RIVERPRO & RIOPRO

ADCP GUIDE

TELEDYNE MARINE
Everywhereyoulook™

P/N 95B-6097-00 (February 2024)

https://www.teledynemarine.com

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REVISION HISTORY

February 2024

- Updated Returning Systems to the TRDI Factory, page 64 Brokerage address.

January 2024

- Updated the CZ command.
- Q-View software no longer requires a registration code.

October 2023

- Updated outline drawing 96B-6060.
- Added to Attaching the Mounting Plate: Using longer bolts or high torque risks the 8mm threaded metal inserts on the end-cap being pulled out of the plastic end-cap 12mm deep hole.

August 2023

- Updated Attaching the Mounting Plate.

July 2023

- Updated website address.
- Added Beam Width specification.

March 2023

- Updated outline installation drawing 96B-6067.

January 2023

- Updated EAR statement.
- Deployment guide now download only.

April 2022

- 95Z-6007-00 replaces the 90Z-8000-00 CD.

January 2022

- Added the 600kHz RiverPro system

August 2021

- Updated how to contact TRDI table
- Replaced *BBTalk* with *TRDI Toolz*
- Added PD0Decoder link

December 2020

- Corrected Bottom Track output data format bytes 17 to 24 and 78 to 81 to reserved
- Updated cover photo

July 2019

- Added note under System Status and LED Behavior about sensor failure details
- Updated logo

June 2018

- Updated Inventory list
- Added Export Administration Regulations (EAR) footers

October 2017

- Added a deployment guide to the system documentation
- Replaced the Quick Start Card with Getting Started with the RiverPro/RioPro
- Updated Inventory list
- Added using cable clips
- Updated Bluetooth connection

August 2015

- Added the RioPro ADCP to the RiverPro manual
- Updated the RiverPro/RioPro Inventory
- Updated the LED behavior table
- Added the Boat Wiring Diagram
- Added Beam Coordinate Systems information to the EX command
- Updated the PT3 command
- Updated the GPS specifications
- Updated the outline installation drawings

October 2014

- Initial release

EXCLUSIONS AND OMISSIONS

This manual covers the RiverPro/RioPro ADCP hardware and firmware. For instructions on using a computer running the *WinRiver II* software, see the WinRiver II User's Guide. For information on using the *SxS Pro* software, see the SxS Software User's Guide.

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
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Sales – rdisales@teledyne.com	Sales – rdie@teledyne.com
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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.

CONVENTIONS USED IN THIS MANUAL

Conventions used in this documentation have been established to help explain how to use the RiverPro/RioPro system quickly and easily.

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

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

```
>break

RioPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

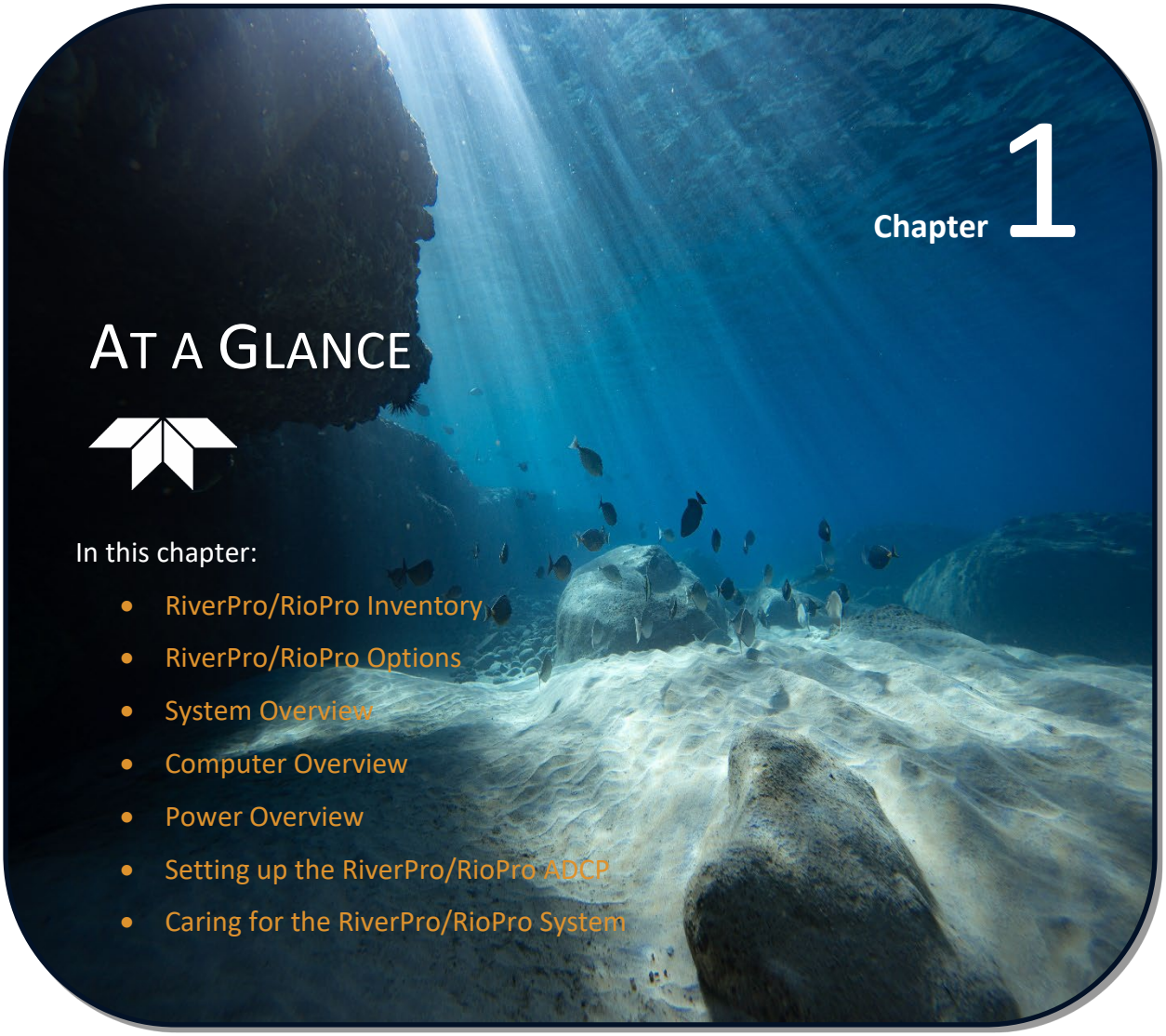
There are four visual aids to help:

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 RiverPro/RioPro ADCP).

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

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



Chapter 1

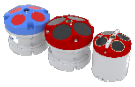
AT A GLANCE

In this chapter:

- RiverPro/RioPro Inventory
- RiverPro/RioPro Options
- System Overview
- Computer Overview
- Power Overview
- Setting up the RiverPro/RioPro ADCP
- Caring for the RiverPro/RioPro System

RiverPro/RioPro Inventory

Included with the RiverPro/RioPro system:

Part Number	Name	Description
RIVPRO1200-I RIVERPRO600-I 707-6025-02	RiverPro 1200 kHz RiverPro 600 kHz RioPro 1200 kHz	 The RiverPro/RioPro system includes the transducer, dummy plug, and protective cap. When unpacking, use care to prevent physical damage to the transducer face and connector. Use a soft pad to protect the transducer.
71B-7007-xx	Tri-hull Boat (optional) (RiverPro1200 only)	 Tri-hull Boat and mounting plate for tethered deployments (shown folded). Various GPS wiring optional configurations are available.
HSRB-RR-xxxx	High Speed Riverboat (optional)	For discharge measurements in applications with high water velocities or challenging surface turbulence conditions where the standard boat does not provide stable operation. Can be used with RiverPro1200/RiverPro600, RioPro, and RiverRay ADCPs.

Included with the RiverPro/RioPro Accessories Kit:

Part Number	Name	Description
UK821 977-7003-00	Shipping case	Shipping case with custom foam cutouts.
73B-6020-xxx	I/O cable	The I/O cable is used for serial communications.
95Z-6007-00	Download instructions	This sheet has instructions for downloading the software and manuals.
	WinRiver II Software	TRDI's river and coastal data acquisition software package where the primary use is for discharge calculation. Although this is its primary function, it can be used for general coastal survey applications.
	TRDI Toolz Software	Utility and testing software package that can be used to test the ADCP.
	SxS Pro Software (optional)	Section-by-Section (SxS) Pro is a stationary ADCP discharge data collection and processing program. Registration code is required to collect data.
	Q-View Software (optional)	*Q-View* is designed for customers using *WinRiver II* software to have easy access to an evaluation of the quality of collected data while they are still in the field and back in the office.
95B-6127-00	Getting Started	A printed reference sheet showing how to get started with the RiverPro/RioPro.
SD1000U DAT5-G01R	USB Bluetooth device	USB Bluetooth device SD1000U and Sena DAT5-G01R antenna.
75BK6068-00 75BK6137-00	Spare parts and tools	The RiverPro1200 includes a driver for removing and connecting the I/O cable strain relief and spare mounting hardware for the Boat mounting plate. The RiverPro600 includes tools and spare hardware.

For instructions on using the USB Bluetooth device, see the WinRiver II or SxS Pro Software User's Guide and the instructions included with the device on the Bluetooth driver CD.

When WinRiver II is installed, shortcuts to the WinRiver II Software User's Guide and quick reference cards are added to the Windows Start menu.

RiverPro 1200 and 600 kHz Overview

The RiverPro transducer assembly contains the end-cap, housing, transducer ceramics, and electronics. The standard acoustic frequencies are four 1200 or 600 kHz Janus beams and one 600 kHz vertical beam. See the Outline Installation Drawings for dimensions and weights.

Picture	Description
	The Input/Output (I/O) cable connects the RiverPro ADCP to the computer and external power supply. When the cable is not connected, use the dummy plug to protect the connector. The LEDs on the end-cap indicates the status of the RiverPro system. The I/O connector should not be exposed to extended periods of heat or direct sunlight. Always apply lubricant before connecting the I/O cable to the RiverPro. The RiverPro is intended to be operated as a surface mounted system only. No depth rating is provided. The Thermistor measures the water temperature.
 1200 kHz	The black urethane faces cover the transducer ceramics. The Vertical Beam allows for depth measurement directly under the RiverPro. Never set the transducer on a hard surface. The urethane faces may be damaged. The RiverPro electronics and transducer ceramics are mounted to the transducer head. The numbers embossed on the end-cap and transducer head indicate the beam number. The RiverPro ADCP incorporates an internal GPS module intended for Georeferenced purposes. The RiverPro captures the GGA and VTG NMEA strings from the internal GPS module and reports them in the PD0 data stream using the general NMEA format. *WinRiver II* provides status of this module and displays the data during both data collection and playback.
 600 kHz	

RioPro Overview

The RioPro is an upgraded 1200 kHz WorkHorse Rio Grande system that contains an updated transducer head, RiverPro electronics, and new end-cap. The system uses the original Rio Grande housing, shipping case, and I/O cable. The standard acoustic frequency is four 1200 kHz Janus beams. See the Outline Installation Drawings for dimensions and weights.

Picture	Description
	The Input/Output (I/O) cable connects the RioPro ADCP to the computer and external power supply. When the cable is not connected, use the dummy plug to protect the connector. The LEDs on the end-cap indicates the status of the RioPro system. ⚠ The I/O connector should not be exposed to extended periods of heat or direct sunlight. ⚠ Always apply silicone lubricant before connecting the I/O cable to the RioPro. The RioPro is intended to be operated as a surface mounted system only. No depth rating is provided. The Thermistor measures the water temperature.
	The orange urethane faces cover the transducer ceramics. ⚠ Never set the transducer on a hard surface. The urethane faces may be damaged. The RioPro electronics and transducer ceramics are mounted to the transducer head. The numbers embossed on the end-cap and transducer head indicate the beam number. The RioPro ADCP incorporates an internal GPS module intended for Georeferenced purposes. The RiverPro captures the GGA and VTG NMEA strings from the internal GPS module and reports them in the PD0 data stream using the general NMEA format. *WinRiver II* provides status of this module and displays the data during both data collection and playback.

Boat Overview

The RiverRay/RiverPro boat (available for RiverPro 1200 only) is designed to maintain the transducer at a constant depth in the water with minimal water flow disturbance.

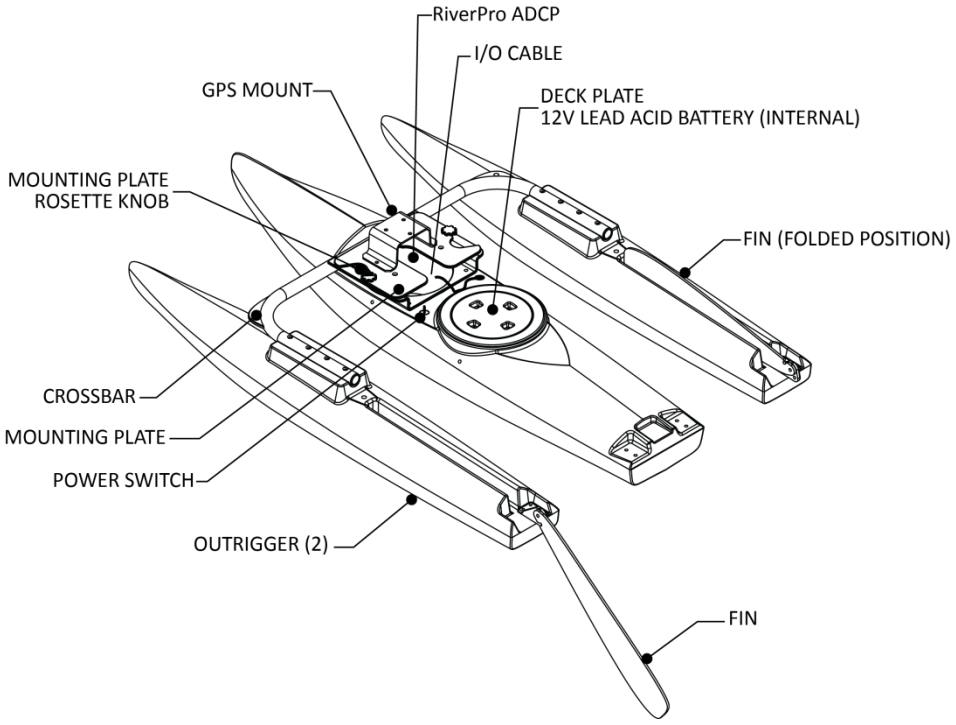


Figure 1. RiverRay/RiverPro1200 Boat Overview

Computer Overview

TRDI designed the RiverPro/RioPro ADCP to use a Windows® compatible computer. The computer controls the RiverPro/RioPro and displays its data, usually through our *WinRiver II* or *SxS Pro* programs.

Minimum Computer Hardware Requirements:

- Windows 10®, Windows 8®, Windows 7® Desktop, Laptop, or Netbook computer
- Screen resolution above 1024x768
- One Serial Port (two or more High Speed UART Serial Port recommended)
- Bluetooth Interface or USB port

Power Overview

The RiverPro/RioPro ADCP requires a DC supply between 10.5 volts and 18 volts. Either an external DC power supply or battery can provide this power. If using a battery, use the largest rated amp-hour battery as possible. A car battery should last one to two days powering a 1200 kHz ADCP.

Check that the battery voltage is above 10.5 Volts DC. RiverPro/RioPro ADCPs will work at 10.5 VDC with at least 400 milli amps; however, batteries with voltages below 11 VDC are at or near their end of life and are approaching uselessness.

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

If the power supply limits the current or the power drop on the cable is significant, then the power on cycle will take longer. It can take up to one minute. If the power shuts down during the inrush current draw, this may not allow the RiverPro/RioPro's electronics to start.

Auto-Adaptive Water Profiling Mode

The RiverPro/RioPro 1200 uses an auto-adaptive water profiling mode which automatically adjusts velocity profiling parameters every ensemble (reading) based on the water depth and other characteristics to maintain a balance between velocity precision, spatial resolution, and data storage requirements. This approach allows consistent data quality throughout a transect and discharge measurement regardless of changes in the water depth or flow characteristics without the need for user intervention.

This mode is currently not available for the RiverPro600.

For more details, please refer to the chapter on Water Profiling Modes in the WinRiver II User Guide.

RiverPro/RioPro Options

- **Maintenance Kit** – These kits contain a complete set of O-Rings and close-up hardware (see Maintenance Kit).
- **Manual Profile Modes** – These modes allow the RiverPro/RioPro to override the automatic profiling mode and adds additional water profiling commands (see Water Profiling Commands). To purchase a feature upgrade, please contact sales. These are the only modes available for the RiverPro600 and are enabled by default.
- **Q-View Software** – *Q-View* is designed for customers using TRDI's discharge measurement products such as the RiverRay, RiverPro/RioPro, StreamPro, and Rio Grande ADCPs with the *WinRiver II* software to have easy access to an evaluation of the quality of collected data while they are still in the field and back in the office.
- **SxS Pro** – The *SxS Pro* software can be used in place of the *WinRiver II* software. To purchase a registration code to enable the software's full capability, please contact field service. *SxS Pro* software can be downloaded at https://tm-portal.force.com/TMsoftwareportal

- **GPS/GNSS wiring and mounting kits** – GNSS stands for Global Navigation Satellite System, a term which encompasses all available systems rather than just the GPS (Global Positioning System) satellites operated by the US. For clarity and brevity, the term GPS will be used throughout the remainder of this manual to refer to all such systems collectively. GPS wiring and mounting kits for the RiverPro boat are available for a variety of GPS systems. GPS wiring and mounting kits are normally ordered in conjunction with new RiverPro systems and any required boat modifications are performed at the factory. Consult TRDI for more information.
- **Hemisphere A631 DGPS kit** –Atlas capable Hemisphere A631 Smart Antenna DGPS & configuration cable.
- **Hemisphere V200 DGPS kits** – Atlas capable Hemisphere V200 vector (heading) Smart Antenna DGPS with configuration cable.
- **Hemisphere S631 RTK kits** – Atlas capable Hemisphere S631 Smart Antenna GNSS system with configuration cable, integrated batteries, and integrated radio/cellular modem. L1/L2, GLONASS, and RTK support included.

GPS manuals and software are available for download: https://www.hemispheregnss.com/

- **High Speed Riverboat** – For discharge measurements in applications with high water velocities or challenging surface turbulence conditions where the standard boat does not provide stable operation. Can be used with RiverPro1200/RiverPro600, RioPro, and RiverRay ADCPs.
- **Carrying Cases** – Soft-sided and hard-sided carrying cases for the RiverPro boat are available. Contact TRDI for more information.
- **Q-Boat 1250 Powered Trimaran** – Using the remote-control Q-Boat for ADCP deployment during river velocity profiling and discharge monitoring offers the ultimate in survey flexibility and personnel safety. No busy highway bridge is needed at the survey location, no people need to be out on dangerous flood waters to take the measurement, and no cableway is necessary. Instead of being determined by accessibility, Q-Boat survey locations can be selected to give the best results possible. Configurations for RiverRay and RiverPro1200 ADCP types are available, and all boats are easily customized for special projects.

Setting up the RiverPro/RioPro System

Use this section to connect the RiverPro/RioPro to a computer and establish communications. Install the *TRDI Toolz* software to communicate with the RiverPro/RioPro. For collecting data, install the *WinRiver II*, *SxS Pro* (optional), and *Q-View* (optional) software.

Bluetooth Connection

Use these next steps to setup a Bluetooth connection to the RiverPro/RioPro.

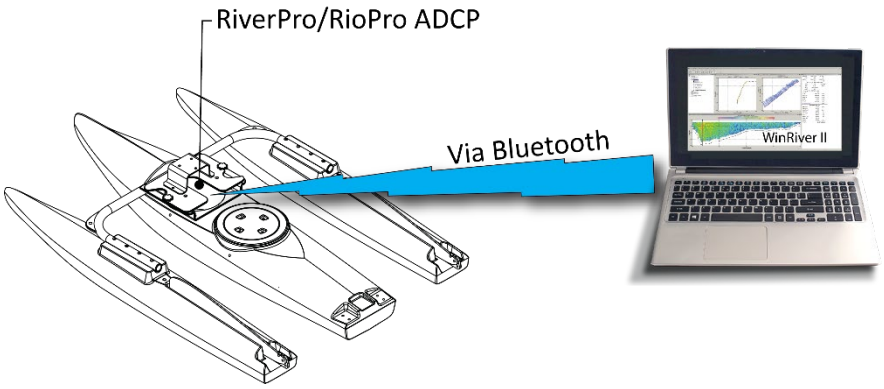


Figure 2. RiverPro/RioPro Connections – Bluetooth Connection

For instruction on using the SD1000U USB Bluetooth device, see the WinRiver II or SxS Pro Software User's Guide and the instructions and Bluetooth CD included with the device.

Some Bluetooth devices may ask for a passkey, PIN code, Pair code, Pairing code, Security code, or Bluetooth code.

In all cases, the code is 0 or 0000 (zero, not the letter o).

The pin code is 0 for systems shipped prior to August 2017 and 0000 for systems shipped after August 2017. If your system is sent in for repair and the Bluetooth module is replaced, the pin code (if needed) will change from 0 to 0000.

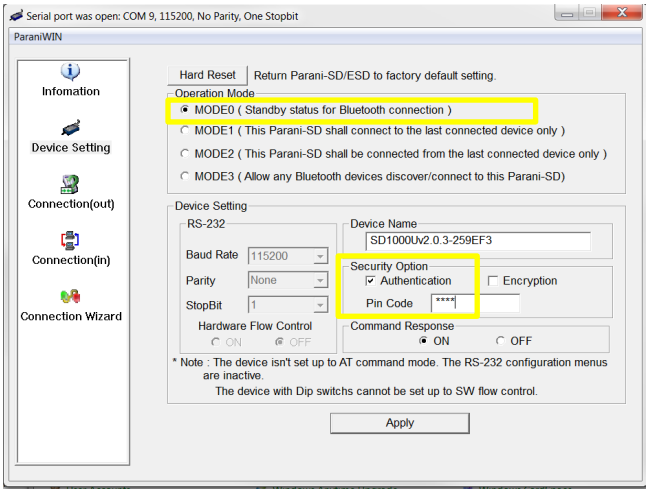
For RiverPro/RioPro systems shipped after August 2017, the Microsoft® Bluetooth drivers work with *WinRiver II*. For best results, use the USB Bluetooth device with the driver supplied with the ADCP for *WinRiver II.*

To connect to a RiverPro/RioPro ADCP using the Bluetooth port:

1. Attach the boat's cable to the ADCP's connector and install the battery in the boat. Turn on the boat power switch. Verify that both the red and green LEDs light. After a few seconds the red LED should go out and the green LED will blink twice and then stay on. This indicates that the RiverPro/RioPro self-test has passed.
2. Plug in the SD1000U device to a USB port and determine the Com port used.

See the WinRiver II SD1000U Bluetooth Communication Setup Card for instructions. When WinRiver II is installed, shortcuts to the WinRiver II Software User's Guide and quick reference cards are added to the Windows Start menu.

3. Run the *ParaniWin* program and connect to the ADCP. With the Bluetooth modules used since August 2017 (or a repaired older unit where the Bluetooth module was replaced) select **Mode 0** and you may or may not need to select **Authentication** (not Encryption). The **Pin Code** is 0000 (four zeros) and click **Apply**.

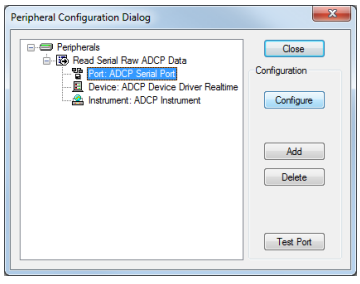


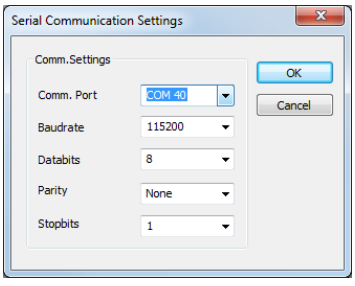
You may need to use either Authentication or no authentication when using *ParaniWin* with an SD100U. Try one, and if does not work try the other. Use whichever one works going forward.

The selection of Mode 0 or Mode 1 is independent of Authentication/no Authentication:

- Mode 1 automatically reconnects to the ADCP but is otherwise identical to Mode 0.
- You must establish an outgoing connection before you can switch to Mode 1, but once in Mode 1 you can connect to a different ADCP without switching back to Mode 0.

4. Exit the *ParaniWin* program.
5. Start *WinRiver II*.
6. On the **Configure** menu, select **Peripherals**.
7. Select **Port: ADCP Serial Port** and then click the **Configure** button.
8. Select the **Comm. Port** number as noted in step 2. The **Baudrate** must be set to 115200. Leave the **Databits**, **Parity**, and **Stopbits** as shown.
9. Click **OK** to close the Serial Communication Settings screen.





Note it may take several seconds to accept the Comm. Port selection.

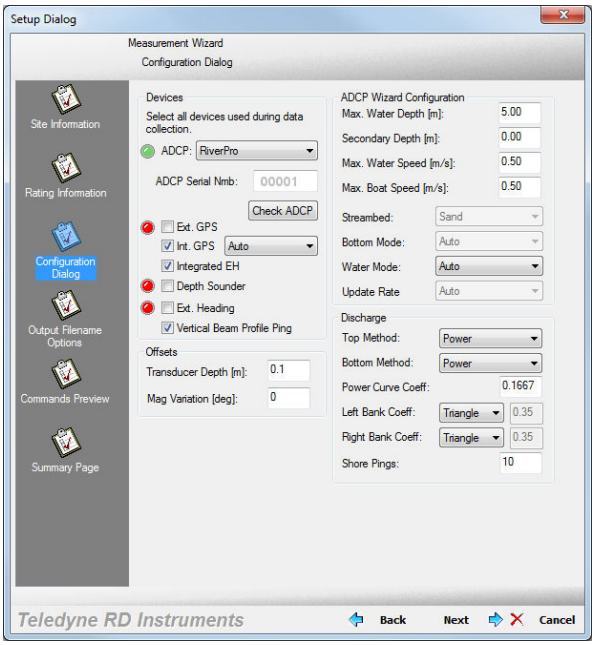
In this example, the Comm. Port is set to Com Port 40.

10. Click the **Test Port** button. The RiverPro/RioPro banner appears.

```
>break

RiverPro/RioPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

11. Click the **Close** button to exit the Test Port Dialog.
12. Click the **Close** button once more to exit the Peripherals Configuration Dialog.
13. Start a new measurement in *WinRiver II*.
14. On the **Configuration Dialog**, ensure the **ADCP** type matches the RiverPro/RioPro and the indicator next to the RiverPro/RioPro is green. Verify the blue LED on the RiverPro/RioPro ADCP is on.



Serial Connection

To set up the RiverPro/RioPro ADCP:

1. The I/O cable connector must be lubricated before connecting. Connect the I/O cable to the RiverPro/RioPro ADCP.

   Always apply silicone lubricant before connecting the I/O cable. See I/O Cable and Dummy Plug and I/O Cable Connector Lubricant for details.

2. Attach the I/O cable to the computer's communication port. The standard communications settings are RS-232, 115200-baud, no parity, 8 data bits and 1 stop bit.
3. Connect a battery or DC power supply to the power connectors. Verify that both the red and green LEDs light. After a few seconds the red LED should go out and the green LED will blink twice and then stay on. This indicates that the RiverPro/RioPro self-test has passed.

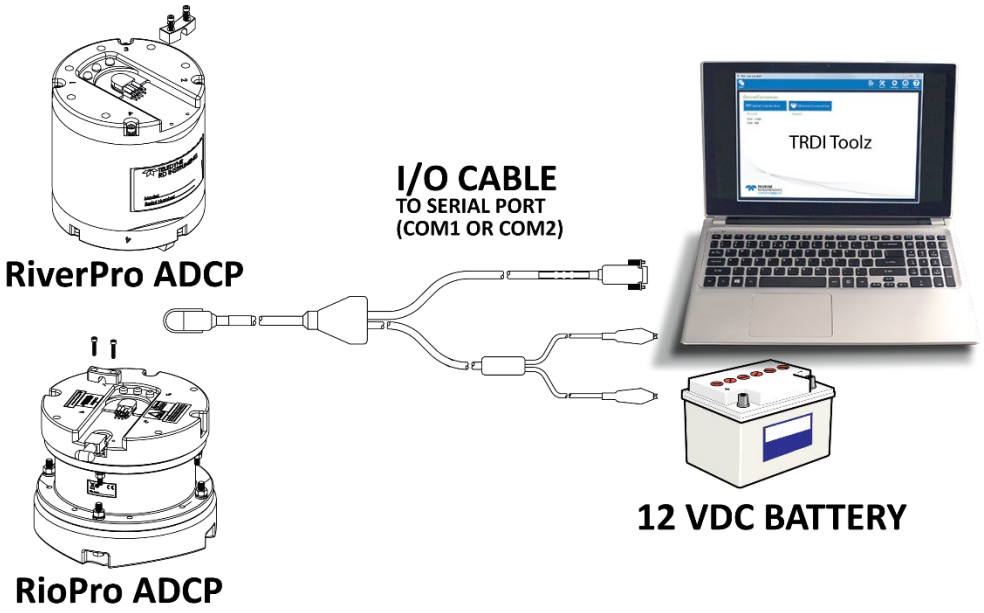


Figure 3. RiverPro/RioPro Serial Connection

For information on how to set up communications with *WinRiver II*, see the WinRiver II Serial Communications Setup Card or see Chapter 2 in the WinRiver II Software User's Guide.

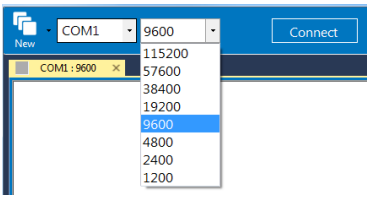
When WinRiver II is installed, shortcuts to the WinRiver II Software User's Guide and quick reference cards are added to the Windows Start menu.

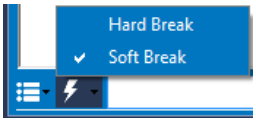
For Bluetooth connection, see Bluetooth Connection.

Connecting to the RiverPro/RioPro

To establish communications with the RiverPro/RioPro ADCP:

1. Connect the system and apply power.
2. Start the *TRDI Toolz* software.
3. Select **New Serial Connection**.
4. Enter the ADCP's communication settings. Select the **COM Port** the serial cable is connected to and set the **Baud Rate** from the drop-down lists.
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 **Soft Break** (= = =). The wakeup banner will display in the terminal window.





RioPro Banner

```
RioPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

RiverPro Banner

```
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

It may be necessary to click inside the terminal window and then click the Break button to wake up the system if multiple communication tabs are open.

If you are unsure of the ADCP's baud rate, use Tools, Find ADCP. *TRDI Toolz* will try different baud rates until it connects to the ADCP.

```
>{¡ɿφ²∩⅄⅄²²jñ~ªñδgJ Checking 9600 baud rate
Checking 115200 baud rate
==
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

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

Changing the Baud Rate in the ADCPs

The RiverPro/RioPro can be set to communicate at baud rates from 1200 to 115200. The factory default baud rate is always 115200 baud. The baud rate is controlled via the CB-command. The following procedure explains how to set the baud rate and save it in the RiverPro/RioPro. This procedure assumes using the program *TRDI Toolz* that is supplied by Teledyne RD Instruments.

```
[BREAK Wakeup A]
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>cr1
[Parameters set to FACTORY defaults]
>
```

Connect the ADCP to the computer and apply power.

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

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

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

Send the CB-command that selects the baud rate you want to use. The table on the left shows the CB-command settings for different baud rates.

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

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

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

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

Exit the *TRDI Toolz* program.

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

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

RiverPro/RioPro Recorder

The recorder contains approximately 16 megabytes of solid-state nonvolatile memory, which can be used to record data. If more data is collected than fits in the memory, the newest data will not be recorded. Once the recorder fills up, the recorder MUST be erased before re-deploying the RiverPro/RioPro (start pinging again).

If the RiverPro/RioPro is set to record data (MR1) and the recorder is full, the RiverPro/RioPro will *not* start pinging and will return a *RECORDER NOT READY* message.

See the TRDI Toolz help file for details on using *TRDI Toolz.*

Enabling the Recorder

The recorder is off by default.

To enable the recorder:

1. Start *TRDI Toolz*.
2. Click the **Break** ( ) button.
3. Send the MR1 command to enable the recorder.

> Using the recorder will slow down the RiverPro/RioPro's ping rate.

4. When done recording data, send the MRo command to turn the recorder off.

Recovering Data from the Recorder

To recover data:

1. Start *TRDI Toolz*.
2. Click the **Break** ( ) button.
3. On the **Tools** menu, click **Download Data**.
4. *TRDI Toolz* uploads the entire contents of the recorder via the serial interface to a host computer using the standard YMODEM protocol for binary file transfer. The data is transferred to the host and stored as binary files.

Erasing Data from the Recorder

To erase data:

1. Start *TRDI Toolz*.
2. Click the **Break** ( ) button.
3. At the ">" prompt, type **ME ErAsE**. To make it more difficult to accidentally erase the data, the word "erase" must be typed with exactly one space after the "ME" (which is not case sensitive) and with alternating upper and lower case letters, as shown.
4. Erasing the recorder will take several minutes, and no status updates are provided during the erase process. When complete, the status will be displayed on screen as shown below.

