beam:  NONE
         Sensors:
             Temperature:   DS18b20 1-Wire
      Heading/Pitch/Roll:              RDI
                Pressure:         Keller30

    CPU Firmware:  61.00a _Phase1_u59
    FPGA Version:2.00.007 [0x2007]

Board Serial Number Data:
 4E 00 00 00 DB A9 A3 28   DS18B20 TMP SNS
 6A 00 00 02 93 E0 C8 23   CDA72B-2134-01B
 87 00 00 02 93 E4 9C 23   DSP72B-2130-00A
 76 00 00 02 AF 7C A6 23   RCV72B-2135-06A
 55 00 00 00 1F C5 71 23   XDR72B-1001-00X
 03 00 00 02 DE 48 99 23   CIO72N-2000-01A
 71 00 00 02 BA 16 2D 23   PTX72B-2131-06A
>
```

Verify the information is consistent with what you know about the setup of your system. If PS0 does *not* list all your sensors, the system may not be configured properly; there is a problem with either the communications to the transducer assembly or a problem with the electronics.

Receive Path Test

This test checks receive-path characteristics, checks for interference signals in the processing circuitry, and checks gain values. A message similar to the following should appear.

Compare these test results with the tests done when the system was first installed. The built-in tests require you to immerse the transducer faces in water. The test may fail in air and if so, is not relevant. Only a failure with the transducer at a minimum in contact with water is a relevant test.

```
>pt3
Receive Path Test (Hard Limited):

Correlation Magnitude:


H-Gain N-BW    L-Gain N-BW
Lag Bm1     Bm2     Bm3     Bm4      Bm1     Bm2     Bm3     Bm4
  0 1000    1000    1000    1000     1000    1000    1000    1000
  1  742     739     743     748      744     741     745     754
  2  336     330     326     336      337     329     339     344
  3   25      32      27      23       35      35      34      40
  4    5      14      13      17        5      12      12       8
  5    8       5      10       6        4       8       5      18
  6   11      11       8      13       13       5      14       3
  7   13      23       2      13        6       2      12       6
```

```
     P       P       P       P

    H-Gain N-BW        L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4
Sin Duty Cycle (percent)
     49  49  49  49     50  48  49  49
      P   P   P   P
Cos Duty Cycle (percent)
     49  49  49  49     50  50  50  49
      P   P   P   P
RSSI Noise Floor (counts)
     45  44  40  53     32  30  26  39
      P   P   P   P

...PASSED
```

Interference Test Pass/Fail Conditions - The Pinnacle pings without transmitting and displays the result of an autocorrelation function performed over 8 lag periods. Ideally, there should be high correlation at near-zero lags, and then decorrelation as the lags get longer. High correlation values at longer lags indicate interference is present.

Contacting TRDI Support

Before returning a system for repair to TRDI, contact TRDI support. Provide the following information:

Provide Unit Setup

Provide a text file with the commands sent to the unit during deployment – Pre- or Suffix it:

`Script_File_[Vehicle_or Deployment_Name_and/or_Date&Time_Goes_Here].txt`

Provide Test Results

If the system failed the PA pre-deployment test or other diagnostics, send a text file with the results.

Describe Deployment Environment & Operational Conditions

It is important to document the deployment environment of the test or mission that has occurred. The following parameters are important:

- Location
- Water description
- Bottom Type – topography and bottom type
- Depth
- Sediment conditions
- Temperatures
- Salinity
- Proximity to ocean structures or acoustic reflectors
- Speed through water

Describe the System Installation

Provide a description of your vehicle, and more specifically a description of the system, ADCP, installation (coupling with the vehicle, material used for the mounting plate, beams behind a fairing, voltage sent to the unit, triggering scenario implemented, etc.).

Provide Raw Data & Describe Issue for Analysis by TRDI

Describe the performance issue or problem.

- Recover the raw data from your instrument. This will preferably be done in the PD0 output format. The information will be sent to TRDI with the complete deployment data if it is not possible to provide PD0 data please identify the data format in which the data was collected.
- Provide screenshots or ensemble numbers to locate region(s) showing the unexpected data behavior.

Provide Additional Data for Analysis by TRDI

If the data you recorded does not match alternate instrumentation providing the same data in the same reference frame, please provide the other device(s) data in a text file or an ASCII Text comma (or other ASCII character) delimited format file. If none of the above are feasible, screenshots of data plots could be provided in place of the above. Attach a description of the data and of the instrument from which it was recorded.

Chapter 6

RETURNING SYSTEMS TO TRDI FOR SERVICE

This chapter covers:

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

Shipping the Pinnacle

This section explains how to ship the Pinnacle.

Remove all customer-applied coatings or provide certification that the coating is nontoxic if shipping a Pinnacle 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 Pinnacle 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 Pinnacle.

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 Pinnacle 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 Pinnacle 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 Pinnacle 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

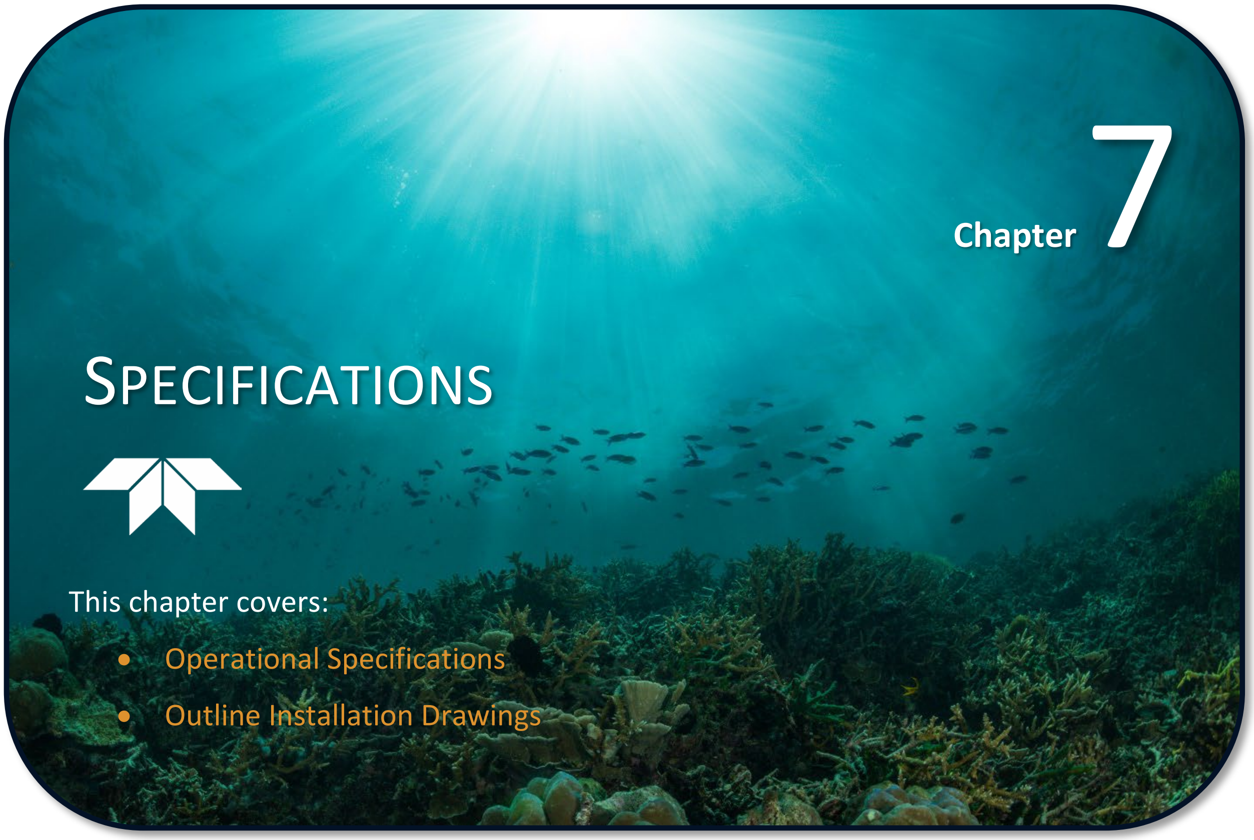
Attention: Sales Administration

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

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

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

NOTES



Chapter 7

SPECIFICATIONS

This chapter covers:

- Operational Specifications
- Outline Installation Drawings

A brief review of Pinnacle 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 Pinnacle 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 Pinnacle transducer. The Pinnacle 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 Pinnacle reduces this statistical uncertainty by averaging a collection of pings. A collection of pings averaged together is an *ensemble*. The Pinnacle's maximum *ping rate* limits the time required to reduce the statistical uncertainty to acceptable levels.

The Pinnacle 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 Pinnacle 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 Pinnacle produces two profiles, one for velocity, and one for echo intensity.

The following tables list the specifications for the Pinnacle. 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 Pinnacle motion, and typical echo intensity levels.
2. The total measurement error of the Pinnacle is the sum of:
   - Long-term instrument error (as limited by instrument accuracy),
   - The remaining statistical uncertainty after averaging,
   - Errors introduced by measurement of Pinnacle heading and motion.
3. Because individual pings are independent, the statistical uncertainty of the measurement can be reduced according to the equation:

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

Water Profile Parameters

Spec	Value
Velocity Accuracy (Long-Term Accuracy)	1.0% ±0.5cm/s
Velocity Range	±9m/s
Velocity Resolution	±0.1cm/s
Depth Cell Size	8m – 64 m (Narrowband) 4m – 64m (Broadband)
Profiling Range	1000m[1]
Number of Depth Cells	128 bins (Narrowband) 255 bins (Broadband)
Water Profiling Modes	WM2 (standard profiling w/ linear A/D) WM10 (narrowband profiling) Interleaved pings.

1. 32m bin, 5C / 35ppt water, Narrowband

Self-Contained Configuration

Spec	Value
Standard Battery Pack	4 Alkaline Battery Packs, 1800 Watt-hours
Optional Battery Pack	4 Lithium Battery Packs, 5400 Watt-hours
Endurance	18 months with Lithium battery packs[1]
Removable recorder (SD memory card)	32 GB

1. 150 pings / hour, 1000m profile

Bottom Track

Spec	Value
Maximum Altitude	2000m
Velocity Range	+/- 9 m/s
Velocity Accuracy	2%

Echo Intensity Profile

Spec	Value
Vertical Resolution	Depth Cell Size
Dynamic Range	80 dB
Precision	±1.5 dB

Transducer and Hardware

Spec	Value
System Center Frequency	45 kHz
Beam Angle	20° Nominal
Configuration	4-beam phased array
Communications	RS232, RS422, or Ethernet RS232/RS422: 1200 – 115200 baud.
Data Output Formats	PD0: Binary or Hex-ASCII NetCDF Matlab

System Power

Spec	Value
DC Input	24 to 50VDC
Peak Power	150W
Quiescent Power	2.2W (wake) 1.1mW (sleep)
Inrush Current	2.3A

Wait approximately 30-seconds between back to back power cycles. This will ensure the electronics residual charges have been dissipated and for the Wake Logic to properly detect the next Cold Start. Cycling the power too quickly can cause the in-rush limiter to not limit the current. In this case, the in-rush current can be as high as 18.8A. Note that the power supply limits the amount of current.

Software

Spec	Value
Configuration **Data Visualization**	Pinnacle Utilities

Environmental

Spec	Value
Operating Temperature	-5 to +45°C
Storage Temperature	-30 to +60°C
Depth Rating	2000 m

Standard Sensors

Spec	Value
Temperature (mounted on transducer)	Range -5 to +45°C Precision ±0.1°C Resolution 0.03°C
Pressure Sensor	Range 600 bar Accuracy 0.1% FS (0.02 bar)
Compass	Heading Accuracy 1°RMS Resolution 0.1° Note 1
Tilt Sensors	Range ±90° Tilt Accuracy ±0.3° Note 2 Resolution 0.06°

1. Heading accuracy is after calibration.
2. Tilt accuracy is <±70° combined tilt.

Available Options

Spec	Value
	All-purpose deck box

Health and Environmental Monitoring (HEMS)

Spec	Value
N/A	Operating Hours Log Over-pressure sensor Pressure cycle counter Max pressure log Leak sensor Transducer health monitor Over temperature sensor (label)

Dimensions and Weight

Spec	Value
System Dimensions – DR **System Dimensions – SC**	See outline installation drawing
System Weight	DIRECT READ 105 ±2 LBS [47.6 ±.9 KG] 2X BATTERY SELF-CONTAINED 145 ±2 LBS [65.8 ±.9 KG] 4X BATTERY SELF-CONTAINED 195 ±2 LBS [88.5 ±.9 KG]

Deck Box

Spec	Value
AC Input voltage	100 to 250 VAC, 50 to 60 Hz
Voltage output to Pinnacle	36V
Input Power (during transmit)	150 W Maximum
Storage temperature range	-30 to 60C
Operating temperature range	-5 to 45C
Maintenance	None required
Dimensions	16.2W X 9.1D X 4.0H
Weight	6lbs.

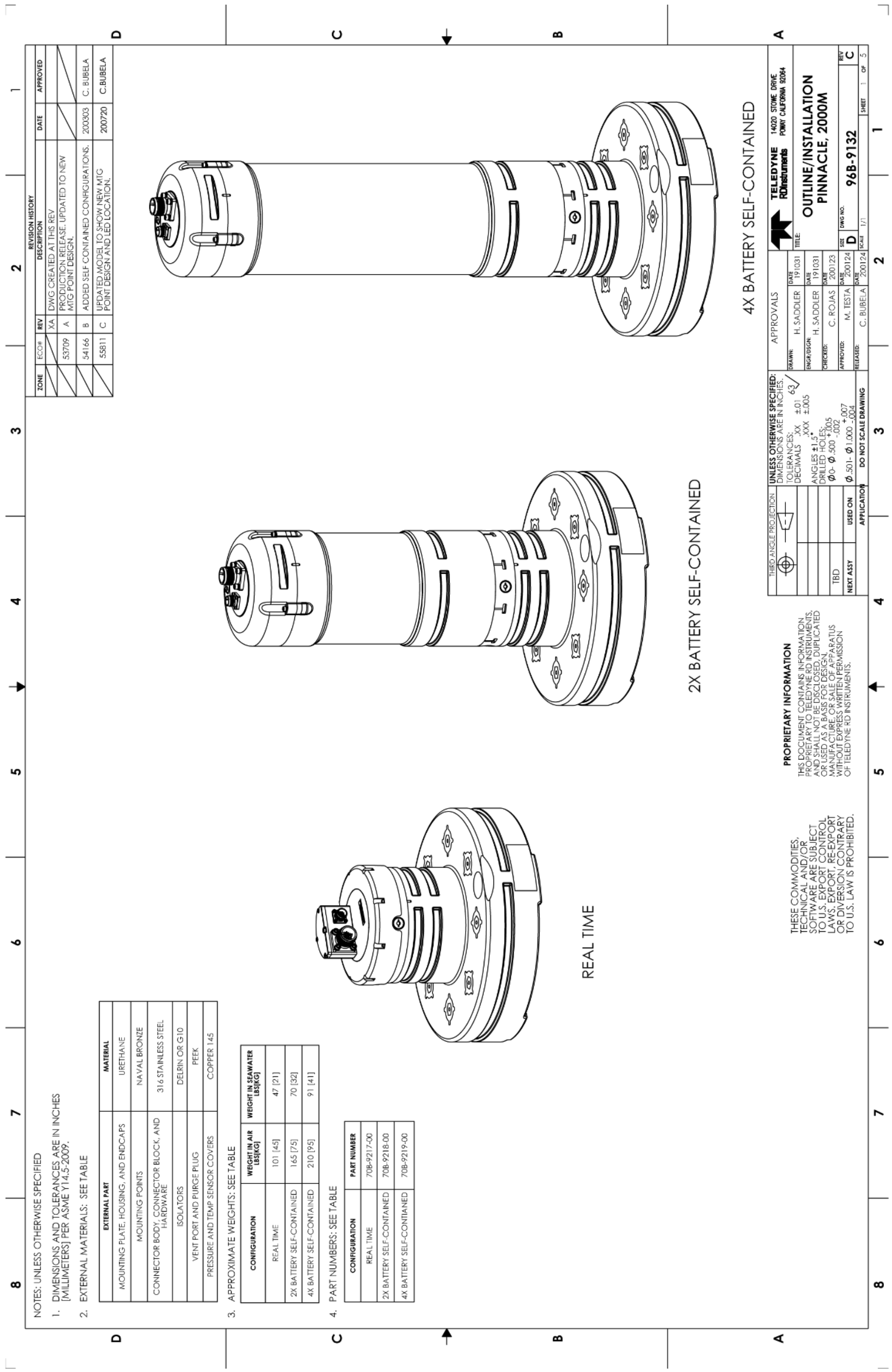
Outline Installation Drawings

The following drawings show the standard Pinnacle dimensions and weights.

Table 12: Outline Installation Drawings

Spec	Value
Pinnacle System	96B-9132
Pinnacle Deck Box	96B-9148

Outline Installation Drawings are subject to change between manual updates.



REVISION HISTORY

ZONE	ECO#	REV	DESCRIPTION	DATE	APPROVED
		XA	DWG CREATED AT THIS REV		
	53709	A	PRODUCTION RELEASE. UPDATED TO NEW MTG POINT DESIGN.		
	54166	B	ADDED SELF CONTAINED CONFIGURATIONS.	200303	C. BUBELA
	55811	C	UPDATED MODEL TO SHOW NEW MTG POINT DESIGN AND LED LOCATION.	200720	C.BUBELA

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS AND TOLERANCES ARE IN INCHES [MILLIMETERS] PER ASME Y14.5-2009.
2. EXTERNAL MATERIALS: SEE TABLE

EXTERNAL PART	MATERIAL
MOUNTING PLATE, HOUSING, AND ENDCAPS	URETHANE
MOUNTING POINTS	NAVAL BRONZE
CONNECTOR BODY, CONNECTOR BLOCK, AND HARDWARE	316 STAINLESS STEEL
ISOLATORS	DELRIN OR G10
VENT PORT AND PURGE PLUG	PEEK
PRESSURE AND TEMP SENSOR COVERS	COPPER 145

3. APPROXIMATE WEIGHTS: SEE TABLE

CONFIGURATION	WEIGHT IN AIR LBS[KG]	WEIGHT IN SEAWATER LBS[KG]
REAL TIME	101 [45]	47 [21]
2X BATTERY SELF-CONTAINED	165 [75]	70 [32]
4X BATTERY SELF-CONTAINED	210 [95]	91 [41]

4. PART NUMBERS: SEE TABLE

CONFIGURATION	PART NUMBER
REAL TIME	70B-9217-00
2X BATTERY SELF-CONTAINED	70B-9218-00
4X BATTERY SELF-CONTIANED	70B-9219-00

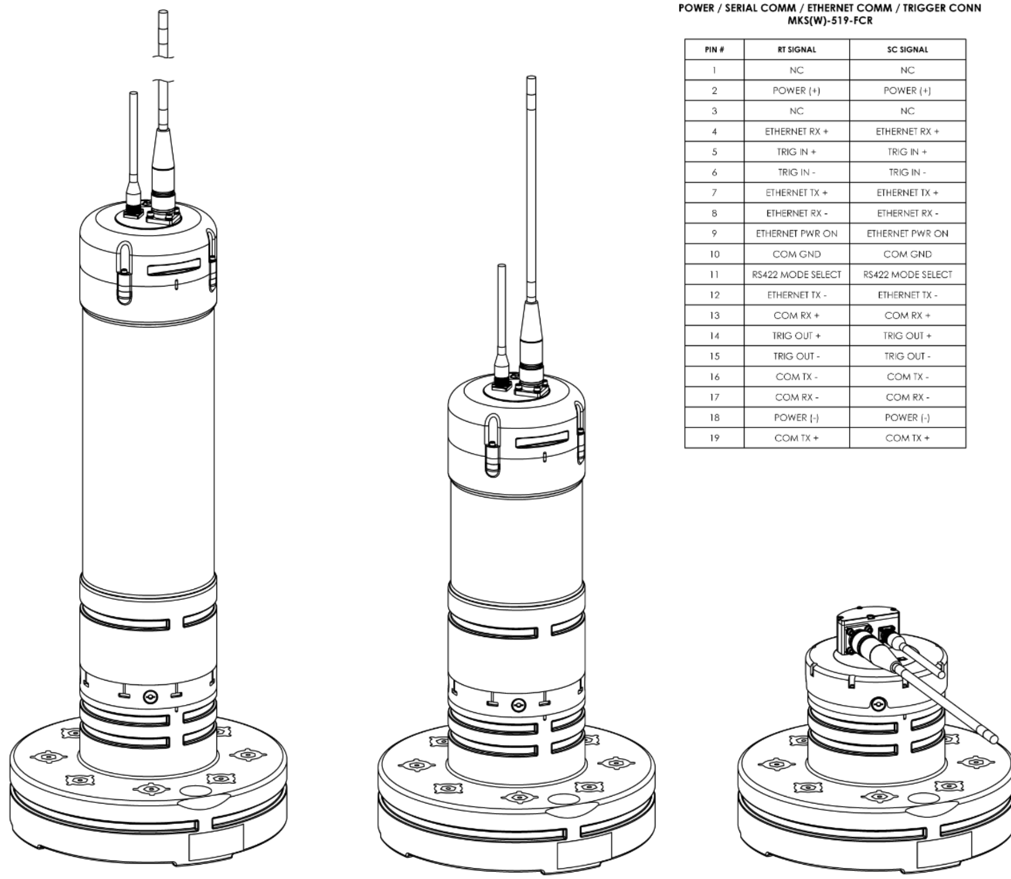
ZONE	ECO#	REV	REVISION HISTORY DESCRIPTION	DATE	APPROVED
			SEE SHEET ONE		

POWER / SERIAL COMM / ETHERNET COMM / TRIGGER CONN MKS(W)-519-FCR

PIN #	RT SIGNAL	SC SIGNAL
1	NC	NC
2	POWER (+)	POWER (+)
3	NC	NC
4	ETHERNET RX +	ETHERNET RX +
5	TRIG IN +	TRIG IN +
6	TRIG IN -	TRIG IN -
7	ETHERNET TX +	ETHERNET TX +
8	ETHERNET RX -	ETHERNET RX -
9	ETHERNET PWR ON	ETHERNET PWR ON
10	COM GND	COM GND
11	RS422 MODE SELECT	RS422 MODE SELECT
12	ETHERNET TX -	ETHERNET TX -
13	COM RX +	COM RX +
14	TRIG OUT +	TRIG OUT +
15	TRIG OUT -	TRIG OUT -
16	COM TX -	COM TX -
17	COM RX -	COM RX -
18	POWER (-)	POWER (-)
19	COM TX +	COM TX +

EXTERNAL SENSOR / EXTERNAL MEMORY CONN MKS(W)-3XL12-FCR

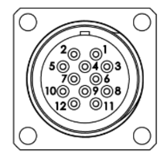
PIN #	RT SIGNAL	SC SIGNAL
1	SENSOR 2 RS232 RX	SENSOR 2 RS232 RX
2	SENSOR 1 RS232 TX	SENSOR 1 RS232 TX
3	SENSOR 2 RS232 TX	SENSOR 2 RS232 TX
4	SENSOR ISO GND	SENSOR ISO GND
5	SENSOR 1 RS232 RX	SENSOR 1 RS232 RX
6	REMOVEABLE MEMORY	NC
7	REMOVEABLE MEMORY	NC
8	REMOVEABLE MEMORY	NC
9	REMOVEABLE MEMORY	NC
10	REMOVEABLE MEMORY	NC
11	REMOVEABLE MEMORY	NC
12	REMOVEABLE MEMORY	NC



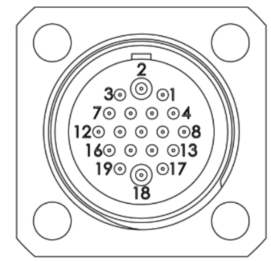
4X BATTERY SELF-CONTAINED

2X BATTERY SELF-CONTAINED

REAL TIME



EXTERNAL SENSOR / EXTERNAL MEMORY MKS(W)-3XL12-FCR FACE VIEW SCALE 3:1



POWER / SERIAL COMM / ETHERNET COMM / TRIGGER MKS(W)-519-FCR FACE VIEW SCALE 3:1

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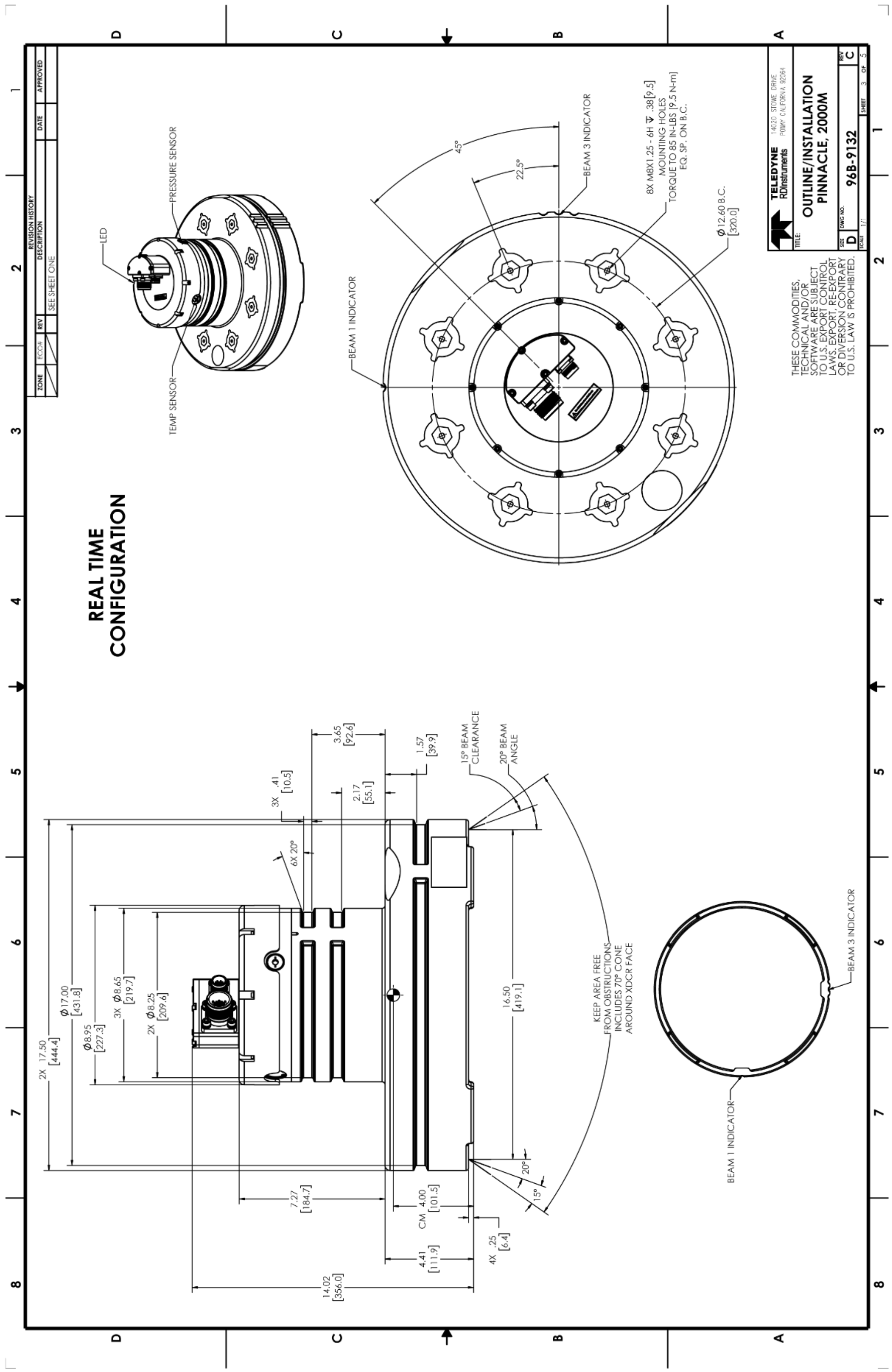
TELEDYNE RDInstruments 14020 STOWE DRIVE POWAY CALIFORNIA 92064

TITLE: OUTLINE/INSTALLATION PINNACLE, 2000M

SIZE D DWG NO. 96B-9132 REV C

SCALE 1/1 SHEET 2 OF 5


REAL TIME CONFIGURATION
PRESSURE SENSOR
LED
TEMP SENSOR
BEAM 1 INDICATOR
BEAM 3 INDICATOR
45°
22.5°
8X M8X1.25 - 6H ↧ .38 [9.5]
MOUNTING HOLES
TORQUE TO 85 IN-LBS [9.5 N-m]
EQ. SP. ON B.C.
Ø12.60 B.C. [320.0]
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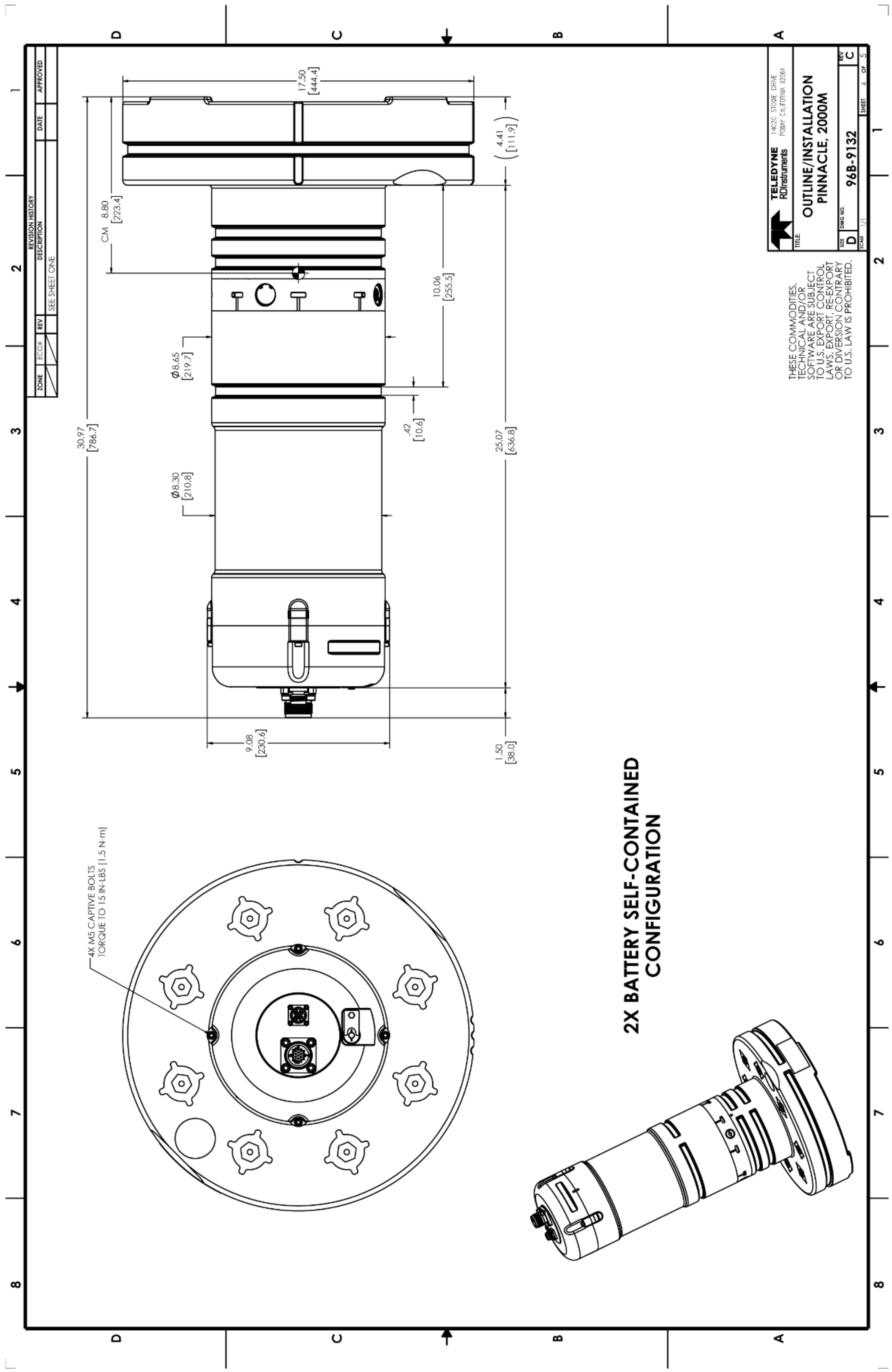
TELEDYNE RDInstruments
OUTLINE/INSTALLATION PINNACLE, 2000M
96B-9132
REVISION HISTORY
SEE SHEET ONE
15° BEAM CLEARANCE
20° BEAM ANGLE
KEEP AREA FREE FROM OBSTRUCTIONS INCLUDES 70° CONE AROUND XDCR FACE
2X 17.50 [444.4]
Ø17.00 [431.8]
Ø8.95 [227.3]
3X Ø8.65 [219.7]
2X Ø8.25 [209.6]
16.50 [419.1]
7.27 [184.7]
CM 4.00 [101.5]
4.41 [111.9]
14.02 [356.0]
4X .25 [6.4]
3X .41 [10.5]
2.17 [55.1]
3.65 [92.6]
1.57 [39.9]
6X 20°


2X BATTERY SELF-CONTAINED CONFIGURATION
4X M5 CAPTIVE BOLTS TORQUE TO 15 IN-LBS [1.5 N-m]
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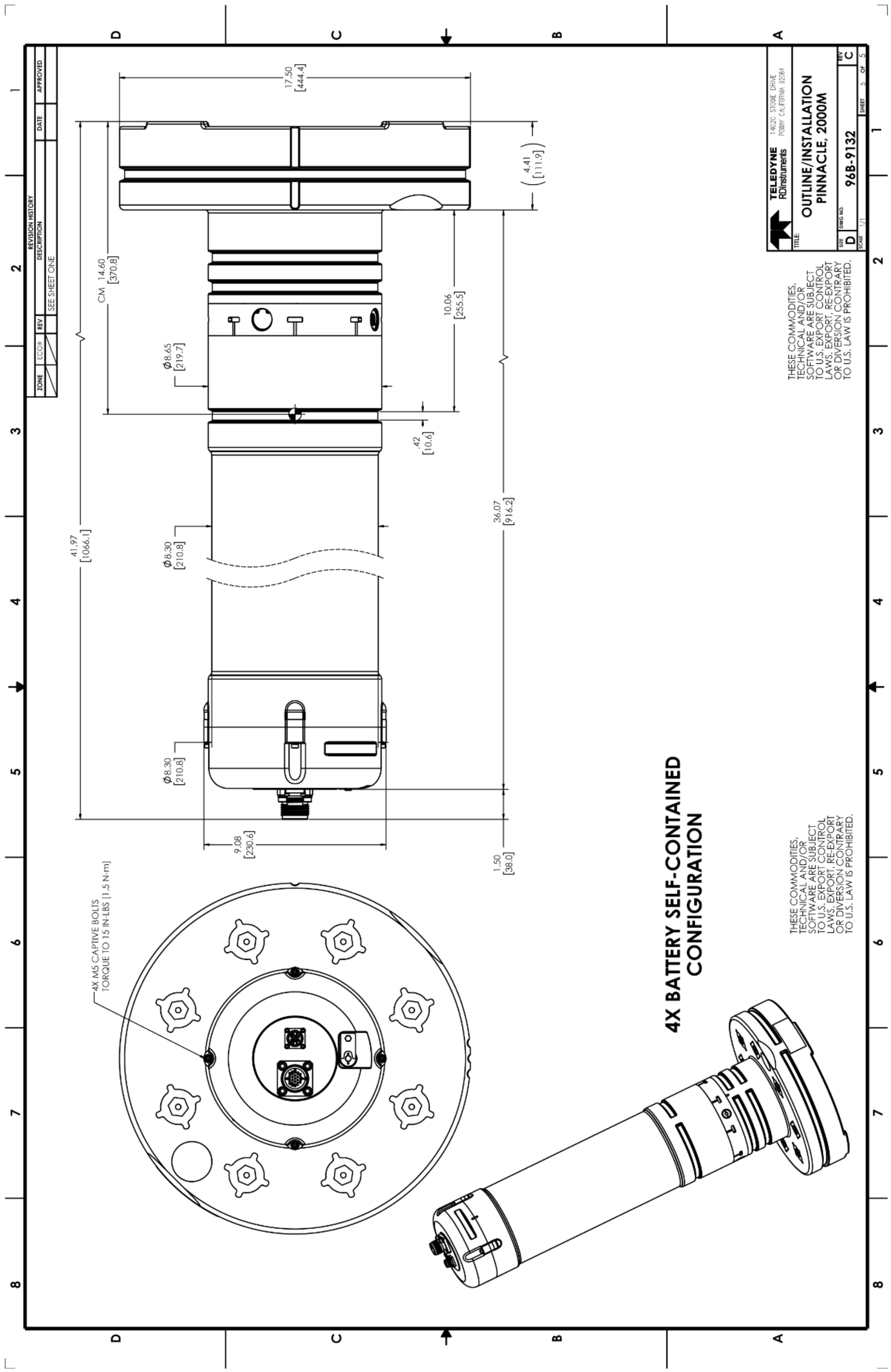
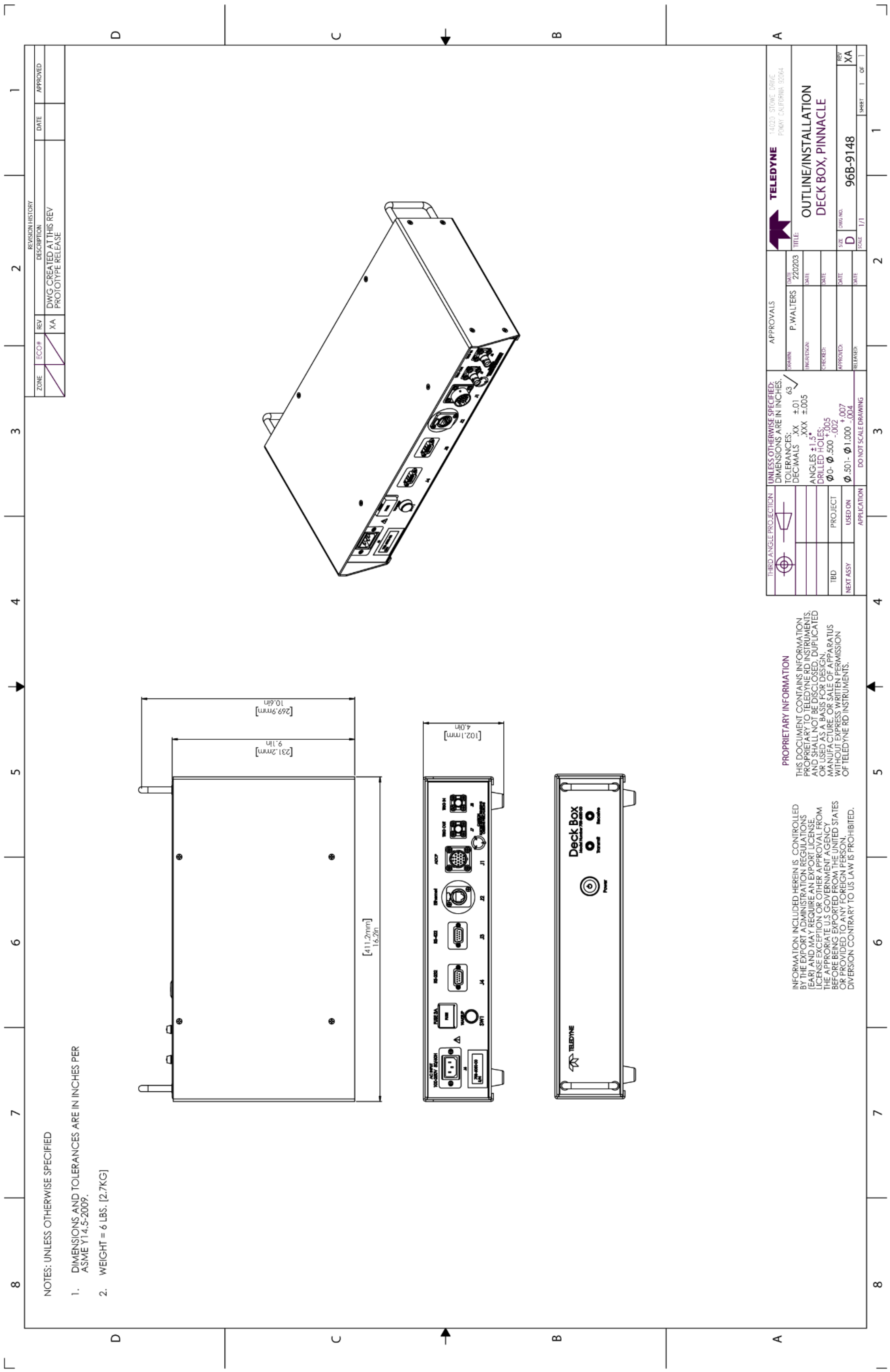
TELEDYNE RD Instruments
OUTLINE/INSTALLATION PINNACLE, 2000M
96B-9132
REVISION HISTORY
SEE SHEET ONE
17.50 [444.4]
4.41 [111.9]
CM 8.80 [223.4]
10.06 [255.5]
Ø8.65 [219.7]
.42 [10.6]
30.97 [786.7]
25.07 [636.8]
Ø8.30 [210.8]
9.08 [230.6]
1.50 [38.0]


OUTLINE/INSTALLATION
PINNACLE, 2000M
96B-9132
4X BATTERY SELF-CONTAINED CONFIGURATION
4X M5 CAPTIVE BOLTS TORQUE TO 15 IN-LBS [1.5 N-m]
THESE COMMODITIES, TECHNICAL AND/OR SOFTWARE ARE SUBJECT TO U.S. EXPORT CONTROL LAWS. EXPORT, RE-EXPORT OR DIVERSION CONTRARY TO U.S. LAW IS PROHIBITED.
17.50 [444.4]
41.97 [1066.1]
CM 14.60 [370.8]
Ø8.65 [219.7]
Ø8.30 [210.8]
10.06 [255.5]
36.07 [916.2]
4.41 [111.9]
.42 [10.6]
9.08 [230.6]
1.50 [38.0]


NOTES: UNLESS OTHERWISE SPECIFIED
1. DIMENSIONS AND TOLERANCES ARE IN INCHES PER ASME Y14.5-2009.
2. WEIGHT = 6 LBS. [2.7KG]
REVISION HISTORY
ZONE ECO# REV DESCRIPTION DATE APPROVED
XA DWG CREATED AT THIS REV PROTOTYPE RELEASE
[269.9mm] 10.6in
[231.2mm] 9.1in
[102.1mm] 4.0in
[411.2mm] 16.2in
Deck Box
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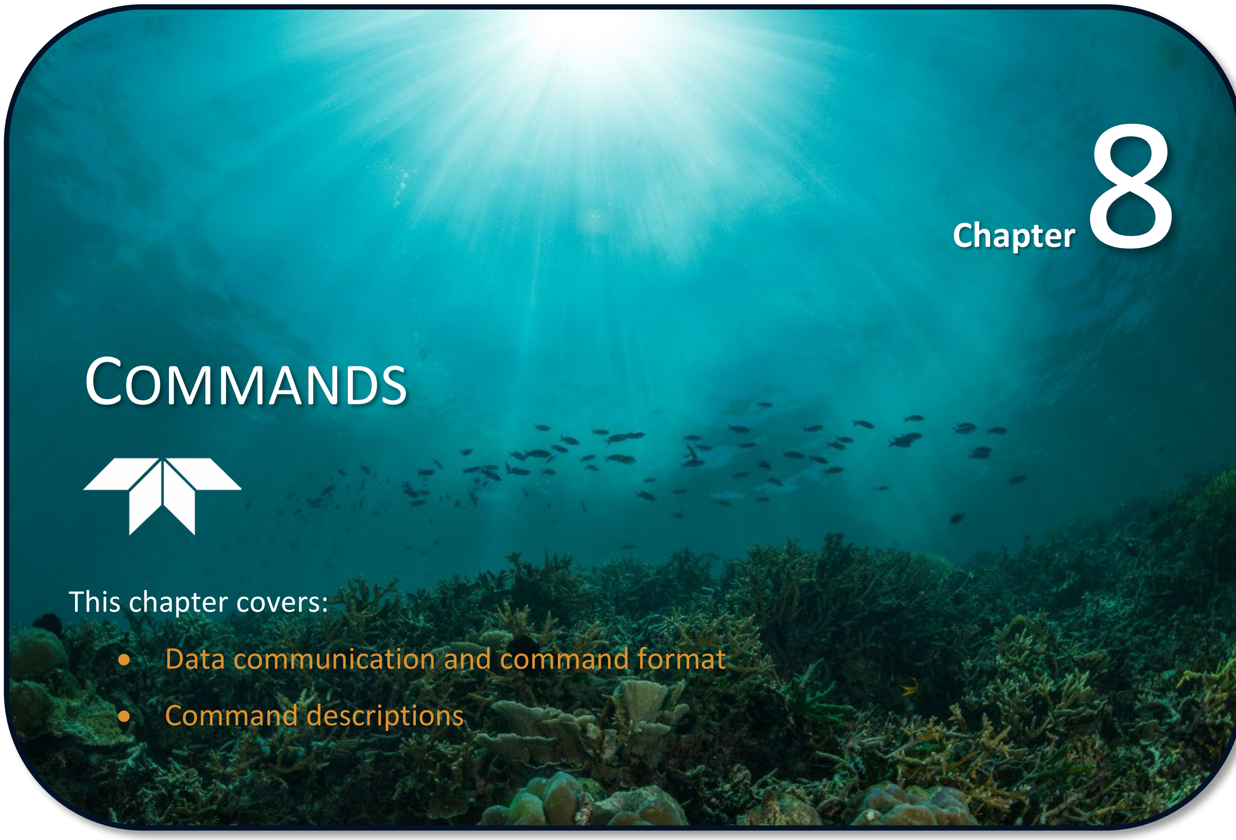
THIRD ANGLE PROJECTION
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES.
TOLERANCES: DECIMALS .XX ±.01 .XXX ±.005
ANGLES ±1.5°
DRILLED HOLES:
DO NOT SCALE DRAWING
APPROVALS
DRAWN P.WALTERS 220203
TELEDYNE
TITLE: OUTLINE/INSTALLATION DECK BOX, PINNACLE
SIZE D
DWG NO. 96B-9148
REV XA
SCALE 1/1



Chapter 8

COMMANDS

This chapter covers:

- Data communication and command format
- Command descriptions

This section defines the commands to set up and control the Pinnacle. Teledyne RD Instruments recommend using the *Pinnacle Utilities* software to control the Pinnacle because entering commands directly from a terminal can be difficult. Most Pinnacle command settings use factory-set values (Table 9). 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.

> This section applies to Pinnacle firmware 71.xx.
>
> 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.
>
> 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

Enter commands with a Windows®-compatible computer running TRDI's *Pinnacle Utilities* or *TRDI Toolz*. The Pinnacle communicates with the computer through an RS-232 (or RS-422) serial or Ethernet interface. TRDI initially sets the Pinnacle at the factory to communicate at 115200 baud, no parity, and one stop bit.

Command Input Processing

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

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

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

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

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