```
>me ErAsE
Erasing recorder (may take a few minutes)...
Erasing recorder (may take a few minutes)...    Recorder erased.
Erasing recorder (may take a few minutes)...    ERR: Can't erase recorder.
>
```

> Once erased, data is not recoverable.

5. When erasing is complete, exit *TRDI Toolz*.

Caring for the RiverPro/RioPro System

This section contains a list of items to be aware of every time the RiverPro/RioPro is handled, used, or deployed. *Please refer to this list often*.

General Handling Guidelines

- Never set the transducer on a hard or rough surface. **The urethane faces may be damaged**.
- Use light amounts of silicone lubricant on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone spray from the metal portions of the pins. **Regular lubrication is required**: Apply silicone lubricant prior to each connection.
- Disconnect the I/O cable by pulling it straight away from the connector. Do not apply any upward or angular force on the end-cap connector as the I/O cable is being disconnected. **Stressing the connector may cause the RiverPro/RioPro to flood**.
- Do not over-tighten the locking sleeve on the I/O cable. **The threads can strip**.
- Do not expose the transducer faces to prolonged sunlight. **The urethane faces may develop cracks**. Cover the transducer faces on the RiverPro/RioPro if it will be exposed to sunlight.
- The I/O connector should not be exposed to extended periods of heat or direct sunlight. **The plastic may become brittle.** Cover the connector on the RiverPro/RioPro if it will be exposed to sunlight.
- Do not store the RiverPro/RioPro in temperatures over 60 degrees C. **The urethane faces may be damaged.**
- Do not scratch or damage the O-ring surfaces or grooves. **If scratches or damage exists, they may provide a leakage path and cause the RiverPro/RioPro to flood.** Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support a RiverPro/RioPro by the external I/O cable. **The connector or cable will break.**

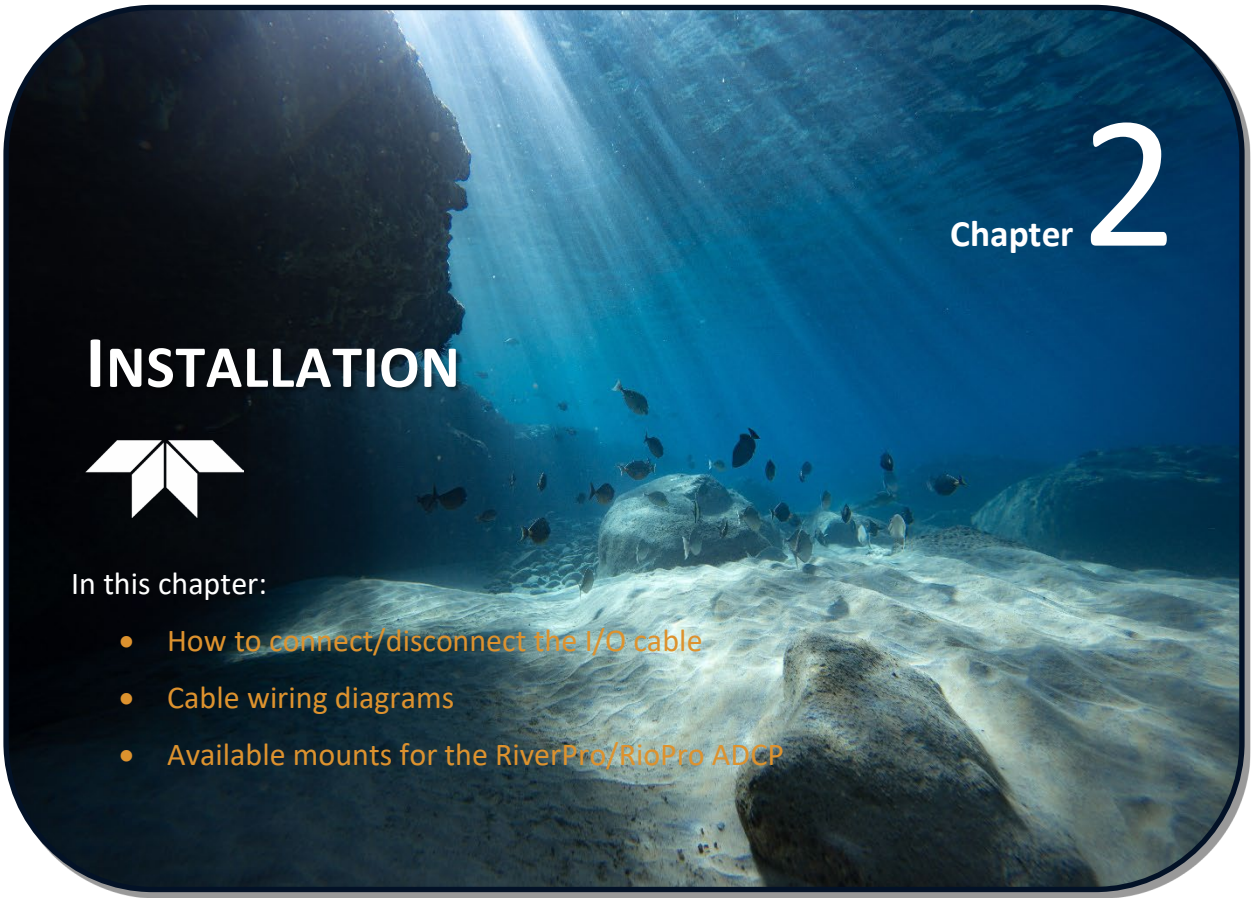
Assembly Guidelines

- Read the Maintenance section for details on RiverPro/RioPro re-assembly. Make sure the housing assembly O-ring stays in the groove when re-assembling the RiverPro/RioPro. Tighten the hardware as specified. **Loose, missing, stripped hardware, or a damaged O-ring can cause the RiverPro/RioPro transducer to flood.**
- The RiverPro/RioPro I/O cable may be connected while slightly wet; **do not connect under water**.

Deployment Guidelines

- Read the WinRiver II Software User's Guide or SxS Pro Software User's Guide. **These guides include tutorials on how to collect data.**
- A compass calibration should be conducted at every new measurement location, and whenever the RiverPro/RioPro mounting or adjacent ancillary equipment is changed or repositioned. **A properly calibrated compass is essential for conducting the Loop Moving Bed test, and for using GPS data as the navigation reference.**
- Avoid using ferro-magnetic materials in the mounting fixtures or near the RiverPro/RioPro. **Ferro-magnetic materials affect the compass.**

NOTES



Chapter 2

INSTALLATION

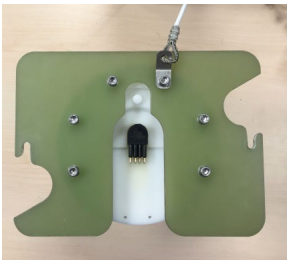
In this chapter:

- How to connect/disconnect the I/O cable
- Cable wiring diagrams
- Available mounts for the RiverPro/RioPro ADCP

Attaching the Mounting Plate

This applies to the RiverPro1200 only.

The mounting plate is in the boat assembly box. Once installed, it can remain installed on the ADCP even while it is in the shipping case.



To attach the mounting plate:

1. Place the RiverPro ADCP on a soft pad to protect the transducer face.
2. Install the mounting plate to the transducer end-cap using the six M6 bolts and washers.
3. Attach the Instrument Safety Cable to one of the forward instrument mounting screws.
4. Tighten the M6 bolts to no more than 10.62 IN-LB (1.20 N.m).

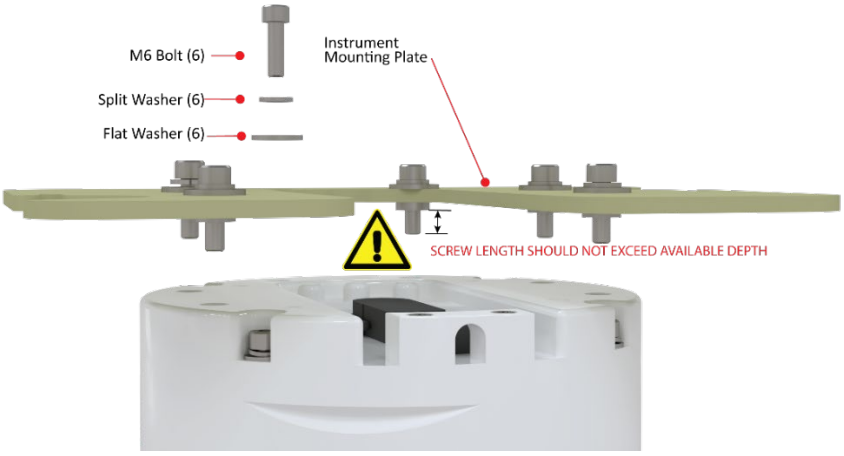
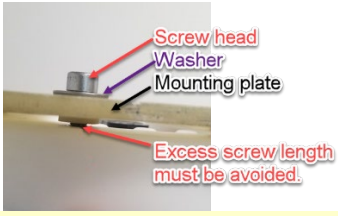


Figure 4. Mounting Plate Installation

Below is an example of a missing split washer which makes the screw too long for the mounting hole.



Use the provided M6X1.0 stainless steel bolts, washers, and split washers in the threaded holes on the End Cap. Spare bolts and washers are included with the spare parts kit.

Tighten the bolts to no more than 1.20 Newton-meters (10.62 LB-IN).

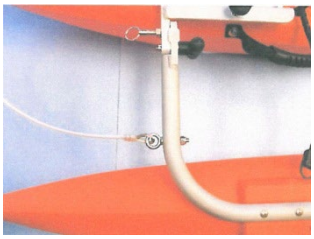
ENSURE THE SCREW LENGTH AFTER THE MOUNTING PLATE AND WASHERS DOES NOT EXCEED THE AVAILABLE DEPTH IN THE ENDCAP. Using longer bolts or high torque risks the 8mm threaded metal inserts on the end-cap being pulled out of the plastic end-cap 12mm deep hole.

Custom Mounting Plates - The thickness of the washers as well as the customer's mounting plate will influence the proper screw length.

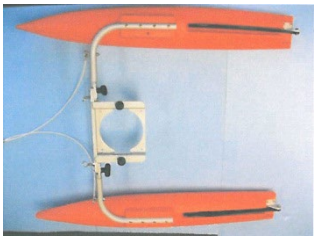
Tethered Boat Assembly

To assemble the boat:

1. Attach the wire rope bridle to the crossbar. Note that there is a top and bottom to the crossbar. Insert the Eye Bolt through each crossbar side as shown.

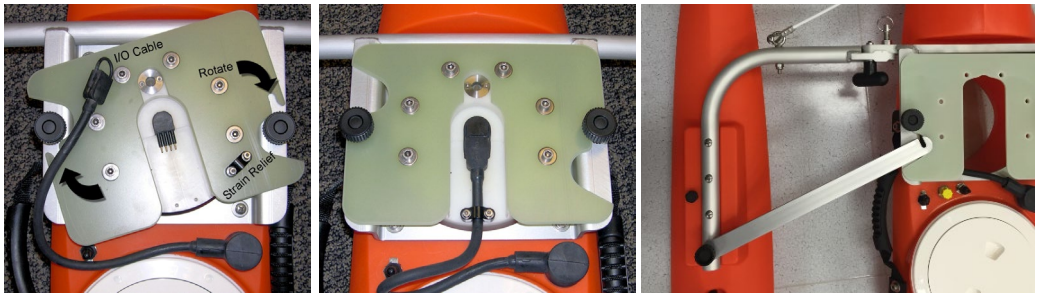


2. Next, attach the outriggers to the crossbar using the M6 x 35mm oval head screws provided.



3. Attach the main hull to the crossbar using the M6 x 16mm pan head screws with lock washer and flat washer as shown, then install the two rosette knob screws into the crossbar.

4. Place the transducer into the boat. Slide the mounting plate until the rosette knob screws are in the slot.



5. Attach the 'RiverPro/RioPro leash' cable from the wire rope bridle to one of the forward mounting plate screws.
6. Attach the support brace using the provided thumbscrews.
7. Tighten the rosette knobs to hold the transducer in place.

8. Connect the power I/O cable to the end-cap connector (see I/O Cable and Dummy Plug).
9. Install the strain relief.

Tethered Boat Battery Connection

The RiverPro boat uses a 12v Lead Acid battery to provide power. The battery should be replaced when the voltage falls below 11 VDC (measure with the cable connected and the power switch on).

Battery replacement can induce both single and double cycle compass errors. The compass must be recalibrated if the battery is replaced.

The battery is not shipped inside the boat. Connect the battery and close the deck plate before deployment.

To connect the battery:

1. Turn the power switch off.
2. Open the circular deck plate by turning it counter-clockwise.
3. Place the battery in the compartment. Use the provided foam blocks to secure the battery inside the compartment.
4. Connect the black flag connector to the battery Negative terminal.
5. Connect the red flag connector to the battery Positive terminal.
6. Check the 4 amp Slo-Blow fuse (size 3AG) is installed in the fuse holder.
7. Close the circular deck plate by turning it clockwise until fully tightened.

I/O Cable and Dummy Plug

The underwater connector (on the end-cap) and the I/O cable and dummy plug are molded wet-mate-able connectors. The end-cap connector is a factory-installed item. TRDI does not recommend removing it for any routine maintenance.

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

To disconnect the cable:

1. Place the RiverPro/RioPro on a soft pad to protect the transducer face. Remove the Strain Relief.
2. Release the retaining strap by pulling it over the connector.
3. Grasp the cable close to the housing (see Figure 5).
4. Pull the cable straight out away from the housing with a gentle rocking motion. Do not apply any upward force on the connector as it is being disconnected.

To connect the cable:

1. Check all pins for signs of corrosion (greenish oxidation or pitting).
2. Use light amounts of silicone lubricant (such as 3M™ Silicone Lubricant (Dry Type) ID No: 62-4678-4930-3) on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone spray from the metal portions of the pins. **Regular lubrication is required**: Apply dry type silicone lubricant prior to each connection.
3. Push the cable straight onto the connector. Attach the Strain Relief.

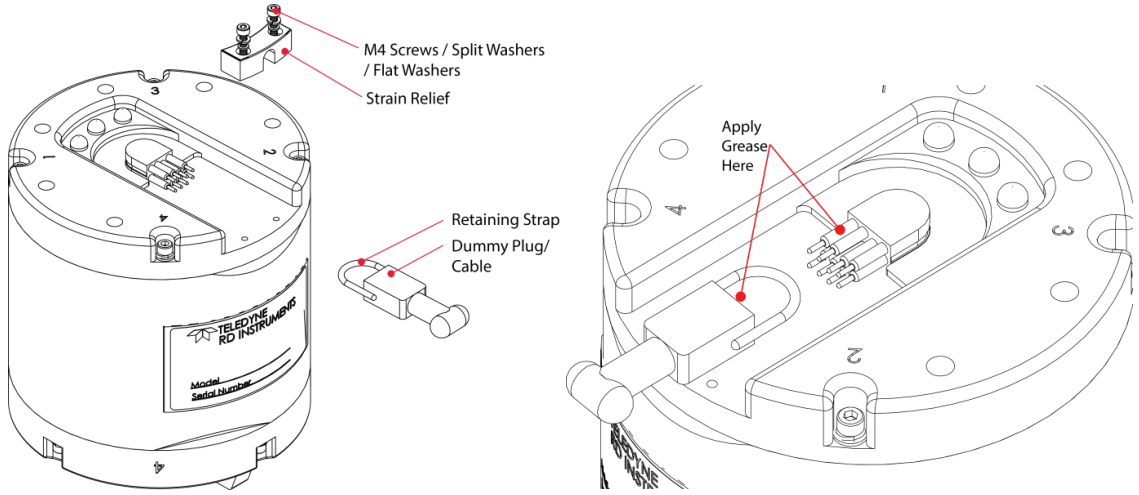


Figure 5. Removing the I/O Cable

Apply silicone lubricant prior to each connection.

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

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

Any damage to the connector's neoprene rubber may cause corrosion on current carrying pins.

Use ONLY silicone-based lubricants. **DO NOT** use petroleum-based lubricants.

When connecting the RiverPro/RioPro I/O cable, do not apply any upward force on the connector as it is being pulled off. Applying an upward angle as the cable is connected puts stress on the end-cap connector. This may cause several serious problems:

1) The end-cap connector or connector pins can crack.

2) The O-ring on the bottom of the end-cap connector can be damaged.

3) The molded urethane on the end-cap connector may separate from the brass insert.

If the end-cap connector is damaged in any of these ways, the RiverPro/RioPro will flood.

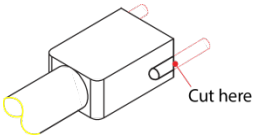
Using the Cable Clips

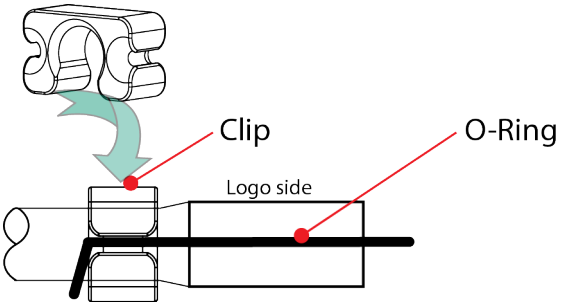
If the retaining strap on the dummy plug or cable breaks, use the cable clips:

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

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

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





75ZK6001-00	Kit, Clip, Cable
75ZK6001-01	Kit, Clip, Dummy Plug

Routing Cables

The Input/Output (I/O) cable connects the RiverPro/RioPro to the computer. TRDI delivers the cable with both connectors attached. The transducer-end connector is molded on, so it can be used below the waterline. The cable is custom-made in lengths specified by the user. Route this cable so:

- The cable can be installed with the connectors attached.
- Avoid sharp bends in cables.
- Cables subjected to vibration or exposed to seawater drag should be adequately clamped to prevent conductor fatigue and ultimate failure.
- Protect the cables with hose if zip-ties are used to secure them to structures (see Figure 6).
- The cable can be easily replaced if it fails.

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

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

Cable Wiring Diagram

This section has information on RiverPro/RioPro cabling. Special user-requests may cause changes to the basic wiring system and may not be shown here.

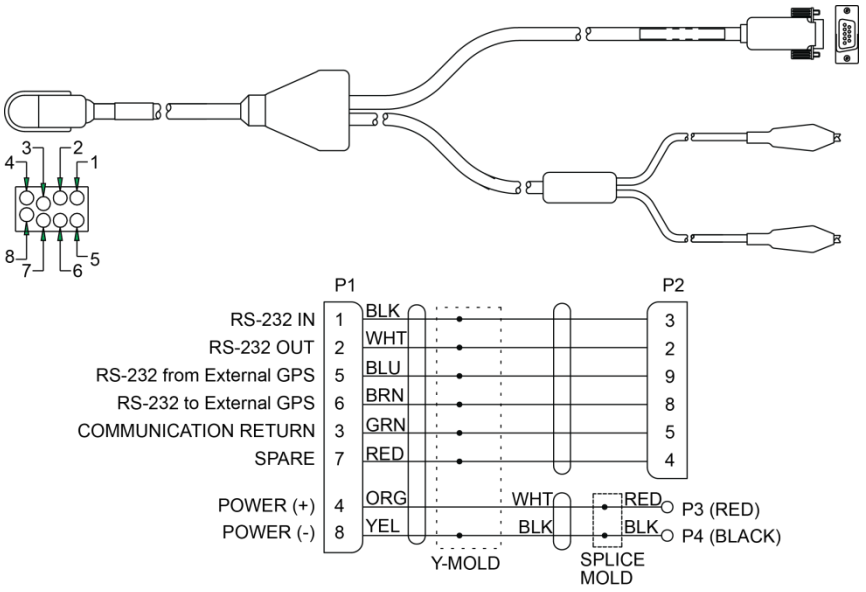


Figure 7. RiverRay/RiverPro/RioPro I/O Cable Wiring

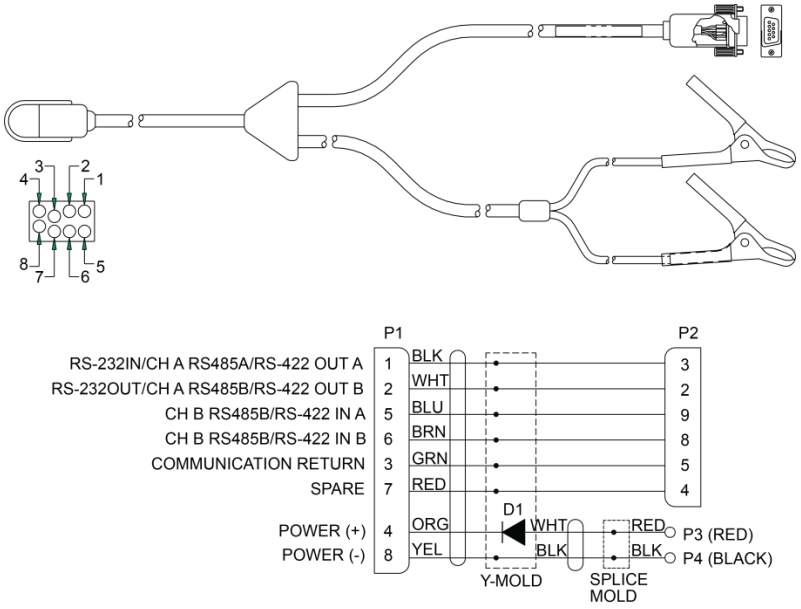


Figure 8. Rio Grande I/O Cable Wiring

Where shown, IN refers to signals going into the RiverPro/RioPro and OUT refers to signals coming out of the RiverPro/RioPro.

If the RiverRay/RiverPro/RioPro cable is not available, a WorkHorse Rio Grande I/O cable can be used. Please note that a 0.7 volt drop in voltage will occur due to the diode installed inside the Rio Grande cable. This protective diode has been added to the RiverPro/RioPro electronics.

Mounting the Instrument

Use the following suggestions when mounting the RiverPro/RioPro ADCP:

- It is desirable to rigidly mount the RiverPro/RioPro to the platform. Avoid the free spinning of the RiverPro/RioPro in this application. The RiverPro/RioPro must stay in the water at all times.
- The RiverPro/RioPro must be mounted deep enough so that turbulence caused by its movement through the water does not allow air bubbles to be attached to the transducer faces.
- Avoid mounting the RiverPro/RioPro near motors and thrusters. They cause air bubbles and will cause bias to the internal compass.
- Avoid mountings that will cause the RiverPro/RioPro to see severe accelerations.

Table 1. Mounting Locations

Mounting Location	Advantages	Disadvantages
Over-the-Side / Side of boat	Easy to deploy Mounts are easy to construct and are adaptable to a variety of boats RiverPro/RioPro draft measurement can be easily obtained	Moderate chance of directional bias in measured discharges with some boats and flows Possibly closer to ferrous metal (engines) or other sources of electromagnetic fields (EMF) Moderate-low risk of damage to RiverPro/RioPro from debris or obstructions in the water Susceptible to roll-induced bias in RiverPro/RioPro depths
Over-the-Side / Bow of boat	Minimizes the chance of directional bias in measured discharges Mounts are relatively easy to construct Usually farther away from ferrous metal (engines) or electromagnetic fields	Increased risk of damage to RiverPro/RioPro from debris or obstructions in the water More difficult to measure RiverPro/RioPro depth Susceptible to pitch-induced bias in RiverPro/RioPro depths, particularly at high speeds or during rough conditions (waves)
In-Hull / Well in center of boat	Protected from debris and obstructions Accurate depth measurements possible Least susceptible to pitch/roll-induced bias in RiverPro/RioPro depths	Often requires special modifications to boat
Tethered mount	Can be deployed from bridges, fixed cableways, or a temporary bank-operated cableway Uses Bluetooth for communications – no cables	Requires waterproof enclosure capable of housing a power supply and wireless radio modem for data telemetry Design of the RiverPro/RioPro mount and the power and communications enclosure should consider the increased drag on the tether that may be experienced if the boat were to flip upside down in the water. Increased chance of losing the RiverPro/RioPro

Over-the-Side Mounting

The over-the-side mount is common if you want the ability to move the RiverPro/RioPro from one platform to another. Make the mount as rigid as possible to limit the amount of pitch and roll applied to the RiverPro/RioPro. Although the tilt sensor can measure a ±70° influence, anything beyond 15° will cause bias to the data that cannot be removed. No matter what mounting style is used, the RiverPro/RioPro must be below the bubble layer. Bubbles will cling to the urethane faces of the RiverPro/RioPro and reduce the range to almost nothing. Usually a mount somewhere aft of amidship is used. A stern mount will cause all sorts of problems due to propeller wake, bubbles, and turbulent water conditions.

The most common over-the-side mounting method for RiverPro/RioPro ADCPs uses a Kentucky Mount style. For more information, see the following:

- http://hydroacoustics.usgs.gov/movingboat/pdfs/KYMount.pdf
- http://hydroacoustics.usgs.gov/movingboat/mbd_deployments.shtml

Our transducer assembly is sturdy, but TRDI did not design it to withstand collisions with all boating objects. TRDI strongly suggests protecting the RiverPro/RioPro if this is a possibility.

Avoid using ferro-magnetic materials in the mounting fixtures or near the RiverPro/RioPro. They affect the compass. Use 316 stainless steel hardware.

See the Outline Installation Drawings for dimensions and weights.

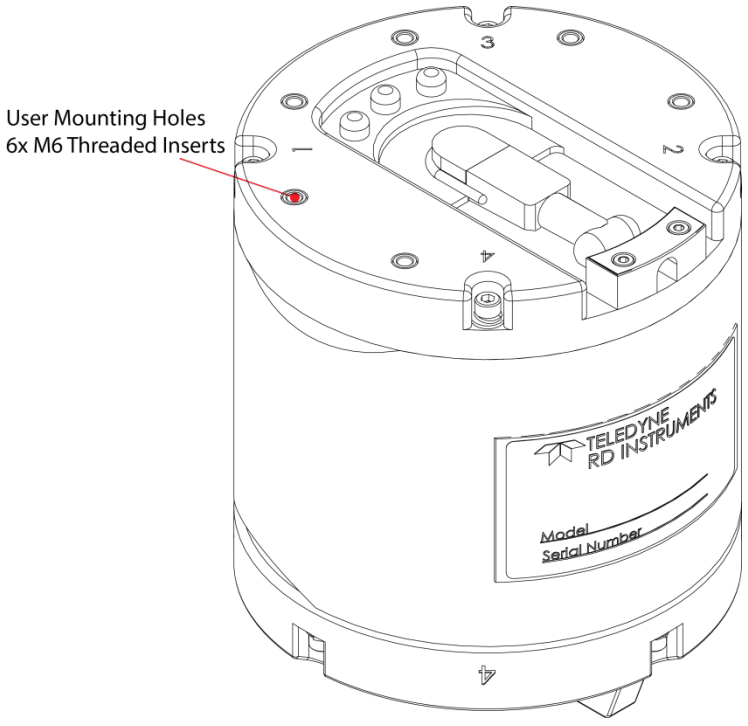


Figure 9. End-Cap User Mounting Holes

Only use M6x1.0 stainless steel hardware.

The maximum thru-hole diameter in the mounting plate is 6.85 mm (0.270 inch). Using a larger thru-hole could result in the threaded metal inserts on the end-cap being pulled out of the plastic end-cap.

In-Hull Mounting

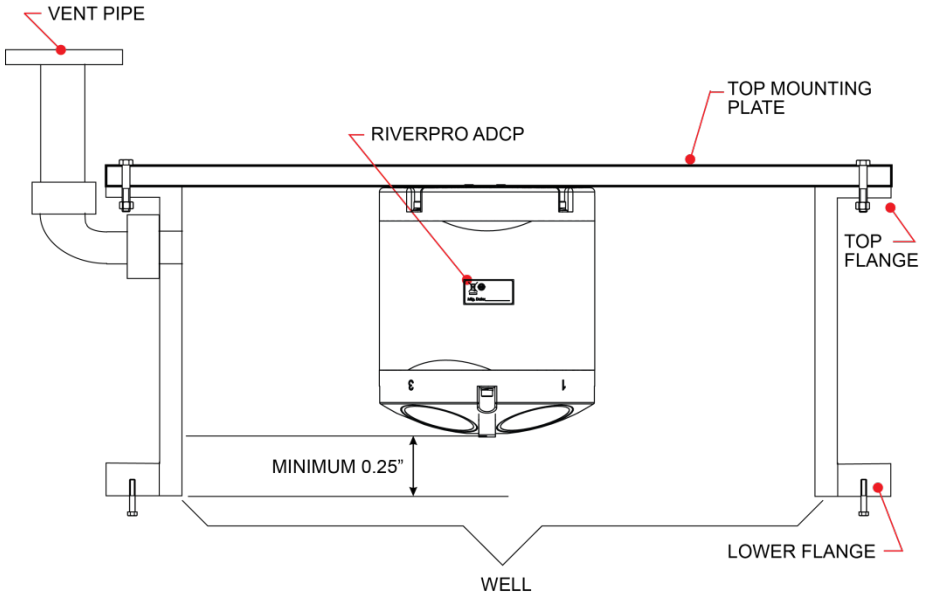
The in-hull mounted RiverPro/RioPro is common when it is intended to keep the system on a single vessel or when over-the-side mounting is not practical for the vessel. For this type of mounting, there are issues of beam clearance and access. Consider several potential problems before deciding where to install the transducer assembly. See the outline installation drawings for specifications on the standard RiverPro/RioPro transducer heads.

Ideally, install the transducer head:

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

Other considerations may be:

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



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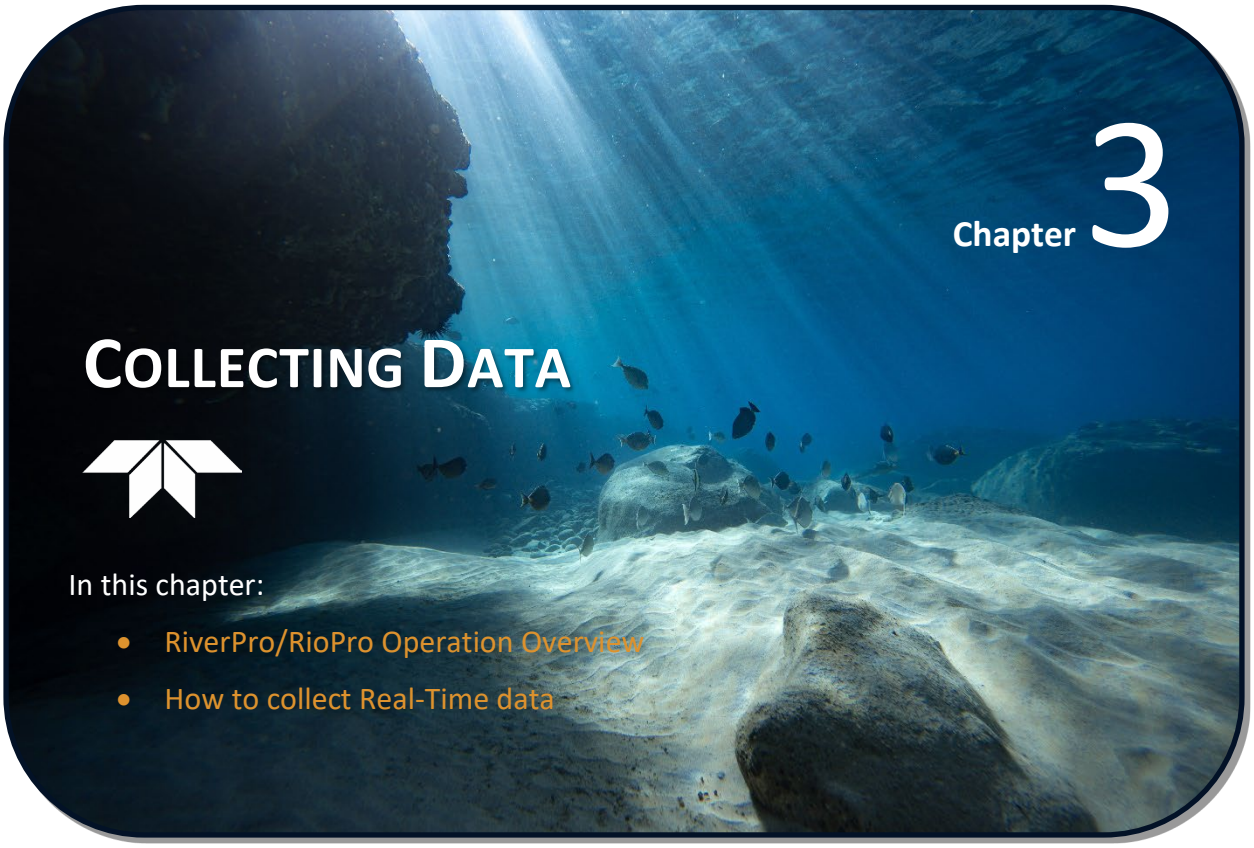


Chapter 3

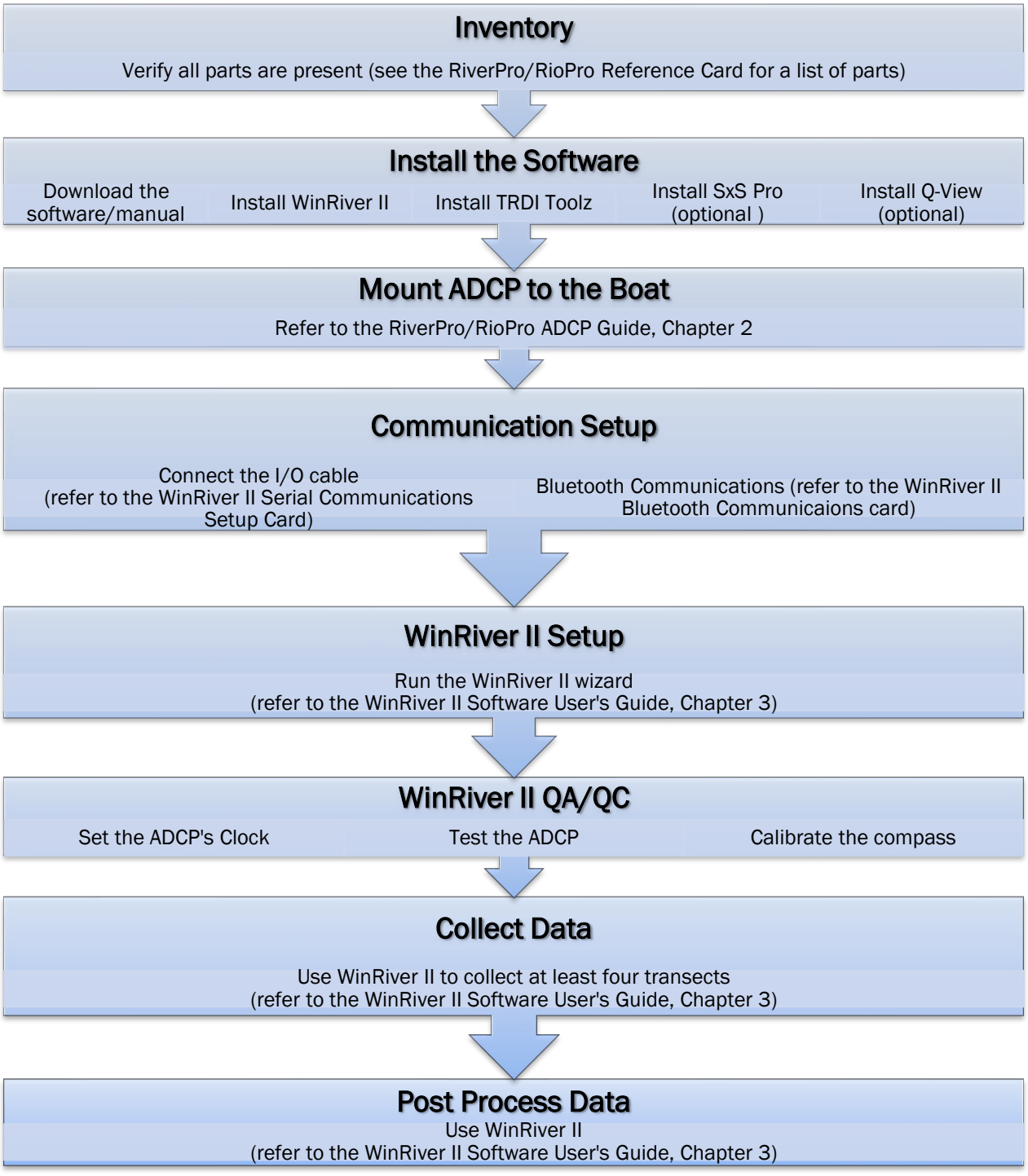
COLLECTING DATA

In this chapter:

- RiverPro/RioPro Operation Overview
- How to collect Real-Time data

RiverPro/RioPro Operation Overview

Use the following figure and description on the next page to collect data with the RiverPro/RioPro:



Glossary

Actors:

- Field Hydrologist/Technician
- Data Analyst Expert (DAE)

Data Collection Terminology:

- Left/Right Bank – The Left bank is defined as the bank that would be on your left side if you were looking downstream.
- Transect – Data collection across the width of the river either from the Left bank to the Right bank or vice versa. (Sometimes referred to as a "Pass" across the river)
- Measurement – A collection (even number) of four or more Transects made of up of an equal number of Transects from Left to Right as Right to Left.
- Measured Discharge – The average of the discharges from the four (or more) transects.

Data Collection Software:

- **WinRiver II** - *WinRiver II* is Teledyne RD Instrument's (TRDI) real-time discharge data collection program for Rio Grande, RiverRay, StreamPro, RiverPro/RioPro and WorkHorse ADCPs.
- **Q-View** - *Q-View* is designed for customers using TRDI's discharge measurement products such as the RiverRay, RiverPro/RioPro, StreamPro, and Rio Grande ADCPs with the *WinRiver II* software to have easy access to an evaluation of the quality of collected data while they are still in the field and back in the office.
- **SxS Pro** - *SxS Pro* is TRDI's stationary ADCP discharge data collection and processing program for Rio Grande, StreamPro, RiverRay, and RiverPro/RioPro ADCP models.

Site/Measurement Conditions:

- Moving Bed/Moving Bottom – Movement downstream (typically) of near bed sediment. Moving Bed conditions will bias bottom-track velocities which assume the streambed is stationary.
- Directional bias – This occurs when the discharges measured for transects from the left bank to the right bank are consistently either greater than or less than discharges measured for transects made from the right bank to the left bank.

Prepare for Discharge Measurement

The Hydrologist arrives at the site with a RiverPro/RioPro and all of the ancillary equipment necessary to perform a discharge measurement.

- **Tethered boat w/ tagline** – The Hydrologist sets up a tagline/pulley system for the tethered boat and then proceeds to install the RiverPro/RioPro in a standard RiverRay boat. Tethered boat measurements can also be performed from a bridge or other structure across the river. This tends to provide reduced control over the tethered boat motion in the water, as the bridle/line length is longer giving the boat more freedom to move with the water currents. Measurements taken from bridges or other structures often encounter greater turbulence in the form of jets and eddies created by the structure or bridge piers.
- **Manned boat** – The RiverPro/RioPro is attached to a Kentucky mount or equivalent mounting method.

If the measurement site is expected to have significant moving bed conditions, the Hydrologist may decide to connect a portable GPS module to the RiverPro/RioPro.

- **Through-ice** – The RiverPro/RioPro is attached to a mounting rod.

The RiverPro/RioPro is connected to a 12V 7AHr gel-cell battery, and it automatically establishes a connection to external devices and begins to acquire a position via its internal GPS. Next, the Hydrologist powers on the laptop, opens the discharge measurement application *WinRiver II* or *SxS Pro* and connects to the RiverPro/RioPro with a wireless connection for a tethered boat or a wired connection using RS-232 for a manned boat.

Measurement Wizard

The Hydrologist selects to start a new measurement within the *WinRiver II* or *SxS Pro* application. Once the Hydrologist enters all of the background information on the site where the measurement will be performed, the software will then automatically detect whether an ADCP is connected and which ADCP product it is.

Run Built-In Tests

The RiverPro/RioPro is commanded to perform a BIT test, and flashes its LED lights to indicate the results of the test. It simultaneously transmits the results of the BIT test, the status of the internal GPS connection and any ancillary devices connected to it to the host computer.

Compass Calibration

Next, the Hydrologist performs a compass calibration. After ensuring that the system is well away from sources of magnetic interference, the Hydrologist starts the compass calibration within the application and then either: slowly rotates the RiverPro/RioPro as suggested by the application (tethered boat/SxS) or slowly drives the boat in circle (manned boat). During the calibration process, feedback is provided to the user as to the quality of the collected magnetic field data at each partition of the 360° of rotation.

Moving Bed Test

At this point the RiverPro/RioPro should be tested and the compass calibration completed; once those steps are complete it is ready to start the moving bed test. The RiverPro/RioPro is placed in the water, and the Hydrologist enters the command to start it pinging within the application.

If the RiverPro/RioPro was left in the hot sun, its temperature can quickly rise to 35° C before use. When initially placed in the water, the thermal mass of the RiverPro/RioPro housing near the temperature sensor initially affects the temperature measurement. Within five minutes it reaches equilibrium and the temperature is accurate within ± 1°C. If the temperature sensor is not allowed to sufficiently equilibrate within the body of water to be measured it can impact Speed Of Sound, velocity, and discharge-measurement accuracy.

Tethered boat – The RiverPro/RioPro is moved to the center of the river, and the stationary moving bed test is started. After five minutes the moving test is stopped, and the application displays the apparent moving bed velocity.

Manned boat – The Hydrologist begins a moving bed loop-test with the boat starting near the river bank. The boat is maneuvered across to the opposite bank and back again. The user stops the test, and the loop test results are displayed.

Either type of moving bed test (stationary or loop) can be performed with either deployment method (tethered boat or manned boat).

Locating the Start and Stop Positions

While the RiverPro/RioPro is pinging, the Hydrologist positions the boat until the application shows that the RiverPro/RioPro is reliably collecting at least two bins of data and marks the position on the tagline for future reference. Measure the distance to the shore from the RiverPro/RioPro. The RiverPro/RioPro is positioned to the opposite bank where two bins of data are reliably collected. Again the tagline is marked and the distance to the shore from the RiverPro/RioPro is measured.

Discharge Measurement

Before starting a discharge measurement with a RiverPro/RioPro ADCP using the moving boat method and *WinRiver II*, the Hydrologist has:

1. Prepared the RiverPro/RioPro, boat, and any external sensors being used
2. Configured the computer, communications link(s), and *WinRiver II* software for data collection using the RiverPro/RioPro and any external sensors
3. Created a measurement file for the site
4. Ran the RiverPro/RioPro Built-In tests
5. Performed the compass calibration procedure
6. Performed a moving bed test

The Hydrologist is now ready to start making the measurement (Moving Boat or Stationary).

Moving Boat Discharge Measurement

A proper moving boat discharge measurement consists of multiple transects – passes across the measurement location from one bank to the other, collecting data continuously as they cross. For each transect, the Hydrologist must maneuver the RiverPro/RioPro to the marked position at one bank of the measurement location (see Locating the Start and Stop Positions) and hold that position while they measure the distance to the shore from the RiverPro/RioPro, start a measurement transect, and enter the starting edge bank and distance into the *WinRiver II* software. After collecting the required number of edge ensembles, the Hydrologist maneuvers the RiverPro/RioPro towards the opposite bank of the measurement location in a smooth and steady manner, collecting data continuously as they travel across the river, and monitoring for data loss and quality issues. When the Hydrologist reaches the marked position at the other bank of the measurement location, they hold that position while they collect the required number of edge ensembles, measure the distance to the bank, end the transect, and enter the ending edge distance in the *WinRiver II* software. After completing each transect, the Hydrologist performs a cursory review of the results and prepares to start the next transect.

The best practice for a moving boat discharge measurement is to collect discharge transects in reciprocal pairs (one transect in each direction across the measurement location) with some minimum number of total transects and/or minimum cumulative total duration for all transects. For locations with steady-state flow conditions all transects should be within some specified percentage of the average discharge (typically 5%), and additional transects and/or cumulative transect duration may be required if that criteria is not met. A minimum of two good water profile bins above the sidelobe cutoff are desired for all ensembles in a transect to enable extrapolation of flow in the unmeasured top and bottom regions of the profile.

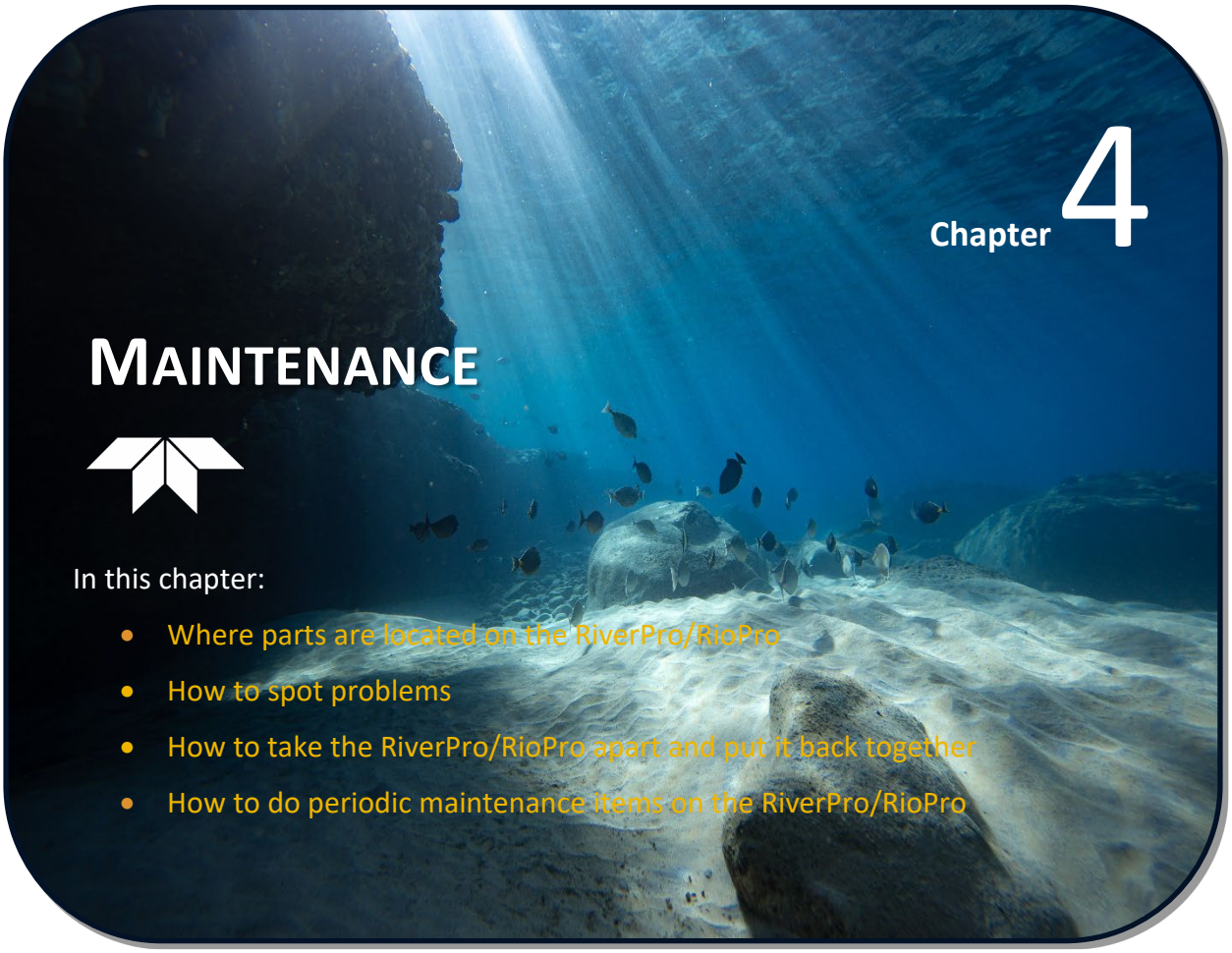
Once sufficient transects have been collected, the Hydrologist/team will perform a QA/QC review of the data. Primary indicators of high RiverPro/RioPro data quality include a minimum loss of Bottom Track depth and velocity data, minimum loss of ensemble and individual bin water profile data, maximization of the measured Q as a percent of total Q, and consistency of the water velocity profile data between bins (vertically) and ensembles (horizontally) across the transect.

Stationary Discharge Measurement