```
>BPA<CR>                                      [input]
>BPA  ERR:  Bad command parameters!<CR><LF>   [Pinnacle 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 Pinnacle completes a data collection cycle, it sends a block of data called a *data ensemble* through the serial communication lines. A data ensemble consists of the data collected, processed, and averaged during the ensemble interval (see TE – Time Per Ensemble). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, and status data.

When data collection begins, the Pinnacle 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 Pinnacle 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 Pinnacle:

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 Pinnacle 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 Pinnacle 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 Pinnacle receives a CR1, it will load into volatile memory the factory default command set stored in ROM (permanent or factory settings).

Command Summary

Table 9 gives a summary of the Pinnacle input commands, their format, default setting, whether the Pinnacle 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 Pinnacle system accepts command changes during operation without the need to stop the ping cycle (by sending a <BREAK>). This allows for dynamic setup configuration without stopping the operation of the Pinnacle. These dynamic setup commands are defined in the column Dynamic Commands in the table below.

Commands used by the Catalyst or passed through to the Doppler are defined in the column Catalyst Commands in the table below.

Table 13: Pinnacle Input Command Summary

Command	Default	Dynamic Command	Catalyst Command	Description
?	N/A	N/A	Yes	Shows command menu
<BREAK> End	N/A	N/A	Yes	Wakes up the unit from sleep, stops the ping cycle. Displays the banner.
= = = (soft break)	N/A	N/A	Yes	
Y	N/A	N/A	Yes	Display banner
OL	N/A	N/A	Yes	Features
Bottom Track Commands				
B?	N/A	Yes	No	Lists available commands
BA nnn	024	No	No	Evaluation Amplitude Min (0-255)
#BB nnnn	0200	No	No	Bottom Blank (0-9999)
BC nnn	000	No	Yes	Correlation Magnitude Min (0-255)
BE nnnn	1000	No	Yes	Max Error Velocity (0-9999mm/s)
BF nnnnn	00000	No	No	Depth Guess (0=Auto, 1-65535 dm)
#BH nnn nnn	105,185	No	No	Gain Switch Threshold (0-255cnts:lo;hi)
#BI nnn	200	No	No	Gain Switch Altitude [0-999m]
BP nnn	0	No	No	Pings per Ensemble (0-999)
BX	20000	No	No	Maximum Altitude (10-65535 dm)
#BY nn	20	No	No	Transmit length (percent)
Control System Commands				
C?	N/A	Yes	Yes	Lists available commands
C1	0	Yes	Yes	Ping Interlock Threshold value (kPa)
CA	300	No	Yes	Communication Timeout (0=Off,10-65536 sec)
CB *nnn*	811	No	Yes	Serial port control (baud rate/parity/stop bits)
CD n	N/A	No	Yes	Ensemble Buffering [0=Off, 1=On]
CF *nnnnnn*	111111	No	Yes	Flow control (EnsCyc; PngCyc; Binary; Serial; X)
CG n	N/A	No	Yes	Set Self Contained Mode [0:1]

Table 13: Pinnacle Input Command Summary

Command	Default	Dynamic Command	Catalyst Command	Description
CK	N/A	No	Yes	Keep parameters as user defaults
CL n	1	No	Yes	Sleep Enable (0=Disabled, 1=Enabled)
CN n	N/A	No	Yes	Ethernet settings
CN 1	N/A	Yes	Yes	Show Network Setup
CN 2	192.168.001.100	Yes	Yes	Set Static IP Address [xxx.xxx.xxx.xxx]
CN 3	1	No	Yes	DHCP Enable [1=DHCP, 0=Static]
CN 4	192.168.001.001	Yes	Yes	Set IP Gateway [xxx.xxx.xxx.xxx]
CN 5	255.255.255.000	No	Yes	Set Subnet Mask
CN 6	000.000.000.000:280	Yes	Yes	UDP Data Destination [xxx.xxx.xxx.xxx:pppp]
CN 7	N/A	No	Yes	Start Networking
#CO e d o	0 1 0	Yes	Yes	Set Out Trig (enab[1|0], Dur[1=T&R,2=T], ofs[-10..+10 ms])
CQ n	2	No	No	Set tx power [0..3]
CR *n*	N/A	No	Yes	Retrieve parameters (0 = User, 1 = Factory)
CS or **Tab**	N/A	No	Yes	Start pinging
CSTATE	N/A	No	Yes	Pinging State Query
CSTOP	N/A	Yes	Yes	Stop Pinging
CW n	0	No	Yes	Select Dual Mode Data (NB / BB)
#CX *m d t*	0 0 0	Yes	Yes	Set Input Trigger [mode, dly (ms), timeout (s)]
CZ	N/A	No	Yes	Put the system to sleep
Environmental Commands				
E?	N/A	Yes	No	Lists available commands
EA ±*nnnnn*	+00000	No	Yes	Heading Alignment [.01 deg cw]
EB +*nnnnn*	+00000	No	Yes	Heading Bias [.01 deg cw]
EC *nnnn*	1500	No	Yes	Speed of Sound (1400 to 1600 m/s)
ED *nnnn*	00200	No	No	Transducer Depth (0 to 65535 dm)
EE *n*	1	No	No	Interpolation (1=Nominal, 0=Raw Beam Calculation)
EH *nnnnn*	0	No	No	Heading nnnnn = 0 to 35999 (000.00 to 359.99 degrees)
EM *n*	0	No	No	Disable beam [0=none|1-4]
EP ±*nnnnn*	+00000	Yes	No	Tilts ±nnnn = -6000 to 6000 (-60.00 to +60.00 degrees)
ER ±*nnnnn*	+00000	Yes	No	Roll ±nnnn = -17999 to 18000 (-179.99 to +180.00 degrees)
ES *nn*	35	No	No	Salinity (nn = 0 to 40)
ET ±*nnnn*	0500	Yes	No	Temperature ±nnnn = -500 to 4500 (-5.00 C to +45.00 C)
EU *n*	0	Yes	Yes	Orientation 0=down, 1=up
EX *nnnnn*	11111	No	Yes	Coordinate Transformation (cct3m)
EZ cdhprstu	11111011	No	No	Sensor Source (C;D;H;P;R;S;T; U)
Narrow Bandwidth Profiling Commands				
N?	N/A	Yes	No	Lists available commands
NA nnn	255	No	No	NB False Target Amplitude Threshold [0-255] (255 disables this filter)
ND v;c;a;p;s;*;*;*;*	111110000	No	No	NB Data Out (Vel;Pwr;Amp; PG, Stat; X; X; X; X)
NE *nnnn*	1000	No	No	NB Error Velocity Threshold (0 to 9999 mm/s)

Table 13: Pinnacle Input Command Summary

Command	Default	Dynamic Command	Catalyst Command	Description
NF *nnnn*	1600	No	No	NB Blanking Distance (37-9999cm)
NN *nnn*	040	No	Yes	NB Number of Bins (1-128)
NP *nnn*	001	No	Yes	NB Number of Pings (0-999)
NS *nnnn*	3200	No	Yes	Bin Size (800-6400 cm)
Performance and Testing Commands				
P?	N/A	Yes	No	Lists available commands
PA	N/A	No	No	Run Go/No-Go Tests
PC0	N/A	No	No	Built-In Test Help menu
PC2	N/A	No	No	Display sensor data – non-scrolling
PC4	N/A	No	No	Display voltage and current data – non-scrolling
PC5	N/A	No	No	Display leak sensor data – non-scrolling
PC20	N/A	No	No	Display sensor data – scrolling
PC40	N/A	No	No	Display voltage and current data – scrolling
PC50	N/A	No	No	Display leak sensor data - scrolling
PD0	0	No	No	Set Output Format (0=ensemble; 1=ASCII (test))
PS0	N/A	Yes	No	Display System Configuration
PS3	N/A	No	Yes	Displays the beam transformation matrix
PS5	N/A	No	No	Displays HEM sensor data
PT0	N/A	No	No	Built-In test Help
PT3	N/A	No	No	Built-In test - Receive Path
PT5	N/A	No	No	Built-In test - Transmit/Receive Continuity
PT9	N/A	No	No	Transmit memory test
PT11	N/A	No	No	FRAM Test
PT12	N/A	No	No	RAM test
PT13	N/A	No	No	ROM test
PT15	N/A	No	No	Communications Test
PT16	N/A	No	No	Clock Test
PT17	N/A	No	No	Compass Test
PT18	N/A	No	No	Temperature Test
PT19	N/A	No	No	Xmt/Rcv Test
PT21	N/A	No	No	Pressure Test
Sensor Commands				
S?	N/A	Yes	No	Lists available commands
SZ	N/A	No	No	Zero out keller30 Pressure
Timing Commands				
T?	N/A	Yes	No	Lists available commands
TB *e hh:mm:ss* *hh:mm:ss* *hh:mm:ss.dd*	0 00:00.00 00:00:00 00:00:00.00	No	No	Burst Mode e - 0-1 (Disable/Enable) <offset> 00:00:00 to 30:00:00 <TPburst> 00:00:00 to 30:00:00 <TEburst> 00:00:00 to 12:00:00.00
TE *hh:mm:ss.ff*	00:00:00.00	No	Yes	Time per ensemble (hours:minutes:seconds.100th of seconds)

Table 13: Pinnacle Input Command Summary

Command	Default	Dynamic Command	Catalyst Command	Description
TF *yy/mm/dd, hh:mm:ss*	N/A	No	Yes	Time of First Ping
TO *abc*	100	No	No	0-3 for each of abc, max one instance of 1-3, no numbers >0 after 0
TP *mm:ss.ff*	00:00.00	No	Yes	Time between pings (minutes:seconds.100th of seconds)
TS *yy/mm/dd, hh:mm:ss*	N/A	No	Yes	Set real-time clock (year/month/day, hours:minutes:seconds)
#TM *nnn*	0 0 0	No	No	Set minimum time between pings {nb [bb bt]} [0..1000 ms]
Broadband Water Profiling Commands				
W?	N/A	Yes	No	Lists available commands
WA *nnn*	050	No	Yes	False target threshold maximum (0 to 255 counts)
WC *nnn*	064	No	Yes	Correlation threshold (0 to 255 counts)
WD *nnn nnn nnn*	111 110 000	No	Yes	Data Out {v;c;a;p;s;*;*;*;*}
WE *nnnn*	2000	No	Yes	Error velocity threshold (0 to 5000 mm/s)
WF *nnnn*	1600	No	No	Blanking Distance [0 to 9999 cm]
#WJ n	1	No	No	BroadBand Rcvr Gain [0=Lo,1=Hi]
WM n	2	No	No	Water Profiling Mode [2]
WN *nnn*	050	No	Yes	Number of Bins [1-255]
WP *nnn*	000	No	Yes	Number of Pings [0-999]
WS *nnnn* [min, max]	1600	No	Yes	Bin Size (cm) [400-6400]
#WT *nnnn*	0000	No	Yes	Transmit length (0 to 6400 cm, 0 = same transmit as WS)
WV *nnn*	0390	No	No	Ambiguity Velocity (cm/s)

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

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

Command Descriptions

Each listing includes the command's purpose, format, default setting (if applicable) range, recommended setting, and description. When appropriate, we include amplifying notes and examples. If a numeric value follows the command, the Pinnacle 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 Pinnacle displays the help for a command group, it also shows the format and present setting of those commands. To see the help or setting for one command, enter the command followed by a question mark. For example, to view the WP command setting, enter WP?.
Examples	See below.

```
  Break Detected: Yes

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Version: 71.0

Not Pinging
>

>?
Available Commands:

B ----------------------- Bottom Mode Commands
C ----------------------- Control Commands
E ----------------------- Environment Commands
F ----------------------- Diagnostics Commands
N ----------------------- NB Profiling Commands
O ----------------------- Feature Commands
P ----------------------- Performance Test Commands
S ----------------------- Sensor Commands
T ----------------------- Time Commands
W ----------------------- Water Profiling (BB) Commands
Y ----------------------- Display Banner
? ----------------------- Display Main Menu


>b?
Available Commands:

BA 024 ------------------ Amplitude Threshold [0..255]
BC 000 ------------------ Correlation Threshold [0..255]
BE 1000 ----------------- Error Velocity Threshold [0-9999mm/s]
BF 00000 ---------------- Depth Guess [0=Auto, 1-65535dm]
BJ 100000000 ------------ Data Out {t;c;*;h;r;*;*;*;*}
BP 0 -------------------- Number of BT Pings in ensemble [0-999]
BX 20000 ---------------- Max Depth (dm) [10-65535 dm]
B? ---------------------- Display B-Command Menu

>wp?
WP 000 ------------------ Number of Pings [0-999]
>
```

Break

Purpose Interrupts Pinnacle without erasing present settings.

Format <BREAK>

Description A BREAK signal interrupts Pinnacle ADCP processing, initializes the system, sends a wake-up (copyright) message, and places the Pinnacle 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.

```
Pinnacle
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Version: 71.0

Not Pinging
>
```

A break does not interrupt a deployment! This is by design, because there will be many cases where the user wishes to wake up Catalyst 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 Pinnacle 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 Pinnacle will NOT go to sleep.

Soft Break

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

```
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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 *Pinnacle Utilities* software for information on how to install additional capability in the Pinnacle.

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 Pinnacle.

>
```

Bottom Track is a feature upgrade. Use *Pinnacle 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 Pinnacle.
Example	See below.

```
>y
Pinnacle
Teledyne RD Instruments (c) 2019
All rights reserved.
Version: 71.0

Not Pinging
>
```

Bottom Track Commands

The Pinnacle 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 ------------------ Amplitude Threshold [0..255]
BC 000 ------------------ Correlation Threshold [0..255]
BE 1000 ----------------- Error Velocity Threshold [0-9999mm/s]
BF 00000 ---------------- Depth Guess [0=Auto, 1-65535dm]
BP 0 -------------------- Number of BT Pings in ensemble [0-999]
BX 20000 ---------------- Max Depth (dm) [10-65535 dm]
B? ---------------------- Display B-Command Menu
```

Bottom-Track Command Descriptions

BA – Amplitude Threshold

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 0

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. We recommend 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 65535 dm (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 Pinnacle 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 Pinnacle uses to search for the bottom if lost.

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

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 999 pings

Default BP 0

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

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

The Pinnacle 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 Pinnacle does not collect bottom-track data.

BX – Maximum Tracking Depth

Purpose	Limits the search range for bottom tracking.
Format	BX *nnnn*
Range	*nnnn* = 0 to 65535 decimeters (meters x 10)
Default	BX 20000

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

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 500 meters (5000 decimeters), set BX to a value slightly larger than 5000 dm, say 5250 dm, instead of 20000 dm. Now if the ADCP loses track of the bottom, it will stop searching for the bottom at 5250 dm (525 m) rather than spend time searching down to 20000 dm (2000 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.

Expert Bottom Track Commands

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

```
>#B?
*** CAUTION: These commands are reserved for RDI use
             and may not be currently supported!

Available Commands:

#BB 0200 ---------------- Blanking distance [0-9999cm]
#BH 105,185 ------------- Gain Switch Threshold (0-255cnts:lo;hi)
#BI 200 ----------------- Gain Switch Altitude [0-999m]
#BY  20 ----------------- Transmit Length (0..99%)
#B? --------------------- Display #B-Command Menu

>
```

#BB – Blanking Distance

Purpose	Sets the blanking distance for Bottom Tracking.
Format	#BB *nnn*
Range	*nnnnn* = 0 to 9999 cm
Default	#BB 0200

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

Description — #BB blanks out bad data close to the transducer head, thus creating a window that reduces unwanted data in the ensemble. This allows the Pinnacle ADCP transmit circuits time to recover before beginning the receive cycle.

#BH – Gain Switch Threshold

Purpose	Sets the RSSI thresholds for switching the receiver gain for a bottom track ping.
Format	#BH *nnn*, *nnn* (lo;hi)
Range	*nnn* = 0 to 255 counts
Default	#BH 105, 185

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

Description — Receiver gain control for bottom track always uses low gain when the altitude over the sea bottom is less than the Gain Switch Altitude (set by the #BI command). When the altitude is above the Gain Switch Altitude:

- Switch to high gain when RSSI is below the low threshold set by the #BH command.
- Switch to low gain when RSSI is above the high threshold set by the #BH command.

Using two thresholds provides hysteresis, so that the gain does not need to switch on every ping when the RSSI is at some in-between level.

#BI – Gain Switch Altitude

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

Format #BI *nnn*

Range *nnn* = 0 to 999 meters

Default #BI 200

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.

#BY – Transmit length (percent)

Purpose Scales the bottom mode transmit.

Format #BY *nnnn*

Range: *nnnn* = 0 to 99 %

Default: #BY 20

Recommended Setting. The default setting for this command should never be changed without through testing, as changes to this parameter have the potential to produce incorrect velocity and/or range data.

Description The BY command sets the transmit length for a bottom track ping as a percentage of the altitude over the sea bottom. The default setting has been designed to optimize the tradeoff between energy consumption and the ability to detect the bottom with combined tilt/slope of up to about 15 degrees. Smaller values result in shorter transmits, which use less energy, but which may not fully ensonify the beam on the sea bottom, especially if the instrument is tilted or if the bottom has a slope, resulting in velocity bias. Larger values result in longer transmit pulses (up to a point) which may allow bottom detection at larger values of tilt/slope, but will consume more energy, and may decrease the resolution of the range-to-bottom measurement.

Control System Commands

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

Available Control System Commands

This section lists the available Control System commands.

```
>c?
Available Commands:

C1    0 ----------------- Ping Interlock Threshold value (kPa)
CA   300 ---------------- Communication Timeout (0=Off,10-65535 sec)
CB 811 ------------------ Serial Port Control {baud;parity;stop}
CD 1 -------------------- Ensemble Buffering [0=Off, 1=On]
CF 111111 --------------- Set Ctrl Flags {e;p;b;s;*;m}
CG 1 -------------------- Set Self Contained Mode [0:1]
CK ---------------------- Save Command Parameters to Flash
CL 1 -------------------- Sleep Enable ( 0=Disabled, 1=Enabled  )
CN ---------------------- Network Menu
CQ 2 -------------------- Set tx power [0..3]
CR ---------------------- Restore Cmd defaults [0=user,1=factory]
CS ---------------------- Start Pinging
CSTATE ------------------ Pinging State Query
CSTOP ------------------- Stop Pinging
CW 0 -------------------- Select dual mode data [0=broad,1=narrow]
CZ ---------------------- Put the system to sleep.
C? ---------------------- Display C-Command Menu
>
```

C1 – Set Xmit Inhibit Pressure Threshold

Purpose	Sets a minimum depth value for the Pinnacle system to start pinging.
Format	C1 *nnn (*0 = always allow pinging)
Range	*nnn* = 0 to 2000 kPa
Default	C1 0

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

Description

This command helps to ensure that the Pinnacle only pings when submerged. The command reads the pressure sensor and transmit is disabled whenever the system detects that it is not sufficiently submerged. The user can adjust the level of sufficient immersion.

When the user has disabled this feature by sending the C1 0 command, then the pressure interlock feature has been disabled and the unit will always start pinging when the CS command is issued.

When the unit is deployed, and the pressure interlock is active (i.e. a standard CS command has been sent, and the pressure threshold is non-zero) the system will go through the motions of “pinging” and outputting data but will not actually transmit if the minimum depth criteria is not satisfied. In the output, velocities are marked bad, and correlations and RSSI values are output as all zeros. This output is unusual and should be a clue to the user that perhaps transmit has been disabled due to insufficient water pressure.

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 300

> 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 Pinnacle will redeploy.

CB – Serial Port Control

Purpose Sets the user-to-Catalyst baud rate parameters (Baud Rate/Parity/Stop Bits).

Format CB *nnn*

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

Default CB 811

> The Pinnacle defaults to CB811 (115200 baud) if this parameter has never been saved to non-volatile memory. Otherwise, it uses the value last saved (i.e. the last time a CK command was issued).

Description The Pinnacle can be set to communicate at baud rates from 1200 to 115200. The Pinnacle and the external device (software) MUST use the same communication parameters to *talk* to each other. After entering valid CB parameters, the Pinnacle responds with a ">" prompt. Then change the external device's communication parameters to match the Pinnacle parameters before sending another command.

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

Table 14: Serial Port Control

Baud Rate	Parity	Stop Bits
1 = not allowed	1 = None (Default)	1 = 1 Bit (Default)
2 = not allowed	2 = Even	2 = 2 Bits
3 = 4800	3 = Odd	
4 = 9600	4 = Low (Space, logical 0)	
5 = 19200	5 = High (Mark, logical 1)	
6 = 38400		
7 = 57600		
8 = 115200 (Default)		

For Direct-Reading applications, there are some non-default settings combinations that can result in data loss in Real-Time output when pinging as-fast-as-possible without stopping. When the bin size is set smaller than the default and/or the bin count is larger than the default, combined with the lowest supported serial output rate (9600 baud), data loss may occur. The recommended (conservative) ping spacing is listed in Table 11. Faster ping rates may work depending on setting specifics but should be verified before deployment.

Table 15. Recommended Minimum Ping Time (TP)

Direct-Reading Configuration	9600 baud	19200 baud or higher
Single profile, default bin size and count	None	None
Interleaved profiles, default bin size and count	None	None
Single profile, small bin size and/or high bin count	3.2 sec	None
Interleaved profiles, small bin size and/or high bin count	6.4 sec	None

CD – Ensemble Buffering

Purpose Sets ensemble buffering on or off.

Format CD *n*

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

Default N/A – depends on setting of CG command. Not reset by CR1/CR0 or a power cycle.

Recommended Setting. Set using *Pinnacle Utilities*.

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.

If the CG command is set to CG0 (Direct-Read Mode), *Pinnacle Utilities* adds the CD0 command to disable buffering. If the CG command is set to CG1 (Self-Contained Mode), *Pinnacle Utilities* adds the CD1 command to enable buffering.

Verify the CD and CG commands are properly set if using a command file that was created without using *Pinnacle Utilities*.

CF – Flow Control

Purpose	Sets various data flow-control parameters.
Format	CF *nnnnnn*
Range	Firmware switches (see description)
Default	CF 111111

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

Description The CF-command defines whether the Pinnacle: generates data ensembles automatically or manually; 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 cards.

Table 16: Flow Control

Command	Description
CF1xxxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF0xxxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the “>” prompt and waits for a new command.
CFx1xxxx	Automatic Ping Cycling – Pings immediately when ready.
CFx0xxxx	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 RiverPro/RioPro is not echoed. This feature manually controls ping timing within the ensemble. Note the prompt output by the RiverPro/RioPro when ready to ping is a less-than symbol (<), to distinguish it from the normal command prompt.
CFxx1xxx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled (see below).
CFxx0xxx	Hex-ASCII Data Output – Not allowed.
CFxxx1xx	Enable Serial Output – Sends the data ensemble out the RS-232/422 serial interface.
CFxxx0xx	Disable Serial Output – Not allowed.
CFxxxxx1	Enable Fixed and Removable data recorders (SD memory cards).
CFxxxxx0	Disable Fixed and Removable data recorders (SD memory cards).

Legacy software such as ddas, will only send the first 5 flags in the CF command to maintain compatibility. The latest version of VmDas sends CF with 6 digits.

CG – Set Self Contained Mode

Purpose	Sets the Direct-Read mode or Self-Contained system type.
Format	CG *n*
Range	*n* = 0, 1 (0 = Direct-Read (DR) Mode, 1 = Self-Contained (SC) Mode)
Default	N/A – depends on setting from *Pinnacle Utilities*. Not reset by CR1/CR0 or a power cycle.

Recommended Setting. Select the system type using *Pinnacle Utilities*.

Description DR and SC differ in behavior in the following ways:

- The System Type is selected using *Pinnacle Utilities* and is not reset by CR1/CR0 or a power cycle.

- Setting the System Type changes what Wizards are available for use in *Pinnacle Utilities*. For example, the Vessel Mount Wizard is only available for DR System Type.
- How *Pinnacle Utilities* checks for an installed/working internal recorder (SD card) is different for a DR and SC system:
    - DR System Type can deploy if a working recorder is not detected.

> In DR System Type, no data is recorded to the Pinnacle's internal recorder. *VmDas* will record data to the Working Folder location on the computer.

-
    - *Pinnacle Utilities* will not allow a SC System Type to deploy if a working internal recorder (SD card) is not detected.
- Energy management is critical for SC battery life. Data buffering helps minimize Pinnacle wake time, but DR data should be rapid (and regular) and continuous pinging.
    - A DR System Type should disable buffering. If CG = 0, *Pinnacle Utilities* adds the CD0 command to disable buffering.
    - A SC System Type should enable buffering. If CG = 1, *Pinnacle Utilities* adds the CD1 command to enable buffering.

> **The CG command must be set to distinguish Direct-Read from Self-Contained systems**. Verify the CD and CG commands are properly set if using a command file that was created without using *Pinnacle Utilities*.

CK – Keep Parameters

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

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

Description CK saves the present user command parameters to non-volatile memory on the CPU board. The Pinnacle 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 Pinnacle 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	Pinnacle never sleeps
CL 1	Pinnacle sleeps if enough time between pings

CN – Ethernet Settings

Purpose Configures the Pinnacle Ethernet network.

Format CN*n*

Range *n*= 1 to 7

Default N/A

Recommended Setting. Use as needed. See Using Ethernet Communications for examples.

Description See below.

```
>cn?
Available Commands:

CN1 --------------------- Show Network Setup
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 000.000.000.000:280 - UDP Data Destination [xxx.xxx.xxx.xxx:pppp]
CN7 --------------------- Start Networking
CN? --------------------- Display C-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:                  PADCP-0003-0003
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
>
```

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

Sets the Pinnacle'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 Pinnacle 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 Pinnacle will “fall back” to use a Static network configuration. This prevents the Pinnacle 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 – UDP Data Destination [xxx.xxx.xxx.xxx:pppp]

Specify the IP address and port of the remote machine where ensemble data is going to be sent. CN6 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 000.000.000.000:280.

```
>cn6 000.000.000.000:280
UDP Data destination set to: 0.0.0.0:280
>
```

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

CN7 –Start Networking

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

CQ – Transmit Power

Purpose Allows the transmit power to be adjusted.

Format CQ *n*

Range *n* = 0 to 3

Default CQ 2

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

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

CR – Retrieve Parameters

Purpose Resets the Pinnacle 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 Pinnacle. The CK command must be sent just before the CS command. Other commands may be sent in any order.

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

Table 17: 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 system type and present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the Pinnacle 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 Pinnacle. 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 Pinnacle 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 Pinnacle.

Format CState

Recommended Setting. Use as needed.

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

```
>cstate
Not Pinging
>
```

CStop – Stop Pinging

Purpose Stops the current deployment.

Format CStop

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

Description Stops autonomous sampling without resetting the Pinnacle.

CW – Select Dual Mode Data (NB/BB)

Purpose Selects whether to tag the BroadBand or NarrowBand water ping data with the ID that the current TRDI software recognizes.

Format CW *n*

Range *n* = 0 (BroadBand), n = 1 (NarrowBand)

Default CW 0

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

Description The Pinnacle has both NarrowBand and BroadBand water profiling modes. Each mode is assigned a unique ID value to allow the processing software to distinguish which mode is being used.

For example, if only BroadBand pings were used, output the BroadBand fixed and variable leaders and the selected BroadBand ping data with the standard (BroadBand) ID. If only NarrowBand pings were used, output the NarrowBand fixed and variable leaders and the selected ping data with the standard ID.

If both BroadBand and NarrowBand pings were used, output the fixed and variable leaders for both bands, and the ping data for all selected types. The CWn command will select which ping type (BroadBand or NarrowBand) will get the standard band ID and the other ping type (BroadBand or NarrowBand) will get the standard ID plus one (see Table 16).

CZ – Put the system to sleep

Purpose Tells the Pinnacle ADCP to power down.

Format CZ

Recommended Setting. Use as needed.

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

Example See below

```
>cz
Going to sleep
```

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

Expert Control System Commands

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

```
>#C?
*** CAUTION: These commands are reserved for RDI use
             and may not be currently supported!

Available Commands:

#C? --------------------- Display C-Command Menu
#CO 0 1   0 ------------- TrigOut (enab[1|0], Dur[1=T&R,2=T], ofs[-10..+10 ms])
#CX 0 0 0 --------------- Set Input Trigger [mode, dly (ms), timeout (s)]
>
```

#CO – Output Trigger Enable

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

Format: #CO (enab[1|0], Dur[1=T&R,2=T], ofs[-10 to +10 ms])

Range: *Enable* (0 = off, 1 = on)
Duration: 1, 2 trigger events:
- 1 = Trigger active during transmit and receive interval.
- 2 = Trigger active during transmit interval only.

Offset: -10 to +10 as described below.

Default: #CO 0 1 0

> Recommended Setting. Set the output trigger using Pinnacle Utilities.
>
> To avoid interference between the Pinnacle and other devices on the vehicle in general applications, #CO 1 1 0 is recommended.

Description: The “*enable*” and “*Duration*” parameters of this command can cause the system to output a trigger through the trigger out line on the end-cap connector/deck box during transmit or both transmit and receive.

The “*offset*” parameter provides a mechanism for the user to configure an optional synchronization offset (+/- 10 ms) to the start of the trigger out.

#CX – Input Trigger Enable

Purpose Enables or disables the trigger.

Format #CX *m d t*

Recommended Setting. Set the triggers using Pinnacle Utilities.

Range *Mode*: 0 = off
1 = Pings after low to high transition
5 = Pings while trigger is high

delay: 0 to 50 ms delay time

timeout: 0 to 10800 second time-out. Setting this to 0 disables the time-out

Default #CX 0 0 0

Description When the *Mode* is 0, the input trigger is disabled.

When the *Mode* is 1, the Pinnacle will ping once within 1ms after the trigger transitions from low to high.

When the *Mode* is 5, the Pinnacle will ping while the trigger is 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).

The trigger delay causes the unit to wait after a trigger is received for pinging to start. Delay after trigger is received is valid only for first ping for #CX mode = 5.

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

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

The thermal transmit duty cycle limit takes precedence over TP for low-frequency, high-power systems such as the Pinnacle 45 kHz. If necessary, an extra delay is added between pings (above and beyond TP) to ensure that the thermal duty cycle limit is observed so that the electronics do not overheat.

Environmental Commands

The Pinnacle 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 ---------------- Xdcr Depth (deci-meters)
EE 0 -------------------- 1=Nominal, 0=Raw Beam Calculation
EH 00000 ---------------- Heading (0..35999; 1/100 degrees)
EM 0 -------------------- Disable beam [0=none|1-4]
EP +00000 --------------- Pitch (+-6000 1/100 degrees)
EQ ---------------------- Store Mag. Cal. file
ER +00000 --------------- Roll  (+-18000 1/100 degrees)
ES 35 ------------------- Salinity (ppt)
ET 1000 ----------------- Water Temperature (.01 deg C)
EU 0 -------------------- System Orientation 1=up,0=down
EX 11111 ---------------- Coordinate Transformations (cct3m)
EZ 11111011 ------------- Sensor Source {c;d;h;p;r;s;t;u}
E? ---------------------- Display E-Command Menu

>
```

EA – Heading Alignment

Purpose	Corrects for physical misalignment between Beam 3 and the heading reference.
Format	EA ±*nnnnn*
Range	±*nnnnn* = -17999 to 18000 (-179.99 to 180.00 degrees)
Default	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 Pinnacle 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 Pinnacle 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 Pinnacle 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 Pinnacle 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 Pinnacle and a vessel's centerline (see EA - Heading Alignment).