A stationary discharge measurement is made by collecting RiverPro/RioPro data with the *SxS Pro* software while keeping the RiverPro/RioPro stationary at multiple locations across the channel, called verticals. For each location, the Hydrologist must maneuver the RiverPro/RioPro to a suitable position in the cross-section and hold that position while they collect data, typically for a minimum of 40 seconds. For each vertical the Hydrologist must enter the distance to the reference point, the RiverPro/RioPro depth, the water depth source, and a flow correction angle (the angle between the distance measurement line and the flow direction for that location or between the distance measurement line and the beam 3 orientation of the RiverPro/RioPro).

Best practice for an SxS discharge measurement is for the discharge associated with each vertical to not exceed 5% of the total discharge for the measurement for a minimum of 20 verticals in a measurement; but in narrow channels a minimum practical spacing of 10-20 cm between verticals is typically used. A minimum of two (2) good water profile bins above the sidelobe cutoff are desired at each vertical to enable extrapolation of flow in the unmeasured top and bottom regions of the profile. After collecting data at each vertical, the technician will review the results for that vertical with the options of accepting or rejecting the collected data, or in some cases extending the data collection interval. Primary indicators of high RiverPro/RioPro data quality for a vertical are minimum number of bad ensembles, successful measurement of depth, low velocity coefficient of variation and flow direction standard deviation in the data for that vertical, and consistency with data collected at adjacent verticals. Successful bottom track velocity measurement may also be required, depending on the *SxS Pro* processing settings.

Once data has been collected at all desired verticals in the cross-section, the Hydrologist will enter the distance from the reference point to the end bank of the channel and perform a QA/QC review of the data. Primary indicators of high RiverPro/RioPro data quality for the overall measurement are small distances from the banks to the adjacent verticals, consistency of the water velocity profile data between bins (vertically) and verticals (horizontally), and a low overall uncertainty for the measurement.



Chapter 4

MAINTENANCE

In this chapter:

- Where parts are located on the RiverPro/RioPro
- How to spot problems
- How to take the RiverPro/RioPro apart and put it back together
- How to do periodic maintenance items on the RiverPro/RioPro

Parts Location Drawings

This section is a visual overview of the RiverPro/RioPro ADCP. Use the following figures to identify the parts used on the system.

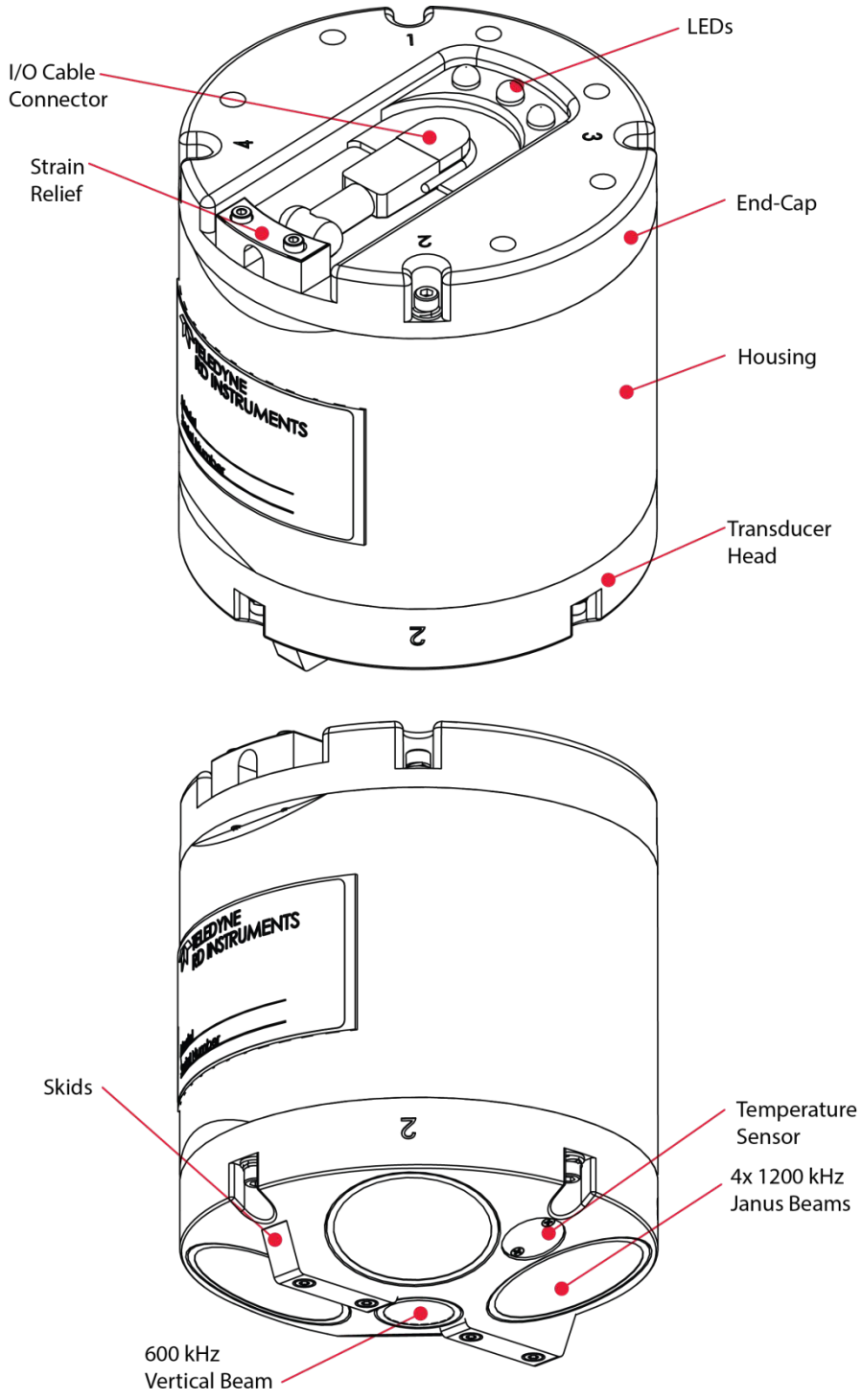


Figure 10. RiverPro 1200 kHz Parts Location

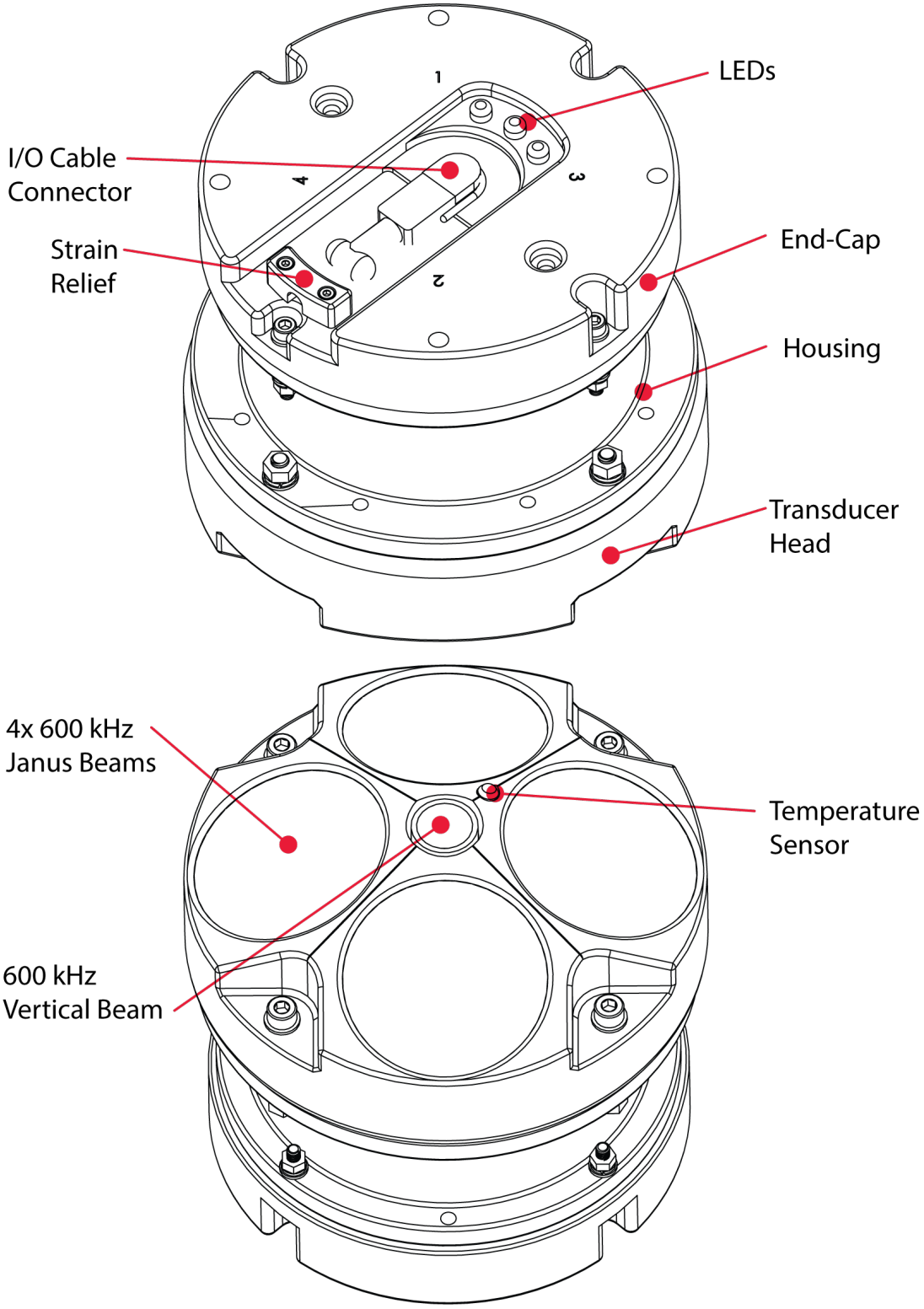


Figure 11. RiverPro 600 kHz Parts Location

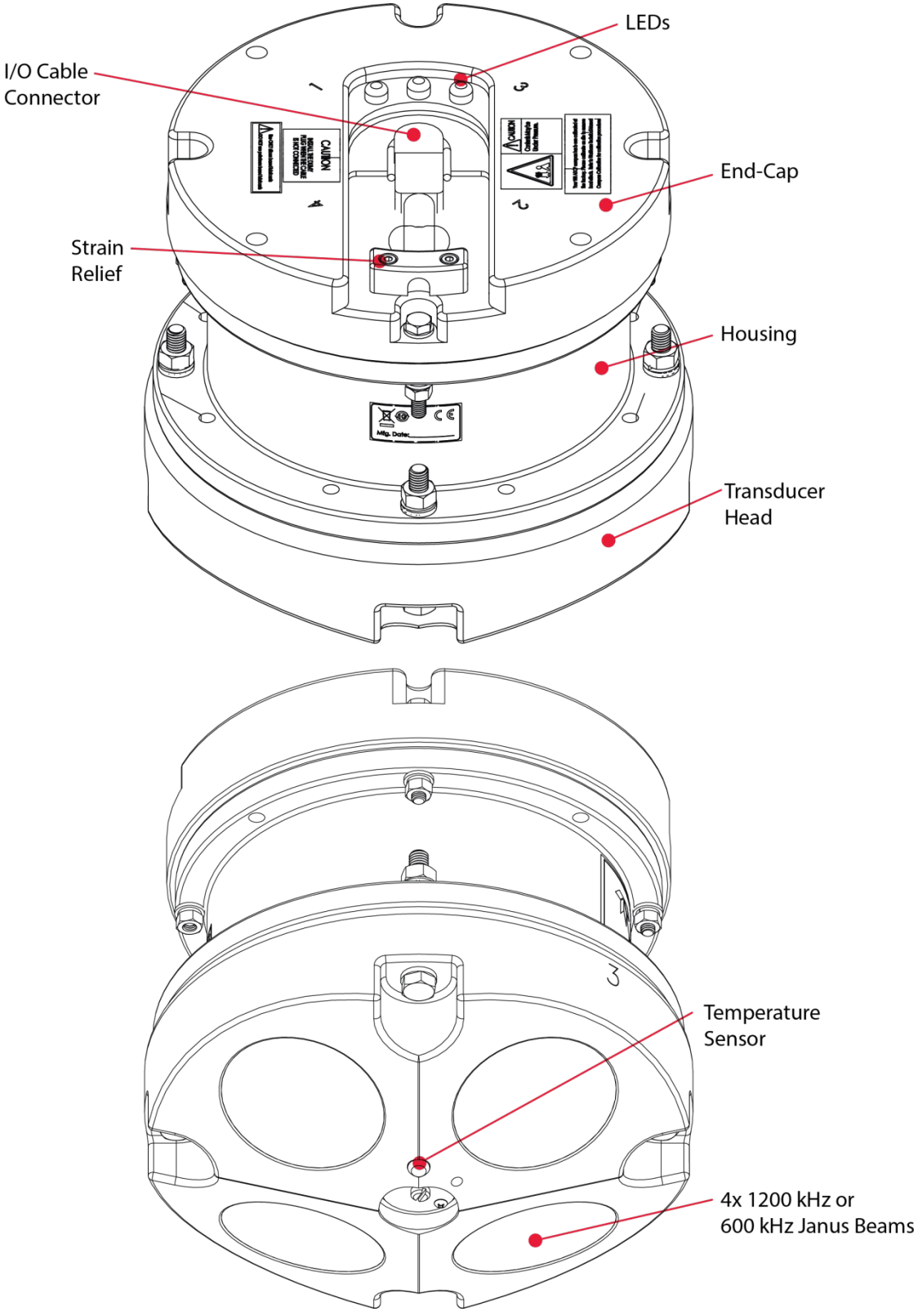


Figure 12. RioPro Parts Location

Maintenance Schedule

To ensure continuous optimal results from the RiverPro/RioPro, TRDI recommends that every RiverPro/RioPro be returned to our factory for an inspection every two to three years. TRDI's customer service will provide the unit with a thorough multi-point inspection and any refurbishment services needed to properly maintain the unit. To learn more about this service, please contact TRDI.

Calibration Items

Use the following calibration schedule:

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

Compass drift effects will accumulate over time. TRDI recommends a factory calibration be done every two to three years. Expect to have more error (due to drift) if a longer period is between factory calibrations.

Maintenance Items

Inspect the RiverPro/RioPro to spot problems:

Item	TRDI Recommended Period
Transducer Beams	The urethane coating is important to RiverPro/RioPro watertight integrity. Many users are not familiar with the early signs of urethane failure. The primary damage to the urethane is from bio-fouling and long exposure to the water and sun. Damage occurs on the surface of the urethane and at the edge where the urethane bonds to the cups. Mishandling, chemicals, abrasive cleaners and excessive depth pressures can also damage the transducer ceramics or urethane coating. Before each deployment, check the urethane coating on the transducer faces for dents, chipping, peeling, urethane shrinkage, hairline cracks and damage that may affect watertight integrity or transducer operation. **Based on experience, TRDI knows that most systems need to have the urethane inspected after three to five years of field use**; shorter periods may be required depending on marine growth.
O-rings	O-rings should be replaced whenever the system is opened and BEFORE they are showing any signs of wear and tear. Replace the end-cap O-ring each time the end-cap is removed. **All O-rings should be replaced every one to two years maximum.**
Housing and End Cap	Inspect for damage and remove biofouling **before each deployment**.
Hardware (bolts, etc.)	Check all bolts, washers and split washers for signs of corrosion before each deployment. **TRDI recommends replacement every one to two years maximum.** Damaged hardware should never be used.
Cables and Connectors	Check the end-cap I/O connector for cracks or bent pins (see Figure 10 and Figure 12) 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. **The I/O cable connectors must be lubricated before every connection.**

Periodic Maintenance Items

These maintenance items should be done prior to using the RiverPro/RioPro.

I/O Cable Connector Lubrication

The I/O connectors require very little maintenance. They are designed to be used in harsh environments and thus limited amounts of dirt and grit do not affect their performance.

Prior to each connection:

1. Use light amounts of silicone lubricant (such as 3M™ Silicone Lubricant (Dry Type) ID No: 62-4678-4930-3) on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone spray from the metal portions of the pins. **Regular lubrication is required**: Apply dry type silicone lubricant prior to each connection. **Use ONLY silicone-based lubricants. DO NOT use petroleum-based lubricants.**
2. After lubricating, fully connect the male and I/O cable female connector in order to spread the lubricant onto the pins and in the sockets. Wipe away any excess lubricant off the outside of the connector.
3. To confirm that the lubricant has been sufficiently applied, disconnect the cable and check for lubricant on all male pins (rubber portion). If the male pins do not have lubricant on them, apply more lubricant and then reconnect the I/O cable.

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

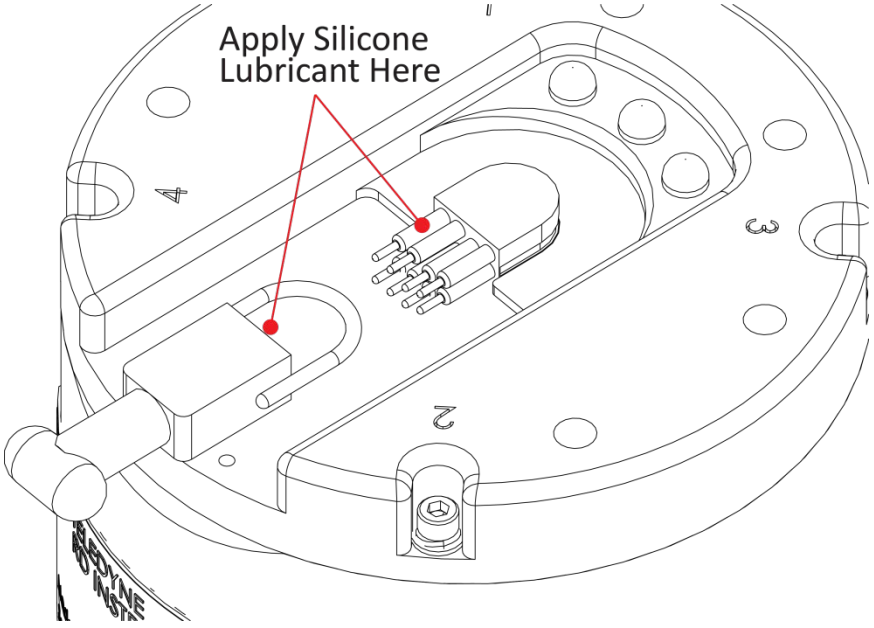


Figure 13. I/O Cable Connector Lubrication

Cleaning the I/O Cable Connectors

After a deployment, clean and remove any accumulated sand or mud from the both the I/O connector on the RiverPro/RioPro and the female socket on the I/O cable.

To clean the connectors:

1. Flush the connector pins and sockets with fresh water (deionized water if available) to remove all dirt, grit, and lubricant.
2. Use a small stiff brush to remove any sand or mud from the connector. Wipe dry using a lint-free wipe.
3. New lubricant must be applied again prior to connecting the dummy plug or cable.

Do NOT use spray-based contact cleaner. The use of some oil-based propellants in spray cans can cause conductivity problems in neoprene.

Cleaning the Temperature Sensor Cover

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

The temperature sensor is embedded in the transducer head (see Figure 10, page 36). The sensor is under a titanium cover that is highly resistant to corrosion.

Removing Biofouling

To remove foreign matter and biofouling:

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

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

If there is heavy fouling or marine growth, the transducer faces may need a thorough cleaning to restore acoustic performance. Barnacles do not usually affect RiverPro/RioPro 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 RiverPro/RioPro to TRDI for repair. If the barnacles cannot be removed without damaging the transducer faces, contact TRDI.

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

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

Final Storage or Shipping Preparation

Store the RiverPro/RioPro in the original shipping crate whenever possible.

1. Remove the battery from the boat and ensure the interior of the boat is dry.
2. Disconnect the I/O cable and remove the transducer from the boat. Place the dummy plug on the transducer cable connector.
3. Dissemble the boat (if required) and place it into its own shipping container.
4. Place the transducer in the foam cutouts in the bottom of the shipping case. The RiverPro transducer will fit into the shipping case with the mounting plate installed. If stored this way, remove the extra foam material that has already been pre-cut from the instrument cavity. This will create a slot in the foam allowing the mounting plate to slide into the case.

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

The dummy plug should be installed any time the I/O cable is removed. Use the dummy plug when the RiverRay transducer is in storage or is being handled.

Do not leave the batteries inside the RiverPro/RioPro boat for extended periods. The batteries may leak, causing damage to the boat. Store the batteries in a cool, dry location (0 to 21 degrees C).

Calibrating the Compass

RiverPro/RioPro compass calibration corrects for distortions in the earth's magnetic fields caused by permanent magnets or ferromagnetic materials near the RiverPro/RioPro. These magnetic field distortions, if left uncorrected, will create errors in the heading data from the RiverPro/RioPro. A compass calibration should be conducted at each measurement location, and whenever the mounting fixture, boat, or ancillary equipment such as batteries or radios are changed or rearranged. Be aware of the following items:

- Compass calibration is especially important when using the RiverPro/RioPro on a manned boat as they often have significant magnetic field distortions from the hull, engine(s), and ancillary equipment. Accurate calibration may not be possible in extreme cases.
- If the mounting fixture or frame has some magnetic field or magnetic permeability, calibrate the RiverPro/RioPro inside the fixture. Depending on the strength and complexity of the fixture's field, the calibration procedure may be able to correct it.
- Ferromagnetic structures such as bridges or sheet piling in the measurement location may interfere with proper compass operation. The compass calibration procedure can NOT correct for heading errors due to these types of structures.

For detailed instructions on calibrating the compass, see the WinRiver II User's Guide.

Calibrating the Compass with WinRiver II

To calibrate the RiverPro/RioPro ADCP compass:

1. On the **Acquire** menu, click **Execute Compass Calibration**.
2. Click the **Calibrate** button.

3. Select **Use Pitch/Roll?**
   - Click **No** if the RiverPro/RioPro will not be subject to pitch and roll (i.e. calm water) (see Figure 14). This calibration requires two rotations (one for calibration and one for verification).
   - Click **Yes** if RiverRay, RiverPro/RioPro, or StreamPro will be subject to pitch and roll (see Figure 15). This calibration requires up to eight rotations (four for calibration and four for verification) while pitching the StreamPro up and down.
4. If needed, click the **Factory Default** button to restore the factory calibration values.

Use the Factory Default button if your compass has problems calibrating or instructed to by TRDI field service.

5. Click the **Start Calibration** button.
6. As you rotate the RiverPro/RioPro, 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(s) are complete, click **OK** on the message box. The calibration error should be less than 2 degrees.

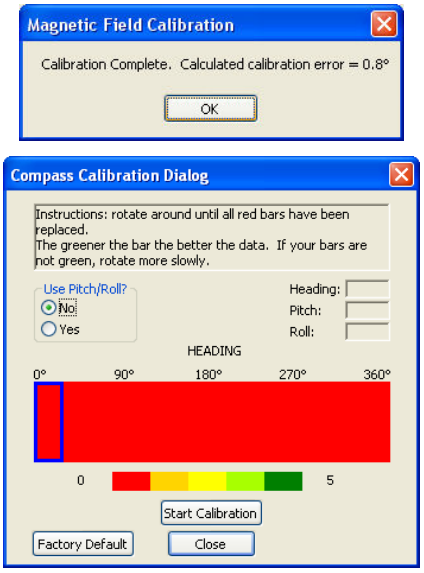


Figure 14. RiverPro/RioPro Compass Calibration Screen

The no Pitch/Roll calibration (also called a single-tilt calibration) requires two rotations while the RiverPro/RioPro is on a flat, level surface.

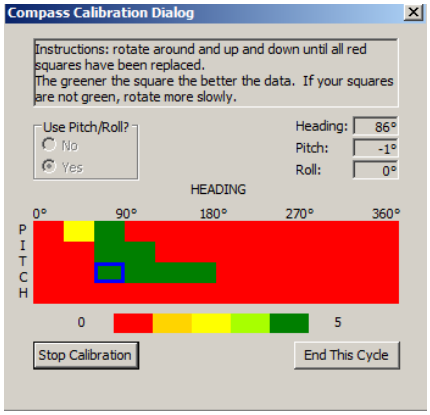


Figure 15. RiverPro/RioPro Compass Calibration Screen – Pitch/Roll

The Pitch/Roll calibration requires eight rotations while pitching the RiverPro/RioPro up and down.

- For the bottom row of squares, pitch the RiverPro/RioPro between -22.5 to -45 degrees.
- For the second row, pitch the RiverPro/RioPro between -22.5 to 0 degrees.
- For the third row, pitch the RiverPro/RioPro between 0 to 22.5 degrees.
- For the top row, pitch the RiverPro/RioPro between 22.5 to 45 degrees.

Each row can be completed during one rotation or you can vary the pitch as you rotate. A good compass calibration requires slow, smooth movement to allow the compass to collect data at each point.

Yearly Maintenance Items

The O-rings, desiccant and hardware should be replaced every one to two years.

Maintenance Kit

Table 2 and Table 3 lists the items in the maintenance kits. These kits are required when the RiverPro /RioPro has been opened. The maintenance kit includes the following tools and spare parts.

The maintenance kits are not included with the RiverPro/RioPro system. They are required to properly close the system.

Order kit number 75BK6032-00 for RiverPro systems.
Order kit number 75BK6072-00 for RioPro and RiverPro600 systems.

Table 2: RiverPro1200 Maintenance Kit

Item #	Part #	Description
1.	DES2	DESICCANT
2.	5020	SILICONE LUBRICANT, 4-PACK
3.	84Z-6000-00	TOOL BAG
4.	972-6001-00	O-RING, BORE, 2-159
5.	972-8044-00	O-RING, FACE, 2-253
6.	M4ALLENDRIVER	M4 BALL WRENCH
7.	M5WASHSPL	SPLIT-WASHER, SST
8.	M5WASHSTD	FLAT WASHER, 10MM OD, SST
9.	M5X0.8X20SHCS	SOCKET HEAD CAP SCREW, 316SS
10.	M5X0.8X30SHCS	SOCKET HEAD CAP SCREW, 316SS
11.	75ZK6001-00	KIT, CLIP, CABLE
12.	75ZK6001-01	KIT, CLIP, DUMMY, PLUG

Table 3: RioPro/RiverPro600 Maintenance Kit

Item #	Part #	Description
1.	5020	SILICONE LUBRICANT, 4-PACK
2.	84Z-6000-00	TOOL BAG, CANVAS
3.	97Z-6052-00	O-RING, 2-260, DURO 70, EPDM
4.	DES3	DESICCANT, SEALED BAG, 2 UN MIL PAK
5.	M10COMBINATIO	WRENCH, 10MM COMB.
6.	M13COMBINATIO	WRENCH, 13MM COMB.
7.	M6WASHSPLTI	WASHER, 6MM SPLIT LOCK TITAN
8.	M6WASHSTDTI	WASHER, FLAT, TITANIUM 12.5MM OD
9.	M6X1.0NUTTI	NUT, HEX, TITANIUM 10MM WIDTH
10.	M6X1.0X45HHTI	SCREW, HEX HD, TITANIUM
11.	M8WASHSPLTI	WASHER, SPLIT LOCK, TITAN
12.	M8WASHSTDTI	WASHER, FLAT, TITANIUM 22.9MM OD
13.	M8X1.25NUTTI	NUT, HEX, TITANIUM 13MM WIDTH
14.	M8X1.25X65HHTI	SCREW, HEX HD, TITANIUM FULL THREADS LENGTH
15.	75ZK6001-00	KIT, CLIP, CABLE
16.	75ZK6001-01	KIT, CLIP, DUMMY, PLUG

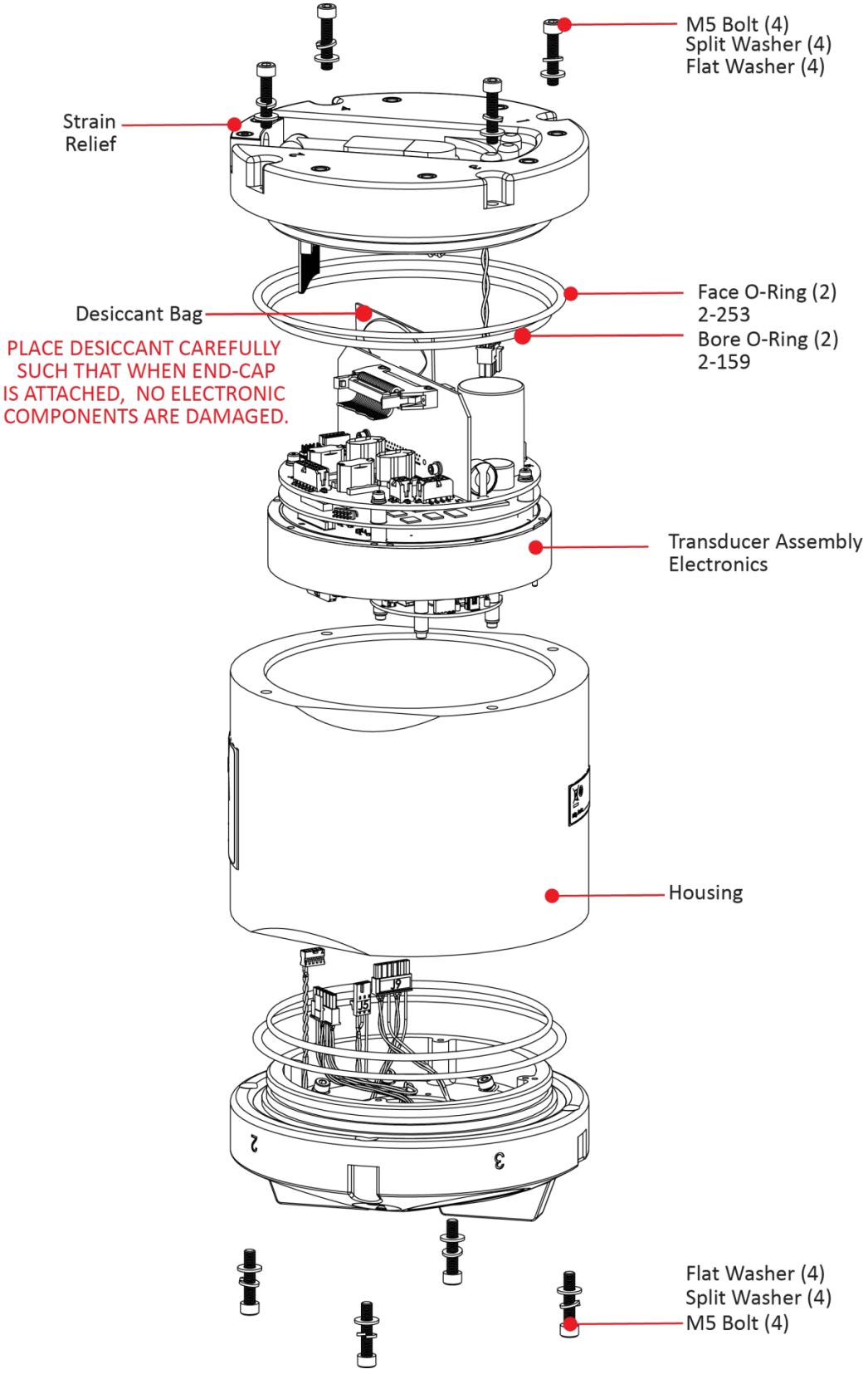


Figure 16. RiverPro Assembly

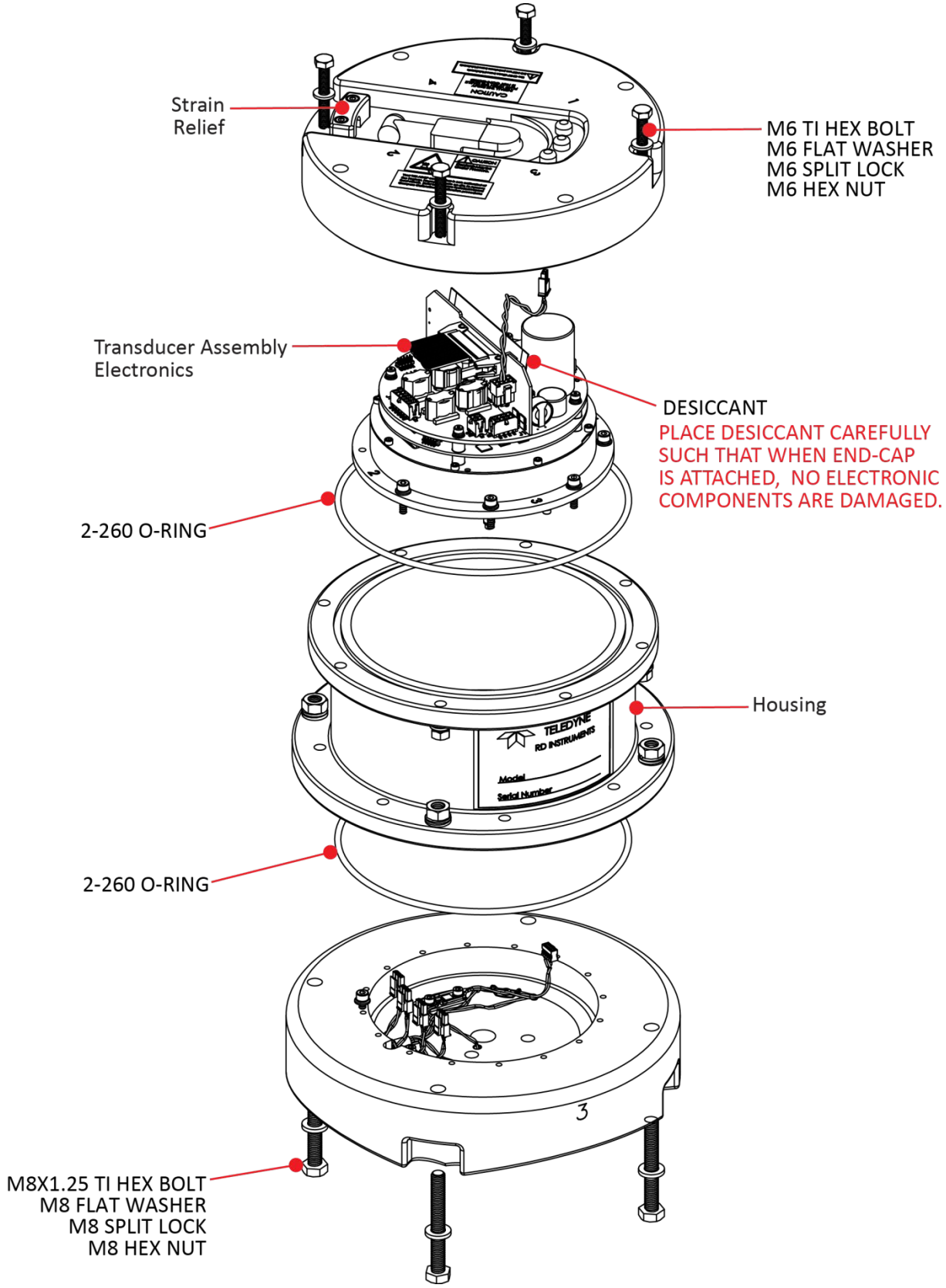


Figure 17. RioPro and RiverPro 600kHz Assembly

End-Cap Removal Procedures

To remove the end-cap:

There are no user replaceable parts in the transducer except for O-Rings and desiccant.

When access to the electronics is required, the end-cap must be removed first to disconnect the ribbon cable and power cable and then remove the housing (see Transducer Head Assembly Removal).The ribbon cable is not long enough to be disconnected when removing the transducer head assembly.

1. Dry the outside of the RiverPro/RioPro.
2. Stand the RiverPro/RioPro on its transducer face on a soft pad.
3. Remove all power to the RiverPro/RioPro.
4. Remove the I/O cable and place the dummy plug on the I/O cable connector (see I/O Cable and Dummy Plug).
5. Inspect the end cap bolts for any signs of damage such as bending, stretched bolts, crushed or deformed bushings, etc. These signs may indicate that there is internal pressure inside the unit.

   If the RiverPro/RioPro flooded, there may be gas under pressure inside the housing. As a precaution, loosen the four end-cap bolts to vent the system.

6. To avoid any possible injury it is ALWAYS recommended to loosen but do not remove the four M5 end-cap bolts and allow any internal pressure to be vented from the system. If the end cap moves as the bolts are loosened, then this may indicate that internal pressure is present. Be sure to only loosen the bolts far enough to allow the system to vent.
7. Once all four end-cap bolts have been loosened and there is no internal pressure, remove the bolts from the end-cap.

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

8. Carefully pull the end-cap away from the housing until access is gained to the internal cable connectors. Use care; the plastic mating surfaces scratch easily. Do not damage the mating surfaces.
9. Disconnect the internal power and I/O ribbon cable connector and the external power cable connector from their jacks. Set the end-cap aside.
10. Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see O-ring Inspection and Replacement). Even small scratches can cause leakage around the O-ring seal.

Transducer Head Assembly Removal

Always remove the end-cap first.

To remove the transducer head:

1. Remove all power to the RiverPro/RioPro.
2. Remove the I/O cable and place the dummy plug on the I/O cable connector (see I/O Cable and Dummy Plug).
3. Remove the end-cap (see End-Cap Removal Procedures).
4. Remove all four transducer head bolts from the transducer head.

5. Set the transducer assembly (transducer face down) on a soft pad. Carefully lift the housing assembly straight up and away from the transducer. Use care; the plastic mating surfaces scratch easily. Do not damage the mating surfaces.
6. Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see O-ring Inspection and Replacement).
7. When ready to re-assemble the RiverPro/RioPro, see RiverPro/RioPro Re-assembly.

RiverPro/RioPro Re-assembly

To replace the end-cap and transducer head, proceed as follows. Use Figure 16 and Figure 17 for parts identification.

- Make sure all printed circuit boards, spacers, cables, and screws have been installed.
- Install one fresh bag of desiccant just before closing the RiverPro/RioPro (see Desiccant Bags).

Desiccant Bags

Desiccant bags are used to dehumidify the housing interior. Desiccant is essential in deployments with plastic housings. Remember that desiccant rapidly absorbs moisture from normal room air. Replace the desiccant bag whenever the RiverPro/RioPro system is opened.

Do not open the desiccant bag. Contact with the silica gel can cause nose, throat, and skin irritation. Do not puncture or tear the desiccant bag. Do not use desiccant bags that are torn or open.

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

To replace the desiccant:

1. Remove the end-cap (see End-Cap Removal Procedures).
2. Remove the new desiccant bag from the airtight aluminum bag.
3. Remove the old desiccant bag and install a new one. Place the desiccant bag as shown in Figure 16 and Figure 17.

Place the desiccant carefully such that when end-cap is attached, no electronic components are damaged.

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

O-ring Inspection and Replacement

This section explains how to inspect/replace the RiverPro/RioPro O-rings. A successful deployment depends on the condition of four O-rings and their retaining grooves. Read all instructions before doing the required actions.

RiverPro

- Transducer and End-cap assembly, face, 2-253
- Transducer and End-cap assembly, bore, 2-159

RioPro and RiverPro600

- Transducer and End-cap assembly, 2-260

TRDI strongly recommend replacing these O-rings whenever the RiverPro/RioPro is disassembled. Inspecting and replacing the O-rings should be the last maintenance task done before sealing the RiverPro/RioPro.

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

To replace/inspect the O-ring:

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

Always use new O-rings. Weak or damaged O-rings will cause the RiverPro/RioPro to flood.

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

Check the O-ring groove thoroughly. Any foreign matter in the O-ring groove will cause the RiverPro/RioPro to flood.

3. If a scratch is on the plastic housing flange O-ring groove, it may be gently sanded using 600-grit (wet) sandpaper. Use care not to cause further damage.
4. Lubricate the O-ring with a thin coat of silicone lubricant. Use as little lubricant as possible - just a sufficient amount to change the color of the O-ring. Apply the lubricant using latex gloves. Do not let loose fibers or lint stick to the O-ring. Fibers can provide a leakage path.

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

Transducer Head Assembly Replacement

Always replace the transducer head prior to replacing the end-cap.

To install the transducer had assembly:

1. Stand the RiverPro/RioPro housing on its end.
2. Inspect, clean, and lubricate the O-ring on the housing (see O-ring Inspection and Replacement). Install the O-rings.

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

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

3. Gently lower the transducer head/electronics assembly into the housing, aligning the mating holes. When mating the housing with the transducer head flange try to apply equal pressure to all parts of the O-ring. Make sure the face O-ring remains in the retaining groove.

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

4. Examine the transducer assembly bolts and washers for corrosion; replace if necessary. Use Figure 16 and Figure 17 for parts identification. All hardware items are needed to seal the RiverPro/RioPro properly.
5. Install all four sets of hardware until “finger tight.”
6. Tighten the bolts in small increments until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value shown in Table 4.

Table 4. Torque Settings

Bolt Size	Torque (pound-inches)	Torque (Newton-meters)
M5X0.8	4.5	0.51
M6X1.0	10.62	1.20
M8X1.25	25.2	2.85

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

Do not over tighten the bolts that hold the transducer, housing, and end cap together. The plastic housing can crack or break if tightened too much. On the other hand, leaving the bolts too loose can cause the system to flood. Tighten the bolts to the recommended torque value shown in Table 4.

End-cap Replacement

Always replace the transducer head first prior to installing the end-cap.

To replace the end-cap:

1. Stand the RiverPro/RioPro on its transducer face on a soft pad.
2. Inspect, clean, and lubricate the O-ring on the housing (see O-ring Inspection and Replacement). Install the O-rings.

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

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

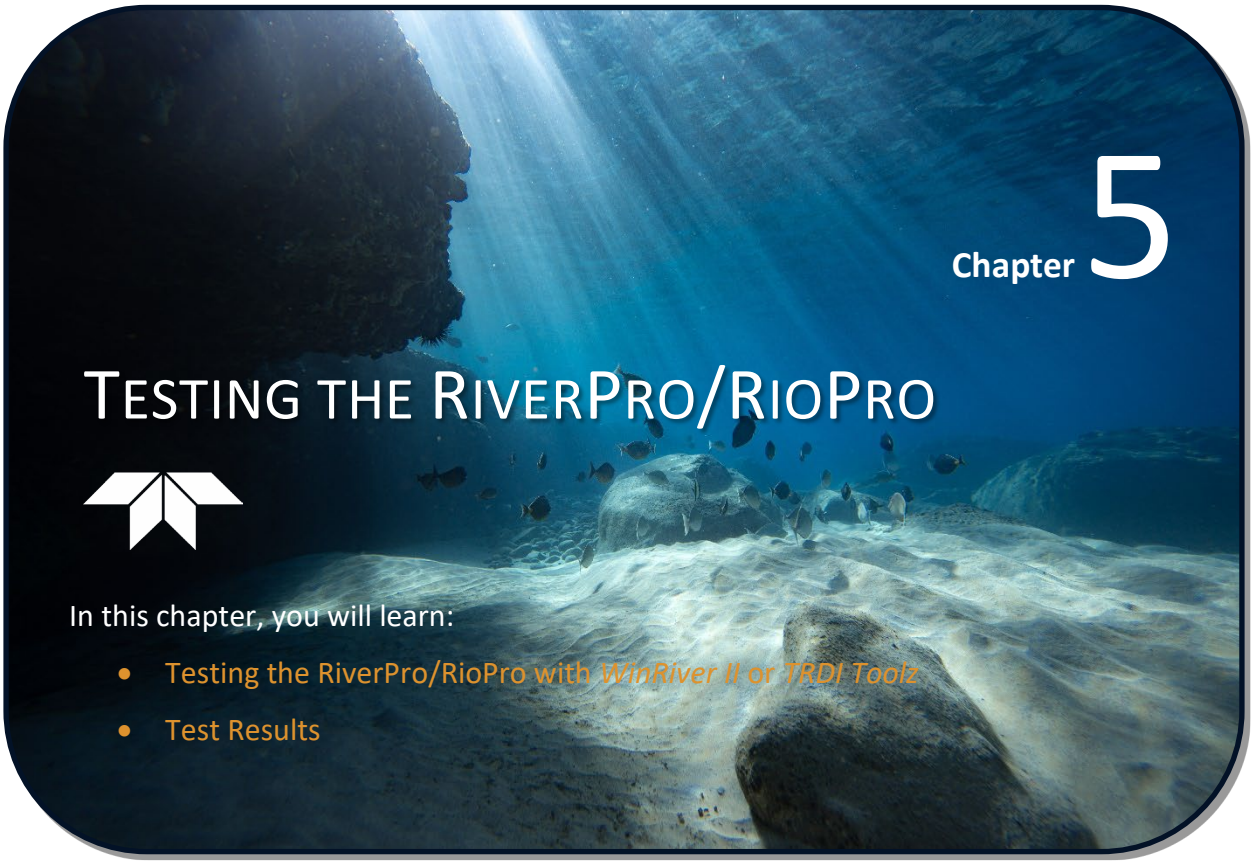
3. Connect the internal power and I/O connector and external power cable connector to their jacks.
4. Place the end-cap on the housing, aligning the mating holes and the beam 3 number embossed on the end-cap with the beam 3 number embossed on the transducer head. When mating the end-cap with the housing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

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

5. Examine the end-cap assembly bolts and washers for corrosion; replace if necessary. Use Figure 16 and Figure 17 for parts identification. All hardware items are needed to seal the RiverPro/RioPro properly.
6. Install all four sets of hardware until “finger-tight.”
7. Tighten the bolts in small increments until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value shown in Table 4.

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

Do not over tighten the bolts that hold the transducer, housing, and end cap together. The plastic housing can crack or break if tightened too much. On the other hand, leaving the bolts too loose can cause the system to flood. Tighten the bolts to the recommended torque value shown in Table 4.



Chapter 5

TESTING THE RIVERPRO/RIOPRO

In this chapter, you will learn:

- Testing the RiverPro/RioPro with *WinRiver II* or *TRDI Toolz*
- Test Results

This chapter explains how to test the RiverPro/RioPro using the *WinRiver II*, *SxS Pro*, and *TRDI Toolz* programs.

Test the RiverPro/RioPro:

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

These test procedures assume all equipment is working. The tests can help isolate problems to a major functional area of the RiverPro/RioPro. For troubleshooting information, see Troubleshooting.

Testing the System using WinRiver II

To test the RiverPro/RioPro using *WinRiver II*:

1. Start *WinRiver II* and establish communications with the RiverPro/RioPro ADCP.

   For help on using *WinRiver II*, see the WinRiver II User's Guide.

2. On the **Acquire** menu, click **Execute ADCP Test** to verify the RiverPro/RioPro is functioning properly. RiverPro/RioPro ADCP tests should be conducted in non-moving or very slow water velocities to obtain the most accurate results.
3. Click **Close** to exit the **ADCP Test** dialog.

   The tests should be run while the RiverPro/RioPro ADCP is in water. Running the test in air will not harm the RiverPro/RioPro, but some tests may fail in air.

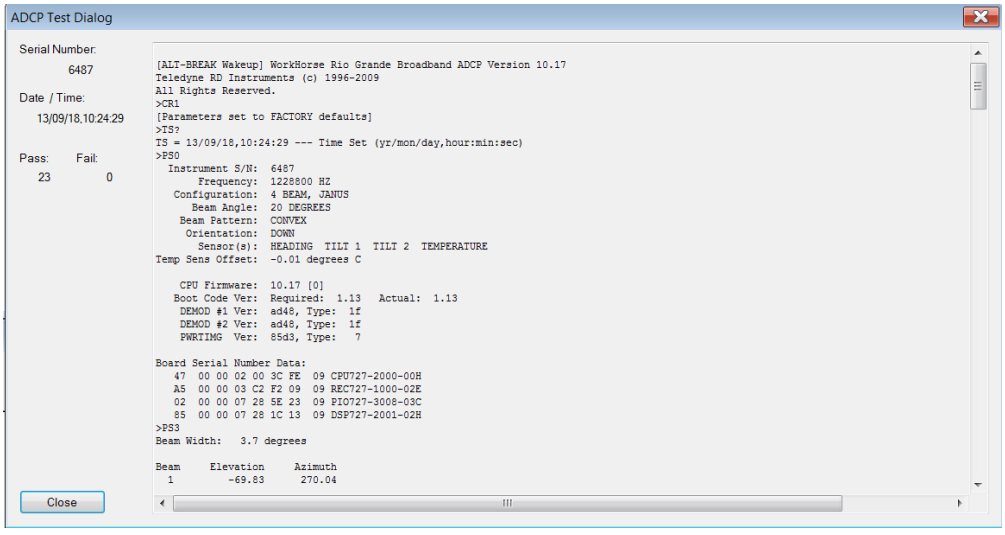


Figure 18. Testing the RiverPro/RioPro using WinRiver II

Testing the System with *SxS Pro*

To test the RiverPro/RioPro using *SxS Pro*:

1. Start *SxS Pro* and establish communications with the RiverPro/RioPro ADCP.

For help on using *SxS Pro*, see the SxS Pro User's Guide.

2. On the **Tests** menu, click **ADCP Tests** to verify the RiverPro/RioPro is functioning properly.
3. Click **Run Tests**.
4. At the end of the test, click the **Stop PC2** button to end the PC2 test. Click **Exit** to exit the **ADCP Tests** dialog.

The tests should be run while the RiverPro/RioPro ADCP is in water. Running the test in air will not harm the RiverPro/RioPro, but some tests may fail in air.

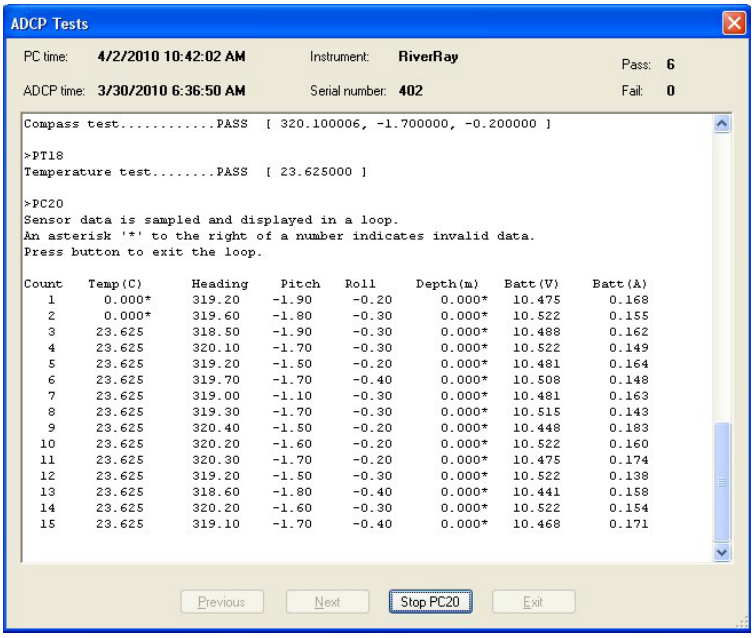


Figure 19. Testing the RiverPro/RioPro using SxS Pro

Testing the System with *TRDI Toolz*

To test the RiverPro/RioPro using *TRDI Toolz*:

1. Interconnect and apply power to the system as described in Setting up the RiverPro/RioPro System.
2. Start the *TRDI Toolz* program.
3. Using *TRDI Toolz*, send the RiverPro/RioPro the following commands: PS0, PS3, PA, and PC2.

For help on using *TRDI Toolz*, see the TRDI Toolz User's Guide.

Test Results

This section shows an example of the test commands.

Display System Parameters

This tells the RiverPro/RioPro to display specific information about the RiverPro/RioPro. For example:

```
>ps0
          System:  RioPro
   Serial Number:  2
       Frequency:  1228800 Hz
Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
   Vertical Beam:  NONE
         Sensors:
             Temperature:   DS18b20 1-Wire
      Heading/Pitch/Roll:        RDI (ISM)
                     GPS:    Internal DGPS


    CPU Firmware:  56.xx  FD0i3
    FPGA Version:7.00.002 [0x7002]

Board Serial Number Data:
BB 00 00 05 0F F9 36 28   DS18B20 TMP SNS
42 00 00 01 A1 12 70 23   XDR717-1150-00B
D6 00 00 01 A5 91 14 23   PIO72B-2201-00A
08 00 00 01 A5 AC 34 23   DSP72B-2212-00C
73 00 00 01 52 D0 C2 23   END72B-2264-01A
86 00 00 01 B8 DD 4A 23   MUX72B-2265-00A
08 00 00 01 B8 F0 29 23   PER72B-2353-05B
8C 00 00 01 A1 58 13 23   RCV72B-2263-02A

>
```

Verify the information is consistent with the configuration of the system. If PS0 does *not* list all of the sensors, there is a problem with either the communications to the transducer or a problem with the receiver board.

Instrument Transformation Matrix

PS3 sends information about the transducer beams. The RiverPro/RioPro uses this information in its coordinate-transformation calculations; for example, the output may look like this:

```
>ps3

Last Save Time: 14/09/26,17:16:41.39
Profiling Beams:         4
Janus Xdcr Type:         Piston
Janus Beam Angle (deg)   20
Janus Beam Freq (Hz)     1228800
Janus Beam Dia (mm)      32
Janus Beam Offset (mm)   0
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

Has V-Beam:        Yes
VBeam Xdcr Type:   Piston
VBeamFreq (Hz)     614400
VBeam Dia (mm)     15
```

```
VBeam Offset (mm) 0
>
```

If the RiverPro/RioPro has beam angle errors, they are reflected in the instrument transformation matrix and the Beam Directional matrix. This matrix, when multiplied by the raw beam data gives currents in the *x*, *y*, *z*, and *e* directions.

Pre-deployment Test

This diagnostic test checks the major RiverPro/RioPro modules and signal paths. The Recorder test counts down from 65536 to 0 as test progresses. If the recorder has data stored in it, the recorder test won't run. To clear the recorder use the ME command. For example, the output may look like this:

```
>pa
RAM test.................PASS
ROM test.................PASS
RTC test.................PASS
UART test................PASS
Compass test.............PASS
Temperature test........PASS
GPS test.................PASS
Recorder test...........PASS
GO

>
```

Display Heading, Pitch, Roll, and Voltage

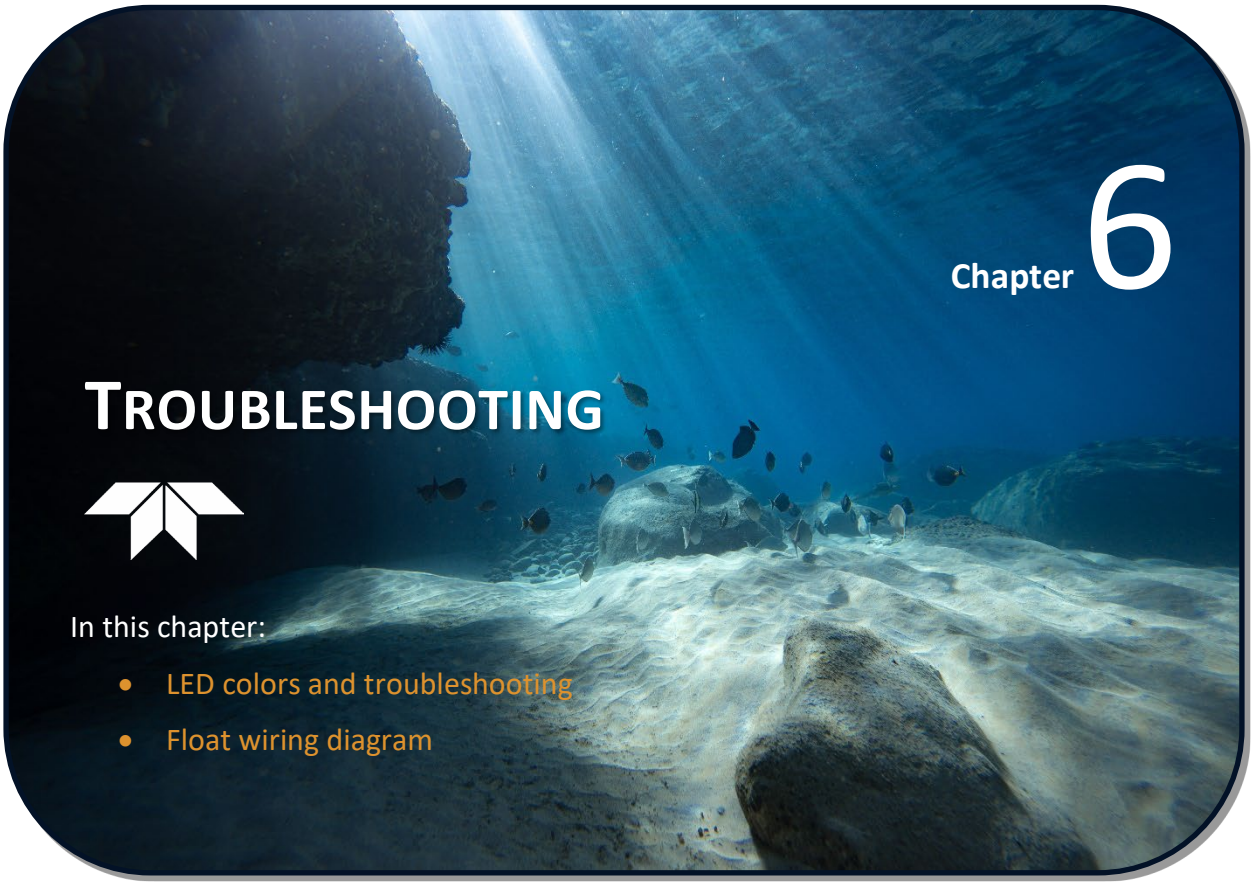
The PC tests displays heading, pitch angle, roll angle, temperature, and voltage in a repeating loop at approximately 0.5-sec update rate. Any key pressed exits this command and returns the user to the command prompt. Sending PC0 will display a help list of the PC commands.

PC2 updates the output without a linefeed. PC20 provides linefeeds with each update.

The Batt(V) battery voltage should be greater than 10.5 volts.

```
>pc0
PC0   = Help
PC2   = Display Sensor Data
PC4   = Display Voltage Monitor ADC Data
PC20  = Display Scrolling Sensor Data
PC40  = Display Scrolling Voltage Monitor Data

>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)
\  9     22.812   340.08    -2.18     1.20     Down    0.000*  11.751   0.156

>
>pc20
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)
   1     22.937   339.86    -2.09     1.26     Down    0.000*  11.757   0.156
   2     22.937   340.11    -2.19     1.21     Down    0.000*  11.757   0.161
   3     23.000   340.26    -2.02     1.26     Down    0.000*  11.737   0.164
   4     23.000   340.40    -2.12     1.20     Down    0.000*  11.757   0.158
   5     22.875   340.19    -1.99     1.26     Down    0.000*  11.757   0.153
```

NOTES



Chapter 6

TROUBLESHOOTING

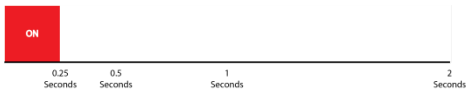
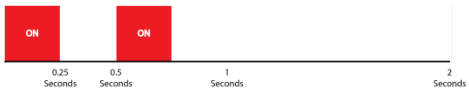
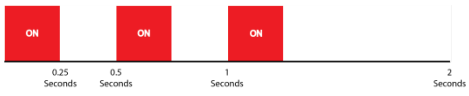
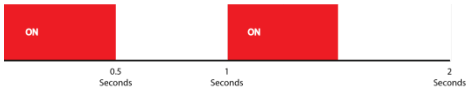
In this chapter:

- LED colors and troubleshooting
- Float wiring diagram

System Status and LED Behavior

The RiverPro/RioPro LED behavior is illustrated in Table 5. The blue LED indicates Bluetooth connection status. The green and red LEDs depict the system status and diagnostic information respectively.

Table 5. LED Behavior

<table>
<tr><th>Condition</th><th>RED</th><th>GREEN</th><th>BLUE</th></tr>
<tr><td>Loading FPGA code</td><td>ON</td><td>ON</td><td rowspan="9">Based on Bluetooth Connect / Pinging</td></tr>
<tr><td>Power Up Self-Test Pass</td><td>OFF</td><td>Two slow blinks then ON
  </td></tr>
<tr><td>System Error: Comms Failure</td><td>One blink every two seconds
  </td><td rowspan="5">Based on Pinging/ Ready/ Standby</td></tr>
<tr><td>System Error: Sensor Failure
**See Note</td><td>Two blinks every two seconds
  </td></tr>
<tr><td>System Error: Bluetooth Failure</td><td>Three blinks every two seconds
  </td></tr>
<tr><td>System Error: Other Failure</td><td>ON</td></tr>
<tr><td>Low Battery</td><td>Slow blinking
  </td></tr>
<tr><td>Ready/Standby</td><td rowspan="3">Based on Battery/ System Error Status</td><td>ON</td><td rowspan="2">Blinks 0.1 sec/ensemble</td></tr>
<tr><td>Pinging</td><td>Blinks 0.1 sec/ensemble</td></tr>
<tr><td>Bluetooth Connect</td><td>based on pinging/ ready/ standby</td><td>ON</td></tr>
</table>

When power is applied and the self-test passes, the Blue and Green LEDs indicate the LAST connection (blue for Bluetooth, green for Serial).

When a NEW connection is established, then the color will match the type of connection.

** Sensor Failure may be due to an internal sensor or an external sensor such as a GPS. The PC2 Built-In test will check internal sensors.

To check external sensors, disconnect the GPS to see if the LED behavior changes. A GPS being used indoors (messages not fully populated), GPS messages not registered in the ADCP, or incorrect baud rate may cause an issue. In *TRDI Toolz*, use the SF menu to check/correct.

Table 6: Troubleshooting the RiverPro/RioPro

Problem / Indication	Possible Solution
LEDs do not light	Check the 12V Lead Acid battery connection. Turn on power switch on tethered boat. Check fuse in boat.
System Error: Red LED on solid or blinking	Send a === (soft break) or use *TRDI Toolz* to wake the RiverPro/RioPro. Cycle power. If this does not help, check 12V Lead Acid battery. System error has been detected. Use *TRDI Toolz* to Test the RiverPro/RioPro. Replace the 12V Lead Acid battery.
Blue LED off	Send a === (soft break) or use *TRDI Toolz* to wake up the RiverPro/RioPro. Try connecting to RiverPro/RioPro using the I/O cable. Replace the 12V Lead Acid battery. Charge the PC battery. Check Bluetooth setup on PC computer.
Bluetooth connection is intermittent	Out of range – The PC must be in a clear line of sight to the RiverPro/RioPro. RiverPro/RioPro internal temperature may be above 50° C. Move the RiverPro/RioPro to a cooler location and attempt to communicate again.

If the system was not powered up for some time, the RTC circuit can be discharged. When power is first applied, it will indicate a System Error (red LED on). Leave the power on for several minutes to charge the capacitor and then cycle power to clear the error.

Verify the RTC clock is set by sending the T? command:

```
>t?
Available Commands:
TE 00:00:00.00 ---------- Time Between Ensembles
TF --/--/--,--:--:-- ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TP 00:00.00 ------------- Time Between Pings
TS 00/01/01,00:05:15.83 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
T? ---------------------- Display T-Command Menu
>
```

If the system date/time is not correct, use the TS command or application software to set the time.

Fuse Replacement

There is one fuse in the tethered boat that protects the RiverPro/RioPro from excessive incoming power. If this fuse continues to blow, check the battery and wiring harness before applying power again.

To replace the fuse:

1. Turn off the power.
2. Open the battery deck plate cover.
3. The fuse is located on the red power cable.
4. Gently pull the fuse housing apart.
5. Check the fuse using an ohmmeter. Replace the fuse if necessary with a 4 amp Slo-Blow fuse (size 3AG).

Boat Wiring Diagram

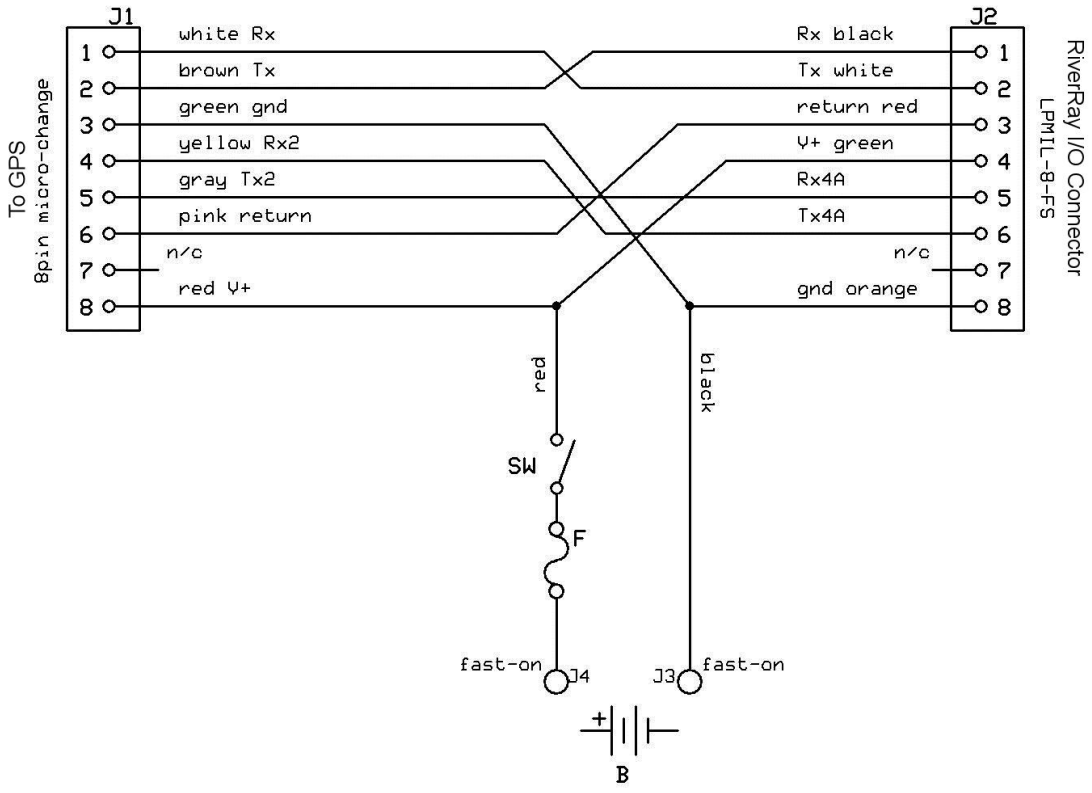


Figure 20. RiverRay/RiverPro/RioPro Boat Wiring Diagram

Table 7: RiverRay/RiverPro/RioPro Boat Wiring

To GPS (J1)			RiverRay I/O Connector (J2)	
8pin micro/change			LPMIL-8-FS Connector	
Pin Number	Function		Function	Pin Number
1	Rx	←	Tx	2
2	Tx	→	Rx	1
3	Gnd	↔	Gnd	8
4	Rx2	←	Tx4A	6
5	Tx2	→	Rx4A	5
6	Coms Return	↔	Coms Return	3
7	n/c		n/c	7
8	V+	↔	V+	4

Chapter 7

RETURNING SYSTEMS TO TRDI FOR SERVICE

In this chapter:

- How to pack and ship the RiverPro/RioPro
- How to get a RMA number
- Where to send your RiverPro/RioPro for repair

Shipping the RiverPro/RioPro

This section explains how to ship the RiverPro/RioPro ADCP.

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

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

TRDI strongly recommends using the original shipping crate whenever transporting the RiverPro/RioPro ADCP.

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

For repackaging with commercially available materials:

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

Returning Systems to the TRDI Factory

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

Step 1 - Request a Return Material Authorization

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

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

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

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What issue(s) need to be corrected

- Name of the Field Service Engineer that knows about the issue
- When you need the instrument returned

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship via air freight, prepaid

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

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

Mark the Package(s)

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

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

Step 4 - Urgent shipments

Send the following information by telephone to TRDI.

Attention: Customer Service Administration

Phone: +1 (858) 842-2700

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

Returning Systems to TRDI Europe Factory

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

Step 1 - Request a Return Material Authorization

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

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

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship Via Air Freight, Prepaid

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

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

Mark the package(s) as follows:

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

Step 4 - Include Proper Customs Documentation

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

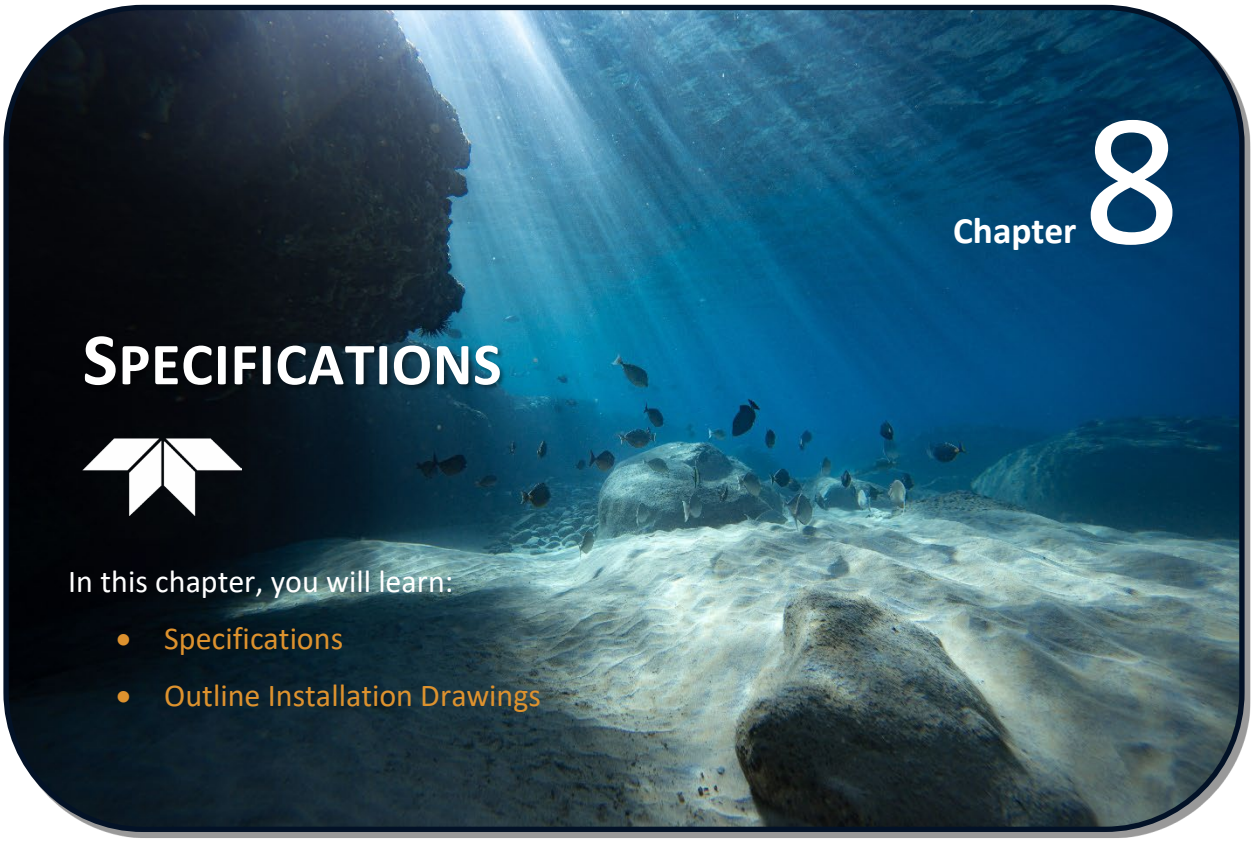
- Contents of the shipment
- Value
- Purpose of shipment (example: "American made goods returned for repair")
- Any discrepancy or inaccuracy in the Customs statement could cause the shipment to be delayed in Customs.

Step 5 - Send the Following Information by Telephone to TRDI

Attention: Sales Administration

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

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



Chapter 8

SPECIFICATIONS

In this chapter, you will learn:

- Specifications
- Outline Installation Drawings

A brief review of RiverPro/RioPro operation may help clarify the specifications listed in this section.

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

The RiverPro/RioPro sends acoustic pulses into the water, samples the return signal, and determines water velocity by the Doppler shift of the signal. The key parameters used in this measurement are:

- The transmitted signal frequency
- The ideal correlation point (transmit lag) of the transmitted signal
- The angle of the RiverPro/RioPro beams, relative to vertical (Janus angle)
- The speed of sound in the water

The transmitted signal frequency is produced by digital circuitry, which is controlled by a very stable, high precision crystal oscillator. No initial factory tuning, or calibration is needed, and the signal remains stable over time due to the stability of the oscillator itself.

Similarly, the transmit lag is produced by the same digital circuitry and is stable for the same reasons as the transmit frequency.

The angle of the RiverPro/RioPro beams is another key parameter in the velocity measurement. The beam angles factor directly into the velocity calculations, so these angles are measured and calibrated at the factory.

The speed of sound in the water is another factor that linearly contributes to the RiverPro/RioPro velocity calculation. This parameter can be provided to the RiverPro/RioPro by an external source, provided as *a priori* information to the instrument, or calculated in real-time by the instrument itself. In the latter case, the speed of sound is calculated from the measured water temperature and the (*a priori* provided) salinity. So, the accuracy of this speed-of-sound is dependent on the accuracy of the temperature measurement. The RiverPro/RioPro use a digital temperature sensor which is based on silicon bandgap technology. This sensor does not require any initial calibration and is very stable over time, so no periodic recalibration is necessary.

Summary

The majority of parameters used in the RiverPro/RioPro measurement are digitally controlled and governed by circuitry that is very stable over time. The other parameters of importance are speed-of-sound and beam angle. The speed of sound accuracy ultimately traces to a silicon device, based on highly stable technology, which does not need re-calibration. The end result is that, once the RiverPro/RioPro has undergone its original factory calibration, its measurements should remain within specification for the lifetime of the device.

Table 8: RiverPro1200/RiverPro600/RioPro1200 Specifications

Water Velocity Profiling	1200 kHz	600 kHz
Operation mode	Broadband / pulse coherent; automatic / manual	
Velocity range	±5m/s default, ±20m/s max	
Profiling range	12cm (see note 1) to 25m (see note 2)	54cm (see note 1) to 110m (see note 2)
Accuracy	±0.25% of water velocity relative to RiverPro/RioPro, ±2mm/s	
Resolution	1mm/s	
Number of cells	15-30 typical, 200 maximum	
Cell size	2cm to 5m	5cm to 5m
Data output rate	1-2Hz (typical)	
Bottom Tracking	**1200 kHz**	**600 kHz**
Operation mode	Broadband	
Velocity range	±9m/s	
Depth range	15cm to 35m (see note 2)	30cm to 100m (see note 2)
Accuracy	±0.25% of bottom velocity relative to RiverPro/RioPro, ±2mm/s	
Resolution	1mm/s	
Slant Beams Depth Measurement	**1200 kHz**	**600 kHz**
Range	15cm to 35m (see note 2)	30cm to 100m (see note 2)
Accuracy	±1% (see notes 3, 4)	
Resolution	1mm	
Vertical Beam Depth Measurement	**1200 kHz**	**600 kHz**
Range	120m (see note 2)	
Accuracy	±1% (see note 4)	
Resolution	1mm	
Transducer and Hardware	**1200 kHz**	**600 kHz**
System frequency	1228.8kHz / 614.4 kHz (vertical beam)	614.4 kHz / 614.4 kHz (vertical beam)
Beam angle	20°	
Beam Width	2° (see note 8)	
Configuration	4 piston transducers, Janus arrangement/1 vertically oriented transducer (RiverPro only)	
Internal memory	16 MB internal recorder	
Communications	Serial port RS-232 binary output at 1200 to 115,200 baud. Bluetooth binary output at 115,200 baud. Range up to 200m. Optional Radio modem, range >30km (line of sight)	
Environmental	**1200 kHz**	**600 kHz**
Standard depth rating	The RiverPro/RioPro is intended to be operated as a surface mounted system only. No depth rating is provided.	
Operating temperature	-5° to 45°C	
Storage temperature	-20° C to 50° C	

Table 8: RiverPro1200/RiverPro600/RioPro1200 Specifications

Power	1200 kHz	600 kHz
Battery (inside boat)	12V, 7A-hr lead acid gel cell	
RiverPro/RioPro DC Input	10.5 to 18 VDC	
Power consumption	1.5W typical	
Battery capacity	> 40 hours continuous operation	
Standard Sensors	**1200 kHz**	**600 kHz**
Temperature (mounted on transducer)		
Range:	-5° to 45° C	
Accuracy:	± 0.5° C	
Resolution:	0.06°	
Tilt (ISM)		
Range:	±90°	
Accuracy:	0.3° for combined tilt < ±70°	
Resolution:	0.06°	
Compass (includes field calibration feature)		
Range:	0 to 360°	
Accuracy:	±1° (see note 5)	
Resolution:	0.1°	
Maximum tilt:	± 70°	
GPS (Embedded)		
Horizontal position accuracy:	3m (see note 6)	
Velocity accuracy:	5cm/s (see note 7)	

1. Distance measured from the center of the first cell to the transducer surface
2. Assumes fresh water, actual range depends on temperature and suspended solids concentration
3. For beam-averaged depth data
4. Assumes uniform water temperature and salinity profile
5. For combined tilt <+/-70° and dip angle <70°
6. CEP, 50%, 24 hours static, -130 dBm, > 6 SVs
7. 50% @ 30 m/s
8. The -3dB beam width (opening angle) for the slant beams for RiverPro 600/1200 is ~2 degrees
   RiverPro beams are orthogonal in plan and inclined 20 degrees off vertical
   The -3dB beam width (opening angle) for the vertical beam on RiverPro 1200 is 9 degrees

Outline Installation Drawing

The following drawings show the standard RiverPro/RioPro dimensions and weights.

Table 9: Outline Installation Drawings

Description	Drawing #
1200 kHz RiverPro	96B-6060
600 kHz RiverPro	96B-6067
1200 kHz RioPro	967-6150

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

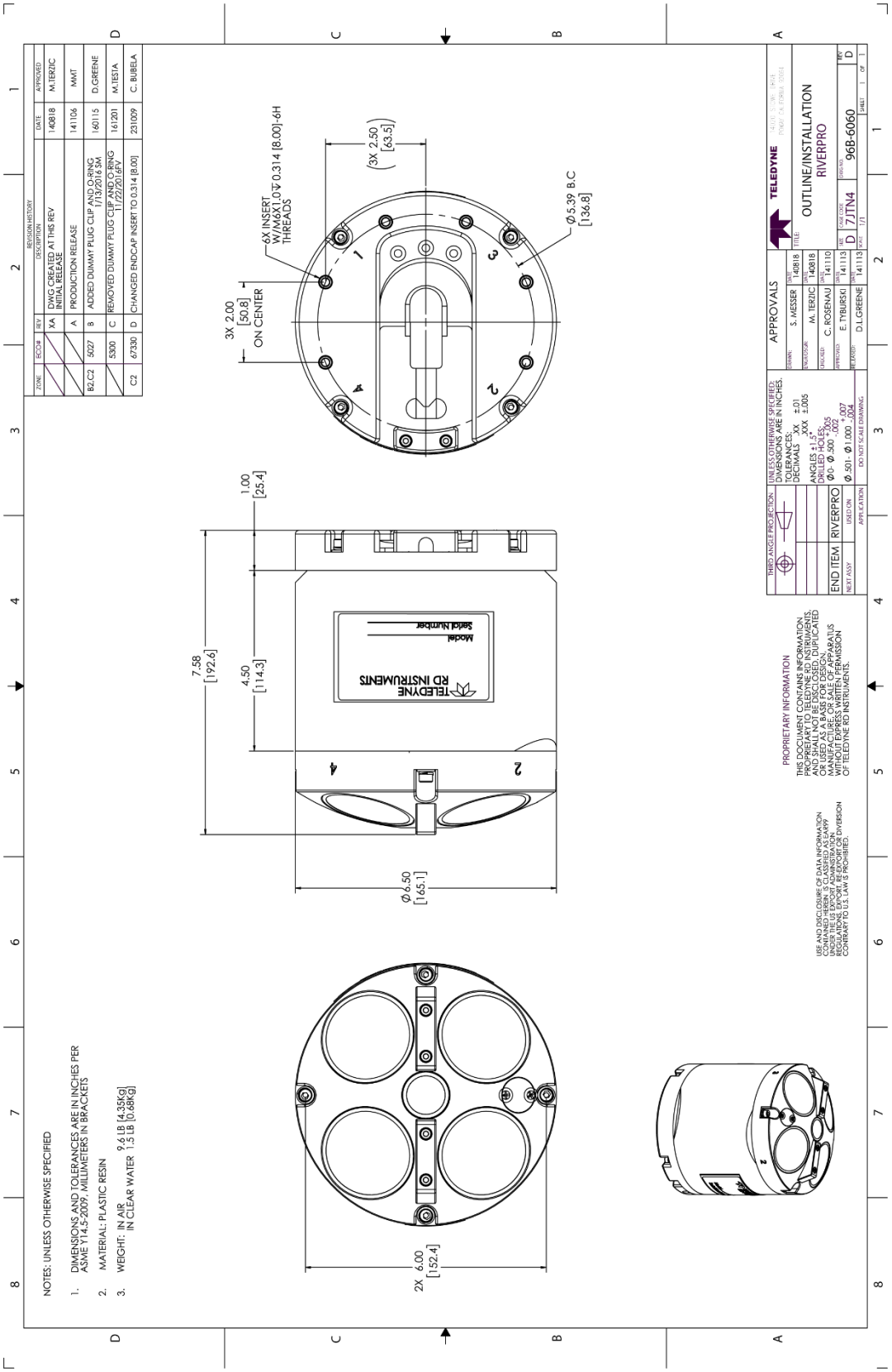


Figure 21. 96B-6060 RiverPro 1200 kHz Outline Installation Drawing

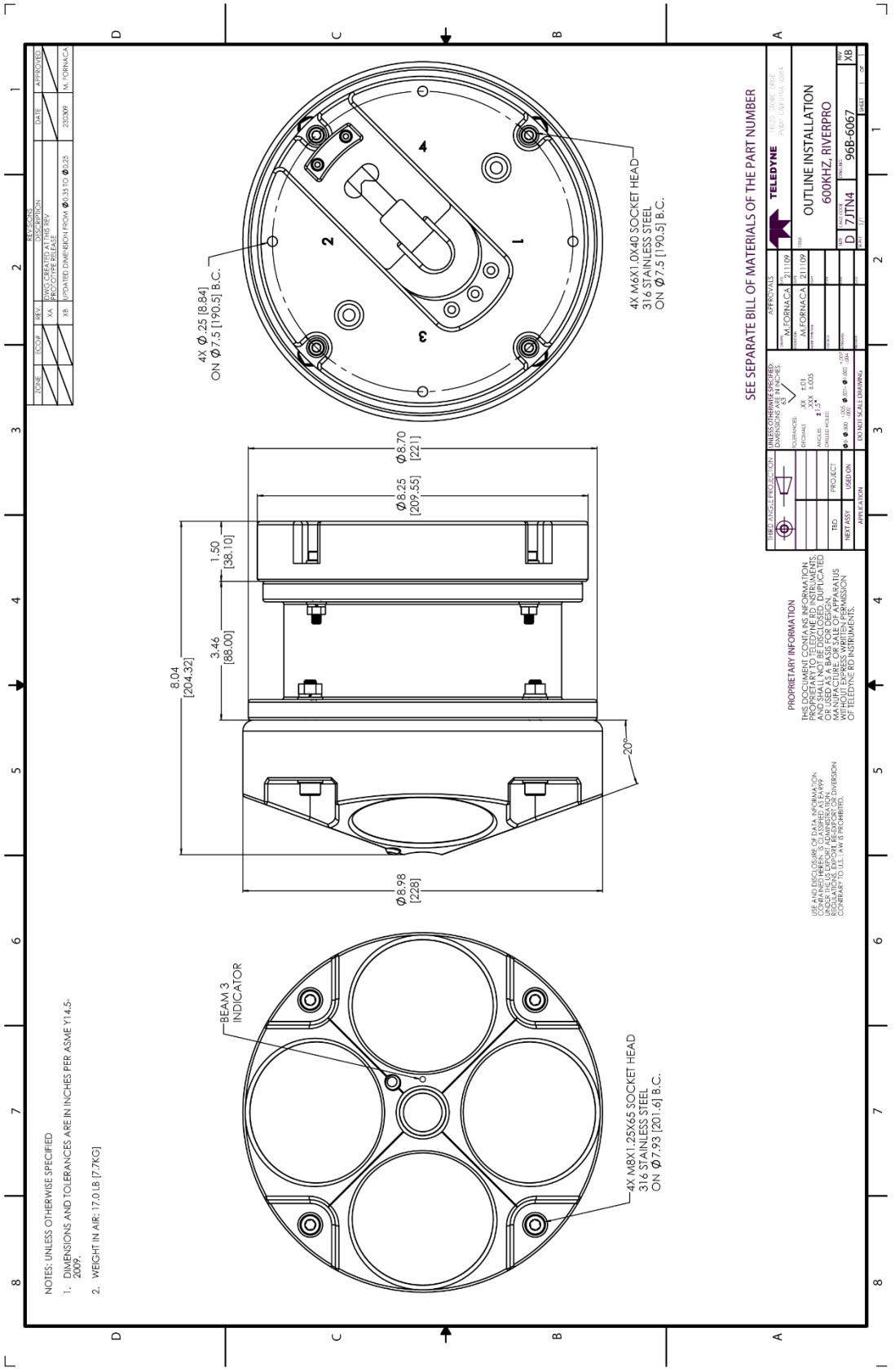


Figure 22. 96B-6067 RiverPro 600 kHz Outline Installation Drawing

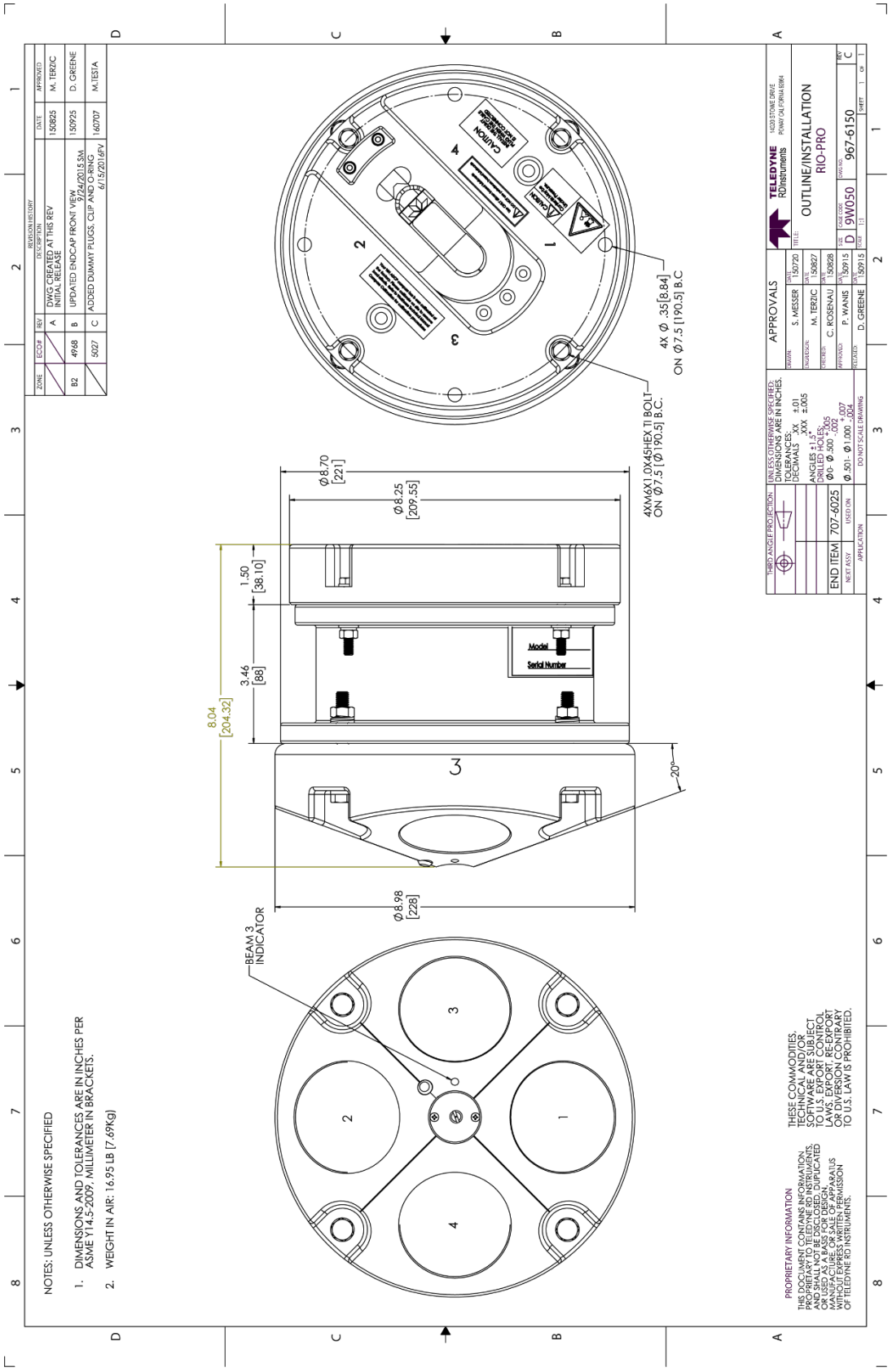
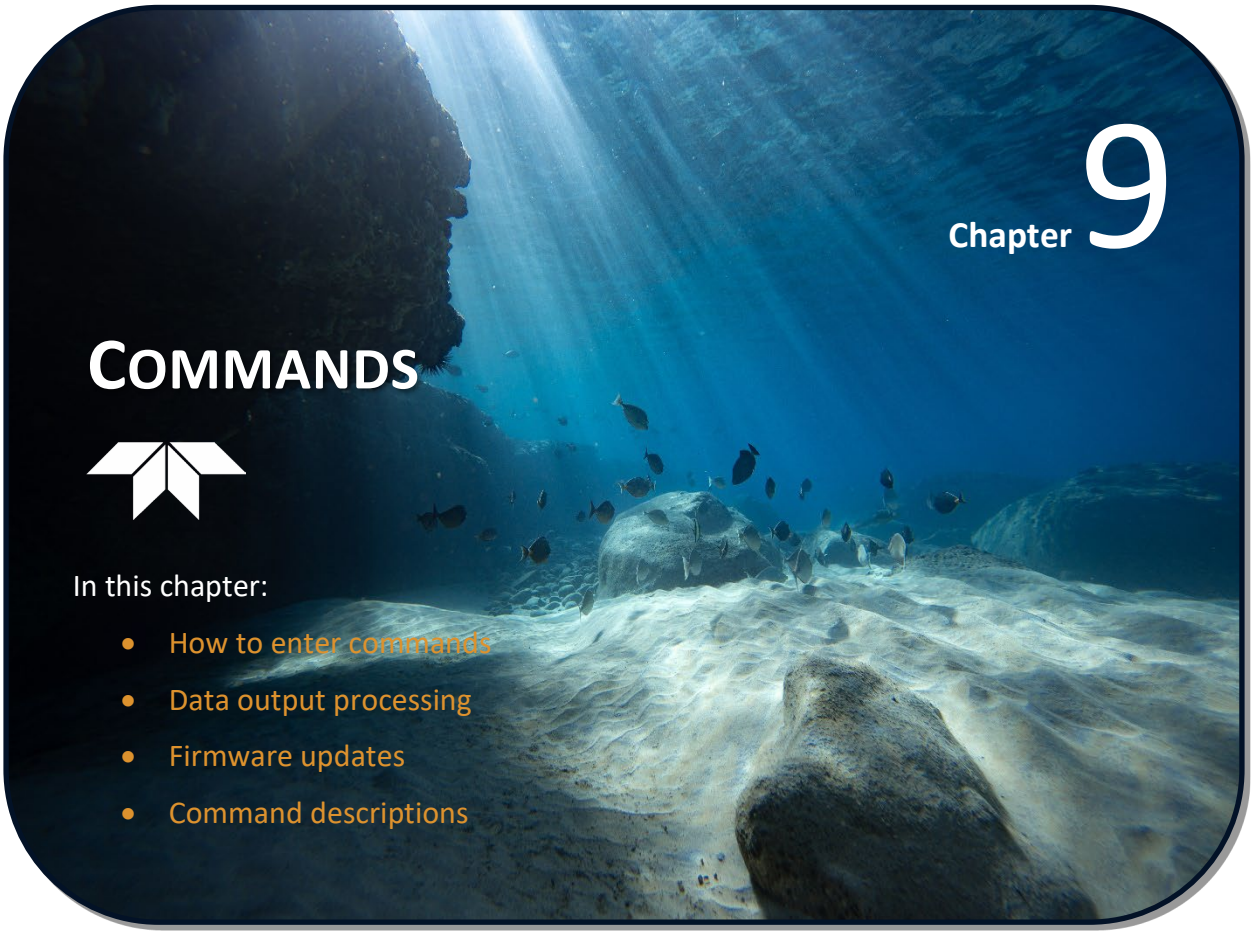


Figure 23. 967-6150 RioPro 1200 kHz Outline Installation Drawing

NOTES



Chapter 9

COMMANDS

In this chapter:

- How to enter commands
- Data output processing
- Firmware updates
- Command descriptions

This section defines the commands used by the RiverPro/RioPro. These commands (Table 10) set up and control the RiverPro/RioPro without using an external software program such as our *WinRiver II* or *SxS Pro* programs. However, TRDI recommends using our software to control the RiverPro/RioPro because entering commands directly from a terminal can be difficult. Most RiverPro/RioPro settings use factory-set values (Table 10). If these values are changed without thought, the deployment could be ruined. *Be sure to know what effect each command has before using it*. Call TRDI for help on understanding the function of any command.

Using *WinRiver II* or *SxS Pro* for real-time deployments to develop the command file will ensure that the RiverPro/RioPro is set up correctly. The commands shown in Table 10 directly affect the range of the RiverPro/RioPro, the standard deviation (accuracy) of the data, and battery usage.

This guide applies to RiverPro/RioPro firmware 56.11.

When new firmware versions are released, some commands may be modified, added, or removed. Read the README file on the website. When an addition or correction to this manual is needed, an Interim Change Notice (ICN) or an updated version of the manual will be posted to our web site. Please check TRDI's web site often at https://tm-portal.force.com/TMsoftwareportal.

Data Communication and Command Format

Enter commands using a Windows compatible computer with a Bluetooth interface running TRDI's *TRDI Toolz*. The RiverPro/RioPro communicates with the computer through the Bluetooth interface or the RS-232 serial interface I/O cable. TRDI initially sets the RiverPro/RioPro at the factory to communicate at 115200 baud, no parity, and one stop bit.

Immediately after power is applied to the RiverPro/RioPro, it enters the STANDBY mode. Send a BREAK signal using *TRDI Toolz* by pressing the **End** key. Alternately, a software break may be sent by sending either "+++" or "===". When the RiverPro/RioPro first powers up or receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The RiverPro/RioPro is now ready to accept commands at the ">" prompt from either a terminal or computer program.>break

```
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

Command Input Processing

Input commands set RiverPro/RioPro 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,

```
>CR1<CR> [Your input]
```

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

```
>CR1<CR>     [Your original input]
[Parameters set to FACTORY defaults]
>            [RiverPro/RioPro response to a valid, no-output command]
```

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

```
>CRA<CR>                                        [Your input]
>CRA  ERR 002:  NUMBER EXPECTED<CR><LF>         [RiverPro/RioPro response]
>
```

After correctly entering all the commands for the application, send the CS-command to put the RiverPro/RioPro into the ping mode and begin the data collection cycle.

Data Output Processing

After the RiverPro/RioPro completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected and averaged during the ensemble interval (see TE command). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, and status data.

RiverPro/RioPro output data can be in either hexadecimal-ASCII (Hex-ASCII) or binary format (set by the CF command). The Hex-ASCII mode is useful when using a terminal to communicate with, and view data from the RiverPro/RioPro. The binary mode is useful for high-speed communication with a computer program. Do not use the binary mode to view data on a terminal since the terminal could interpret some binary data as control codes.

Most of Teledyne RD Instruments' software supports binary PD0 Output Data Format.

When data collection begins, the RiverPro/RioPro 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 RiverPro/RioPro 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 RiverPro/RioPro:

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

Firmware Updates

The firmware for RiverPro/RioPro systems is located on flash memory chips on the CPU board. New firmware can be downloaded from https://tm-portal.force.com/TMsoftwareportal.

To update the firmware:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Click **Tools**, **Firmware Update**.
4. Select the **.m0* firmware update file.

Feature Upgrades

The feature upgrade installation program is used to install the Section-by-Section (SxS) feature upgrade in a RiverPro/RioPro.

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

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

Many feature upgrades require the latest firmware version to be installed in the RiverPro/RioPro. Update the firmware before installing a feature upgrade (see Firmware Updates).

To install a feature upgrade:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Click **Tools**, **Activate Features**.
4. Select the **.Feature* update file.
5. Using *TRDI Toolz* send the OL command (see OL – Display Feature List) to verify the feature upgrade has been installed.

Command Summary

Table 10 gives a summary of the RiverPro/RioPro input commands, their format, and a brief description of the parameters they control, and the factory default command settings.

When newer firmware versions are released, some commands may be modified or added. Read the README file for the latest changes.

Table 10: RiverPro/RioPro Input Command Summary

Command Default	Description
?	Shows command menu (deploy or system)
<BREAK> End	Interrupts or wakes up RiverPro/RioPro and loads last settings used
Y	Display banner
OI	Install New Feature
OL	Display Feature List
BP 1	Number of BT Pings in ensemble [0-999]
BX 00500 (1200), 00800 (600)	Max Depth (dm) [10-65535 dm]
CA0	Communication Timeout (0=Off,10-65536 sec)
CB811	Serial port control (baud rate/parity/stop bits)
CF 11111	Set Ctrl Flags {e;p;b;s;*}
CK	Save Command Parameters to Flash as user defaults
CR	Restore command defaults (0=user, 1=factory)
CS	Start pinging
CSTATE	Pinging State Query
CSTOP	Stop pinging
CT 0	Turnkey (0 = OFF, 1 = ON)
CW	Output the Last Stored Ensemble
CZ	Put the system to sleep
EA +00000	Heading alignment (-179.99 to 180.00 degrees)
EB +00000	Heading bias (-179.99 to 180.00 degrees)
EC 1485	Speed of Sound (1400 to 1600 m/s)
ED 00000 -	Transducer Depth (0 to 65535 dm)
EH 00000 -	Heading (000.00 to 359.99 degrees)
EP +00000	Pitch (-70.00 to +70.00 degrees)
ER +00000	Roll (-70.00 to +70.00 degrees)
ES 00	Salinity (0 to 45)
ET 2100	Temperature (-5.00 to +35.00 degrees C)
EU 0	System Orientation 1=up,0=down
EX 00000	Coordinate Transformation (Xform:Type; Tilts; 3Bm; Map)
EZ 1011101	Sensor Source (C;D;H;P;R;S;T)

Table 10: RiverPro/RioPro Input Command Summary

Command Default	Description
ME	ErAsE recorder
MM	Show memory usge
MN RP	Set deployment name (1….6 characters)
MR 0	Set recorder on/off [0=off, 1=on)
MQ	Streaming download (addr, nbytes)
MY	Y-modem download
PA	Pre-deployment tests
PC1	Beam Continuity Built-in test
PC2	Display Heading, Pitch, Roll, and Orientation Built-in test
PD0	Set Output Format (0=ensemble; 1=vbeam)
PF	Results from most recent PA tests
PS0	Display System Configuration
PS3	Display Instrument Transformation Matrix
PT*nnn*	Built-In test (0 to 200)
SA	Compass calibration [0=help]
SF3	External NMEA Menu 0=help
SI1	Internal GPS Menu 0=help
SZ220	Sensors Installed [Compass, Temperature, CTD]
TE 00:00:00.00	Time per ensemble (hours:minutes:seconds.100th of seconds)
TF --/--/--,--:--:-- --	Time of first ping (year/month/day, hours:minutes:seconds)
TP 00:00.00	Time between pings (minutes:seconds.100th of seconds)
TS 14/09/30,09:56:51.62	Set real-time clock (year/month/day, hours:minutes:seconds)
VG 00000	Vertical beam depth guess (0 to 10000 cm)
VP 001	Enable vertical beam pings (0, 1)
WC 064,080,096	Correlation Threshold [0-255]
WD 1110000001	Data Out {v;c;a;p;s;*;*;*;*;m}
WF (1200, WM3), 0019 (1200, WM2 or 12), 0025 (600)	Blanking Distance (cm) [0-500]
WM 0003 (1200), 0002 (600)	Water Profiling Mode [2,3,12]
WN 200	Number of Bins [1-200]
WO 001	Number of SubPings [1-999]
WP 001	Number of Pings [1-999]
WS 0005	Bin Size (cm) [1-500]
WV 0250	Ambiguity Velocity (cm/s)

Table 10: RiverPro/RioPro Input Command Summary

Command Default	Description
ZB 0	Bandwidth [0=Wide (25%), 1=Narrow (6.25%)]
ZC 064	Correlation Threshold (counts) [0..255]
ZD 111100000	Data Out {v;c;a;p;s;*;*;*;*}
ZF 020	Blanking Distance (cm) [0-500]
ZG 1	Gain [0=low, 1=high]
ZM 2	V-Beam Profile Mode [2=Linear, 12=LinPhasePlaneAvg]
ZN 010	Number of Bins [1-200]
ZO 004	Number of Mode-12 Subpings [0-20]
ZP 000	Number of Pings [0-999]
ZS 010	Bin Size (cm) [2-500]
ZV 250	Ambiguity Velocity (cm/s) [5-700]

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 RiverPro/RioPro 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 RiverPro/RioPro displays the help for a command group, it also shows the format and present setting of those commands. To see the help or setting for one command, enter the command followed by a question mark. For example, to view the CB command setting, enter **CB?**.

Examples — See below.

```
>break

RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx

?
Available Commands:
B ----------------------- Bottom Mode Commands
C ----------------------- Control Commands
E ----------------------- Environment Commands
M ----------------------- Recorder Commands
O ----------------------- Feature Commands
P ----------------------- Performance Test Commands
S ----------------------- Sensor Control
T ----------------------- Time Commands
V ----------------------- Vertical Beam Mode Commands
W ----------------------- Water Profiling Commands
Y ----------------------- Display Banner
Z ----------------------- Vertical Beam Profile Commands
? ----------------------- Display Main Menu
>

>cb?
CB = 811 ----------------- Serial Port Control (Baud [8=115200]; Par; Stop)
>
```

The RiverPro/RioPro will hide menu options when in different water modes.

Vertical Beam commands are only available in 5 beam systems.

Z commands are only available in RiverPro 1200.

Break

Purpose Interrupts the RiverPro/RioPro without erasing present settings.

Format <BREAK>

Recommended Setting. Use as needed.

Description A BREAK signal interrupts RiverPro/RioPro processing. It is leading-edge triggered and must last at least 300 ms. A BREAK initializes the system, sends a wake-up (copyright) message, and places the RiverPro/RioPro in the DATA I/O mode. The BREAK command does not erase any settings or data.

Using *TRDI Toolz*, pressing the **End** key sends a BREAK.

Software Breaks can be used with *TRDI Toolz* and *WinRiver II*. The RiverPro/RioPro will use the "= = =" string instead of a break.

Example <BREAK>

```
QBREAK A
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

```
CBREAK
RioPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

When a break is sent, the first line of the banner indicates the RiverPro/RioPro's communication configuration:

- **QBREAK A -** RiverPro/RioPro response to a hard break on the serial RS-232 I/O cable.
- **CBREAK** - RiverPro/RioPro response to a soft break on the serial RS-232 I/O cable or Bluetooth communication.

Hard breaks are not supported over Bluetooth.

- **[ALARM Wakeup A]** => When a break is sent, if the battery has a low voltage reading the following message appears:

```
[ALARM Wakeup A]
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
>
```

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

OL – Display Feature List

Purpose Lists the special firmware upgrades that are installed.

Format OL

Recommended Setting. Use as needed.

Description Lists special features that are installed. See Feature Upgrades for information on how to install additional capability in the RiverPro/RioPro.

Examples See below.

```
>ol                        FEATURES
------------------------------------------------------------
Feature                                                Installed
------------------------------------------------------------
Manual Profile Modes                                       Yes
SxS                                                        No

See your technical manual or contact TRDI for information on
how to install additional capability in your RiverPro/RioPro.

>
```

The *Section-By-Section (SxS)* feature allows transects to be completed by measuring at different user selected points on the river. This makes it possible to measure streams that are frozen over.

Manual Profile Modes allow the RiverPro/RioPro to override the automatic profiling mode and adds additional water profiling commands (see Water Profiling Commands)

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

Y – Display Banner

Purpose Displays the RiverPro/RioPro banner.

Format Y

Recommended Setting. Use as needed.

Description

Example Y

```
>y
RiverPro
Teledyne RD Instruments (c) 2022
All rights reserved.
Firmware Version: 56.xx
```

Bottom Track Commands

The RiverPro/RioPro uses these commands for bottom-tracking applications. Bottom track commands tell the RiverPro/RioPro to collect speed-over-bottom data and detected range-to-bottom data.

Available Bottom Track Commands

This section lists the most often used Bottom Track commands.

```
>B?
Available Commands:

BP 1 -------------------- Number of BT Pings in ensemble [0-999]
BX 00500 ---------------- Max Depth (dm) [10-65535 dm]
B? ---------------------- Display B-Command Menu
```

Bottom Track Command Descriptions

BP – Number of BT Pings

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

Format BP*nnn*

Range *nnn* = 0 to 999 pings

Default BP001

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

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

The RiverPro/RioPro interleaves bottom-track pings with water-track pings (see TP command). If BP = zero, the RiverPro/RioPro does not collect bottom-track data.

The RiverPro/RioPro automatically extends the ensemble interval (TE) if BP x TP > TE.

BX – Maximum Tracking Depth

Purpose Sets the maximum tracking depth in bottom-track mode.

Format BX*nnnn*

Range *nnnn* = 10 to 65535 decimeters (meters x 10)

Default BX 00500 (1200), 00800 (600)

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

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

Example If the maximum depth in the deployment area is 20 meters (200 decimeters), set BX to a value slightly larger than 200 dm, say 210 dm, instead of the default 500 dm. Now if the RiverPro/RioPro loses track of the bottom, it will stop searching for the bottom at 210-dm (21 m) rather than spend time searching down to 500-dm (50 m).

Control System Commands

The RiverPro/RioPro uses the following commands to control certain system parameters.

Available Control System Commands

This section lists the available Control System commands.

```
>C?
Available Commands:

CA     0 ---------------- Communication Timeout (0=Off,10-65536 sec)
CB 811 ----------------- Serial Port Control {baud;parity;stop}
CF 11111 ---------------- Set Ctrl Flags {e;p;b;s;*}
CK ---------------------- Save Command Parameters to Flash
CR ---------------------- Restore Cmd defaults [0=user,1=factory]
CS ---------------------- Start Pinging
CSTATE ------------------ Pinging State Query
CSTOP ------------------- Stop Pinging
CT 0 -------------------- Turnkey (0 = OFF, 1 = ON)
CW ---------------------- Output the Last Stored Ensemble
CZ ---------------------- Put the system to sleep.
C? ---------------------- Display C-Command Menu
>
```

Control System Command Descriptions

CA – Communication Timeout

Purpose	Sets the timeout period for the activity timer.
Format	CA*nnnnn*
Range	*nnnnn* = 0 (off), 10 to 65536 seconds
Default	CA0

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 RiverPro/RioPro will go to sleep or deploy itself, depending on the setting of the CT (Turnkey) command. If Turnkey mode is enabled (CT1) then the RiverPro/RioPro will self-deploy after the activity timeout period has elapsed.