Examples

1. A Pinnacle system is receiving heading from a compass. A magnetic variation chart for the deployment area shows a variation of W3.5 (-3.5). To counteract the effects of this magnetic field, enter a heading bias value of -3.5. To convert -3.5 to an EB -command value, multiply the desired bias angle in degrees by 100: EB = -3.5 × 100 = -350 = EB -350.

2. Magnetic maps (such as NOAA) usually provides these types of reading: 10°10'W 1995 (9'E/year). This means the magnetic offset in the year 2001 at this location is (- (10+10/60) + (9/60*6)) = -9.26666 degrees. Set the EB command value to EB -926.

EC – Speed of Sound

Purpose	Sets the speed of sound value used for Pinnacle 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.

Horizontal velocities do not depend on speed of sound for Pinnacle Phased Array systems. If users insist on using an external speed of sound, then send an EC command to update. The system will respond with the "*Pinging and may not be implemented*" message, but the EC command does update.

Potential Impact: Some ADCP users routinely correct for speed of sound on their piston systems, and if they do this to Pinnacle data, they will introduce an error. If the speed of sound is updated from an external source (for example, using a CTD or similar external measurement to measure the speed of sound), the EC command must be sent. It is strongly recommended to let the Pinnacle system handle the speed-of-sound correction internally.

Description

EC (or the calculated speed of sound in the water) sets the sound speed value used by the Pinnacle to scale vertical range and depth cell size if the EZ command 'c' field (speed-of-sound source) is set to 0. The Pinnacle always uses a fixed speed of sound of 1536 m/s for velocity. See the primer for information on speed of sound calculations.

ED – Depth of Transducer

Purpose	Sets the Pinnacle transducer depth.
Format	ED nnnnn
Range	nnnnn = 0 to 65535 decimeters (meters x 10)
Default	ED 00000

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

Description ED sets the Pinnacle transducer depth. This measurement is taken from sea level to the transducer face. The Pinnacle uses ED in its speed of sound calculations. The Pinnacle 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 Pinnacle overrides the manually set ED value and uses depth from the Keller pressure sensor. If the pressure sensor is not available, the Pinnacle uses the ED command.

EE – Nominal Beam Output

Purpose	Specifies using nominal beam or raw beam calculation output.
Format	EE *n*
Range	n = 0, 1 (1 = Nominal, 0 = Raw Beam Calculation)
Default	EE 0

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

Description The EE command determines whether raw beam velocities are output as measured (EE = 0, raw beam calculation), or whether a correction is applied (EE = 1) for the error in the apparent vertical velocity component that is inherent in a phased array transducer since the auto-correlation peak shifts for the vertical component due to changes in the water sound speed.

For the nominal beam output (EE = 1), the raw beam velocities are rotated to the instrument frame and the vertical velocity component is corrected for error due to the shift in the auto-correlation peak, and the velocities are then rotated back to beam-radial through the nominal Janus beam angle for output.

EH – Heading

Purpose	Sets the Pinnacle 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 Pinnacle heading. This heading value is assumed to be in instrument coordinates. Figure 16. Pinnacle Pitch and Roll shows transducer beam axis and tilt signs.

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 Pinnacle overrides the manually-set EH value and uses heading from the ISM compass. If EZ Heading field is zero the Pinnacle uses the manual EH command settings.

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

EM – Disable Beam

Purpose Used to disable one of the Pinnacle's beams.

Format EM *n*

Range *n* = 0 to 4 (0 = No beam suppressed, 1 to 4 = beam number to suppress)

Default EM 0

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

Description Used to disable a beam that cannot provide useful information, for example, a beam that is permanently obstructed. The disabled beam's ensemble velocity output is set to BAD, -32768 and the correlation and RSSI values are set to zero.

EP – Pitch Angle

Purpose Sets the Pinnacle pitch (tilt 1).

Format EP ±*nnnn*

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

Default EP +00000

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

Description EP sets the Pinnacle 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 = 1400
```

EQ – Store MagCal Data

Purpose Stores the compass calibration data to a file.

Format EQ

Range N/A

Default N/A

Recommended Setting. Sent by customer only when *Pinnacle Utilities* software is not used.

Description Stores the compass calibration data.

```
>eq
Mag Cal Data stored to file Data/Calibrations/PADCP-0003-0003-Compass-20190228T114351.cal

>
```

ER – Roll Angle

Purpose Sets the Pinnacle 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 +00000

Use EP for pitch and ER for roll if using fixed values. The normal usage will be to get pitch and roll from the internal ISM Compass sensor, 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 = #ER01400 (+ is understood)
#ER = -3.50 × 100 = -350 = #ER-00350
```

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 Pinnacle uses ES in its speed of sound calculations. The Pinnacle 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 4500 (-5.00 C to +45.00 C)

Default ET 1000

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

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

EU – Up/Down Orientation

Purpose Sets the Pinnacle 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 Pinnacle.

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 11111

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 18: Coordinate Transformation Processing Flags

Setting	Description
EX00xxx	No transformation. Radial beam coordinates, i.e., 1, 2, 3, 4. Heading/Pitch/Roll not applied.
EX01xxx	Instrument coordinates. X, Y, Z vectors relative to the Pinnacle. 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 (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 Pinnacle 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. TRDI outputs the water profile bin 1 position for a level system only. We do not adjust the bin 1 position, or the cell sizes, for any tilt. Bin mapping attempts to combine data from sections of the beams that are at the same depth in the water, and does not make any attempt to calculate how that depth might change for a tilted system. The setting of the EX command has no effect on the reported bin 1 distance or the cell size.

EZ – Sensor Source

Purpose	Selects the source of environmental sensor data.
Format	EZ *cdhprstu*
Range	Firmware switches {c;d;h;p;r;s;t;u} (see description)
Default	EZ 11111110

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

Description Setting the EZ-command firmware switches tells the Pinnacle to use data from a manual setting or from an associated sensor. When a switch value is nonzero, the Pinnacle 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 19: 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)	Internal ISM Compass
P	Pitch (tilt 1)	Manual #EP (see EP - Pitch and Roll Angles)	Internal ISM Compass
R	Roll (tilt 2)	Manual #ER (see ER - Roll Angle)	Internal ISM Compass
S	Salinity	Manual ES (see ES – Salinity)	Not Allowed
T	Temp	Manual #ET (see ET - Temperature)	Internal transducer sensor
U	Up/Down Orientation	Manual #EU (see EU - Up/Down Orientation)	Not Allowed

Example EZ11111011 means calculate speed of sound from available depth salinity and temperature, use Keller pressure sensor for depth, use ISM compass for heading, pitch, and roll, ES command sets salinity, uses the TRDI internal temperature sensor, manual up/down orientation set with the EU command.

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

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

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

Diagnostic Commands

The diagnostic command is for TRDI use.

Available Commands

```
>f?
Available Commands:

FX ---------------------- Clear Diagnostics Information. Usage: FX 9999
F? ---------------------- Display F-Command Menu
>
```

Diagnostics Command Descriptions

FX – Clear Diagnostics Information

Purpose	Clears diagnostic information.
Format	FX 9999
Range	N/A
Default	N/A

Use *Pinnacle Utilities* to clear the diagnostic information.

Description For TRDI use.

```
>fx 9999
Clearing Diagnostics Information .done
Initializing ADCP. Please Wait for few seconds
 ===================================
 === Pinnacle BOOTLOADER ===
 Version 0.1.6
 ===================================

Wake Source: Not Cold
Break Detected: No
MCU RST TYPE:Soft Reset
HW WDOG:Enabled


----- STAGE 0 - INITIALIZATION ----

  [INIT] Look for backup application image in the NAND flash...  NOT FOUND.
  [INIT] Valid application found in internal flash.
    Length: 488464 | version: 2.
  [INIT] Bootloader initialization done.
    Valid firmware:                             yes
    Valid backup:                               no


Enter | to halt boot process...
Booting automatically in:
4
3
2
1

>>>>>>>>>>>>STARTING APPLICATION...<<<<<<<<<<<<

>
```

Narrow Bandwidth Profiling Commands

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

Available Narrow Bandwidth Profiling Commands

This section lists the available Narrow Bandwidth Profiling commands.

```
>n?
Available Commands:

NA 255 ------------------ False Target Amplitude Threshold [0-255]
ND 111110000 ------------ Data Out {v;c;a;p;s;*;*;*;*}
NE 1000 ----------------- Error Velocity Threshold (mm/s)
NF 1600 ----------------- Blanking Distance (cm)
NN 040 ------------------ Number of Bins [0-128]
NP 001 ------------------ Number of Pings
NS 3200 ----------------- Bin Size (cm)
N? ---------------------- Display N-Command Menu
```

Narrow Bandwidth Profiling Command Descriptions

NA – Narrow Bandwidth Profiling False Target Threshold

Purpose	Sets a false target (fish) filter
Format	NA*n*
Range	*n* = 0 to 255 counts
Default	NA255

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

Description	The Pinnacle uses the NA-command to screen profile data for false targets (usually fish). NA sets the maximum difference between echo intensity readings among the four profiling beams. If the NA threshold value is exceeded, the Pinnacle 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.
Notes	A NA value of 255 disables this feature. A typical setting is 55 to 75.

ND – Narrow Bandwidth Profiling Data Out

Purpose	Selects the type of data that is output by the Pinnacle.		
Format	ND *abc def ghi*		
Range	*a* = 0 to 1	*d* = 0 to 1	*g* = 0 to 1
	b = 0 to 1	*e* = 0 to 1	*h* = 0 to 1
	c = 0 to 1	*f* = 0 to 1	*i* = 0 to 1
Default	ND111 110 000		

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

Description The ND selects the type of data that is output depending on the value in each field. Setting a bit to 1 enables the output while a 0 disables output. The fields listed below.

a = velocity	*d* = percent good	*g* = reserved
b = power	*e* = status	*h* = reserved
c = echo intensity	*f* = reserved	*i* = reserved

If NP = 0, then no narrowband profile data is output regardless of the ND setting.

NE – Narrow Bandwidth Profiling Error Velocity Threshold

Purpose Sets the maximum error velocity for good profile data.

Format NE*n*

Range *n* = 0 to 9999 mm/s

Default NE1000

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

Description NE sets a threshold value used to flag water-current data as good or bad. If the Pinnacle's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The NE-command screens for error velocities in both beam and transformed-coordinate data.

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.

NF – Narrow Bandwidth Profiling Blanking Distance

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 NF*n*

Range *n* = 37 to 9999 cm

Default NF1600

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

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

Small NF values may show ringing/recovery problems in the first depth cells that cannot be screened by the ADCP. TRDI recommends setting NF to no less than the default value.

NN – Narrow Bandwidth Profiling Number of Bins

Purpose Sets the number of depth cells collected in each profile.

Format NN*nnn*

Range *nnn* = 1 to 128 depth cells

Default NN040

> Set using *Pinnacle Utilities* software.

Description The NN command sets the number of bins (depth cells) over which the Pinnacle collects data. The range of the profile is set by the number of bins (NN) times the size of each bin (NS).

NP – Narrow Bandwidth Profiling Number of Pings

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

Format NP*nnn*

Range *nnn* = 0 to 999 pings

Default NP001

> Set using *Pinnacle Utilities* software.

Description NP sets the number of narrowband profile pings to average together in each ensemble before sending profile data.

> The Pinnacle interleaves profile pings with bottom-track pings (see TP - Time Between Pings).
>
> If NP = zero, the Pinnacle does not collect narrowband profile data.
>
> When using *VmDas*, the typical setup will use single ping (NP1) when doing Narrow Bandwidth profiling.
>
> The existing NP, WP and BP commands will define the ping counts for the NB, BB and BT pings. If BT is non-zero, BT sub-pings will be included in all burst mode samples.

NS – Narrow Bandwidth Profiling Bin Size

Purpose Selects the volume of water for one measurement bin (depth cell).

Format NS*nnnn*

Range *n* = 800 to 6400 cm

Default NS3200

> Set using *Pinnacle Utilities* software.

Description NS sets the size of bins (depth cells) over which the Pinnacle collects data. The range of the profile is set by the number of bins (NN) times the size of each bin (NS).

Expert Narrow Bandwidth Profiling Descriptions

This section lists the expert Narrow Bandwidth Profiling commands. Commands that start with the # sign are considered "expert" commands.

```
>#N?
*** CAUTION: These commands are reserved for RDI use
             and may not be currently supported!

Available Commands:

#NA 9,003 --------------- Acquisition Parameters {bw;nbins}
#NC +0000 --------------- Local Oscillator Offset (Hz)
#ND 0 ------------------- Platform Dynamics [0=RIG, 1=SHIP]
#NJ 1 ------------------- NarrowBand Rcvr Gain [0=Lo,1=Hi]
#NM 030,0258 ------------ Measurement Parameters {rate;min freq}
#NP +06,+00 ------------- Power Threshold {acquire;track} (dB)
#NR 050,1,9 ------------- Tracker Parameters {gain;reproc;bw}
#NS 0 ------------------- NB Sim Index <indx>; {0=off, 1-5}
#NT 0000 ---------------- NarrowBand Profile Xmt Length (cm)
#NY 0 ------------------- Enable correlation output [1=on, 0=off]
#NZ 10000 --------------- NarrowBand Velocity Scale (0.01 %)
#N? --------------------- Display #N-Command Menu
>
```

Except for the #ND command, the #N commands should be left at the default settings or set by the *Pinnacle Utilities* Wizards and therefore, are not documented.

#ND – Platform Dynamics

Purpose	Sets different firmware defaults, primarily affecting narrowband processing parameters based on the maximum expected observed velocities (which are higher on a ship than on a stationary platform).
Format	#ND *n*
Range	*n* = 0, 1 (0 = RIG, 1 = SHIP)
Default	#ND 0

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

Description	Use the #ND command to switch between RIG and SHIP configurations. If a vessel is holding station, switching to RIG may get more range.

Performance and Testing Commands

The Pinnacle uses the following commands for calibration and testing.

Available Performance and Testing Commands

This section lists the available Performance and Testing commands.

```
>p?
Available Commands:

PA ---------------------- Run Go/No-Go Tests
PC ---------------------- Built In Tests [0=help]
PD 0 -------------------- Set Output Format (0=ensemble; 1=ASCII (test))
PF ---------------------- Results from most recent PA tests
PS ---------------------- System Info [0=config,3=xform,5=hem]
PT ---------------------- Built-in-Test Commands; PT0=Help
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. These tests check non-volatile memory and ROM of the processor board. Also, the transmit and receive circuitry is tested using the PT3 and PT5 tests, respectively. See PT3 – Receive Test and PT5 – Transmit/Receive Continuity Check Test for more details.

The transducer **must** be submerged in water when running the PA test. If this test fails in air, it does NOT indicate a system fail. Run the test in water.

Example See below

```
>pa
RAM test................PASS
ROM test................PASS
Tx/Rx Check.............PASS
Receive Path test.......PASS
RTC test................PASS
UART test...............PASS
Compass test............PASS
Temperature test........PASS
Pressure test...........PASS
Ping Order (TO) Test....PASS

GO for Deployment
```

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* = 0, 2, 20, 4, 40, 5, 50
Description	PC0 displays the help menu. PC2 continuously displays at approximately 1 sec update the current system temperature, pressure, depth, heading, pitch and roll.
Example	See below.

```
>pc0
PC0   = Help
PC2   = Display Sensor Data
PC4   = Display Voltage Monitor ADC Data
PC5   = Display Leak Sensor ADC Data
PC20  = Display Scrolling Sensor Data
PC40  = Display Scrolling Voltage Monitor Data
PC50  = Display Scrolling Leak Sensor ADC Data

>
```

PC2 or PC20

The PC2 test updates the data inline using cursor commands and the PC20 test performs the same test, but output the data in a line-by-line fashion to accommodate terminals that do not properly support cursor commands.

```
>pc2
Sensor data is sampled and displayed in a loop.
An asterisk '*' to the right of a number indicates invalid data.
Press any key to exit the loop.

Count    Temp(C)   Heading    Pitch      Roll  Up/Down Depth(m) Batt(V) Batt(A)
\ 11     23.250    193.39    -0.12      0.25     Down     1.478   33.903   0.050
>
```

PC4 or PC40

The PC4 test updates the data inline using cursor commands and the PC40 test performs the same test, but output the data in a line-by-line fashion to accommodate terminals that do not properly support cursor commands.

```
>pc4
Battery ADC data is sampled and displayed in a loop.
Press any key to exit the loop.

Count Chan0 Chan1 Chan2 Chan3 Chan4 Chan5 Vbatt  Ibatt VDD1  VDD3  Vlsu  Vlsl
\ 49  09a9  0020  0d30  0b7f  0e89  0e8a  33.94  0.062 3.30  1.80  2.27  2.27

>
```

See Binary Variable Leader Data Format, bytes 35 to 42 for a description of the ADC channels.

PC5 or PC50

The PC5 test updates the data inline using cursor commands and the PC50 test performs the same test, but output the data in a line-by-line fashion to accommodate terminals that do not properly support cursor commands.

```
>pc50
Leak detector ADC data is sampled and displayed in a loop.
Press any key to exit the loop.
 DetA   DetB
 0e6d   0e88
 0e89   0e8b
>
```

PD – Data Stream Select

Purpose	Selects the type of ensemble output data structure.
Format	PD *n*
Range	*n* = 0
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 Pinnacle. For a full description of the PD0 format, see PD0 Output Data Format

Ensemble Timing – When in burst mode there will be two ensemble periods that overlap.

Output Formatting – The ensemble output formatting routines supports single ping non-averaged data.

Ensemble Time – The PD0 ensemble time will be the time of the first sub-ping reported in the output.

Ensemble Numbers – Each PD0 output has an ensemble number. This ensemble number is incremented for each output.

PS – Display System Parameters

Purpose	Displays Pinnacle system configuration data.
Format	PS*n*
Range	*n* = 0, 3, 5

PS0 – System Configuration Info

PS0 displays system configuration info.

```
>ps0
   Serial Number:  0
       Frequency:  44000 Hz
 Transducer Type:  PHASEDARRAY
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
   Vertical Beam:  NONE
         Sensors:
             Temperature:   DS18b20 1-Wire
      Heading/Pitch/Roll:              RDI
                Pressure:         Keller30


    CPU Firmware:  71.00
    FPGA Version:2.00.007 [0x2007]

Board Serial Number Data:
 4E 00 00 00 DB A9 A3 28   DS18B20 TMP SNS
 6A 00 00 02 93 E0 C8 23   CDA72B-2134-01B
 87 00 00 02 93 E4 9C 23   DSP72B-2130-00A
 76 00 00 02 AF 7C A6 23   RCV72B-2135-06A
 55 00 00 00 1F C5 71 23   XDR72B-1001-00X
 03 00 00 02 DE 48 99 23   CIO72N-2000-01A
 71 00 00 02 BA 16 2D 23   PTX72B-2131-06A

>
```

PS3 – Instrument Transformation Matrix

PS3 sends information about the transducer beams. The Pinnacle uses this information in its coordinate-transformation calculations. For example, the output may look like this:

```
>ps3

Last Save Time: 19/01/08,07:26:48.31
Profiling Beams: 4
Freq(Hz) 44000
Dia (mm) 76

Beam Positions:
Bm         X        Y        Z         P        R        E
1   0.0000   0.0000   0.0000   0.0000   0.0000  20.0000
2   0.0000   0.0000   0.0000   0.0000   0.0000  20.0000
3   0.0000   0.0000   0.0000   0.0000   0.0000  20.0000
4   0.0000   0.0000   0.0000   0.0000   0.0000  20.0000

Instrument Transformation Matrix:
1.4619 -1.4619  0.0000  0.0000
0.0000  0.0000 -1.4619  1.4619
0.2660  0.2660  0.2660  0.2660
1.0337 -1.0337 -1.0337  -1.0337
>
```

PS5 - Health and Environment Monitoring Sensors

The PS5 command reports the value of HEM sensors: S1 (operating time), S2 (over-pressure count), S3 (maximum pressure seen), and S7 (total pressure cycles). The PS5 output will read N/A for the Maximum pressure seen reading if no pressure was measured/recorded.

```
PS5
Operating time: 4327.5 hours
Maximum pressure seen: 652.378 dBar
Over-pressure events: 3
Pressure cycles: 25
```

PT – Diagnostic Tests

Purpose	Displays results of the system diagnostic tests.
Format	PT*nnn*
Range	*n* = 0, 3, 5, 9, 11, 12, 13, 15, 16, 17, 18, 19, 21, 100, 200, 300
Description	See below

PT0 - Help

The PT0 command displays the test menu (shown below). As implied by the NOTE, adding 100 to the test number repeats the test continually until the Pinnacle receives a <BREAK>. Sending PT200 runs the PT3 and PT5 tests. PT300 runs the PT3 and PT5 tests continually until the Pinnacle receives a <BREAK>.

Example:

```
>pt0
Built In Tests
----------------
  PT0  = Help
  PT3 <mode> = Receive Path Test [mode: 0=HL, 1=COR, 2=SNR]
  PT5  = Transmit/Receive Loop Test
  PT9  = Transmit Memory Test
  PT11 = FRAM Test
  PT12 = RAM Test
  PT13 = ROM Test
  PT15 = Communications Test
  PT16 = Clock Test
  PT17 = Compass Test
  PT18 = Temperature Test
  PT19 = Xmt/Rcv Test
  PT21 = Pressure Test
```

PT3 – Receive Test

This test displays receive path characteristics. This test must be done with the transducer in water. Sending PT3 1 will run the Linear version of the test.

The transducer **must** be submerged in water when running the PT3 test. If this test fails in air, it does NOT indicate a system fail. Run the test in water.

Example:

```
>pt3
Receive Path Test (Linear/Cor):
Correlation Magnitude:

    H-Gain N-BW                         L-Gain N-BW
Lag Bm1     Bm2     Bm3     Bm4      Bm1     Bm2     Bm3     Bm4
  0 1000    1000    1000    1000     1000    1000    1000    1000
  1  727     731     747     750      744     748     745     747
  2  290     296     334     340      331     339     333     337
  3   64      66      32      23       37      39      23      30
  4   26      36      14      14        9       7       4       8
  5   42      53       6       3       16       5       9      14
  6   44      50       8       2        7       7      11       8
  7   42      39       9      10        2       8       6      11
      P       P       P       P

    H-Gain N-BW        L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4
RSSI Noise Floor (counts)
     59  59  35  40     33  33  23  29
      P   P   P   P

...PASSED
```

```
>pt3 0
Receive Path Test (Hard Limited):
Correlation Magnitude:

    H-Gain N-BW                         L-Gain N-BW
Lag Bm1      Bm2      Bm3      Bm4      Bm1      Bm2      Bm3      Bm4
  0 1000     1000     1000     1000     1000     1000     1000     1000
  1  727      731      738      736      743      742      731      739
  2  292      293      319      323      330      330      308      319
  3   68       71       26       34       31       37       35       27
  4   50       43        3       19       15        2        3        2
  5   41       58       11       16       13       17       15       10
  6   53       54       13       10        3        6        8        8
  7   42       49        6        6        5        3       10        5
      P        P        P        P

    H-Gain N-BW          L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
Sin Duty Cycle (percent)
     50  48  50  49      49  48  49  50
      P   P   P   P
Cos Duty Cycle (percent)
     50  50  49  50      48  51  50  49
      P   P   P   P
RSSI Noise Floor (counts)
     59  59  35  40      34  33  24  29
      P   P   P   P

...PASSED

>pt3 1
Receive Path Test (Linear/Cor):
Correlation Magnitude:

    H-Gain N-BW                         L-Gain N-BW
Lag Bm1      Bm2      Bm3      Bm4      Bm1      Bm2      Bm3      Bm4
  0 1000     1000     1000     1000     1000     1000     1000     1000
  1  730      729      749      744      744      749      745      747
  2  296      291      341      325      332      343      332      332
  3   55       71       27       44       27       30       33       43
  4   29       34       14        5        1        2        8       10
  5   41       37        3       11        6       11        4        6
  6   42       40        7        5        2        9        5        4
  7   39       42        8       11       12       11        5        8
      P        P        P        P

    H-Gain N-BW          L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
RSSI Noise Floor (counts)
     59  59  35  41      33  33  24  29
      P   P   P   P

...PASSED

>pt3 2
Receive Path Test (Linear/SNR):
SNR (dB):

    H-Gain N-BW                         L-Gain N-BW
Lag Bm1     Bm2     Bm3     Bm4       Bm1     Bm2     Bm3     Bm4
  0 999.9   999.9   999.9   999.9     999.9   999.9   999.9   999.9
  1   4.3     4.3     4.7     4.8       4.6     4.7     4.6     4.8
  2  -3.7    -3.8    -2.9    -2.9      -3.0    -2.9    -3.1    -2.8
  3 -11.8   -11.2   -14.4   -13.7     -14.9   -14.5   -15.3   -15.8
  4 -15.0   -14.9   -23.3   -17.9     -18.9   -22.0   -23.1   -19.7
  5 -14.0   -13.1   -24.6   -17.9     -23.3   -20.1   -21.7   -25.3
  6 -14.0   -13.5   -19.1   -19.9     -22.1   -28.5   -25.2   -30.2
  7 -13.4   -13.2   -22.0   -19.9     -22.8   -19.8   -18.6   -23.5
      P       P       P       P
```

```
    H-Gain N-BW         L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
RSSI Noise Floor (counts)
     59  59  35  41      33  33  23  29
      P   P   P   P

...PASSED

>
```

PT3 is considered to have normal values if:

1. Correlation at the last lag is less than 25%.
2. The duty cycle of sine and cosine does not vary from 50% by more than +/-15%.
3. RSSI noise level is less than 90 counts for the high gain, wide bandwidth setting.

PT5 – Transmit/Receive Continuity Check Test

The transducer **must** be submerged in water when running the PT5 test. If this test fails in air, it does NOT indicate a system fail. Run the test in water.

This test checks the entire for signal path continuity (transmitter – transducer – receiver). The test determines if the transducer electronics are connected and, if so, whether the ceramics are connected. The test must be run with the transducer in water. The first line of the test result measures the noise amplitude level of the system in counts; this is used as a reference in the test.

The transducer electronics connection is tested by comparing the amplitude level in the middle of the transmit pulse to the noise level. If it is above a threshold, the transducer electronics are connected to the electronics enclosure.

The test to determine whether the ceramics are connected to the transducer electronics is attempted only if the transducer electronics are connected. The ceramic connection is confirmed by comparing the amplitude level immediately after transmit (the ringing level) to the noise level. If it is greater than the noise level by a threshold, then the ceramic is connected.

Example:

```
>pt5
Transmit/Receive Continuity Check:

Test                                       Beam
                      1             2             3             4
Noise(Amp/Rslt):    58/ PASSED    63/ PASSED    75/ PASSED    59/ PASSED
Elect(Amp/Rslt):   168/CONNECTED 172/CONNECTED 180/CONNECTED 169/CONNECTED
Ceramics(Amp/Rslt):10/CONNECTED 15/CONNECTED 12/CONNECTED 18/CONNECTED

RESULT...PASSED
```

PT5 has the following pass/fail criteria:

1. Noise level is less than 90 counts = passing.
2. The amplitude level at ½ transmit is at least 120 counts for the transducer electronics to be considered connected.
3. The amplitude level immediately after transmit must be no more than 30 counts below the transmit level for the phased array system to pass. Otherwise, the ceramic(s) will be considered disconnected and the test will report a failure.

PT9 - Transmit Memory Test

The PT9 test performs a write/read test of each memory location in the transmit RAM, which is used to hold the signal pattern that is transmitted during a ping.

```
>pt9
XMIT RAM Test....PASSED
```

PT11 - FRAM Test

Format PT11 [*n*]

Range [n] = optional second parameter enables the verbose output (for troubleshooting). The flags that can be set in the new optional second parameter are as follows:

PT11: Quick test (skips the pattern test). This is the default if no second parameter is given.

PT11 1: Long test; adds the pattern tests of the full memory.

PT11 2: Verbose mode; enables the verbose output. Also includes display of the device ID info.

PT11 4: Display the device ID information without all the other verbose output.

The flags can be combined. For example: PT11 3: Long test with verbose output. PT11 5: Long test with display of device ID info.

The PT11 command performs the following tests of the FRAM (used to store recorder directory information):

- **Pattern Test**: Writes 4 patterns to each address in the FRAM space, and reads back from these addresses to make sure the data was correctly written. The pattern test takes approximately eight minutes to run.
- **Address Test**: This tests the address bus by writing consecutive number to addresses that have only 1 bit set (i.e. write 1 to 0x00000001, then write 2 to 0x00000002, then write 3 to 0x00000004, and so on). After writing to these locations, read the data back and verify that it is what was expected.
- **Data Test**: This tests the data bus in FRAM memory by writing data values that have only one bit set (i.e. 0x01, 0x02, 0x04) to consecutive locations in memory. Then read back to make sure that all data was written properly.
- **ID Test**: verify that the memory device is communicating properly (although the address bus and data bus tests would also fail if the part was not functioning). The ID test simply reads and validates the ID info that is available from the memory part.

Failure on any of these tests will produce a FAIL result for PT11.

```
>pt11 4
FRAM test...
DevID=7f7f7f7f7f7fc22400
PASS
>
```

PT12 - RAM Test

The PT12 command performs the tests described for PT11 above on the RAM.

```
>pt12
RAM test...PASS
```

PT13 - ROM Test

The PT13 command performs a test of the flash ROM by comparing the CRC of the data in ROM with the CRC value stored in FLASH. If the values differ, PT13 will result in a FAIL.

```
>pt13
ROM Test...PASS  [ 60e0 ]
```

PT15 - Communications Test

The PT15 command performs a test of the communications between the Doppler and Catalyst.

```
>pt15
Communications test.....PASS
```

PT16 - RTC Test

The PT16 command performs a test of the Real-Time Clock.

```
>pt16
RTC test................PASS
```

PT17 – Compass Test

The PT17 command performs a test of the internal compass.

```
>pt17
Compass test............PASS  [ 210.100006, -0.200000, 0.100000 ]
```

PT18 – Temperature Test

The PT18 command performs a test of the temperature sensor.

```
>pt18
Temperature test........PASS  [ 22.625000 ]
```

PT19 – Xmt/Rcv Test

The PT19 command performs a test of the transmit and receive circuits.

```
>pt19
```

PT21 – Pressure Test

The PT21 command performs a test of the pressure sensor.

```
>pt21
Pressure test........PASS  [ 22.033001 ]
```

Sensor Commands

The Pinnacle 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 Out Keller30 Pressure

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

Use *Pinnacle Utilities* to zero the pressure sensor

Description	This command zeros the Keller30 pressure sensor at the specific location where the Pinnacle 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.

Definitions and Abbreviations

The following terms apply to the ping timing for Pinnacle:

- **Burst Mode** – the operating mode where TB is configured to enable a second “burst” ensemble interval, with a separate offset, TPb and TEb. Which ping type is scheduled by TB depends on the 2nd term of the TO command.
- **Ensemble** – the set of pings or samples encapsulated within a single interval of TE or TEb (Burst mode)
- **Interleaved Mode** – the operating mode when TB is disabled. In this mode, all enabled ping types (BB, NB, BT) will be conducted one after the other in a single Ping Group, with a time of TP applied between Ping Groups, in the order set by TO
- **Ping** – a single ping of a given type (NB, BB, or BT)
- **Ping Group** – a collected group of different ping types that occur sequentially. In Interleaved mode, this can be one, two, or all three, ping types, separated by TP. In burst mode, if BP > 0, each NB or BB ping will have a paired BT ping, forming a ping group of 2 pings, separated by TP or TPb.
- **PD0** – a binary output generated by Pinnacle.
- **Sample** – equivalent to a Ping Group, one or more pings, grouped together in time.
- **Sample Mode** – the default operating mode of Pinnacle, a PD0 will be generated for each ping group. The types of data included in a given sample’s PD0 depend on which pings are enabled (WP, NP, BP) and operating mode (TB).
- **TB** – Enable, sets the relative order of NB, BB, and BT pings when in Interleaved Mode. When in Burst mode, the first term of TO indicates which ping type (NB/BB) should be controlled by TE and TP, and the second term of TO indicates which ping type should be controlled by TEb and TPb.
- **TP** – Time between ping groups, when there is more than one ping per ensemble.
- **TPb** – Time between ping groups for the 2nd (burst) Ensemble.

Available Timing Commands

This section lists the available Timing commands.

```
>t?
Available Commands:

TB 0 00:00.00 00:00.00 00:00:00.00  Burst Configuration
TE 00:00:00.00 ---------- Time Between Ensembles
TF --/--/--,--:--:-- ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TO 100 ------------------ Ping Type Order, 0=none, 1=NB, 2=BB, 3=BT
TP 00:00.00 ------------- Time Between Ping Groups
TS 19/03/01,08:50:33.00 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
T? ---------------------- Display T-Command Menu

>
```

TB – Burst Mode

Purpose Enables Burst mode.

Format TB *e hh:mm:ss hh:mm:ss hh:mm:ss.dd*

Range e = 0 or 1 (0 = Disable, 1 = Enable)
<offset> 00:00:00 to 30:00:00
<TPburst> 00:00:00 to 30:00:00
<TEburst> 00:00:00 to 12:00:00.00

Default TB 0 00:00.00 00:00.00 00:00:00.00

> Recommended Setting. Use *Pinnacle Utilities* to set the timing commands.

Description The TB command enables burst mode and defines the ping timing for the second burst. The first burst will use the standard ping timing commands, TP and TE. Ping counts will use the ping count command defined for each ping type, NP, WP and BP. The profile pings will be assigned based on the order defined by the TO command with the first burst executing the first profile ping type and the second burst executing the second profile ping type.

In burst mode, one burst will have NB sub-pings and one will have BB sub-pings. A BT sub-ping will be included in both bursts, if the BP command is non-zero.

The command selects burst modes and sets the parameters for the second burst.

Format: TB <enabled> <offset> <TP> <TE>

<enabled> 1 = enable, 0 = disable burst mode

<Offset> Offset the second burst from the start of the first burst in same format as TP.

<TP> Time between second burst samples in same format as TP command

<TE> Time between second burst ensembles in same format at TE command.

TE – Time Per Ensemble

Purpose The TE command will set the time between Ensembles for interleaved mode. When in burst mode it will set the time between ensembles for the first burst.

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 00:00:00.00

> Recommended Setting. Use *Pinnacle Utilities* to set the timing commands.

Description During the ensemble interval set by TE, the Pinnacle transmits the number of pings set by the WP-command (see WP – Pings Per Ensemble). If TE = 00:00:00.00, the Pinnacle starts collecting the next ensemble immediately after processing the previous ensemble.

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

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

TF – Time of First Ping

Purpose Sets the time the Pinnacle starts data collection.

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

Range

yy	= year	00-99
mm	= month	01-12
dd	= day	01-31 (leap years are accounted for)
hh	= hour	00-23
mm	= minute	00-59
ss	= second	00-59

Default TF --/--/--,--:--:--

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

Description The TF command delays the start of data collection. The Pinnacle can be deployed in the Standby mode and have it automatically start data collection at a preset time. When the command is given to the Pinnacle to start pinging, TF is tested for validity. If valid, the Pinnacle sets its alarm clock to TF, goes to sleep, and waits until time TF before beginning the data collection process.

Example If the exact time of the first ping needs to be on November 23, 2013 at 1:37:15 pm, enter TF13/11/23, 13:37:15. If the Pinnacle should begin pinging immediately after receiving the CS command (see notes), do not enter a TF command value.

1. Although a TF command may be sent to the Pinnacle, the CS command also must be sent before deploying the Pinnacle.
2. If the entry is not valid, the Pinnacle sends an error message and does not update the wake-up time.
3. Sending a <BREAK> clears the TF time.
4. The delimiters are optional and may be spaces.

TO – Ping Type Order

Purpose Sets the order of ping execution for each sample.

Format TO abc <a = 1st ping type> <b = 2nd ping type> <c = 3rd ping type>

Range 0 = none, 1 = NB, 2 = BB, 3 = BT

a = 1st ping type, b = 2nd ping type, c = 3rd ping type.
0-3 for each abc; max one instance of 1-3, no numbers >0 after 0.

Default TO 100

```
>WP?
WP 000 ------------------ Number of Pings [0-999]
>BP?
BP 0 -------------------- Number of BT Pings in ensemble [0-999]
>NP?
NP 001 ------------------ Number of Pings
>TO?
```

```
TO 100 ------------------ Ping Type Order, 0=none, 1=NB, 2=BB, 3=BT
```

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

Pinnacle Utilities sets the TO command correctly and warns the user if the command is set incorrectly. If the TO command is incorrect, *Pinnacle Utilities* will not deploy the system.

Potential impacts: The TO command sets which ping type is first in a burst use case where narrowband and broadband ping types are grouped into separate bursts. This has some complicated interplay with the TB command, because it is built on the assumption that the ping type with the longer TE is "first". **Command line users should thoroughly test their command setting before deployment.**

Description The TO command sets the order of ping execution for each sample. In interleaved mode, the sub-pings will execute in the defined order as a sample. In burst mode, the command defines the burst order of the NB or BB ping with the first listed profile type executed in the first burst. The default configuration is for the first sub-ping to be a NB ping, the second a BB ping and the third a BT ping. For example, to execute the BB sub-ping first, BT last, set the TO command to TO 2 1 3.

This is an example of interleaved scheduling with a narrowband, broadband and bottom track ping in each sample.