CB – Serial Port Control

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

Format CB*nnn*

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

Default CB811

Recommended Setting. The default setting for this command is recommended for most applications and 115200 baud is required for Bluetooth operation.

Description The RiverPro/RioPro and the computer MUST use the same communication parameters to *talk* to each other (see Changing the Baud Rate in the ADCPs). After valid CB parameters are entered, the RiverPro/RioPro responds with a ">" prompt. Then change the external device's communication parameters to match the RiverPro/RioPro parameters before sending another command.

Table 11: Serial Port Control

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

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

CF – Set Control Flags

Purpose Sets various RiverPro/RioPro data flow-control parameters.

Format CF*nnnnn*

Range Firmware switches (see description)

Default CF11111

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

Description The CF-command defines whether the RiverPro/RioPro: generates data ensembles automatically or manually; generates pings immediately or manually; sends serial output data in binary or Hex-ASCII format; sends or does not send output data to the serial interface.

Table 12: Set Control Flags

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF0xxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the “>” prompt and waits for a new command.
CFx1xxx	Automatic Ping Cycling – Pings immediately when ready.
CFx0xxx	Manual Ping Cycling – Sends a < character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the 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.
CFxx2xx	Hex-ASCII Data Output, Carriage Return-Linefeed delimited -- Sends the ensemble in readable hexadecimal-ASCII format with a Carriage Return-Linefeed at the end of each ensemble, if serial output is enabled (see below).
CFxx1xx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled (see below).
CFxx0xx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled (see below).
CFxxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/422 serial interface.
CFxxx0x	Disable Serial Output – No ensemble data are sent out the RS-232/422 interface.
CFxxxx1	Reserved
CFxxxx0	Reserved

CK – Save Command Parameters to Flash

Purpose Stores present parameters to non-volatile memory.

Format CK

Recommended Setting. Use as needed.

Description CK saves the present user command parameters to non-volatile memory on the CPU board. The RiverPro/RioPro maintains data stored in the non-volatile memory (user settings) even if power is lost. It does not need a battery. Recall parameters stored in non-volatile memory with the CR0-command (see CR – Restore Command Defaults).

Always use the CK command in the configuration files.

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

CR – Restore Command Defaults

Purpose Resets the RiverPro/RioPro command set to factory settings.

Format CR*n*

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

Recommended Setting. Use as needed.

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

Table 13: Restore Command Defaults

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).

CR keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the RiverPro/RioPro maintains communications with the computer.

CS – Start Pinging (Go)

Purpose Starts the data collection cycle (same as the **Tab** key in *TRDI Toolz*).

Format CS

Recommended Setting. Use as needed. Use *WinRiver II* to create the command file. The CS command will be added to the end of the command file or sent by the software.

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

1. After a CS command is sent to the RiverPro/RioPro, no changes to the commands can occur until a <BREAK> is sent.
2. If the RiverPro/RioPro is set to record data (MR1) and the recorder is full, the RiverPro/RioPro will *not* start pinging and will return a *RECORDER NOT READY* message.

CState – Pinging State Query

Purpose Displays the status of the RiverPro/RioPro.

Format CState

Recommended Setting. Use as needed.

Description Displays either “Pinging” or “Not Pinging”, depending on the state of the RiverPro/RioPro.

CStop – Stop Pinging

Purpose Stops the current deployment.

Format CStop

Recommended Setting. Use as needed.

Description Stops autonomous sampling without resetting the RiverPro/RioPro.

CT – Turnkey Mode

Purpose Sets the Turnkey mode.

Format CT*x*

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

Default CT0

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

Description If the Turnkey mode is enabled, the RiverPro/RioPro will self-deploy (i.e. start pinging) within 10 seconds after a break unless a valid command is received within that time. After

that, the RiverPro/RioPro will self-deploy when the activity timer (set by the CA command) period expires.

CW – Output the Last Stored Ensemble

Purpose Requests the most recently stored ensemble for output.

Format CW

Recommended Setting. Use the WinRiver II software - Data Recovery.

Description Recalls the most recently stored ensemble for output. This command is only valid during a deployment when recording is enabled and will give an error message until valid data is available. The CW command is available for PD0 output formats, and follows the CF command setting for binary or Hex-ASCII output.

CZ – Put the system to sleep

Purpose Tells the RiverPro/RioPro to power down.

Format CZ

Recommended Setting. This command should be used whenever batteries have been connected and commands to start a deployment are not sent.

Description Sending the CZ-command powers down the RiverRay only when using serial communications. RiverRay processing is interrupted and the RiverRay goes in the STANDBY mode (RAM is maintained).

If the RiverRay is running a sensor test under battery power, a *fully charged battery will be discharged in a few days*.

If the system is communicating using Bluetooth, the CZ command will NOT set the unit to sleep. This would result in low power to the Bluetooth module and therefore not being able to communicate with the system.

```
>cz
Going to sleep

>cz
Sleep command only allowed over maintenance port!
```

Environmental Commands

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

Available Environmental Commands

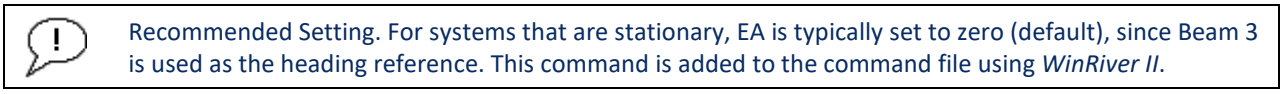
This section lists the available Environmental commands.

```
>e?
Available Commands:

EA +00000 --------------- Heading Alignment (0.01 deg)
EB +00000 --------------- Heading Bias (0.01 deg)
EC 1485 ----------------- Speed Of Sound (m/s)
ED 00000 ---------------- Xdcr Depth (deci-meters)
EH 00000 ---------------- Heading (0..35999; 1/100 degrees)
EP +00000 --------------- Pitch (+-7000 1/100 degrees)
ER +00000 --------------- Roll  (+-7000 1/100 degrees
ES 00 ------------------- Salinity (ppt)
ET 2100 ----------------- Water Temperature (.01 deg C)
EU 0 -------------------- System Orientation 1=up,0=down
EX 00000 ---------------- Coordinate Transformations (cct3m)
EZ 1011101 -------------- Sensor Source {c;d;h;p;r;s;t}
E? ---------------------- Display E-Command Menu
>
```

Environmental Command Descriptions

EA – Heading Alignment

Purpose	Corrects for physical misalignment between Beam 3 and the heading reference.
Format	EA±*nnnnn*
Range	±*nnnnn* = -17999 to 18000 (-179.99 to 180.00 degrees)
Default	EA00000



Description	EA is a heading alignment angle (referenced to Beam 3) used as a new zero reference for heading output and for transformation to earth coordinates. Use the EB-command to correct for heading bias (e.g., magnetic declination).
Example	The RiverPro/RioPro is mounted in place on a moving ship. Beam 3 has been rotated 45 clockwise (+45) from the ship's centerline. Use the EA command to tell the RiverPro/RioPro 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 RiverPro/RioPro heading value and the heading reference.

Format — EB±*nnnnn*

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

Default — EB00000

> Recommended Setting. Set using the magnetic variation setting in WinRiver II.

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

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

EC – Speed of Sound

Purpose — Sets the speed of sound value used for RiverPro/RioPro data processing.

Format — EC*nnnn*

Range — *nnnn* = 1400 to 1600 meters per second

Default — EC 1485

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

Description — EC sets the sound speed value used by the RiverPro/RioPro to scale velocity data, depth cell size, and range to the bottom. The RiverPro/RioPro assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

> If the EZ Speed of Sound field = 0, the RiverPro/RioPro overrides the manually-set EC value and calculates speed of sound using the values determined by transducer depth (ED), salinity (ES), and transducer temperature (ET). EZ also selects the source for ED, ES, and ET.

ED – Depth of Transducer

Purpose Sets the RiverPro/RioPro transducer depth.

Format ED*nnnnn*

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

Default ED00000

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

Description ED sets the RiverPro/RioPro transducer depth. This measurement is taken from the water level to the center of the slant beam transducers. The RiverPro/RioPro uses ED in its speed of sound calculations. The RiverPro/RioPro assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

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

EH – Heading

Purpose Sets the RiverPro/RioPro heading angle.

Format EH*nnnnn*

Range *nnnnn* = 0 to 35999 (000.00 to 359.99 degrees)

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

Description EH sets the RiverPro/RioPro heading angle of beam 3. When mounted on a stationary platform, the RiverPro/RioPro assumes beam 3 points north (0).

Example Convert heading values of 34 and 3.5 to EH-command values.

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

If the EZ Heading field = 1, the RiverPro/RioPro overrides the manually set EH value and uses heading from the transducer's internal sensor. If the sensor is not available, the RiverPro/RioPro uses the manual EH setting.

EP – Pitch (Tilt 1)

Purpose Sets the RiverPro/RioPro pitch (tilt 1) angle.

Format EP±*nnnn*

Range ±*nnnn* = +-7000 1/100 degrees

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

Description EP sets the RiverPro/RioPro pitch (tilt 1) angle.

Example Convert pitch values of +14 and -3.5 to EP-command values.

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

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

ER – Roll (Tilt 2)

Purpose Sets the RiverPro/RioPro roll (tilt 2) angle.

Format ER±*nnnn*

Range ±*nnnn* = +-7000 1/100 degrees

Recommended Setting. Use the EZ-command to default to the sensor module.

Description ER sets the RiverPro/RioPro roll (tilt 2) angle.

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
```

If the EZ Roll field = 1, the RiverPro/RioPro overrides the manually set ER value and uses roll from the transducer's internal tilt sensor. If the sensor is not available, the RiverPro/RioPro uses the manual ER setting.

ES – Salinity

Purpose Sets the water's salinity.

Format ES*nn*

Range *nn* = 0 to 45

Default ES0

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

Description ES sets the water's salinity. The RiverPro/RioPro uses ES in its speed of sound calculations. The RiverPro/RioPro 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 3500 (-5 to +35C)

Default ET2100

Recommended Setting. Use the EZ-command to default to the sensor module.

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

EU – System Orientation

Purpose Sets the RiverPro/RioPro system orientation, up or down.

Format EUn

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

Default n = 0

Recommended Setting. Use the EZ-command to default to the sensor module.

Description EU sets the RiverPro/RioPro system orientation, up or down.

If the EZ Roll field is not zero, the RiverPro/RioPro overrides the manually set EU value and uses orientation from the transducer's internal tilt sensor. If the sensor is not available, the RiverPro/RioPro uses the manual EU setting.

EX – Coordinate Transformation

Purpose Sets the coordinate transformation processing flags.

Format EX*xxptb*

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

Default EX00000

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

Description EX sets firmware switches that control the coordinate transformation processing for velocity and percent-good data.

Table 14: 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 RiverPro/RioPro. Heading/Pitch/Roll not applied.
EX10xxx	Ship coordinates (Note 1) X, Y, Z vectors relative to the ship. Heading not applied. EA-command used, but not the EB-command. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EX11xxx	Earth coordinates (Note 1) East, North, Vertical vectors relative to Earth. Heading applied. EA and EB-commands used. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EXxx1xx	Use tilts (pitch and roll) in transformation (see Note 2)
EXxxx1x	Allows 3-beam solutions if one beam is below the correlation threshold set by WC
EXxxxx1	Allow bin mapping (see Note 4)

1. For ship and earth-coordinate transformations to work properly, set the Heading Alignment (EA) and Heading Bias (EB) correctly. Also ensure that the tilt and heading sensors are active (EZ).
2. Setting EX bit 3 (Use Tilts) to 0 collects tilt data without using it in the ship or earth-coordinate transformations.
3. Each RiverPro/RioPro uses its own beam calibration matrix to correct data for beam pointing errors (e.g., if the beams erroneously point toward 21 degrees instead of 20 degrees). Correction is applied when the data are converted from beam coordinates to earth coordinates. If beam-coordinate data is output, you will need to apply the beam corrections yourself to obtain the best possible data.
4. TRDI outputs the 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.

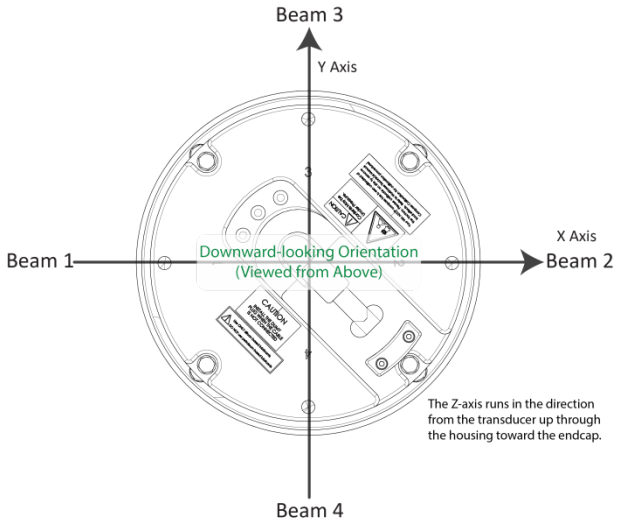
Beam Coordinate Systems

The RiverPro/RioPro 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 23). When you look at the face of the transducer head, the transducers are labeled clockwise in the order 3-1-4-2 (Figure 24). 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 Bottom Track output data format assumes that the instrument is stationary and the bottom is moving.

- If Beam 3 is going forward, then the Y velocity is negative.
- If Beam 2 is going forward, then X velocity is negative.
- If the bottom is going towards the face of a down facing ADCP, then Z is positive.

Figure 24. 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 ADCP, for the downward-looking orientation, these axes are identical to the instrument axes:

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

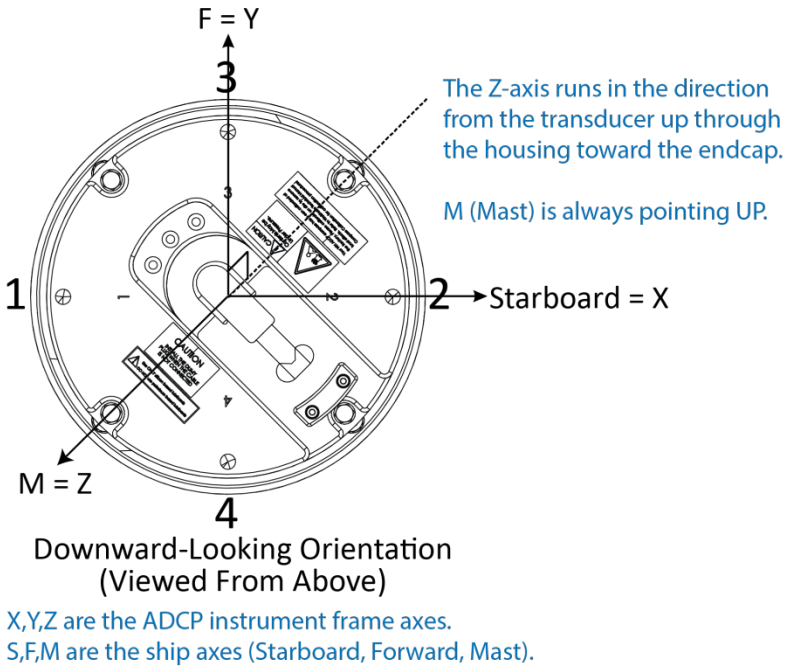


Figure 25. RiverPro/RioPro Coordinate Transformation

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 25).

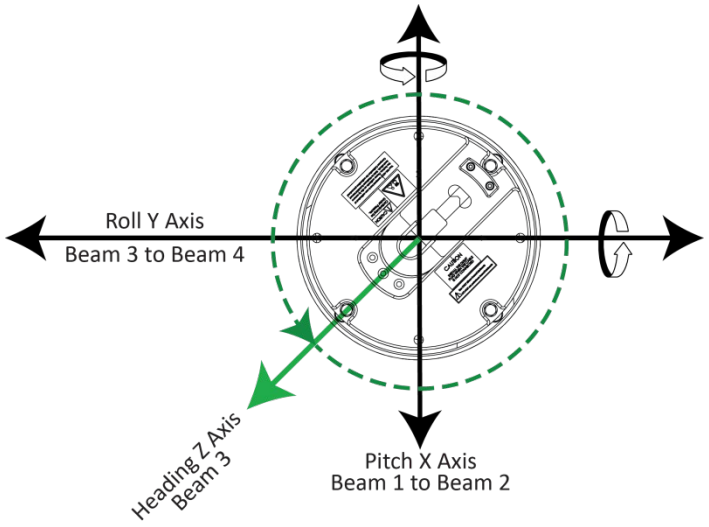


Figure 26. RiverPro/RioPro Pitch and Roll

Angle of the RiverPro/RioPro	Sign
Beam 3 higher than Beam 4	Positive Pitch
Beam 1 higher than Beam 2	Positive Roll

EZ – Sensor Source

Purpose Selects the source of environmental sensor data.

Format EZ*cdhprst*

Default EZ1011101

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

Range Firmware switches (see description)

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

Table 15: Sensor Source Switch Settings

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

Example EZ1011101 means calculate speed of sound from readings, use pressure sensor, transducer heading, internal tilt sensors, and transducer temperature.

Recorder Commands

The recorder contains approximately 16 megabytes of solid-state nonvolatile memory, which can be used to record data. If more data is collected than fits in the memory, the newest data will not be recorded. Once the recorder fills up, the recorder MUST be erased before re-deploying the RiverPro/RioPro (start pinging again).

If the RiverPro/RioPro is set to record data (MR1) and the recorder is full, the RiverPro/RioPro will *not* start pinging and will return a *RECORDER NOT READY* message.

Using the recorder will slow down the RiverPro/RioPro's ping rate.

Available Recorder Commands

This section lists the available Recorder commands.

```
>m?
Available Commands:

ME ---------------------- ErAsE recorder
MM ---------------------- Show memory usage
MN RP ------------------- Set deployment name [1..6 characters]
MR 0 -------------------- Set recorder on/off [0=off,1=on]
MQ ---------------------- Streaming Download (addr, nbytes)
MY ---------------------- Y-Modem Download
M? ---------------------- Display M-Command Menu
```

Recorder Command Descriptions

This section lists the Recorder commands.

ME – Erase Recorder

Purpose Erase the contents of the recorder.

Format ME ErAsE

Recommended Setting. Use as needed.

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

Once erased, data is not recoverable.

Erasing the recorder will take several minutes, and no status updates are provided during the erase process. When complete, the status will be displayed on screen as shown below.

```
>me ErAsE
Erasing recorder (may take a few minutes)...
Erasing recorder (may take a few minutes)...    Recorder erased.
Erasing recorder (may take a few minutes)...    ERR: Can't erase recorder.
>
```

MM – Show Memory Usage

Purpose Shows recorder memory usage in megabytes.

Format MM

Recommended Setting. Use as needed.

Description Shows memory usage and free memory.

```
>mm
Recorder Usage: used = 16681216, free = 30464
```

MN – Set File Name

Purpose Sets the file name for the recorder.

Format MN *xxxxxx*

Range *xxxxxx* = file name up to 6 characters long

Default MN RP

Recommended Setting. Use as needed.

Description The MN command sets the deployment name to be used for any future deployments. The deployment name can be up to 6 characters long, and may contain letters, numbers, or the underscore (i.e. "_") character. If no deployment name is specified, a default of "RP" is used. The deployment name is used as part of the file name for data files when downloaded to the computer using *TRDI Toolz* (see Recovering Data from the Recorder).

To prevent data files on the computer from being overwritten, a ten-digit time stamp is appended to the file name when **OK** is clicked on the **Download Directory** dialog box.

For example, the file *RP3281997475.p0* would contain data for the deployment named "RP" (the *3281997475* in the filename is the number of seconds since January 1st, 1900). The file extension is always "*.p0*". Waiting 25 seconds and downloading the same data again will change the file name to *RP3281997500.p0*.

MR – Set Recorder On/Off

Purpose Turns the recorder on or off.

Format MR*n*

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

Default MR0

Recommended Setting. Use as needed.

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

Using the recorder will slow down the RiverPro/RioPro's ping rate.

MQ – Streaming Download

Purpose Downloads the recorder.

Format MQ (StartAddr, nbytes)

Range StartAddr: 0 to FFFFFE (Hex)
nBytes: 1 to 16777216 (decimal)

Default N/A

Recommended Setting. Use *TRDI Toolz* to recover data (see Recovering Data from the Recorder).

Description Downloads the recorder in a streaming fashion, without any special communications protocol.

The sum of StartAddr and nBytes must not exceed the available data on the recorder, or the command will be rejected.

MY – Y-Modem output

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

Format MY

Recommended Setting. Use *TRDI Toolz* to recover data (see Recovering Data from the Recorder).

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

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

Performance and Testing Commands

The RiverPro/RioPro 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=vbeam)
PS ---------------------- System Info [0=config,3=xform]
PT ---------------------- Built-in-Test Commands; PT0=Help
PF ---------------------- Results from most recent PA tests
P? ---------------------- Display P-Command Menu
>
```

Performance and Testing Command Descriptions

PA – Run Go/No-Go Tests

Purpose Sends/displays results of a series of RiverPro/RioPro system diagnostic tests.

Format PA

Recommended Setting. Use as needed.

Description These diagnostic tests check the major RiverPro/RioPro modules and signal paths. These tests check the following boards/paths.

- Recorder - verifies recorder operation (this test takes several minutes to complete).
- DSP - RAM, ROM, and DSP-to-CPU Communications.
- Sensors - verifies sensor operation.

Example see below

```
>pa
RAM test.............PASS
ROM test.............PASS
RTC test.............PASS
UART test............PASS
Compass test.........PASS
Temperature test.....PASS
Recorder test........PASS
GO

>
```

PC – User Interactive Built-In Tests

Purpose Sends/displays results of user-interactive RiverPro/RioPro system diagnostic tests.

Format PC*nnn*

Range *nnn* = 0, 2, 20, 4, 40 (PC0 = Help menu; see below for others)

Recommended Setting. Use as needed.

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

Examples See below.

PC0 – Help Menu

Sending PC0 displays the help menu.

```
>pc0
PC0   = Help
PC2   = Display Sensor Data
PC4   = Display Voltage Monitor ADC Data
PC5   = Display BlueTooth RSSI Data
PC6   = Display GPS RSSI Data
PC20  = Display Scrolling Sensor Data
PC40  = Display Scrolling Voltage Monitor Data
PC50  = Display BlueTooth RSSI Data
PC60  = Display GPS RSSI Data
>
```

PC2 – Display Sensor Data

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

```
>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)
\  9     22.812   340.08    -2.18     1.20     Down    0.000*  11.751   0.156
```

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

PC20 – Display Scrolling Sensor Data

Sending PC20 displays temperature, heading, pitch angle, roll angle, depth, and battery voltage in a repeating loop at approximately 0.5-sec update rate. Press any key to exit this command and return to the command prompt.

```
>pc20
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)
   1     22.937   339.86    -2.09     1.26     Down    0.000*  11.757   0.156
   2     22.937   340.11    -2.19     1.21     Down    0.000*  11.757   0.161
   3     23.000   340.26    -2.02     1.26     Down    0.000*  11.737   0.164
   4     23.000   340.40    -2.12     1.20     Down    0.000*  11.757   0.158
   5     22.875   340.19    -1.99     1.26     Down    0.000*  11.757   0.153

>
```

PC4 – Display Voltage Monitor ADC Data

The PC4 Batt (V) value is ~ 0.8 volts below the supply voltage. VDD1 and VDD3 should be within 0.01 volts of the values shown in the example data.

```
>pc4
Battery ADC data is sampled and displayed in a loop.
Press any key to exit the loop.

Count  Chan0  Chan1  Chan2  Chan3    Batt(V)   Batt(A)  VDD1     VDD3
\ 11    0685   00c6   0d49   0b7f    11.878    0.121    3.328    1.797
```

PC40 – Display Scrolling Voltage Monitor ADC Data

PC40 is the same as PC4 except the data is displayed in a repeating loop at approximately 0.5-sec update rate.

```
>pc40
Battery ADC data is sampled and displayed in a loop.
Press any key to exit the loop.

Count  Chan0  Chan1  Chan2  Chan3    Batt(V)   Batt(A)  VDD1     VDD3
   0    0684   00ca   0d49   0b80    11.871    0.123    3.328    1.797
   0    0683   00e2   0d49   0b7f    11.865    0.138    3.328    1.797
   0    0684   00ba   0d49   0b80    11.871    0.114    3.328    1.797
   0    0684   00b2   0d49   0b7f    11.871    0.109    3.328    1.797
>
```

PC5 – Display BlueTooth RSSI Data

TRDI use only.

PC50 – Display Scrolling BlueTooth RSSI Data

TRDI use only.

PC6 – Display GPS RSSI Data

TRDI use only.

PC60 – Display Scrolling GPS RSSI Data

TRDI use only.

PD – Set Output Format

Purpose Selects the type of ensemble output data structure.

Format PD*n*

Range *n* = 0, 1 (0=ensemble; 1= TRDI use only)

Default PD0

Recommended Setting. Use the default setting for this command.

Description PD0 sends the real water-current data set.

PS – Display System Parameters

Purpose Displays the RiverPro/RioPro system configuration data.

Format PS*n*

Range *n* = 0, 3 (see description)

Recommended Setting. Use as needed.

Description See below.

PS0 – System Configuration

PS0 sends the RiverPro/RioPro hardware/firmware information. For example, the output may look like this:

```
>ps0
          System:  RioPro
   Serial Number:  2
       Frequency:  1228800 Hz
Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
   Vertical Beam:  NONE
         Sensors:
             Temperature:   DS18b20 1-Wire
      Heading/Pitch/Roll:        RDI (ISM)
                     GPS:    Internal DGPS


    CPU Firmware:  56.xx  FD0i3
    FPGA Version:7.00.002 [0x7002]

Board Serial Number Data:
BB 00 00 05 0F F9 36 28   DS18B20 TMP SNS
42 00 00 01 A1 12 70 23   XDR717-1150-00B
D6 00 00 01 A5 91 14 23   PIO72B-2201-00A
08 00 00 01 A5 AC 34 23   DSP72B-2212-00C
73 00 00 01 52 D0 C2 23   END72B-2264-01A
86 00 00 01 B8 DD 4A 23   MUX72B-2265-00A
08 00 00 01 B8 F0 29 23   PER72B-2353-05B
8C 00 00 01 A1 58 13 23   RCV72B-2263-02A

>
```

PS3 – Instrument Transformation Matrix

PS3 sends information about the transducer beams. The RiverPro/RioPro uses this information in its co-ordinate-transformation calculations; for example, the output may look like this:

```
>ps3

Last Save Time: 14/09/26,17:16:41.39
Profiling Beams:         4
Janus Xdcr Type:         Piston
Janus Beam Angle (deg)   20
Janus Beam Freq (Hz)     1228800
Janus Beam Dia (mm)      32
Janus Beam Offset (mm)   0
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

Has V-Beam:        Yes
VBeam Xdcr Type:   Piston
VBeamFreq (Hz)     614400
VBeam Dia (mm)     15
VBeam Offset (mm)  0
>
```

If the RiverPro/RioPro needs beam angle corrections, a TRDI calibrated beam angle matrix is loaded into the instrument. This is done when the instrument is manufactured. For details, download a copy of the RiverPro/RioPro Coordinate Transformation booklet (https://www.teledynemarine.com/en-us/support/Pages/rdi-technical-support-information.aspx).

PT – Built-In Tests

Purpose Sends/displays results of RiverPro/RioPro system diagnostic test.

Format PT*nnn*

Range *nnn* = 0, 3, 11 to 18, 20 (PT0 = Help menu)

Recommended Setting. Use as needed.

Description These diagnostic tests check the major RiverPro/RioPro modules and signal paths.

```
>pt0
Built In Tests
----------------
  PT0  = Help
  PT3 [mode] = Receive Path Test, mode 0 = hard limited (default), 1 = linear, 2 = SNR
  PT11 = FRAM Test
  PT12 = RAM Test
  PT13 = ROM Test
  PT14 = Recorder Test
  PT15 = Communications Test
  PT16 = Clock Test
  PT17 = Compass Test
  PT18 = Temperature Test
  PT20 = GPS Test
>
```

PT3

This test displays receive path characteristics. The test result is given as eight nibbles (1 nibble = 4 bits). Each nibble represents the result for a particular beam (most significant nibble = beam 1, least significant nibble = beam 8) (four beam RiverPro/RioPro systems utilize the four most significant nibbles). In this example, TRDI only describes which bit is set for beam 2 for a given failure type.

Sending **PT3** or **PT3 0** (default) displays the Hard Limited output. Sending **PT3 1** displays the 8-bit sampling Linear output.

This test has three parts:

- **Correlation Magnitude –** The RiverPro/RioPro pings without transmitting and displays the result of an autocorrelation function performed over 14 lag periods (only the first 8 are displayed). Ideally, there should be high correlation at near-zero lags, and then lower correlations as the lag number increases. For the PT3 or PT3 0 command, values above 500 for lag greater than two indicates interference or hardware problems. For the PT3 2 command, values above 10 for lags greater than zero indicate interference or a hardware problem.
- **Sin / Cos Duty Cycle –** For the PT3 or PT3 0 commands, this shows the percentage of samples that are in phase (cos) or 90 degrees out of phase (sin) with the carrier signal. The total of the sin and cos duty cycles should be close to 100 and both values should be in the range 45-55. If either the sin or cos duty cycles are out of this range indicates interference or a hardware problem.
- **RSSI Noise Floor –** For the PT 3 or PT 3 0 commands and PT 3 1 command, this shows the RSSI value at various gains and bandwidths. These values give the noise floor for RSSI. Values above 55 for the H-Gain N-BW noise floor indicate a possible interference or a hardware problem. Values below 45 indicate that the RSSI needs to be recalibrated at the factory. PT3 2 runs the same test as PT3 1 using Linear data but reports SNR instead of correlation.

```
>pt3 0
Receive Path Test (Hard Limited):
Correlation Magnitude:
    H-Gain W-BW                       L-Gain W-BW
Lag Bm1      Bm2      Bm3      Bm4      Bm1      Bm2      Bm3      Bm4
  0 1000     1000     1000     1000     1000     1000     1000     1000
  1  707      726      749      732      833      825      822      817
  2  112      169      348      214      515      494      493      478
  3  345      285      216      256       97       64       81       56
  4  181      142       36      113       22       16       14       16
  5  155      112       39       97        5       10       20        3
  6   33       16       24       22        2        8       11       12
  7   38        5       54       12       23       11       12       13

    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  822      861      860      856      833      826      825      825
  2  474      572      572      556      503      496      490      487
  3   41      132      156      110       68       67       59       52
  4   72       13       89       20       12        6       18       10
  5   57       22       77       17       13       15       21       13
  6   57       31       75       21        4        6        7        3
  7   55       28       68       31       11        5        2        5

    H-Gain W-BW         L-Gain W-BW         H-Gain N-BW         L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
Sin Duty Cycle (percent)
     48  47  51  54      51  50  49  50      48  47  52  55      50  50  51  49
Cos Duty Cycle (percent)
     50  49  49  53      49  50  49  49      51  47  51  54      51  49  50  52
RSSI Noise Floor (counts)
     53  51  48  49      43  45  45  44      40  41  39  39      35  38  38  36

>pt3 1
Receive Path Test (Linear):
Correlation Magnitude:
```

```
    H-Gain W-BW                         L-Gain W-BW
Lag Bm1      Bm2      Bm3      Bm4      Bm1      Bm2      Bm3      Bm4
  0 1000     1000     1000     1000     1000     1000     1000     1000
  1  749      742      777      754      840      827      827      824
  2  332      297      405      332      530      498      500      491
  3  250      213      186      207       97       66       69       52
  4   11       57       56       33        8        8       17        6
  5  145       73       58       62        3        7        8        7
  6   54       11       15        9        2       11        2        7
  7   29       11       19        8       15        2       10       10

    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  832      861      856      854      833      829      827      830
  2  498      573      561      557      507      499      494      499
  3   80      127      157      111       60       54       57       55
  4   70       33       80       19       15        8        3        4
  5   68       35       67        4        8        2       17        6
  6   53       15       56       16        4        6        9        4
  7   57       23       58       19       17        4        6       10

    H-Gain W-BW         L-Gain W-BW         H-Gain N-BW         L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
RSSI Noise Floor (counts)
     54  52  48  48      44  46  46  44      40  41  40  39      35  38  38  37

>pt3 2
Receive Path Test (Linear):
SNR (dB):
    H-Gain W-BW                         L-Gain W-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   4.7    4.7    5.5    4.9      7.3    6.7    6.8    6.7
  2  -3.3   -3.6   -1.6   -3.1      0.6   -0.1   -0.1   -0.2
  3  -5.1   -5.9   -6.3   -6.2     -8.8  -11.8  -11.5  -12.2
  4 -20.3  -12.1  -12.3  -12.0    -19.1  -17.5  -19.7  -17.4
  5  -7.7  -10.7  -11.9  -11.0    -20.8  -18.9  -21.4  -21.0
  6 -12.0  -20.6  -21.3  -21.1    -22.9  -26.2  -20.8  -19.5
  7 -13.8  -20.4  -16.2  -21.8    -20.9  -25.0  -21.2  -20.7

    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   7.0    7.9    7.8    7.7      7.0    6.8    6.8    6.9
  2   0.0    1.3    1.1    1.0      0.2   -0.1   -0.1    0.0
  3 -10.4   -7.7   -7.2   -8.7    -11.7  -12.7  -11.8  -12.1
  4 -11.0  -14.5  -10.5  -17.6    -22.0  -22.4  -18.4  -18.5
  5 -10.8  -16.5   -9.7  -18.3    -18.9  -24.8  -20.6  -21.8
  6 -11.6  -16.3  -11.1  -19.5    -23.1  -20.6  -19.9  -24.2
  7 -12.0  -17.7  -11.2  -18.3    -22.1  -22.3  -24.0  -23.7

    H-Gain W-BW         L-Gain W-BW         H-Gain N-BW         L-Gain N-BW
    Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
RSSI Noise Floor (counts)
     54  51  48  48      43  46  46  44      40  41  40  39      35  38  38  37

>
```

PT11 = FRAM Test

```
>pt11

FRAM test...PASS

>
```

PT12 = RAM Test

```
>pt12
```

```
RAM test...PASS

>
```

PT13 = ROM Test

```
>pt13
ROM Test.................PASS  [ 7b5f ]

>
```

PT14 = Recorder Test

```
>pt14
Recorder Test.................PASS

>
```

PT15 = Communications Test

```
>pt15
Communications test.....PASS

>
```

PT16 = Clock Test

```
>pt16
RTC test.................PASS

>
```

PT17 = Compass Test

```
>pt17
Compass test............PASS  [ 210.100006, -0.200000, 0.100000 ]

>
```

PT18 = Temperature Test

```
>pt18
Temperature test........PASS  [ 24.750000 ]

>
```

PT20 = GPS Test

```
>pt20
GPS test.................PASS
>
```

PF – Results from most recent PA tests

Purpose Outputs the results of the last PA test.

Format PF

Recommended Setting. Use as needed.

Description This command gives a summary of the last PA test.

Example See below

```
>pf
 Test Results
PA Test last run at: 2012/07/22 15:42:25.77

RAM         test... PASSED
ROM         test... PASSED
RTC         test... PASSED
REC         test... PASSED
UART        test... PASSED
COMPASS     test... PASSED
TEMPERATURE test... PASSED
GO
```

Sensor Control Commands

The main reasons for compass calibration are installation of the instrument into a new mount or boat or moving to a new location for data collection. Each new mount or boat potentially carries a different magnetic signature, and the earth's magnetic field characteristics vary from location to location even over relatively short distances. The compass calibration algorithm corrects for the distortions caused by these external field changes to give an accurate measurement.

Available Sensor Control Commands

This section lists the available compass commands.

```
>S?
Available Commands:

SA ---------------------- Compass Cal [0=help]
SF 3 -------------------- External NMEA Menu 0=help
SI 1 -------------------- Internal GPS Menu 0=help
SZ 220 ------------------ Sensors Installed [Compass, Temperature, CTD]
S? ---------------------- Display S-Command Menu
>
```

Compass Command Descriptions

SA – Compass Cal

Purpose	Calibrates the compass to remove hard and soft iron effects.
Format	SAx
Range	x = 0 to 4 (0 = help)
Default	N/A

Recommended Setting. Use *WinRiver II* to calibrate the compass. The compass must be calibrated if the boat and/or mounting have changed or the RiverPro/RioPro is moved to a new location.

Description Command used to display compass module information, enter calibration mode, and set compass module parameters.

For details on how to calibrate the compass, see the WinRiver II User's Guide.

ISM Examples

```
>sa0

ISM Compass Calibration & Test Menu

Options:
    0:  Display ISM Commands
    1:  Pass Through Mode
    2:  ISM Module Info
    3:  zero pitch & roll
    4:  Clear pitch and roll zero offsets

>
```

```
>sa1
```

No response. The system goes into pass through mode where all input is passed through directly to the compass. Send a break to reset the system and cancel Pass Through Mode.

```
>sa2

Part No.: SNR71B-1072-01
SN: 231A67ED 000000A8
FW Ver: 45.05

>sa3

ISM Zero offsets Enabled, Pitch -1.430328 deg, Roll 0.010684 deg
Save new values? Y|[N]
Save Done

>sa4
ISM Zero offsets Disabled, Pitch 0.000000 deg, Roll 0.000000 deg
Save new values? Y|[N]
Save Done
```

SF – External NMEA Menu

Purpose Sets the RiverPro/RioPro GPS input port to match the external GPS unit.