```
Sample commands
WP 2
NP 2
BP 2
TO 1 2 3
TP 00:00:10
TE 00:00:30
TB 0

Ping Sequence
0123456789012345678901234567890123456789012345678901234567890123456
NWB       NWB                NWB       NWB                NWB       NWB
TE--------------------------->|<--------------------------->|
TP------->|                   |<------>|                    |<------->|
```

If the TO command is not properly configured, you will not get the data you expect.

TP – Time Between Ping Groups

Purpose The TP command will set the time between samples in interleaved mode. When in burst mode it will set the time between samples for the first burst.

Format TP *mm:ss.ff*

Range *mm* = 00 to 30 minutes
ss = 00 to 59 seconds
ff = 00 to 99 hundredths of seconds

Default TP 00:00.00

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

The TP command performs differently than previous ADCPs. TP now defines the time between groups of ping types within a measurement. For example, if NB, BB and BT pings are all enabled, then TP will set the time for each cycle of all three pings.

Potential impacts: *VmDas* users are accustomed to TP setting the time between all pings. There are some workarounds for them. First, determine the minimum time required for each ping type (using *Pinnacle Utilities*) and then use the reverb delay for each ping separately using the #TM command. Adding an appropriate #TM offset will make all times equal.

Alternatively, Trigger In is configured to require a trigger for each ping type. Providing regularly spaced triggers will make all ping times equal.

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

During the ensemble interval set by TE, the Pinnacle transmits the number of pings set by the WP command (see WP – Pings Per Ensemble). TP determines the spacing between the pings. If TP = 0, the Pinnacle pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs for processing. Several commands determine the actual ping time WF – Blank after Transmit, WN – Number of Depth Cells, WS – Depth Cell Size, and actual water depth).

Example TP 00:00.10 sets the time between pings to 0.10 second.

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

TS – Set Real-Time Clock

Purpose Sets the Pinnacle'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 *Pinnacle Utilities* to set the clock.

Example TS 19/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2019.

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

Expert Timing Command Descriptions

This section lists the expert Timing commands. Commands that start with the # sign are considered "expert" commands.

```
>#T?
*** CAUTION: These commands are reserved for RDI use
             and may not be currently supported!

Available Commands:

#TM      0     0     0 ----- Set ping group reverb delay {nb bb bt}
#T? --------------------- Display #T-Command Menu

>
```

#TM – Set Ping Group Reverb Delay

Purpose	Sets the minimum time between NB, BB, and BT pings.
Format	#TM *nb bb bt*
Range	*n* = 0 to 1000 ms
Default	#TM 0 0 0

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

Description During the ensemble interval set by TE, the Pinnacle transmits the number of pings set by the WP, NP, and BP commands. #TM determines the minimum spacing between the pings based on the time it takes to transmit each ping plus the overhead that occurs for processing.

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]
WC 064 ------------------ Correlation Threshold [0-255]
WD 111110000 ------------ Data Out {v;c;a;p;s;*;*;*;*}
WE 2000 ----------------- Error Velocity Threshold (mm/s)
WF 1000 ----------------- Blanking Distance (cm) [0-500]
WM 0002 ----------------- Water Profiling Mode [0,2,31]
WN 050 ------------------ Number of Bins [1-255]
WP 000 ------------------ Number of Pings [0-999]
WS 1600 ----------------- Bin Size (cm) [400-6400]
WV 0390 ----------------- Ambiguity Velocity (cm/s)
W? ---------------------- Display W-Command Menu

>
```

WA – False Target Threshold Maximum

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

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

Description: The Pinnacle 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 Pinnacle rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.

A WA value of 255 turns off this feature.

WC – 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

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

Description The Pinnacle 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 Pinnacle 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 Pinnacle.

Format WD *abc def ghi*

Range Firmware switches (see description)

Default WD 111 110 000

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

Description WD uses firmware switches to tell the Pinnacle the types of data to collect. The Pinnacle always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the Pinnacle 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 111 110 000 (default) tells the Pinnacle to collect velocity, correlation magnitude, echo intensity, percent-good and status.

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 Pinnacle 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*

The WE command works with or without the # sign. For example, using WE or #WE are both valid commands.

Range *nnnn* = 0 to 9999 mm/s

Default WE 2000

Description The WE command sets a threshold value used to flag water-current data as good or bad. If the Pinnacle'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 *nnnn* = 0 to 9999 cm

Default WF1600

> 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 Pinnacle 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 Pinnacle.

WM – Profiling Mode

Purpose Selects the application-dependent profiling mode used by the Pinnacle.

Format WMn

Range n = 2

Default WM2

> 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 Pinnacle collects data.
Format	WN*nnn*
Range	*nnn* = 001 to 255 depth cells
Default	WN050

Use *Pinnacle Utilities* to set the number of depth cells.

Description: The range of the Pinnacle 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 *Pinnacle Utilities* to set the bin size and number of bins. The Pinnacle system ensemble size is a maximum of 4500 bytes. If the command file is generated without using *Pinnacle Utilities* and sets up to 255 Broadband bins and 128 Narrowband bins, the ensemble size will be over 6000 bytes. The Pinnacle system computes the ensemble size on CS and fails the deployment if it exceeds the ensemble size threshold.

WP – Pings per Ensemble

Purpose	Sets the number of pings to average in each data ensemble.
Format	WP*nnnnn*
Range	*nnnnn* = 0 to 999 pings
Default	WP0

Use *Pinnacle 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 Pinnacle does not collect water-profile data.
2. The Pinnacle 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	400 to 6400 cm
Default	WS1600

Use *Pinnacle Utilities* to set the depth cell size.

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

WV – Ambiguity Velocity

Purpose	Sets the radial ambiguity velocity for profile.
Format	WV*nnn*
Range	*nnn* = 020 to 700 cm/s
Default	WV390

> It is strongly recommended that the WV command be left at the default value of 390.

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

Expert Water Profiling Commands

This section lists the expert Water Profiling commands. Commands that start with the # sign are considered "expert" commands.

```
>#W?
*** CAUTION: These commands are reserved for RDI use
             and may not be currently supported!

Available Commands:
#WJ 1 ------------------- BroadBand Rcvr Gain [0=Lo,1=Hi]
#WT 0000 ---------------- Transmit Length (cm)
#W? --------------------- Display #W-Command Menu
>
```

#WJ – Receiver Gain Select

Purpose	Allows the Pinnacle to reduce receiver gain by 40 dB for profile mode.
Format	#WJ*n*
Range	*n* = 0 (low), 1 (high)
Default	#WJ1

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

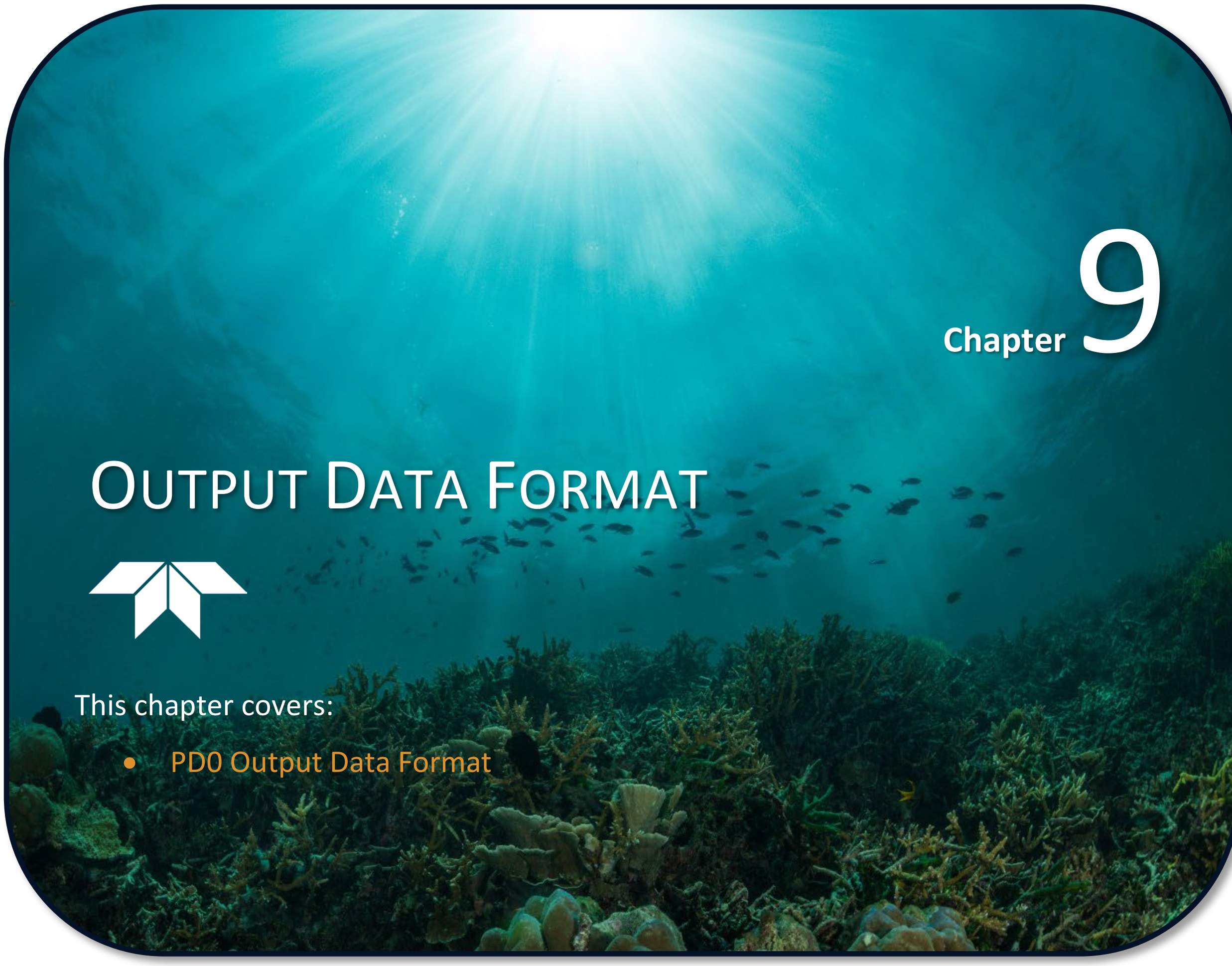
Description	#WJ0 tells the Pinnacle to reduce receiver gain by 40 dB. This may increase data reliability in shallow-water applications where there is a high content of backscatter material. #WJ1 (the default) uses the normal receiver gain.

#WT – Transmit Length

Purpose	Selects a transmit length different from the depth cell length (cell sampling interval) as set by the WS command (see WS – Depth Cell Size).
Format	WT*nnnn*
Range	*nnnn* = 0 to 6400 cm (0 = same transmit as WS)
Default	#WT0000

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

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



Chapter 9

OUTPUT DATA FORMAT

This chapter covers:

- PD0 Output Data Format

Binary Output

This section shows the format of all files to be created by Pinnacle. Pinnacle will have two processing engines; here referred to as "Doppler" and "Catalyst". Doppler creates raw beam coordinate data that can contain narrowband, 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 28 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 Pinnacle.

Binary Standard Output Data Buffer Format

Figure 28 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.

Always Output	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (65 BYTES)
	VARIABLE LEADER DATA (79 BYTES)
Primary water profile data (Broadband or Narrowband as set by the CW command). All fields are optional as set by WD or ND command.	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
Secondary water profile data (Narrowband or Broadband as set by the CW command). Only included if the PD0 message contains both broadband and narrowband data. If included, then fixed and variable leader are always output, other fields may or may not be included as set by ND or WD.	**FIXED LEADER DATA** (50 BYTES)
	VARIABLE LEADER DATA (60 BYTES)
	VELOCITY (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	BOTTOM-TRACK (81 BYTES)
	PING ATTITUDE (29, 55, or 81 BYTES)
	ISM (21 BYTES)
Always Output	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 33. Binary Standard Output Data Buffer Format

Some data outputs are in bytes per depth cell. As an example, the size of a PD0 message if both broadband and narrowband were included, with 64 bins in broadband and 32 bins in narrowband, 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)
63     Bytes of Fixed Leader Data (fixed)
79     Bytes of Variable Leader Data (fixed)
258    Bytes of Velocity Data (2+8x32)
130    Bytes of Correlation Magnitude Data (2+4x32)
130    Bytes of Echo Intensity (2+4x32)
130    Bytes of Percent Good(2+4x32)
130    Bytes of Status(2+4x32)
81     Bytes of Bottom Track Data (fixed)
55     Bytes of Ping Attitude Data (2 ping types)
21     Bytes of ISM Data (fixed)
2      Bytes of Reserved for TRDI Use (fixed)
2      Bytes of Checksum Data (fixed)
-------------------------------------------------------
2815   Bytes of data per ensemble
```

Note that the Broadband and Narrowband data types can have either the "standard" ID or "standard plus 1", as defined by the CW command. Data IDs are shown in Table 16.

Table 20: Standard or Standard Plus 1 Data Format IDs

Standard ID		Standard plus 1 ID		Description
MSB	LSB	MSB	LSB	
00	00	00	01	Fixed Leader
00	80	00	81	Variable Leader
01	00	01	01	Velocity Profile Data
02	00	02	01	Correlation Profile Data
03	00	03	01	Echo Intensity Profile Data
04	00	04	01	Percent Good Profile Data

The CW command selects which ping type (BroadBand or NarrowBand) will get the standard ID and the other ping type (BroadBand or NarrowBand) will get the standard plus one ID (see CW – Select Dual Mode Data).

The Pinnacle always sends the Least Significant Byte (LSB) first.

Sample PD0 from Doppler to Catalyst

The data from Doppler to Catalyst is always single-ping data, so the "percent good" and "status" data items are not needed and are not included in the PD0 messages from the Doppler.

Data types for broadband, narrowband, or bottom track pings will only be included in PD0 messages where that ping has occurred. There are two possible arrangements for different ping types in the Pinnacle ADCP: interleaved pinging and burst pinging.

- In the interleaved case, each ping group always consists of one ping of each enabled ping type, so all PD0 messages will have the same data items included (broadband and/or narrowband and/or bottom track).
- In burst mode – which can include a set of broadband pings and/or a set of narrowband pings (but no bottom track) – each PD0 data frame will only include broadband data item or a narrowband data item.

Sample PD0 messages for a single data type message (either a burst ping or a system configuration where only one water profile data type is enabled) is shown below in Table 17 and Table 18. In these examples the “Bursting Example” from [6] is used as the system configuration. As shown in these tables, the PD0 message only contains one fixed leader and variable leader, which the variable leader associated with the water profile (primary profile or secondary profile) that is currently being output.

Table 21. PD0 output from Doppler for single data type – primary profile output

Data Item	ID	Bytes	Notes
Header	7F7F	20	7 data types
Fixed Leader	0000	65	
Variable Leader	0080	79	
Velocity	0100	282	35 depth cells
Correlation	0200	142	35 depth cells
Echo Intensity	0300	142	35 depth cells
Ping Attitude	5902	29	
ISM	5901	21	
Reserved		2	
Checksum		2	
		784	*Bytes total*

Table 22. PD0 output from Doppler for single data type – secondary profile output

Data Item	ID	Bytes	Notes
Header	7F7F	20	7 data types
Fixed Leader	0001	65	
Variable Leader	0081	79	
Velocity	0101	282	35 depth cells
Correlation	0201	142	35 depth cells
Echo Intensity	0301	142	35 depth cells
Ping Attitude	5902	29	
ISM	5901	21	
Reserved		2	
Checksum		2	
		784	*Bytes total*

A "fully populated" PD0 message from the Doppler – representing the case where the Pinnacle is configured for interleaved pings with all ping types (Broadband, Narrowband, Bottom-Track) enabled is shown below in Table 19. The system configuration in this example is the "Real Time Vessel Mount" example.

Table 23. PD0 Output from Doppler for all ping types

Data Item	ID	Bytes	Notes
Header	7F7F	32	13 data types
Fixed Leader	0000	65	
Variable Leader	0080	79	
Velocity	0100	402	50 depth cells
Correlation	0200	202	50 depth cells
Echo Intensity	0300	202	50 depth cells
Fixed Leader	0001	65	
Variable Leader	0081	79	
Velocity	0101	322	40 depth cells
Correlation	0201	162	40 depth cells
Echo Intensity	0301	162	40 depth cells
Bottom Track	0600	81	
Ping Attitude	5902	81	
ISM	5901	21	
Reserved		2	
Checksum		2	
		1959	*Bytes total*

In Figure 29 below we see an illustration of PD0 data output from the Doppler when operating in interleaved mode. As shown in the figure, the PD0 message is output once per ping group, where a "ping group" consists of a single narrowband ping and/or a single broadband ping and/or a single bottom track ping. In Figure 29 all three ping types are shown, but it should be understood one or more of these ping types may be omitted in practice.

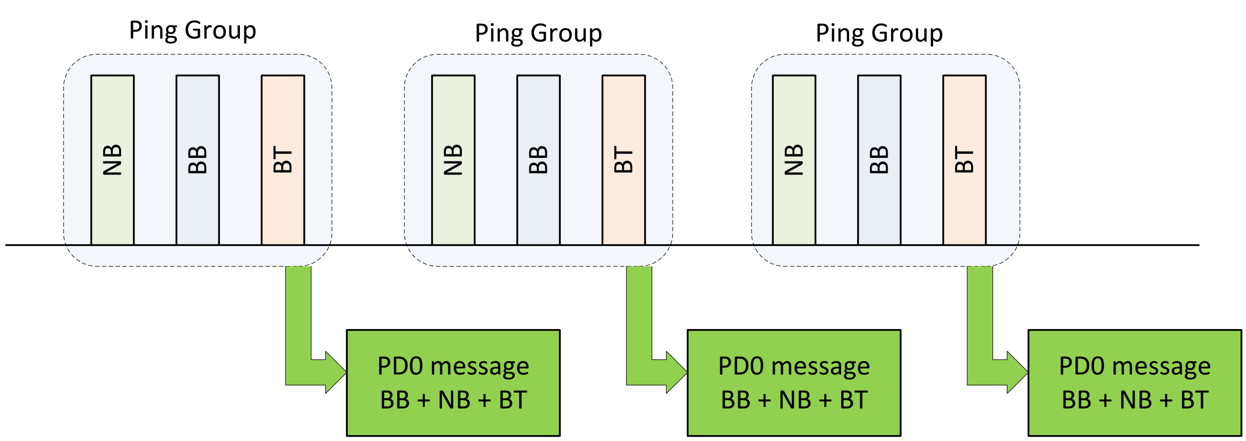


Figure 34. PD0 output from Doppler in interleaved mode

Figure 30 below is an illustration of PD0 data output from the Doppler when operating in burst mode, with water profile pings only. As shown in the figure, each individual ping forms its own ping group and a PD0 message is output once per ping (a.k.a. ping group).

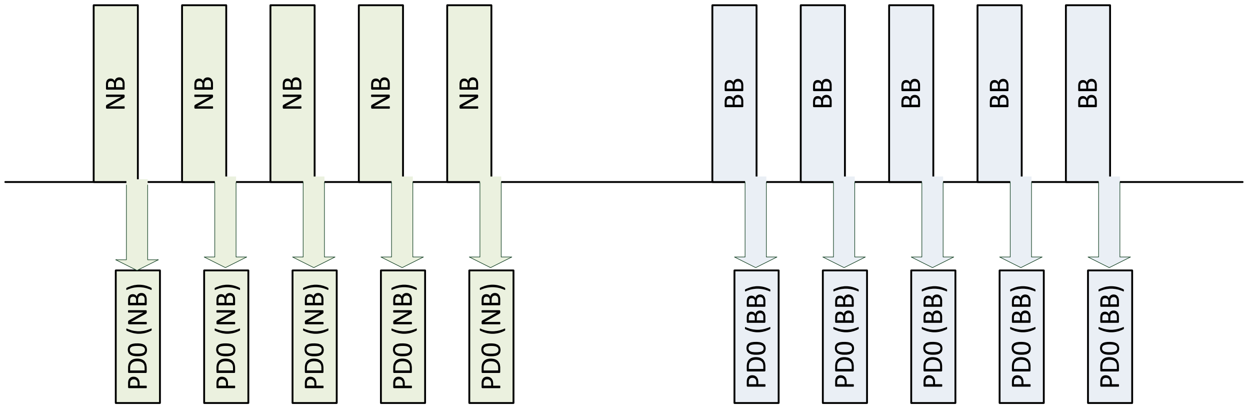


Figure 35. PD0 output from Doppler in burst mode (Water Profile only)

Figure 31 below is an illustration of PD0 data output from the Doppler when operating in burst mode, with water profile pings and bottom track pings. This mode of operation is not allowed in the initial release (Release 1), but is planned for a future release of Pinnacle. When in burst mode, the Pinnacle will output one bottom track ping for each water profile ping, and the water profile ping plus bottom track ping together form a single ping group. The Pinnacle Doppler outputs a PD0 message for each ping group.

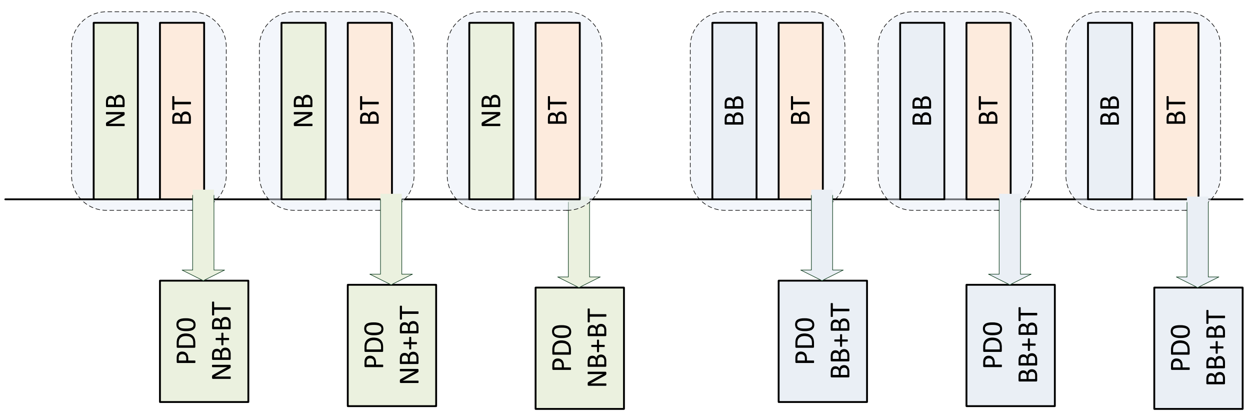


Figure 36. PD0 output from Doppler in burst mode (Water Profile plus Bottom Track)

Sample PD0 from Catalyst Data

In the Pinnacle system, the user always has access to the original raw PD0 data. Because of this, in the processed data files we discard data items that were only used to aid in calculating the final results being displayed. Specifically, we discard the ping attitude and ISM data types, 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. The data corresponding to the previous example (Table 19) is shown here in processed form as Table 20.

Table 24. PD0 Output from Catalyst after processing

Data Item	ID	Bytes	Notes
Header	7F7F	32	13 data types
Fixed Leader	0000	65	
Variable Leader	0080	79	
Velocity	0100	402	50 depth cells
Correlation	0200	202	50 depth cells
Echo Intensity	0300	202	50 depth cells
Percent Good	0400	202	50 depth cells
Fixed Leader	0001	65	
Variable Leader	0081	79	
Velocity	0101	322	40 depth cells
Correlation	0201	162	40 depth cells
Echo Intensity	0301	162	40 depth cells
Percent Good	0401	162	40 depth cells
Bottom Track	0600	81	
Reserved		2	
Checksum		2	
		2221	*Bytes total*

The Pinnacle ADCP outputs packets of data that will contain any or all of narrowband 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 or NP command, 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*.

Catalyst 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 Pinnacle uses a linear interpolation along each beam to the target depth.

Dynamic attitude compensation

- Long range systems can take up to three seconds to make a 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 NP commands will be created for each data type.

Binary 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 37. Binary 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 25: Binary 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).

Binary Fixed Leader Data Format

BYTE	7	6	5	4	3	2	1	0	
1	FIXED LEADER ID 0000 or 0001							00h or 01h	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 ↓ 54	RESERVED	↓
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 38. Binary Fixed Leader Data Format

Fixed Leader data 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.

As shown in Table 22 below, the contents of the Fixed Leader will vary depending on whether the leader is associated with broadband (Wx commands) or narrowband (Nx commands) data.

Table 26: Binary Fixed Leader Data Format

Binary Byte	Field	Description
1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word 0000 or 0001 (see CW – Select Dual Mode Data). 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 Pinnacle 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 or NN command. Scaling: LSD = 1 depth cell; Range = 1 to 255 depth cells
11,12	Pings Per Ensemble	Contains the number of (broadband or narrowband) 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 or NS command. 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 or NF command. 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. If the ping was a narrowband ping then it will show 10.

Table 26: Binary Fixed Leader Data Format

Binary Byte	Field	Description
18	Broad Bandwidth Profiling Water Correlation Threshold	If the profile ping was a broadband ping, then byte 18 is the value of WC. If the profile ping was a narrowband ping then it is zero.
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
20	Reserved	Reserved
21,22	Error Velocity Threshold	This field, initially set by the WE or NE 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 narrowband ping and/or a single bottom track ping). The time reported is TP or TB(TP) depending on the burst state.

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`
		`xxxxxxx1 = uses EU from Up/down 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`

Table 26: Binary Fixed Leader Data Format

Binary Byte	Field	Description
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/NS), the profiling mode (WM), the blank after transmit distance (WF/NF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
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 or NA 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 Pinnacle.
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 or NP command. Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
63-65	System Frequency	System frequency, in Hz

Binary Variable Leader Data Format

BYTE	7	6	5	4	3	2	1	0	
1	VARIABLE LEADER ID 80h or 81h								LSB
2	VARIABLE LEADER ID 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

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

BYTE	7	6	5	4	3	2	1	0	
	BIT POSITIONS								
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 39. Binary 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 27: Binary Variable Leader Data Format

Binary Byte	Field	Description
1,2	VID / Variable Leader ID	Stores the Variable Leader identification word 0080 or 0081 (see CW – Select Dual Mode Data). 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 Pinnacle's Built-in Test function. A zero code indicates a successful BIT result.