Format SF*n*

Range *n* = 0, 1, 2, 3-9

Default SF3

Recommended Setting. Use as needed.

Description Use the SF command to set the GPS port baud rate. Use SF2 to output GPS diagnostic data. When auto-baud detection mode is enabled (SF9), the RiverPro/RioPro will cycle through the valid baud rates and then listen for a period of time for a NEMA data stream. The auto-baud detection is disabled while pinging to ensure ping-timing is not impacted.

Example See below

SF Command	Description
SF0	Help menu
SF1	Disable
SF2	GPS diagnostic data
SF3	4800 Baud (Default)
SF4	9600 Baud
SF5	19200 Baud
SF6	38400 Baud
SF7	57600 Baud
SF8	115200 Baud
SF9	Auto

```
>sf?
SF 3 -------------------- GPS Baud 1=disable, 0=help, 3=4800, 4=9600, ...
>
```

Send the SF2 command to display the GPS string the instrument is receiving. If the baud rate between the GPS and the RiverPro/RioPro does not match, the GPS string will not be readable (i.e. “garbage” characters). If the GPS is not connected, there is no output.

```
>sf2
GPS Diagnostics enabled, pinging disabled
GPS DIAGNOSTIC:804788,W,2,05
GPS DIAGNOSTIC:2.50,5.00,M,0

>GPS DIAGNOSTIC:00,M,000,0111
GPS DIAGNOSTIC:40<CR><LF>$GPGGA,17
GPS DIAGNOSTIC
Decode:$GPGGA,170855.70,3237.178869,N,11713.804788,W,2,05,2.50,5.
00,M,0.00,M,000,0111*40
GPS DIAGNOSTIC:855.90,3237.1
GPS DIAGNOSTIC:8844,N,11713.
GPS DIAGNOSTIC:04951,W,2,05,
GPS DIAGNOSTIC:.50,5.00,M,0.
GPS DIAGNOSTIC:0,M,000,0111*
GPS DIAGNOSTIC:B<CR><LF>$GPGGA,170
GPS DIAGNOSTIC
Decode:$GPGGA,170855.90,3237.178844,N,11713.804951,W,2,05,2.50,5.
00,M,0.00,M,000,0111*4B

>sf?
SF 3 -------------------- GPS Baud 1=disable, 0=help, 3=4800, 4=9600, ...
>sf8                                  Set the baud rate to the actual GPS rate. If the baud
                                      rate is in question then one may have to step through
                                      these steps a few times.
>sf2                                  Then SF2
                                      GPS Diagnostics enabled, pinging disabled

>GPS DIAGNOSTIC:$GPGGA,100413.
GPS DIAGNOSTIC:0,3237.213845,N,11713.796522,W,2,05,2.50,5.00,M,0.00,M,000,0111*4
9<CR><LF>$GPVTG,22.801,
GPS DIAGNOSTIC Decode:$GPGGA,100413.10,3237.213845,N,11713.796522,W,2,05,2.50,5.
00,M,0.00,M,000,0111*49
GPS DIAGNOSTIC Decode:$GPVTG,22.801,T,,,2.124,N,3.933,K,D*73
GPS DIAGNOSTIC:382,F*34<CR><LF>$GPZDA,170413.10,26,09,2012,08,00*63<CR><LF>$GPHD
T,22.8,T*0D<CR>
GPS DIAGNOSTIC Decode:$GPDBT,27.230,f,8.300,M,163.382,F*34
GPS DIAGNOSTIC Decode:$GPZDA,170413.10,26,09,2012,08,00*63
GPS DIAGNOSTIC Decode:$GPHDT,22.8,T*0D
GPS DIAGNOSTIC:$GPGGA,100414.
GPS DIAGNOSTIC:0,3237.214386,N,11713.796241,W,2,05,2.50,5.00,M,0.00,M,000,0111*4
F<CR><LF>$GPVTG,23.709,
GPS DIAGNOSTIC Decode:$GPGGA,100414.10,3237.214386,N,11713.796241,W,2,05,2.50,5.


>sf7       Baud rate deliberately set wrong
>sf2
GPS Diagnostics enabled, pinging disabled

>GPS DIAGNOSTIC:$ □†„…&„¦¥åÄ„
GPS DIAGNOSTIC:f†¤¤§¦DÆÁ„¦‡Ää„F†‡ÄÂHÄ„
‡D

¥äÅ*ÀÆ$¤ÄÃ)…ÄÃ„b¤
GPS DIAGNOSTIC:å¦ÅÂ
```

SI – Internal NMEA Menu

Purpose Used for Internal GPS status and diagnostic information.

Format SI*n*

Range *n* = 0, 1, 2, 10, -1, 11, 20, 30

Default SI1

Recommended Setting. Use as needed.

Description Use the SI command to retrieve Internal GPS status and diagnostic information. The baud rate is fixed to 115200.

Example See below

```
>si0
Internal GPS status: IDLE,  baud option 8
        Baud rate 115200(8)
Usage: SI <option>
 Options:
  0    help
  1    status
  2    toggle diagnostics
  10   detect baud now
  -1   disable
  11   enable
  20   message list sub-menu
  30   set device baud to 115200

>
```

SZ – Sensors Installed

Purpose Determines what sensors are installed and detected.

Format SZ?

Default N/A

Recommended Setting. Use as needed.

Description Shows the sensors installed.

Example See below

```
>sz
CTD Not Supported!
>
```

Timing Commands

The following commands set the timing of various profiling functions.

Available Timing Commands

This section lists the available Timing commands.

```
>T?
Available Commands:

TE 00:00:00.00 ---------- Time Between Ensembles
TF --/--/--,--:--:-- ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TP 00:00.00 ------------- Time Between Pings
TS 14/09/30,09:56:51.62 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
T? ---------------------- Display T-Command Menu
>
```

Timing Command Descriptions

TE – Time Per Ensemble

Purpose	Sets the minimum interval between data collection cycles (data ensembles).
Format	TEhh:mm:ss.ff
Range	*hh* = 00 to 23 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TE00:00:00.00

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

Description	During the ensemble interval set by TE, the RiverPro/RioPro collects one automatic ensemble. If TE = 00:00:00.00, the RiverPro/RioPro starts collecting the next ensemble immediately after processing the previous ensemble.
Example	TE01:15:30.00 tells the RiverPro/RioPro to collect data ensembles every 1 hour, 15 minutes, 30 seconds.

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 RiverPro/RioPro wakes up to start 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

Recommended Setting. Use as needed.

Description — TF delays the start of data collection. This command sets the RiverPro/RioPro in the Standby mode and it will automatically start data collection at a preset time (typically used in battery operated instruments). When the command is given to the RiverPro/RioPro to start pinging, TF is tested for validity. If valid, the RiverPro/RioPro sets its alarm clock to TF, goes to sleep, and waits until time TF before beginning the data collection process.

Example — To set the exact time of the first ping to be on November 23, 2013 at 1:37:15 pm, enter TF13/11/23, 13:37:15. Do not enter a TF command value to begin pinging immediately after receiving the CS command (see notes).

1. If a TF command is sent to the RiverPro/RioPro, the CS command must also be sent before deploying the RiverPro/RioPro.
2. If the entry is not valid, the RiverPro/RioPro sends an error message and does not update the wake-up time.
3. Sending a <BREAK> clears the TF time.

TP – Time Between Pings

Purpose — Sets the *minimum* time between pings. In automatic operation, this is the same as Time Between Ensembles (TE command).

Format — TP*mm:ss.ff*

Range

mm	= 00 to 30 minutes
ss	= 00 to 59 seconds
ff	= 00 to 99 hundredths of seconds

Default — TP00:00.00

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

Description — The RiverPro/RioPro pings with an automatic ping setup and adjusts the ping times as required.

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

TS – Set Real-Time Clock

Purpose Sets the RiverPro/RioPro's internal real-time clock.

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

Range

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

Recommended Setting. Set using *TRDI Toolz* or *WinRiver II*.

Example TS13/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2013.

1. When the RiverPro/RioPro 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 RiverPro/RioPro sends an error message and does not update the real-time clock.

Vertical Beam Range Commands

The following commands define the criteria used to collect the vertical beam data.

The vertical beam is not available for RioPro systems.

Standard Vertical Beam Range Commands

This section lists the Vertical Beam commands.

```
>V?
Available Commands:

VG 00000 ---------------- Depth Guess cm
VP 001 ------------------ Number of Pings [0-999]
V? ---------------------- Display V-Command Menu
>
```

VG – Depth Guess

Purpose: Sets the listen window to a fixed range. This command can be used if the range to bottom is known to be close to the fixed range to prevent searching.

Format: VG*nnnnn*

Range: *nnnnn* = 0 to 10000 cm

Default: VG0

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

Description: VG sets a fixed range to bottom for configuring the vertical beam ping listen window, transmit length, etc., and prevents the ping from entering search mode. The bottom will only be found if it is sufficiently close to this fixed range.

For specific uses only. Not recommended for general use.

VP – Number of Vertical Beam Pings

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

Format: VP*nnn*

Range: *nnn* = 0 to 1

Default: VP001

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

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

Water Profiling Commands

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

Standard Water Profiling Commands

The available water profiling commands are different for each water mode. The commands listed below show the commands for each water mode. The added commands are highlighted.

```
>wm3
>w?
Available Commands:

WC 064,080,096 ---------- Correlation Threshold [0-255]
WD 1110000001 ----------- Data Out {v;c;a;p;s;*;*;*;*;m}
WM 0003 ----------------- Water Profiling Mode [2,3,12]
W? ---------------------- Display W-Command Menu
```

Manual Mode Water Profiling WM2 and WM12 are feature upgrades for RiverPro/RioPro systems (see Feature Upgrades). This upgrade adds the following highlighted commands.

```
>wm2
>w?
Available Commands:

WC 064,080,096 ---------- Correlation Threshold [0-255]
WD 1110000001 ----------- Data Out {v;c;a;p;s;*;*;*;*;m}
WF 0016 ----------------- Blanking Distance (cm) [0-500]
WM 0002 ----------------- Water Profiling Mode [2,3,12]
WN 200 ------------------ Number of Bins [1-200]
WP 001 ------------------ Number of Pings [1-999]
WS 0005 ----------------- Bin Size (cm) [2-500]
WV 0250 ----------------- Ambiguity Velocity (cm/s)
W? ---------------------- Display W-Command Menu

>wm12
>W?
Available Commands:

WC 064,080,096 ---------- Correlation Threshold [0-255]
WD 1110000001 ----------- Data Out {v;c;a;p;s;*;*;*;*;m}
WF 0016 ----------------- Blanking Distance (cm) [0-500]
WM 0012 ----------------- Water Profiling Mode [2,3,12]
WN 200 ------------------ Number of Bins [1-200]
WO 001 ------------------ Number of SubPings [1-999]
WP 001 ------------------ Number of Pings [1-999]
WS 0005 ----------------- Bin Size (cm) [1-500]
WV 0250 ----------------- Ambiguity Velocity (cm/s)
W? ---------------------- Display W-Command Menu
```

WC – Correlation Threshold

Purpose — Sets the minimum threshold for correlation magnitude that velocity data must meet to be considered valid.

Format — WC*nnn, nnn, nnn*

Range — *nnn* = 0 to 255 counts

Default — WC 064,080,096

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

Description — The RiverPro/RioPro uses WC to screen water-track data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and depth cell size (WS). WC sets the threshold of the correlation below, which the ADCP flags the data as bad and does not average the data into the ensemble. The second and third thresholds are used for Water Mode 3 (WM3) so different thresholds can be set for mode 2 type ping, coherent pings, or pulse-to-pulse pings.

> The default threshold is 64 counts. A solid target would have a correlation of 128 counts.

WD – Data Out

Purpose — Selects the data types collected by the RiverPro/RioPro.

Format — WD v;c;a;p;s;*;*;*;*;m

Range — Firmware switches (see description)

Default — WD 1110000001

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

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

v = Velocity	*c* = Correlation	*a* = Echo Intensity	*p* = Percent good	s = Status
*= Reserved	*= Reserved	*= Reserved	*= Reserved	*m* = Beam Correction Matrix

Example — WD 1110000001 (default) tells the RiverPro/RioPro to collect velocity, correlation magnitude, echo intensity, percent-good, and beam correction matrix.

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 RiverPro/RioPro does not collect water-profile data.
3. Spaces in the command line are allowed.
4. Status data is not used, as it does not mean anything.

WF – Blank after Transmit

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

Format WF*nnnn*

Range *nnnn* = 0 to 500 cm

Default WF0016 (1200, WM3), 0019 (1200, WM2 or 12), 0025 (600)

Recommended Setting. The default setting for this command is recommended for most applications. If you are using *WinRiver II*, let the software set the WF command setting.

Description WF positions the start of the first depth cell at some vertical distance from the transducer head. This allows the RiverPro/RioPro 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.

WM – Water Profiling Mode

Purpose Selects the application-dependent profiling mode used by the RiverPro/RioPro.

Format WM*nnnn*

Range *nnnn* = 2, 3, and 12 (see description)

Default WM0003 (1200), 0002 (600)

Recommended Setting. The default setting for this command is recommended for most applications. If you are using *WinRiver II*, let the software set the WM command setting.

Description The WM command lets you select 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.

Table 16: Water Modes

Mode	Description
WM2	Manual mode
WM3	Automatic mode (Default)
WM12	Manual mode High Ping Rate

The default mode is the Automatic Mode (WM3). WM2 and WM12 are considered “manual modes”, and are feature upgrades (see Feature Upgrades).

WN – Number of Bins

Purpose Sets the number of bins (depth cells) over which the RiverPro/RioPro collects data.

Format WN*nnn*

Range *nnn* = 1 to 200 depth cells

Default WN200

Recommended Setting. Set using *WinRiver*.

Description The range of the RiverPro/RioPro is set by the number of depth cells (WN) times the size of each depth cell (WS).

WO – Number of SubPings

Purpose Controls the number of SubPings in Mode 12 water profiling.

Format WO*x*

Range *x* = 1 to 100 sub-pings

Default WO001

Recommended Setting. Special applications only.

Description: In Mode 12, a number of sub-pings are transmitted very rapidly and their results are averaged internally to form a single Mode 12 ping.

This command has no effect unless the WM command is set to WM12.

WP – Number of Pings

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

Format WPnnn

Range nnn = 0 to 999 pings

Default WP001

Recommended Setting. Set using *WinRiver*.

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

1. If WP = zero the RiverPro/RioPro does not collect water-profile data.
2. The RiverPro/RioPro automatically extends the ensemble interval (TE) if WP x TP > TE.

WS – Bin Size

Purpose Selects the volume of water for one measurement cell (bin).

Format WSnnn

Range nnn = 2 to 500 cm

Default WS005

Recommended Setting. Set using *WinRiver*.

Description The RiverPro/RioPro collects data over a variable number of bins. WS sets the size of each bin in vertical centimeters.

WV – Ambiguity Velocity

Purpose Sets the radial ambiguity velocity.

Format WV*nnnn*

Range *nnnn* = 5 to 999 cm/s

Default WV0250

Recommended Setting. Set using the WinRiver II wizard.

Description Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur. Rule of thumb: Set WV to the maximum relative horizontal velocity between water-current speed and RiverPro/RioPro speed.

The WV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam when operating in water mode 1 (WM1). WV is 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 (RiverPro/RioPro motion plus water speed). The following formula is used to determine the setting of the WV command: WV = (Max. Apparent Vel. cm/s) * sin(beam angle) * 1.5, where 1.5 is a safety factor.

Vertical Beam Profile Commands

The following commands define the criteria used to collect the vertical beam profile data.

Vertical beam profiling extends the ping time approximately 25% for manual modes. Ping time depends on water depth and number of bins.

RioPro systems do not include a vertical beam.

Not available on RiverPro600 systems.

Standard Vertical Beam Profile Commands

This section lists the vertical beam profile commands.

```
>Z?
Available Commands:

ZB 0 -------------------- Bandwidth [0=Wide (25%), 1=Narrow (6.25%)]
ZC 064 ------------------ Correlation Threshold (counts) [0..255]
ZD 111100000 ------------ Data Out {v;c;a;p;s;*;*;*;*}
ZF 020 ------------------ Blanking Distance (cm) [0-500]
ZG 1 -------------------- Gain [0=low, 1=high]
ZM 2 -------------------- V-Beam Profile Mode [2=Linear, 12=LinPhasePlaneAvg]
ZN 010 ------------------ Number of Bins [1-200]
ZO 004 ------------------ Number of Mode-12 Subpings [0-20]
ZP 000 ------------------ Number of Pings [0-999]
ZS 010 ------------------ Bin Size (cm) [2-500]
ZV 250 ------------------ Ambiguity Velocity (cm/s) [5-700]
Z? ---------------------- Display Z-Command Menu
>
```

ZB – Vertical Beam Bandwidth

Purpose: Sets the vertical beam profile bandwidth (sampling rate).

Format: ZB*n*

Range: *n* = 0=Wide (25%), 1=Narrow (6.25%)

Default: ZB0

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

Description: Narrow bandwidths allow the RiverPro to profile farther, but the standard deviation is increased by as much as 2.5 times.

ZC – Vertical Beam Correlation Threshold

Purpose: Sets the minimum threshold for correlation magnitude that vertical beam profile velocity data must meet to be considered valid.

Format: ZC*nnn*

Range: *nnn* = 0 to 255 counts

Default: ZC064

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

Description: The RiverPro uses ZC to screen vertical beam profile data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and vertical beam profile depth cell size (ZS). ZC sets the threshold of the correlation below, which the RiverPro/RioPro 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 128 counts.

ZD – Vertical Beam Data Out

Purpose: Selects the vertical beam profile data types collected by the RiverPro.

Format: ZD *vca ps** ***

Range: Firmware switches (see description)

Default: ZD 111100000

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

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

v = Velocity	*p*= Percent good	* = Reserved
c = Correlation	s = Status	* = Reserved
a = Echo Intensity	* = Reserved	* = Reserved

ZF – Vertical Beam 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: ZF*nnn*

Range: *nnn* = 0 to 500 cm

Default: ZF020

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

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

ZG – Vertical Beam Gain

Purpose: Allows the RiverPro to reduce receiver gain by 40 dB.

Format: ZG*n*

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

Default: ZG1

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

Description: ZG0 tells the RiverPro 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. ZG1 (the default) uses the normal receiver gain.

ZM – Vertical Beam Profile Mode

Purpose: Selects the vertical beam profiling mode used by the RiverPro.

Format: ZM*n*

Range: *n* = 2, 12 (see description)

Default: ZM2

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

Description: The ZM command sets 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.

ZM2 refers to water mode 2 (WM2) pings for the vertical beam profile ping. WM2 pings are very similar to TRDI's traditional WM1 pings, except that they use 8-bit sampling instead of 1-bit sampling. These pings use a relatively short lag (i.e. large ambiguity velocity), and make the assumption that the velocities being measured will never rise above the ambiguity velocity; i.e. there is no ambiguity resolving being done.

ZM12 is essentially the same type of measurement as ZM2, except that there are subpings (the number being set by the ZO command) being averaged together in the phase plane, before the resulting average is converted from phase data to velocity. This has the effect of increasing the effective ping rate (and thus, lowering standard deviation) in very low-dynamic environments. If the dynamics of the environment are too high (e.g. if the RiverPro is bouncing around), ZM12 would tend to smear together data sampled at different orientations, resulting in lower-quality measurements.

ZN – Vertical Beam Number of Bins

Purpose: Sets the number of vertical beam profile bins (depth cells) over which the RiverPro collects data.

Format: ZN*nnn*

Range: *nnn* = 1 to 200 bins

Default: ZN010

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

Description: The range of the RiverPro vertical beam is set by the number of bins (ZN) times the size of each bin (ZS). The backscatter level is also a factor in determining the range that can be effectively measured by the vertical beam.

ZO – Vertical Beam Number of Mode-12 Subpings

Purpose: Controls the number of sub-pings of Mode 12 vertical beam profiling.

Format: ZO*nnn*

Range: *n* = 0 to 20 sub-pings

Default: ZO004

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

Description: In Mode 12, a number of sub-pings are transmitted very rapidly and their results are averaged internally to form a single Mode 12 ping.

> This command has no effect unless the ZM command is set to ZM12.

ZP – Vertical Beam Number of Pings

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

Format: ZP*nnn*

Range: *nnn* = 0 to 999 pings

Default: ZP000

> Recommended Setting. The default setting is ZP0, which disables vertical beam profiling; if you want a vertical beam profile, set ZP to >0.

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

ZS – Vertical Beam Bin Size

Purpose: Sets the vertical length of the bin, which indirectly sets the volume.

Format: ZS*nnn*

Range: *nnn* = 2 to 500 cm

Default: ZS010

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

Description: The RiverPro collects data over a number of bins. ZS sets the size of each bin in vertical centimeters.

ZV – Vertical Beam Ambiguity Velocity

Purpose: Sets the vertical beam radial ambiguity velocity.

Format: ZV*nnn*

Range: *nnn* = 5 to 700 cm/s

Default: ZV 250

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

Description: Set ZV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur. Rule of thumb: Set ZV to the maximum relative horizontal velocity between water-current speed and RiverPro speed.

The ZV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam when operating in water mode 2 or 12 (ZM2 or ZM12). ZV is used to improve the single-ping standard deviation. The lower the value of the ZV command, the lower the single-ping standard deviation.

Set the ZV command based on the maximum apparent velocity (RiverPro motion plus water speed). The following formula is used to determine the setting of the ZV command: ZV = (Max. Apparent Vel. cm/s) * sin(beam angle) * 1.5, where 1.5 is a safety factor.

Note that the minimum setting of the ZV command is ZV005 and the maximum setting due to internal processing limitations is limited based on the setting of the ZB bandwidth command.

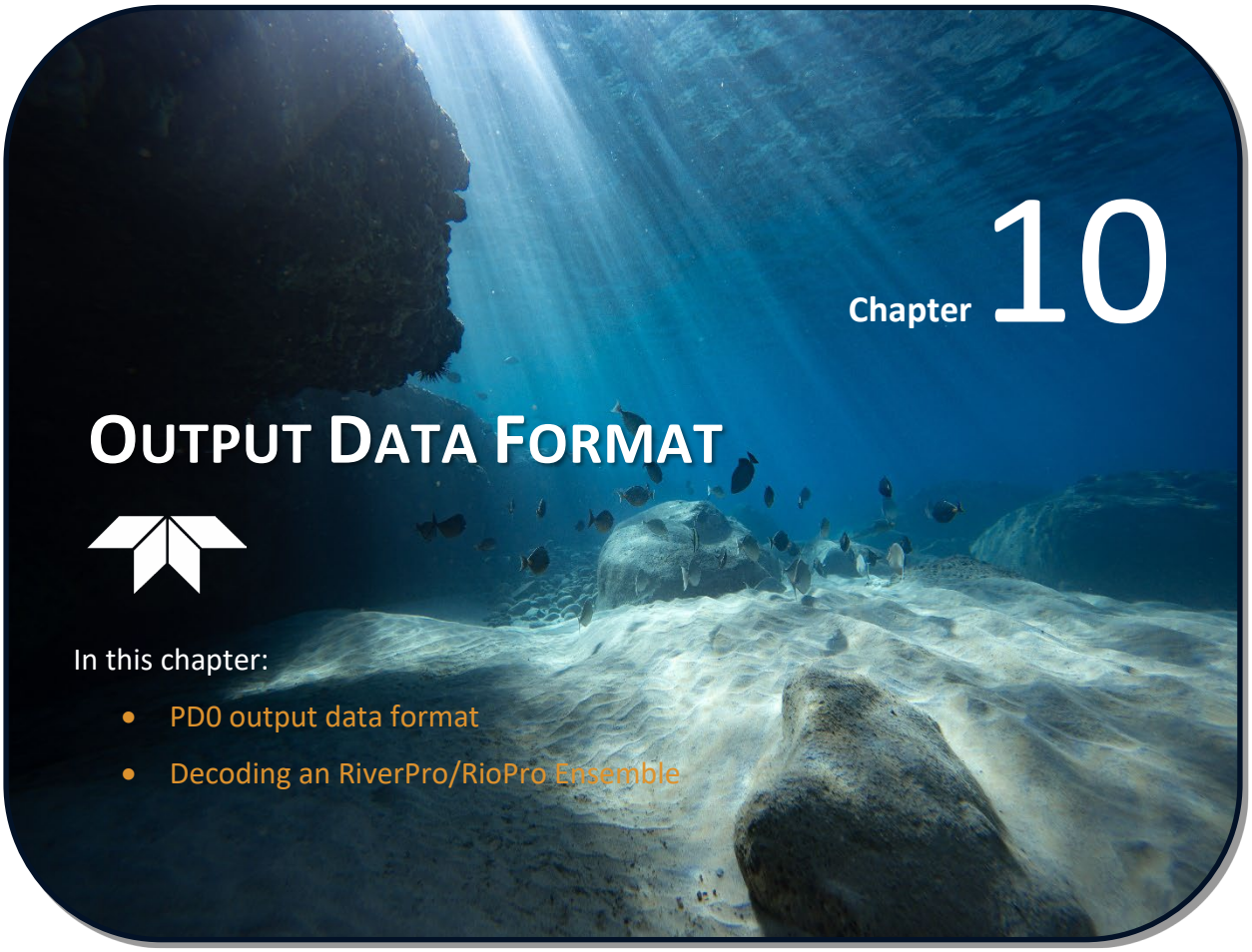
ZV is limited to 330 cm/s in Narrow bandwidth mode (ZB1), which increases the profiling range by 10% compared to Broad bandwidth mode (ZB0).

When the ZB command is set to ZB0, the max value is ZV700.

In either case, while you can set a value as low as 5 cm/s, this will likely cause ambiguity errors. TRDI recommends setting ZV to ≥ 100cm/s for most applications.

The 1.5 value is a safety factor.

NOTES



Chapter 10

OUTPUT DATA FORMAT

In this chapter:

- PD0 output data format
- Decoding an RiverPro/RioPro Ensemble

PD0 Output Data Format

This section shows the output data format of the RiverPro/RioPro and explains it in enough detail to help create your own data processing or analysis programs (see How to Decode an RiverPro/RioPro Ensemble).

The following description is for the standard PD0 RiverPro/RioPro output data format. Figure 27 through Figure 45 shows the ASCII and binary data formats for the RiverPro/RioPro PD0 mode. Table 18 through Table 45 defines each field in the output data structure.

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

The RiverPro/RioPro by default is set to collect velocity, correlation data, echo intensity, and percent good data. The data, preceded by ID code 7F7F, contains header data (explained in Table 18). The fixed and variable leader data is preceded by ID codes 0000 and 8000, (explained in Table 19 and Table 20). The RiverPro/RioPro always collects the Header and Leader.

The remaining lines include Water Velocity Profile data and Bottom Track data, described in detail below. Note that for certain conditions, RiverPro/RioPro adds a new type of Water Velocity Profile data called ‘surface bins’. Surface bin data may have a different bin size than the remainder of the velocity profile. The table below shows some of the most common IDs.

Table 17: Data ID Codes

ID	LSB	MSB	Description
0x7F7F	7F	7F	Header
0x0000	00	00	Fixed Leader
0x0080	80	00	Variable Leader
0x0100	00	01	Velocity Profile Data
0x0200	00	02	Correlation Profile Data
0x0300	00	03	Echo Intensity Profile Data
0x0400	00	04	Percent Good Profile Data
0x0600	00	06	Bottom Track Data
0x4100	00	41	Vertical Beam Range Data
0x0F01	01	0F	Vertical Beam Profile Leader Data
0x0A00	00	0A	Vertical Beam Profile Velocity Data
0x0B00	00	0B	Vertical Beam Profile Correlation Data
0x0C00	00	0C	Vertical Beam Profile Echo Intensity Data
0x0D00	00	0D	Vertical Beam Profile Percent Good Data
0x0E00	00	0E	Vertical Beam Profile Status Data
0x0010	10	00	Surface Layer Velocity Leader
0x0110	10	01	Surface Layer Velocity
0x0210	10	02	Surface Layer Correlation Profile Data
0x0310	10	03	Surface Layer Echo Intensity Profile Data
0x0410	10	04	Surface Layer Percent Good Profile Data
0x4401	01	44	Automatic Mode Setup
0x4400	00	44	Firmware Status Data
0x2022	22	20	NMEA GPS Data Messages
0x3200	00	32	Transformation Matrix

The RiverPro/RioPro always sends the Least Significant Byte (LSB) first.

RioPro systems do not include the vertical beam outputs.

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (59 BYTES)
	VARIABLE LEADER DATA (65 BYTES)
PROFILE DATA (as selected - cell size and number of cells is dynamic)	**WATER VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	WATER CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	WATER ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	WATER PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	WATER STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BOTTOM TRACK	**BOTTOM TRACK DATA** (89 BYTES)
SURFACE LAYER DATA (as selected)	**SURFACE LAYER LEADER** (7 BYTES)
	SURFACE VELOCITY (2 BYTES + 8 BYTES PER DEPTH CELL)
	SURFACE CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	SURFACE ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	SURFACE PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	SURFACE STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
AUTOMATIC WATER PROFILE (if selected)	**AUTOMATIC MODE 3 SETUP DATA** (101 BYTES)
FIRMWARE STATUS	**FIRMWARE STATUS DATA** (22 BYTES)
VERTICAL BEAM RANGE (RiverPro only)	**VERTICAL BEAM RANGE** (9 BYTES)
VERTICAL BEAM PROFILE DATA (RiverPro only)	**VERTICAL BEAM PROFILE LEADER** (40 BYTES)
	VERTICAL BEAM WATER VELOCITY (2 BYTES + 2 BYTES PER DEPTH CELL)
	VERTICAL BEAM WATER CORRELATION MAGNITUDE (2 BYTES + 1 BYTES PER DEPTH CELL)
	VERTICAL BEAM WATER ECHO INTENSITY (2 BYTES + 1 BYTES PER DEPTH CELL)
	VERTICAL BEAM WATER PERCENT GOOD (2 BYTES + 1 BYTES PER DEPTH CELL)
	VERTICAL BEAM WATER STATUS (2 BYTES + 1 BYTES PER DEPTH CELL)
NMEA MESSAGES	**NMEA GPS MESSAGES – if present** (15+ BYTES)
BEAM CORRECTION MATRIX (if selected)	**BEAM CORRECTION MATRIX –** (34 BYTES)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 27. PD0 Standard Output Data Buffer Format

The number of data cells output will depend on the depth during the ensemble and will vary from ensemble to ensemble. Some data types will only appear in the output if enabled by command.

WinRiver II may add additional bytes.

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

Header Data Format

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

See Table 18 for a description of the fields.

Figure 28. Header Data Format

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

Table 18: Header Data Format

Hex Digit	Binary Byte	Field	Description
1,2	1	HDR ID / Header ID	Stores the header identification byte (7Fh).
3,4	2	HDR ID / Data Source ID	Stores the data source identification byte (7Fh for the RiverPro/RioPro).
5-8	3,4	Bytes / Number of bytes in ensemble	This field contains the number of bytes from the start of the current ensemble up to, but not including, the 2-byte checksum (Figure 45).
9,10	5	Spare	Undefined.
11,12	6	No. DT / Number of Data Types	This field contains the number of data types selected for collection. By default, fixed/variable leader, velocity, correlation magnitude, echo intensity, and percent good are selected for collection. This field will therefore have a value of six (4 data types + 2 for the Fixed/Variable Leader data).
13-16	7,8	Address Offset for Data Type #1 / Offset for Data Type #1	This field contains the internal memory address offset where the RiverPro/RioPro will store information for data type #1 (with this firmware, always the Fixed Leader). Adding “1” to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #1 begins (the first byte of the ensemble is Binary Byte #1).
17-20	9,10	Address Offset for Data Type #2 / Offset for Data Type #2	This field contains the internal memory address offset where the RiverPro/RioPro will store information for data type #2 (with this firmware, always the Variable Leader). Adding “1” to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #2 begins (the first byte of the ensemble is Binary Byte #1).
21-24 thru 2n+13 to 2n+16	11,12 thru 2n+5, 2n+6	Address Offsets for Data Types #3-n / Offset for Data Type #3 through #n	These fields contain internal memory address offset where the RiverPro/RioPro will store information for data type #3 through data type #n. Adding “1” to this offset number gives the absolute Binary Byte number in the ensemble where Data Types #3-n begin (first byte of ensemble is Binary Byte) #1).

Fixed Leader Data Format

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
1	FIXED LEADER ID								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	REAL/SIM FLAG								
8	LAG LENGTH								
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS								
11	PINGS PER ENSEMBLE								LSB
12									MSB
13	DEPTH CELL LENGTH								LSB
14									MSB
15	BLANK AFTER TRANSMIT								LSB
16									MSB
17	PROFILING MODE								
18	LOW CORR THRESH								
19	NO. CODE REPS								
20	PERCENT GOOD								
21	ERROR VELOCITY MAXIMUM {WE}								LSB
22									MSB
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS {TP}								
26	COORDINATE TRANSFORM {EX}								
27	HEADING ALIGNMENT {EA}								LSB
28									MSB
29	HEADING BIAS {EB}								LSB
30									MSB
31	SENSOR SOURCE {EZ}								
32	SENSORS AVAILABLE								
33	BIN 1 DISTANCE								
34									
35	XMIT PULSE LENGTH BASED ON								LSB
36									MSB

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
37	SPARE								LSB
38									MSB
39	FALSE TARGET THRESH {WA}								
40	SPARE								
41	TRANSMIT LAG DISTANCE								LSB
42									MSB
43	CPU BOARD SERIAL NUMBER								LSB
↓									↓
50									MSB
51	SYSTEM BANDWIDTH								LSB
52									MSB
53	SYSTEM POWER								
54	SPARE								
55	INSTRUMENT SERIAL NUMBER								MSB
↓									
58									LSB
59	BEAM ANGLE								

See Table 19 for a description of the fields

Figure 29. Fixed Leader Data Format

In Mode 3 (WM3) the Data Ping is the source of all values describing the ping, such as Code Reps, Transmit Length, and Lag. Values in the Fixed Leader are no longer fixed and may change from ping to ping, e.g. Cell count, Cell Size, Cell 1 Start, Lag Length. Fixed Leader data also contains hardware information. The RiverPro/RioPro always sends Fixed Leader data as output data (LSBs first).

Table 19: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word (00 00h).
5,6	3	fv / CPU F/W Ver.	Contains the version number of the CPU firmware.
7,8	4	fr / CPU F/W Rev.	Contains the revision number of the CPU firmware.
9-12	5,6	Sys Cfg / System Configuration	This field defines the RiverPro/RioPro hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows. LSB BITS 7 6 5 4 3 2 1 0 - - - - - 0 0 0 75-kHz SYSTEM - - - - - 0 0 1 150-kHz SYSTEM - - - - - 0 1 0 300-kHz SYSTEM - - - - - 0 1 1 600-kHz SYSTEM - - - - - 1 0 0 1200-kHz SYSTEM - - - - - 1 0 1 2400-kHz SYSTEM - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - SENSOR CONFIG #1 - - 0 1 - - - - SENSOR CONFIG #2 - - 1 0 - - - - SENSOR CONFIG #3 - 0 - - - - - - XDCR HD NOT ATT. - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 0 15E BEAM ANGLE - - - - - - 0 1 20E BEAM ANGLE - - - - - - 1 0 30E BEAM ANGLE - - - - - - 1 1 OTHER BEAM ANGLE 0 1 0 0 - - - - 4-BEAM JANUS CONFIG 0 1 0 1 - - - - 5-BM JANUS CFIG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD) Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods). Note: XDCR HD ATTACHED refers to whether the chassis and transducer are delivered as one piece; This is not a sensor detect.
13,14	7	PD / Real/Sim Flag	This field is set by default as real data (0).
15,16	8	Lag Length	Lag Length. The lag is the time period between sound pulses. This is varied as required by the RiverPro/RioPro.
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The RiverPro/RioPro 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 RiverPro/RioPro does not make this validity check. Table 24 (Percent-Good Data Format) has more information.
19,20	10	Number of Cells	Contains the number of depth cells over which the RiverPro/RioPro collects data. This value changes as measurement conditions, primarily depth, change. This value does not include the number of cells in surface data, when present. Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells
21-24	11,12	Data Pings Per Ensemble	Contains the number of data pings averaged together the automatic pinging of the RiverPro/RioPro. Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
25-28	13,14	Depth Cell Length	Contains the length of one depth cell of non-surface layer data. Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)

Table 19: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
29-32	15,16	Blank after Transmit	Contains the blanking distance used by the RiverPro/RioPro to allow the transmit circuits time to recover before the receive cycle begins. This value is fixed. Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Signal Processing Mode	Contains the Signal Processing Mode. May be 0,1,2,3, or 31.
35,36	18	Low Corr Thresh	Contains the minimum threshold of correlation that water-profile data can have to be considered good data. This is automatically varied by the RiverPro/RioPro Scaling: LSD = 1 count; Range = 0 to 255 counts
37,38	19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse for non-surface layer data. Uses Data Ping value. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	Percent Good	This field is always 1.
41-44	21,22	WE / Error Velocity Threshold	This field, initially set by the WE-command, contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, the RiverPro/RioPro flags all four beams of the affected bin as bad. Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s
45,46 47,48 49,50	23 24 25	Minutes Seconds Hundredths	These fields, set by the TP-command, contain the amount of time between ping groups in the ensemble. NOTE: The RiverPro/RioPro automatically extends the ensemble interval (set by TE) if (WP x TP > TE).
51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX-command). These firmware switches indicate how the RiverPro/RioPro collected data. xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES) xxx01xxx = INSTRUMENT COORDINATES xxx10xxx = SHIP COORDINATES xxx11xxx = EARTH COORDINATES xxxxx1xx = TILTS (PITCH AND ROLL) USED IN SHIP OR EARTH TRANSFORMATION xxxxxx1x = 3-BEAM SOLUTION USED IF ONE BEAM IS BELOW THE CORRELATION THRESHOLD SET BY THE WC-COMMAND xxxxxxx1 = BIN MAPPING USED
53-56	27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (EA-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
57-60	29,30	EB / Heading Bias	Contains a correction factor for electrical/magnetic heading bias (EB-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ-command). These firmware switches indicate the following. FIELD DESCRIPTION x1xxxxxx = CALCULATES EC (SPEED OF SOUND) FROM ED, ES, AND ET xx1xxxxx = USES ED FROM DEPTH SENSOR xxx3xxxx = USES EH FROM TRANSDUCER HEADING SENSOR Xxxx3xxx = USES EP FROM TRANSDUCER PITCH SENSOR Xxxxx3xx = USES ER FROM TRANSDUCER ROLL SENSOR xxxxxx1x = USES ES (SALINITY) FROM CONDUCTIVITY SENSOR xxxxxxx1 = USES ET FROM TRANSDUCER TEMPERATURE SENSOR NOTE: If the field = 0, or if the sensor is not available, the RiverPro/RioPro uses the manual command setting. If the field = 3, the RiverPro/RioPro uses the reading from the internal sensor or an external synchro sensor (only applicable to heading, roll, and pitch). Although a "2" can be entered in the EZ-command string, the RiverPro/RioPro only displays a 0 (manual) or 1 or 3 (internal/external sensor).
63,64	32	Sensor Avail	This field reflects which sensors are available. The bit pattern is the same as listed for the EZ-command (above).