```
BIT byte13
Error
Code Description
0x01 Transmitter Shutdown
0x02 Transmitter Overcurrent
0x03 Transmitter Undercurrent
0x04 Transmitter Undervoltage
0x05 RTC low battery
0x06 RTC was stopped
0x07 High-precision timer calibration error
0x08 High-precision timer error
0x09 RTC alarm error

0x10 FIFO interrupt missed
0x11 FIFO ISR re-entry

0x20 Sensor communication failure
0x21 Sensor start failure
0x22 temperature sensor failure
0x23 pressure sensor failure
0x24 tilt sensor failure
0x25 Salinity sensor failure
0x26 Sensor start failure
0x27 Sensor not okay
0x28 Bad Communications with sensor

0x29 Compass: Invalid handle returned
0x2A Compass: Can't initialize device
0x2B Compass: Can't start device
0x2C Compass: Device not working

0x2D Temperature: Can't init memory
0x2E Temperature: Can't init device
0x2F Temperature: Device not working

0x30 Stuck UART
0x31 UART Transmit timeout
0x32 UART IRQ Stuck
0x33 UART Buffer stuck
0x34 UART IRQ Active
0x35 UART cannot clear interrupt
0x36 UART break timed out
0x37 UART sleep timed out

0x38 Cat/Dopp interface failure
0x39 Cat/Dopp data transfer failure
0x3A Cat/Dopp data buffer failure

0x40 Vert beam did not detect surface

0x50 RTC low battery
0x51 RTC time not set
0x52 RTC calibration failure

// Loop Recorder Faults
0x60 Lost Nonvolatile pointers
0x61 Erase operation failed
0x62 Error writing from flash to buffer 1
0x63 Error writing from buffer 1 to flash
0x64 Timed out checking if page is erased
0x65 Bad return when checking page
0x66 Loop recorder Slate Full

0x70 Unable to write to FRAM

// HEM Faults
0x80 HEM Temperature data not valid
0x81 HEM Pressure data not valid
0x82 Failed to update HEM temperature data
0x83 Failed to update HEM pressure data
0x84 Failed to read HEM temperature data
0x85 Failed to read HEM pressure data
0x86 Failed to read HEM SPI state
0x87 Operating time over max
0x88 Pressure reading over sensor limit
0x89 Leak detected in sensor A
0x8A Leak detected in sensor B
0x8B Xmit inhibited by pressure switch
```

Table 27: Binary Variable Leader Data Format

Binary Byte	Field	Description

		`0x8C Over-temp detected at PTX temp sensor`
		
		`0xA0 Sleep inhibited by activity timer`
		
		`0xE0 Firmware fault`
		`0xE1 Memory failure`
		`0xE2 Memory allocation failure`
		`0xE3 NB ping does not support system freq`
		
		`0xFE Sleep failure`
		`0xFF Power failure`
		
		`BIT Number of Errors byte 14`
		`Number of BIT errors`

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 Pinnacle 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`

36	ADC Channel 1	
37	ADC Channel 2	
38	ADC Channel 3	
39	ADC Channel 4	
40	ADC Channel 5	
41	ADC Channel 6	

Table 27: Binary Variable Leader Data Format

Binary Byte	Field	Description
42	ADC Channel 7	The values for ADC channels 0 to 3 are displayed by the PC4 command. For example, if Byte 36 returns 64h, then 64h = 100 decimal, divided by 10 = 10 + 24 VDC offset = 34 VDC input voltage. The values for ADC channels 4 and 5 are sampled during pinging and are output in the Variable Leader for the PD0 output format. * See PC5/50 command for more details on how to decode the raw A/D counts into Leak Status.
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
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 Pinnacle 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.

Binary Velocity Data Format

BYTE	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID							00h or 01h	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 40. Binary Velocity Data Format

The number of depth cells is set by the WN-command or NN 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 28: Binary Velocity Data Format

Binary Byte	Field	Description
1,2	Velocity ID	Stores the velocity data identification word 0100 or 0101 (see CW – Select Dual Mode Data). 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.

Binary Correlation Magnitude, Echo Intensity, Percent Good, and Status Format

BYTE	BIT POSITIONS: 7/S 6 5 4 3 2 1 0	
1	ID CODE	LSB
2		MSB
3	DEPTH CELL #1, FIELD #1	
4	DEPTH CELL #1, FIELD #2	
5	DEPTH CELL #1, FIELD #3	
6	DEPTH CELL #1, FIELD #4	
7	DEPTH CELL #2, FIELD #1	
8	DEPTH CELL #2, FIELD #2	
9	DEPTH CELL #2, FIELD #3	
10	DEPTH CELL #2, FIELD #4	
↓	(SEQUENCE CONTINUES FOR UP TO 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 41. Binary Correlation Magnitude, Echo Intensity, Percent Good and Status Format

The number of depth cells is set by the WN-command or NN 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).

Correlation magnitude data for Narrow Bandwidth ensembles give the magnitude of the energy (power) in the low pass filter. Values of 170 to 190 counts represent normal levels. Lower values mean a reduced signal to noise ratio.

Table 29: Binary Correlation Magnitude Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the correlation magnitude data identification word 0200 or 0201) see CW – Select Dual Mode Data). 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 or NN 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 30: Binary Echo Intensity Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the echo intensity data identification word 0300 or 0301 (see CW – Select Dual Mode Data). 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 or NN 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 31: Binary Percent-Good Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the percent-good data identification word 0400 or 0401 (see CW – Select Dual Mode Data). 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 or NN command), following the same format as listed above for depth cell 1.

Binary Bottom-Track Data Format

BIT POSITIONS									
BYTE#	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	RESERVED								
↓									↓
16									
17	BEAM#1 BT RANGE								LSB
18									MSB
19	BEAM#2 BT RANGE								LSB
20									MSB
21	BEAM#3 BT RANGE								LSB
22									MSB
23	BEAM#4 BT RANGE								LSB
24									MSB
25	BEAM#1 BT VEL								LSB
26									MSB
27	BEAM#2 BT VEL								LSB
28									MSB
29	BEAM#3 BT VEL								LSB
30									MSB

BYTE#	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

(BIT POSITIONS)

Figure 42. Binary 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 32: Binary Bottom-Track Data Format

Binary Byte	Field	Description
1,2	ID Code	Stores the bottom-track data identification word 0600 or 0601 (see CW – Select Dual Mode Data). 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

Binary Ping Attitude Data Format

This data type encodes the movement of the heading, pitch, and roll during the ping for the various ping types. It is a successor to the "variable attitude" data types used in the Ocean Surveyor. This data type is produced by the Doppler engine and consumed by the Catalyst.

As described in Figure 38 below, this data type can be 29, 55, or 81 bytes long depending on whether one, two, or three ping types are included in the current PD0 message.

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
1	PING ATTITUDE DATA ID 0x5902	LSB
2		MSB
3	Ping Count (n)	LSB
4	Ping ID	
5	Valid Flag	
6	Heading Ping 1	LSB
7		
8		
9		MSB
10	Pitch Ping 1	LSB
11		
12		
13		MSB
14	Roll Ping 1	LSB
15		
16		
17		MSB
18	Heading Rate Ping 1	LSB
19		
20		
21		MSB
22	Pitch Rate Ping 1	LSB
23		
24		
25		MSB

BYTE	7	6	5	4	3	2	1	0	
26	Roll Rate Ping 1								LSB
27									
28									
29									MSB
↓	(Sequence Continues up to n = 3 Ping Types)								↓
+1	ID Ping n								
+2	Data Valid Flag Ping n								
+3	Heading Ping n								LSB
+4									
+5									
+6									MSB
+7	Pitch Ping n								LSB
+8									
+9									
+10									MSB
+11	Roll Ping n								LSB
+12									
+13									
+14									MSB
+15	Heading Rate Ping n								LSB
+16									
+17									
+18									MSB
+19	Pitch Rate Ping n								LSB
+20									
+21									
+22									MSB
+23	Roll Rate Ping n								LSB
+24									
+25									
+26									MSB

Figure 43. Binary Ping Attitude Data Format

The number of Water/Bottom Ping Types varies based on the setting of the EE, WP, NP, and BP 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 33: Ping Attitude Data Format

Binary Byte	Field	Description
1,2	Ping Attitude ID	0x5902
3	Ping Count	Number of Pings reported.
		Data repeated for each ping up to 3.
4	ID	Ping ID, 1= NB, 2 = BB, 3 = BT
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.
30	ID	Ping ID, 1= NB, 2 = BB, 3 = BT
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.
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.
56	ID	Ping ID, 1= NB, 2 = BB, 3 = BT
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.

Binary ISM Data format

This contains the full heading, pitch, roll, and magnetometer data captured during the ping. The data frame providing this information has been included in Appendix C – ISM Data Frame Definition.

BYTE#	7	6	5	4	3	2	1	0	
1	ISM 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 44. ISM Data Format

Table 34: Binary ISM Data Format

Binary Byte	Field	Description
1,2	ISM ID	Stores the ISM data identification word 0x5901
3	Valid Flag	Flags whether data was received from ISM 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 ISM 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. Use *Pinnacle Utilities* to post-correct data to remove magnetic influences.

Binary Reserved BIT Use

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

Figure 45. Binary Reserved BIT Use

Table 35: Binary Reserved for TRDI Format

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

Binary Checksum Data Format

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

Figure 46. Binary Checksum Data Format

Table 36: Binary 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.

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/

Appendix A

TRANSITIONING TO A PINNACLE SYSTEM

This chapter covers:

- Comparison between the LongRanger and Pinnacle System
- Pinnacle Summary Description

What Pinnacle is:

The Pinnacle system is a phased array ADCP intended to replace the Long Ranger and OOIII38DR. The Pinnacle ADCP includes bottom tracking (as a differentiator from the LongRanger), so there is also the potential for replacing some Ocean Surveyor systems. The primary market segments intended are oceanography and offshore energy.

What Pinnacle isn't:

Pinnacle systems are not intended for waves or turbulence measurements. The assumption is that the long range/low resolution nature (in space and time) operating envelope for Pinnacle makes it unsuitable for most, if not all, waves or turbulence researchers.

- Pinnacle does not have a vertical beam. It is not precluded from future releases.
- Pinnacle will not support LADCP operations.
- Pinnacle is not intended to be a navigation product.

Table 37. Comparison between LongRanger and Pinnacle System

LongRanger/QuarterMaster	Pinnacle
644 m range (using 32 m, narrowband, with a 32 V supply)	1000 m range (using 32 m, narrowband, with a 32 V supply)
Standard depth rating 1500 m (3000 and 6000 m optional)	Standard depth rating 2000 m
4 beams	4 beams
Piston transducer	Phased Array transducer
20-degree beam angle	20-degree beam angle
4-degree beam width	3.2-degree beam width
Size (Diameter) 55 cm	Size (Diameter) 44.4 cm
Set up using *PlanADCP*	Set up using *Pinnacle Utilities*
Deployed using *WinSC*	Deployed using *Pinnacle Utilities*
Test using *BBTalk/TRDI Toolz*	Test using *Pinnacle Utilities*
Real-Time data collection using *VmDas*	Real-Time data collection using *Pinnacle Utilities* (*VmDas* built-in)
Review Self-Contained data using *Velocity/WinADCP*	Review Self-Contained data using *Pinnacle Utilities*
Memory card on DSP requires housing removal to access card. Slow data download via serial port.	Removable recorder (SD memory card) with easy access next to batteries on Self-Contained systems. Fast data download via Ethernet.
Ping in air allowed	Ping in air allowed, but not recommended.
Not bottom track capable	Bottom track included
LADCP capable	LADCP not available
Requires compass calibration after battery replacement or use default calibration.	Calibration available, but not required. Raw ISM data stored for post-correction to remove magnetic influences.
No processing done by ADCP	Catalyst processing options include ADCP processing (coordinate transforms, screening, averaging)
Aluminum with paint. Requires anodes to protect system.	Corrosion resistant materials (plastic or plastic coated). No anodes.
No LEDs for user feedback	LED Status lights programmed for self-contained operations. Indications of deployed and ready, deployed and set for later start, error (failed BIT)
No Health and Environment Monitoring sensors	Health and Environment Monitoring sensors included

Pinnacle Summary Description

Performance

- Profiling range 1000 m (32 m bins, narrowband)
- Bottom Track Range 1500 m
- Bottom Track Accuracy 1% (threshold), <0.7% (objective)
- Water Velocity Accuracy 1%
- Self-Contained Deployments of up to 18 months

Processing

- Narrowband, Broadband and Bottom Track
- Interleaved or burst sampling

File Handling

- Raw data preserved
- Separate files created with screened, transformed ensemble averages
- Raw ISM data stored for post calibration
- File structure is PD0 based (new data types added)

Mechanical Configuration

- Module for direct read can be paired with module for self-contained
- Modules for self-contained can be stacked for longer deployments
- Modules for self-contained can be converted to an external battery case
- Corrosion Resistant housing (plastic coated)
- 2000 m depth rating
- Universal bolt pattern for mounting handling accessories

User interface

- Ethernet or Serial communication
- Simultaneous Trigger-In/Trigger-Out
- LEDs for user feedback
- User communication will be with Catalyst, so data collection will not be interrupted unless necessary (*i.e.* to change the ping setup).

Other Features

- Removable recorder (SD memory card) in battery module for self-contained deployments (no need to access electronics)
- Under 60-minute turn-around time for Self-Contained deployments
- Helium port, leak detection, Health and Environment Monitoring sensors

NOTES

Appendix B

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 34.

CE

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 RD Instruments USA 14020 Stowe Drive Poway, California 92064	**Teledyne RD Instruments Europe** 2A Les Nertieres 5 Avenue Hector Pintus 06610 La Gaude, France	**Teledyne RD Technologies** 1206 Holiday Inn Business Building 899 Dongfang Road, Pu Dong Shanghai 20122 China

Material Disclosure Table

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

Table 38. 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.

Notes