Table 19: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
65-68	33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first non-surface layer depth cell (bin). This value is dynamic and automatically set for each ping by the RiverPro/RioPro. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-72	35,36	Xmit pulse length	This field contains the length of the transmit pulse. This is the value for non-surface layer cells and is automatically set by the RiverPro/RioPro. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
73,74	37	Spare	This field is always 1.
75,76	38	Spare	This field is always 1.
77,78	39	WA / False Target Threshold	Contains the threshold value used to reject data received from a false target, usually fish (WA-command). Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
79,80	40	Spare	This field is always 1.
81-84	41,42	Transmit lag distance	This field, set automatically by the RiverPro/RioPro, contains the distance between pulse repetitions. This applies only to non-surface layer cells. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters
85-100	43-50	CPU Board Serial Number	Contains the serial number of the CPU board.
101-105	51-52	System Bandwidth	Word contains bandwidth that would be used for mode 1 or 2. Does not contain mode 3 or 31 information.
106-107	53	System Power	This field is always 0.
108-109	54	Spare	Spare
110-119	55-58	Serial #	Instrument serial number. The CPU Board Serial number is stored in Big Endian (MSB sent first).
120 -121	59	Beam Angle	Beam angle

Variable Leader Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	VARIABLE LEADER ID								80h
2									00h
3	ENSEMBLE NUMBER								LSB
4									MSB
5	RTC YEAR {TS}								
6	RTC MONTH {TS}								
7	RTC DAY {TS}								
8	RTC HOUR {TS}								
9	RTC MINUTE {TS}								
10	RTC SECOND {TS}								
11	RTC HUNDREDTHS {TS}								
12	ENSEMBLE # MSB								
13	BIT FAULT								
14	BIT COUNT								
15	SPEED OF SOUND {EC}								LSB
16									MSB
17	DEPTH OF TRANSDUCER {ED}								LSB
18									MSB
19	HEADING {EH}								LSB
20									MSB
21	PITCH (TILT 1) {EP}								LSB
22									MSB
23	ROLL (TILT 2) {ER}								LSB
24									MSB
25	SALINITY {ES}								LSB
26									MSB
27	TEMPERATURE {ET}								LSB
28									MSB
29	MPT MINUTES								
30	MPT SECONDS								
31	MPT HUNDREDTHS								
32	HDG STD DEV								
33	PITCH STD DEV								
34	ROLL STD DEV								

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0
35	ADC CHANNEL 0							
36	ADC CHANNEL 1							
37	ADC CHANNEL 2							
38	ADC CHANNEL 3							
39	ADC CHANNEL 4							
40	ADC CHANNEL 5							
41	ADC CHANNEL 6							
42	ADC CHANNEL 7							
43								
↓	RESERVED							
57								
58	RTC CENTURY							
59	RTC YEAR							
60	RTC MONTH							
61	RTC DAY							
62	RTC HOUR							
63	RTC MINUTE							
64	RTC SECOND							
65	RTC HUNDREDTH							
66	LAG NEAR BOTTOM							

See Table 20 for a description of the fields.

Figure 30. Variable Leader Data Format

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

Table 20: Variable Leader Data Format

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

5-8	3,4	Ens / Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply.
			Scaling: LSD = 1 ensemble; Range = 1 to 65,535 ensembles
			NOTE: The first ensemble collected is #1. At "rollover," we have the following sequence:
			`1 = ENSEMBLE NUMBER 1`
			`↓`
			`65535 = ENSEMBLE NUMBER 65,535 | ENSEMBLE`
			`0 = ENSEMBLE NUMBER 65,536 | #MSB FIELD`
			`1 = ENSEMBLE NUMBER 65,537 | (BYTE 12) INCR.`

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

27-28	13	BIT Fault	Fault code for active fault. If more than one fault is active, as indicated by the BIT Count, the active faults codes will cycle on the each successive ping. Fault codes include:
			`1 Transmitter Shutdown`
			`2 Transmitter OverCurrent`
			`3 Transmitter UnderCurrent`
			`4 Transmitter UnderVoltage`
			`16 FIFO Interrupt Missed`
			`17 FIFO ISR Re-entry`
			`41 Compass handler error`
			`42 Compass init fail`
			`43 Compass start fail`
			`44 Compass fail`
			`45 Temperature memory fail`
			`46 Temperature init fail`
			`47 Temperature device fail`
			`48 AP Stuck UART`
			`49 UART TX timeout`
			`50 UART IRQ Stuck`
			`51 UART Buffer Stuck`
			`52 UART IRQ Active`
			`53 UART not cleared`
			`54 UART break timed out`
			`55 UART sleep timed out`
			`80 RTC low battery`
			`81 RTC time not set`
			`82 RTC calibration failure`
			`96 Loop recorder fail`
			`176 GPS init fail`
			`177 GPS start fail`
			`178 GPS comm fail`
			`192 Bluetooth init fail`
			`193 Bluetooth comm fail`
			`209 NMEA msg init fail`
			`224 Firmware fault`
			`225 Memory fault`

25-26	14	BIT count	This field contains the current number of active faults detected by the RiverPro/RioPro's Built-in Test function. A zero code indicates no active faults.
29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s

Table 20: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
37-40	19,20	EH / Heading	Contains the RiverPro/RioPro heading angle (EH-command). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees
41-44	21,22	EP / Pitch (Tilt 1)	Contains the RiverPro/RioPro pitch angle (EP-command). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
45-48	23,24	ER / Roll (Tilt 2)	Contains the RiverPro/RioPro roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing RiverPro/RioPro, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing RiverPro/RioPro, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
53-56	27,28	ET / Temperature	Contains the temperature of the water at the transducer head (ET-command). This value may be a manual setting or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees
57,58 59,60 61,62	29 30 31	MPT minutes MPT seconds MPT hundredths	This field contains the Minimum Pre-Ping Wait Time between ping groups in the ensemble.
63,64 65,66 67,68	32 33 34	H/Hdg Std Dev P/Pitch Std Dev R/Roll Std Dev	These fields contain the standard deviation (accuracy) of the heading and tilt angles from the gyrocompass/pendulums. Scaling (Heading): LSD = 1°; Range = 0 to 180° Scaling (Tilts): LSD = 0.1°; Range = 0.0 to 20.0°
69-70	35	ADC Channel 0	0
71-72	36	ADC Channel 1	Battery Voltage 0.1volts
73-74	37	ADC Channel 2	0
75-76	38	ADC Channel 3	0
77-78	39	ADC Channel 4	0
79-80	40	ADC Channel 5	0
81-82	41	ADC Channel 6	0
83-84	42	ADC Channel 7	0
85-114	43-57	Reserved	0
115-116	58	RTC Century	These fields contain the time from the RiverPro/RioPro's Y2K compliant real-time clock (RTC) that the current data ensemble began. The TT-command (Set Real-Time Clock) initially sets the clock. The RiverPro/RioPro does account for leap years.
117-118	59	RTC Year	
119-120	60	RTC Month	
121-122	61	RTC Day	
123-124	62	RTC Hour	
125-126	63	RTC Minute	
127-128	64	RTC Seconds	
129-130	65	RTC Hundredths	
131-132	66	Lag Near Bottom	Lag Near Bottom (1=true, 0=false)

Velocity Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VELOCITY ID								LSB 00h
2									MSB 01h
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
5	DEPTH CELL #1, VELOCITY 2								LSB
6									MSB
7	DEPTH CELL #1, VELOCITY 3								LSB
8									MSB
9	DEPTH CELL #1, VELOCITY 4								LSB
10									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
13	DEPTH CELL #2, VELOCITY 2								LSB
14									MSB
15	DEPTH CELL #2, VELOCITY 3								LSB
16									MSB
17	DEPTH CELL #2, VELOCITY 4								LSB
18									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 200 CELLS)								↓
1019	DEPTH CELL #200, VELOCITY 1								LSB
1020									MSB
1021	DEPTH CELL #200, VELOCITY 2								LSB
1022									MSB
1023	DEPTH CELL #200, VELOCITY 3								LSB
1024									MSB
1025	DEPTH CELL #200, VELOCITY 4								LSB
1026									MSB

See Table 21 for description of fields

Figure 31. Velocity Data Format

The number of cells for all profile data types is dynamic and will change from ensemble to ensemble. The maximum cell count is 200.

The RiverPro/RioPro 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 RiverPro/RioPro scales velocity data in millimeters per second (mm/s). A value of –32768 (8000h) indicates bad velocity values.

All velocities are relative based on a stationary instrument. To obtain absolute velocities, algebraically remove the velocity of the instrument. For example,

```
RELATIVE WATER CURRENT VELOCITY:    EAST 650 mm/s
INSTRUMENT VELOCITY            : (-) EAST 600 mm/s
ABSOLUTE WATER VELOCITY        :     EAST  50 mm/s
```

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

EX-CMD	COORD SYS	VEL 1	VEL 2	VEL 3	VEL 4
EX00xxx	BEAM	TO BEAM 1	TO BEAM 2	TO BEAM 3	TO BEAM 4
EX01xxx	INSTRUMENT	Bm1-Bm2 axis	Bm4-Bm3 axis	TO XDUCER	ERR VEL
EX10xxx	SHIP	PRT-STBD	AFT-FWD	TO SURFACE	ERR VEL
EX11xxx	EARTH	TO EAST	TO NORTH	TO SURFACE	ERR VEL

Positive values indicate water movement toward the RiverPro/RioPro

Table 21: Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word (00 01h).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
9-12	5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2. See above.
13-16	7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3. See above.
17-20	9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4. See above.
21-2052	11-1026	Cells 2 – 128 (if used)	These fields store the velocity data for depth cells 2 through 128 (depending on the setting of the WN-command). These fields follow the same format as listed above for depth cell 1.

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

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	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 200 CELLS)								↓
511	DEPTH CELL #200, FIELD #1								
512	DEPTH CELL #200, FIELD #2								
513	DEPTH CELL #200, FIELD #3								
514	DEPTH CELL #200, FIELD #4								

See Table 22 through Table 25 for a description of the fields.

Figure 32. Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

The number of cells for all profile data types is dynamic and will change from ensemble to ensemble. The maximum cell count is 200.

Correlation magnitude data give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The RiverPro/RioPro represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target). A value of zero indicates bad correlation values.

Table 22: Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word (00 02h).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam #4. See above.
13 – 1028	7 – 514	Cells 2 – 200 (if used)	These fields store correlation magnitude data for depth cells 2 through 200 for all four beams. These fields follow the same format as listed above for depth cell 1.

The echo intensity scale factor is about 0.45 dB per RiverPro/RioPro count. The RiverPro/RioPro does not directly check for the validity of echo intensity data.

Table 23: Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the echo intensity data identification word (00 03h).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam #4. See above.
13 – 1028	7 – 514	Cells 2 – 200 (if used)	These fields store echo intensity data for depth cells 2 through 200 for all four beams. These fields follow the same format as listed above for depth cell 1.

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 RiverPro/RioPro references percent-good data as shown below.

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

Note 1. Because profile data did not exceed correlation threshold (WC command).

Note 2. Because the error velocity threshold was exceeded (WE command).

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the RiverPro/RioPro 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 RiverPro/RioPro to reject some of its depth cell data. This causes the RiverPro/RioPro to calculate velocities with three beams instead of four beams. When the RiverPro/RioPro does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further depth cell, the RiverPro/RioPro 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 not typical nor desired percentages. Typically, all four beams should be about equal and greater than 25%.

On the other hand, if velocities were collected in INSTRUMENT, SHIP, or EARTH coordinates, the example values show:

FIELD 1 – Percentage of good 3-beam solutions – Shows percentage of successful velocity calculations (50%) using 3-beam solutions.

FIELD 2 – Percentage of transformations rejected – Shows percent of error velocity (5%) that was higher than the WE-command setting. WE has a default of 5000 mm/s. This large WE setting effectively prevents the RiverPro/RioPro 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 24: Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word (00 04h).
5,6	3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
7,8	4	Depth cell 1, Field 2	Stores percent-good data for depth cell #1, field 2. See above.
9,10	5	Depth cell 1, Field 3	Stores percent-good data for depth cell #1, field 3. See above.
11,12	6	Depth cell 1, Field 4	Stores percent-good data for depth cell #1, field 4. See above.
13-1028	7-514	Depth cell 2 – 200 (if used)	These fields store percent-good data for depth cells 2 through 200, following the same format as listed above for depth cell 1.

Table 25: Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the status data identification word (00 05h).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, field 1. 1=good, 0=bad
7,8	4	Depth cell 1, Field 2	Stores status data for depth cell #1, field 2. 1=good, 0=bad
9,10	5	Depth cell 1, Field 3	Stores status data for depth cell #1, field 3. 1=good, 0=bad
11,12	6	Depth cell 1, Field 4	Stores status data for depth cell #1, field 4. 1=good, 0=bad
13-1028	7-514	Depth cell 2 – 200 (if used)	These fields store status data for depth cells 2 through 200, following the same format as listed above for depth cell 1.

Bottom-Track Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	BOTTOM-TRACK ID								LSB 00h
2									MSB 06h
3	BT PINGS PER ENSEMBLE {BP}								LSB
4									MSB
5	BT DELAY BEFORE RE-ACQUIRE								LSB
6									MSB
7	BT CORR MAG MIN								
8	BT EVAL AMP MIN								
9	BT PERCENT GOOD MIN								
10	BT MODE {BM}								
11	BT ERR VEL MAX								LSB
12									MSB
13	RESERVED								
14									
15									
16									
17	RESERVED								LSB
18									MSB
19									LSB
20									MSB
21									LSB
22									MSB
23									LSB
24									MSB
25	BEAM#1 BT VEL								LSB
26									MSB
27	BEAM#2 BT VEL								LSB
28									MSB
29	BEAM#3 BT VEL								LSB
30									MSB
31	BEAM#4 BT VEL								LSB
32									MSB
33	BEAM#1 BT CORR.								
34	BEAM#2 BT CORR.								
35	BEAM#3 BT CORR.								
36	BEAM#4 BT CORR.								

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
37	BEAM#1 EVAL AMP								
38	BEAM#2 EVAL AMP								
39	BEAM#3 EVAL AMP								
40	BEAM#4 EVAL AMP								
41	BEAM#1 BT %GOOD								
42	BEAM#2 BT %GOOD								
43	BEAM#3 BT %GOOD								
44	BEAM#4 BT %GOOD								
45 ↓ 70	RESERVED								
71	BT MAX. 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	RESERVED								MSB
79									MSB
80									MSB
81									MSB
82 83 84 85	RESERVED								
86	RANGE BEAM 1								
87	RANGE BEAM 2								
88	RANGE BEAM 3								
89	RANGE BEAM 4								

Figure 33. Bottom-Track Data Format

This data is output only if the BP-command is > 0. See Table 26 for a description of the fields.

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

The LSB is always sent first.

Table 26: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the bottom-track data identification word (00 06h).
5-8	3,4	BP/BT Pings per ensemble	Stores the number of bottom-track pings to average together in each ensemble (BP-command). If BP = 0, the RiverPro/RioPro does not collect bottom-track data. The RiverPro/RioPro automatically extends the ensemble interval (TE) if BP x TP > TE. Scaling: LSD = 1 ping; Range = 0 to 999 pings
9-12	5,6	BT delay before reacquire	This field is always 0.
13,14	7	BC/BT Corr Mag Min	Stores the minimum correlation magnitude value (BC-command). Scaling: LSD = 1 count; Range = 0 to 255 counts
15,16	8	BA/BT Eval Amp Min	Stores the minimum evaluation amplitude value (BA-command). Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	BT %Gd Minimum	This field is always 0.
19,20	10	BM/BT Mode	Stores the bottom-tracking mode (BM-command).
21-24	11,12	BE/BT Err Vel Max	Stores the error velocity maximum value (BE-command). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
25-32	13–16	Reserved	Reserved
33-48	17-24	Reserved	Reserved
49-64	25-32	BT Velocity/Beam #1-4 BT Vel	The meaning of the velocity depends on the EX (coordinate system) command setting. The four velocities are as follows: a) Beam Coordinates: Beam 1, Beam 2, Beam 3, Beam 4 b) Instrument Coordinates: 1->2, 4->3, toward face, error c) Ship Coordinates: Starboard, Fwd, Upward, Error d) Earth Coordinates: East, North, Upward, Error
65-72	33-36	BTCM/Beam #1-4 BT Corr.	Contains the correlation magnitude in relation to the water bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes (Table 5).
73-80	37-40	BTEA/Beam #1-4 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
81-88	41-44	BTPG/Beam #1-4 BT %Good	Contains bottom-track percent-good data for each beam, which indicate the reliability of bottom-track data. It is the percentage of bottom-track pings that have passed the RiverPro/RioPro's bottom-track validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
89-92 93-96 97 – 100	45,46 47,48 49,50	Reserved	Reserved. These fields are always 0.
101- 116	51-58	Reserved	Reserved. These fields are always 0.
117- 124	59-62	Reserved	Reserved. These fields are always 0.
125- 132	63-66	Reserved	Reserved. These fields are always 255.
133- 140	67-70	Reserved	Reserved. These fields are always 0.
141- 144	71,72	BX/BT Max. Depth	Stores the maximum tracking depth value (BX-command). Scaling: LSD = 1 decimeter; Range = 80 to 9999 decimeters
145-152	73-76	RSSI/Bm #1-4 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

Table 26: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
153, 154	77	GAIN	Contains the Gain level for shallow water. See WJ-command.
155-162	78-81	Reserved	Reserved
163-167	82-83	Reserved	Reserved. This word is always 1.
168-170	84-85	Reserved	Reserved. These fields are always 0.
171-179	86-90	Range	Contains the least significant byte of the vertical range from the RiverPro/RioPro to the water 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. Scaling: LSD = 1 cm, Range = 1 to 255 cm

Surface Layer Velocity Leader Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	SURFACE LAYER LEADER ID								LSB 10h
2									MSB 00h
3	SURFACE LAYER CELL COUNT								LSB
4	SURFACE LAYER CELL SIZE								LSB
5									MSB
6	SURFACE LAYER CELL 1 DISTANCE								LSB
7									MSB

Figure 34. Surface Layer Leader Format

Table 27: Surface Layer Leader Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Surface Layer Leader ID	Stores the surface layer velocity data identification word (10 00h).
5-6	3	Cell Count	Stores number of cells in the surface layer.
7-10	4,5	Cell Size	Stores surface layer cell size in centimeters.
11-14	6,7	Cell 1 distance	Stores distance to middle of first surface layer cell in centimeters.

Only present when there are surface layer bins to report.

Surface Layer Velocity Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VELOCITY ID								LSB 10h
2									MSB 01h
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
5	DEPTH CELL #1, VELOCITY 2								LSB
6									MSB
7	DEPTH CELL #1, VELOCITY 3								LSB
8									MSB
9	DEPTH CELL #1, VELOCITY 4								LSB
10									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
13	DEPTH CELL #2, VELOCITY 2								LSB
14									MSB
15	DEPTH CELL #2, VELOCITY 3								LSB
16									MSB
17	DEPTH CELL #2, VELOCITY 4								LSB
18									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 5 CELLS)								↓
35	DEPTH CELL #5, VELOCITY 1								LSB
36									MSB
37	DEPTH CELL #5, VELOCITY 2								LSB
38									MSB
39	DEPTH CELL #5, VELOCITY 3								LSB
40									MSB
41	DEPTH CELL #5, VELOCITY 4								LSB
42									MSB

See Table 28 for description of fields

Figure 35. Surface Layer Velocity Format

Table 28: Surface Layer Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the surface layer velocity data identification word (10 01h).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1.
9-12	5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2.
13-16	7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3.
17-20	9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4.
21-84	11-42	Cells 2 – 5 (if used)	These fields store the surface layer velocity data for depth cells 2 through 5 (depending on measurement conditions). These fields follow the same format as listed above for depth cell 1.

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

	BIT POSITIONS								
BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	DEPTH CELL #1, FIELD #4								
7	DEPTH CELL #2, FIELD #1								
8	DEPTH CELL #2, FIELD #2								
9	DEPTH CELL #2, FIELD #3								
10	DEPTH CELL #2, FIELD #4								
↓	(SEQUENCE CONTINUES FOR UP TO 5 CELLS								↓
19	DEPTH CELL #5, FIELD #1								
20	DEPTH CELL #5, FIELD #2								
21	DEPTH CELL #5, FIELD #3								
22	DEPTH CELL #5, FIELD #4								

See Table 29 through Table 31 for a description of the fields.

Figure 36. Surface Data Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

The number of Surface Layer depth cells is specified by the Surface Layer Leader Cell Count field.

Correlation magnitude data give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The RiverPro/RioPro represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target). A value of zero indicates bad correlation values.

Table 29: Surface Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the surface layer correlation magnitude data identification word (10 02h).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam #4. See above.
13 – 44	7 – 22	Cells 2 – 5 (if used)	These fields store correlation magnitude data for depth cells 2 through 5 (depending on measurement conditions) for all four beams. These fields follow the same format as listed above for depth cell 1.

The echo intensity scale factor is about 0.6 dB per RiverPro/RioPro count. The RiverPro/RioPro does not directly check for the validity of echo intensity data.

Table 30: Surface Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the surface layer echo intensity data identification word (10 03h).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam #4. See above.
13 – 44	7 – 22	Cells 2 – 5 (if used)	These fields store echo intensity data for depth cells 2 through 5 (depending on measurement conditions) 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 RiverPro/RioPro references percent-good data as shown below.

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

Note 1. Because profile data did not exceed correlation threshold (WC command).

Note 2. Because the error velocity threshold was exceeded (WE command).

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the RiverPro/RioPro 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 RiverPro/RioPro to reject some of its depth cell data. This causes the RiverPro/RioPro to calculate velocities with three beams instead of four beams. When the RiverPro/RioPro does 3-beam solutions, it stops calculating the error velocity because it needs four beams

to do this. At some further depth cell, the RiverPro/RioPro 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 not typical nor desired percentages. Typically, all four beams should be about equal and greater than 25%.

On the other hand, if velocities were collected in INSTRUMENT, SHIP, or EARTH coordinates, the example values show:

FIELD 1 – Percentage of good 3-beam solutions – Shows percentage of successful velocity calculations (50%) using 3-beam solutions.

FIELD 2 – Percentage of transformations rejected – Shows percent of error velocity (5%) that was higher than the WE-command setting. WE has a default of 5000 mm/s. This large WE setting effectively prevents the RiverPro/RioPro 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: Surface Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the surface layer percent-good data identification word (10 04h).
5,6	3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
7,8	4	Depth cell 1, Field 2	Stores percent-good data for depth cell #1, field 2. See above.
9,10	5	Depth cell 1, Field 3	Stores percent-good data for depth cell #1, field 3. See above.
11,12	6	Depth cell 1, Field 4	Stores percent-good data for depth cell #1, field 4. See above.
13-44	7-22	Depth cell 2 – 5 (if used)	These fields store percent-good data for surface layer depth cells 2 through 5 (depending on measurement conditions), following the same format as listed above for depth cell 1.

Table 32: Surface Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the surface status data identification word (10 05h).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, field 1. 1=good, 0=bad
7,8	4	Depth cell 1, Field 2	Stores status data for depth cell #1, field 2. 1=good, 0=bad
9,10	5	Depth cell 1, Field 3	Stores status data for depth cell #1, field 3. 1=good, 0=bad
11,12	6	Depth cell 1, Field 4	Stores status data for depth cell #1, field 4. 1=good, 0=bad
13-44	7-22	Depth cell 2 – 5 (if used)	These fields store status data for depth cells 2 through 5, following the same format as listed above for depth cell 1.

Automatic Mode 3 Setup

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1.	ID CODE								LSB
2.									MSB
3.	BEAM COUNT								
4.	BEAM 1 SETUP								
5.	BEAM 1 DEPTH								LSB
6.									MSB
7.	BEAM 1 DATA PING COUNT								
8.	BEAM 1 Ping Type								
9.	BEAM 1 Cell Count								LSB
10.									MSB
11.	BEAM 1 Cell Size								LSB
12.									MSB
13.	BEAM 1 Bin 1 Mid								LSB
14.									MSB
15.	BEAM 1 Code Reps								
16.	BEAM 1 Transmit Length								LSB
17.									MSB
18.	BEAM 1 Lag Length								LSB
19.									MSB
20.	BEAM 1 Transmit Bandwidth								
21.	BEAM 1 Receiver Bandwidth								
22.	BEAM 1 Min Ping Interval								LSB
23.									MSB
24.	BEAM 2 SETUP								
25.	BEAM 2 DEPTH								LSB
26.									MSB
27.	BEAM 2 DATA PING COUNT								
28.	BEAM 2 Ping Type								
29.	BEAM 2 Cell Count								LSB
30.									MSB
31.	BEAM 2 Cell Size								LSB
32.									MSB
33.	BEAM 2 Bin 1 Mid								LSB
34.									MSB
35.	BEAM 2 Code Reps								

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
36.	BEAM 2 Transmit Length								LSB
37.									MSB
38.	BEAM 2 Lag Length								LSB
39.									MSB
40.	BEAM 2 Transmit Bandwidth								
41.	BEAM 2 Receiver Bandwidth								
42.	BEAM 2 Min Ping Interval								LSB
43.									MSB
44.	BEAM 3 SETUP								
45.	BEAM 3 DEPTH								LSB
46.									MSB
47.	BEAM 3 DATA PING COUNT								
48.	BEAM 3 Ping Type								
49.	BEAM 3 Cell Count								LSB
50.									MSB
51.	BEAM 3 Cell Size								LSB
52.									MSB
53.	BEAM 3 Bin 1 Mid								LSB
54.									MSB
55.	BEAM 3 Code Reps								
56.	BEAM 3 Transmit Length								LSB
57.									MSB
58.	BEAM 3 Lag Length								LSB
59.									MSB
60.	BEAM 3 Transmit Bandwidth								
61.	BEAM 3 Receiver Bandwidth								
62.	BEAM 3 1 Min Ping Interval								LSB
63.									MSB
64.	BEAM 4 SETUP								
65.	BEAM 4 DEPTH								LSB
66.									MSB
67.	BEAM 4 DATA PING COUNT								
68.	BEAM 4 Ping Type								
69.	BEAM 4 Cell Count								LSB
70.									MSB
71.	BEAM 4 Cell Size								LSB
72.									MSB

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
73.	BEAM 4 Bin 1 Mid								LSB
74.									MSB
75.	BEAM 4 Code Reps								
76.	BEAM 4 Transmit Length								LSB
77.									MSB
78.	BEAM 4 Lag Length								LSB
79.									MSB
80.	BEAM 4 Transmit Bandwidth								
81.	BEAM 4 Receiver Bandwidth								
82.	BEAM 4 Min Ping Interval								LSB
83.									MSB
84.	Reserved								

Figure 37. Automatic Mode Setup Data

Table 33: Automatic Mode Setup Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the status data identification word ID 4401h
5,6	3	Beam Count	Stores the Beam Count
7,8	4	Mode	Stores the Beam 1 setup
9-12	5-6	Depth	Stores the Beam 1 Depth in cm
13,14	7	Data Ping Count	Stores the Beam 1 Data Ping Count
15,16	8	Ping Type	Stores the Beam 1 Ping Type 0=mode 2, 1=p-p, 2=coherent
17-20	9-10	Cell Count	Stores the Beam 1 Cell Count
21-24	11-12	Cell Size	Stores the Beam 1 cell size in cm
25-28	13-14	Bin 1 Mid	Stores the Beam 1 Bin 1 Mid in cm
29,30	15	Code Reps	Stores the Beam 1 number of Code Reps
31-34	16-17	Transmit Length	Stores the Beam 1 Transmit Length in cm
35-38	18-19	Lag Length	Stores the Beam 1 Lag Length in cm
39,40	20	Transmit Bandwidth	Stores the Beam 1 Transmit Bandwidth
41,42	21	Receiver Bandwidth	Stores the Beam 1 Receiver Bandwidth
43-46	22-23	Min Ping Interval	Stores the Beam 1 Min Ping Interval in ms
47,48	24	Mode	Stores the Beam 2 setup
49-52	25-26	Depth	Stores the Beam 2 Depth in cm
53,54	27	Data Ping Count	Stores the Beam 2 Data Ping Count
55,56	28	Ping Type	Stores the Beam 2 Ping Type 0=mode 2, 1=p-p, 2=coherent
57-60	29-30	Cell Count	Stores the Beam 2 Cell Count
61-64	31-32	Cell Size	Stores the Beam 2 cell size in cm

Table 33: Automatic Mode Setup Format

Hex Digit	Binary Byte	Field	Description
65-68	33-34	Bin 1 Mid	Stores the Beam 2 Bin 1 Mid in cm
69,70	35	Code Reps	Stores the Beam 2 number of Code Reps
71-74	36-37	Transmit Length	Stores the Beam 2 Transmit Length in cm
75-78	38-39	Lag Length	Stores the Beam 2 Lag Length in cm
79,80	40	Transmit Bandwidth	Stores the Beam 2 Transmit Bandwidth
81,82	41	Receiver Bandwidth	Stores the Beam 2 Receiver Bandwidth
83-86	42-43	Min Ping Interval	Stores the Beam 2 Min Ping Interval in ms
87,88	44	Mode	Stores the Beam 3 setup
89-92	45-46	Depth	Stores the Beam 3 Depth in cm
93,94	47	Data Ping Count	Stores the Beam 3 Data Ping Count
95,96	48	Ping Type	Stores the Beam 3 Ping Type 0=mode 2, 1=p-p, 2=coherent
97-100	49-50	Cell Count	Stores the Beam 3 Cell Count
101-104	51-52	Cell Size	Stores the Beam 3 cell size in cm
105-108	53-54	Bin 1 Mid	Stores the Beam 3 Bin 1 Mid in cm
109,110	55	Code Reps	Stores the Beam 3 number of Code Reps
111-114	56-57	Transmit Length	Stores the Beam 3 Transmit Length in cm
115-118	58-59	Lag Length	Stores the Beam 3 Lag Length in cm
119,120	60	Transmit Bandwidth	Stores the Beam 3 Transmit Bandwidth
121,122	61	Receiver Bandwidth	Stores the Beam 3 Receiver Bandwidth
123-126	62-63	Min Ping Interval	Stores the Beam 3 Min Ping Interval in ms
127,128	64	Mode	Stores the Beam 4 setup
129-132	65-66	Depth	Stores the Beam 4 Depth in cm
133,134	67	Data Ping Count	Stores the Beam 4 Data Ping Count
135,136	68	Ping Type	Stores the Beam 4 Ping Type 0=mode 2, 1=p-p, 2=coherent
137-140	69-70	Cell Count	Stores the Beam 4 Cell Count
141-144	71-72	Cell Size	Stores the Beam 4 cell size in cm
145-148	73-74	Bin 1 Mid	Stores the Beam 4 Bin 1 Mid in cm
149,150	75	Code Reps	Stores the Beam 4 number of Code Reps
151-154	76-77	Transmit Length	Stores the Beam 4 Transmit Length in cm
155-158	78-79	Lag Length	Stores the Beam 4 Lag Length in cm
159,160	80	Transmit Bandwidth	Stores the Beam 4 Transmit Bandwidth
161,162	81	Receiver Bandwidth	Stores the Beam 4 Receiver Bandwidth
163-166	82-83	Min Ping Interval	Stores the Beam 4 Min Ping Interval in ms
167,168	84	Reserved	Reserved

Firmware Status Data

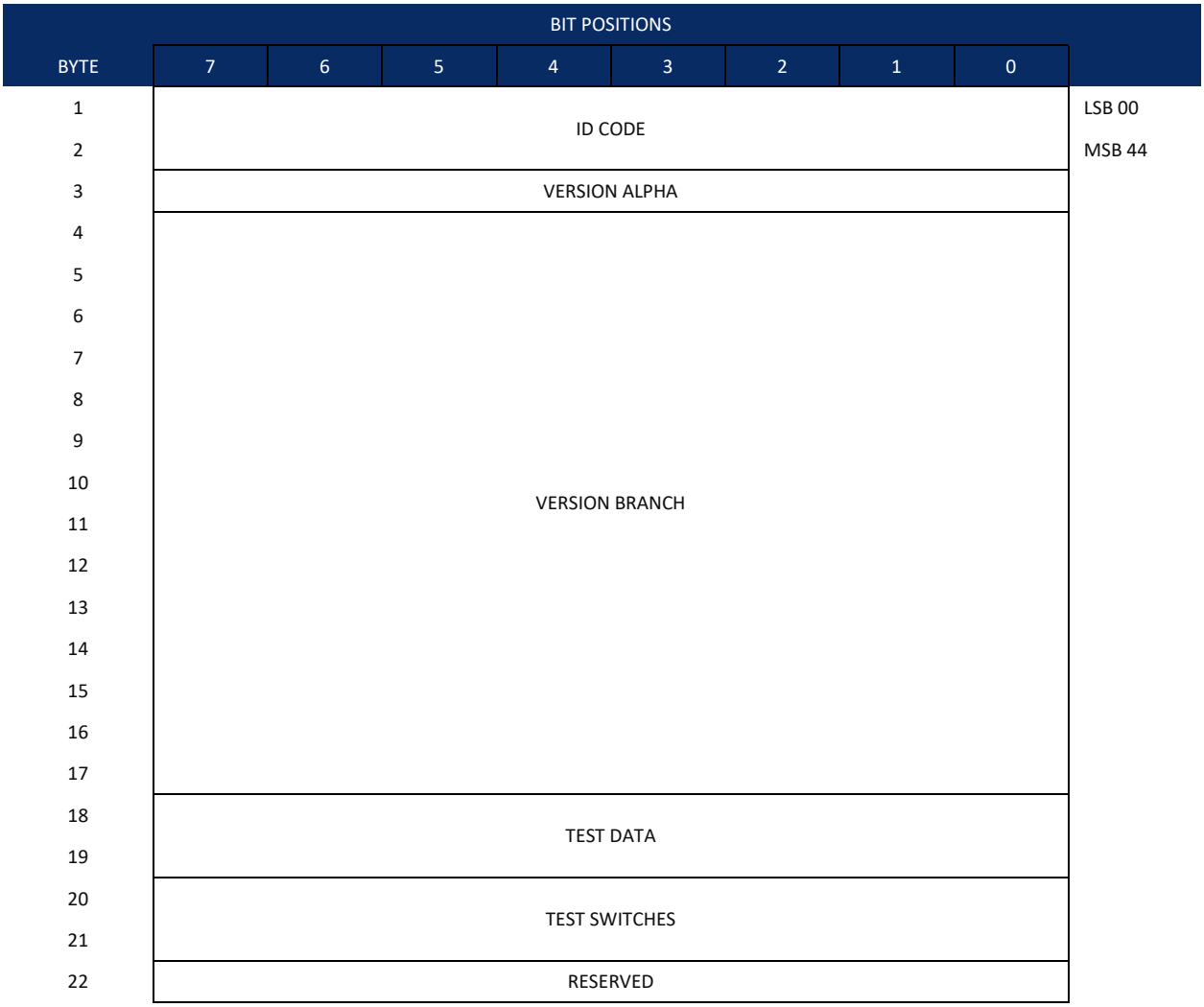


Figure 38. Firmware Status Data

Table 34: Firmware Status Format

Hex Digit	Binary Byte	Field	Description
1-4	1-2	ID Code	Stores the status data identification word ID 4400h.
4,6	3	Version Alpha	ASCII character
7-34	4-17	Version Branch	ASCII character string
35-38	18-19	Test Data	Word Test Data Selected
39-42	20-21	Test Switches	Word Test Switch Selected
43,45	22	Reserved	Reserved

Vertical Beam Range Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VERTICAL BEAM RANGE ID								LSB 00h
2									MSB 41h
3	EVAL AMP								
4	RSSI AMP								
5	RANGE TO BOTTOM								
6									
7									
8									
9	STATUS								

Figure 39. Vertical Beam Range Format

Table 35: Vertical Beam Range Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam data identification word (00 41h).
5-6	3	Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo.
7-8	4	RSSI Amp	Contains the RSSI value for the sample at the middle of the bottom echo.
9-16	5-8	Range to Bottom	Contains the vertical beam range to the bottom. Scaling: LSD = 1 mm; Range = 0 to 100000 mm.
17-18	9	Status	Contains flags, defined as follows: <d7:d3> Reserved <d2> Gain setting: 0 = LowGain; 1 = HighGain <d1:d0> Status: 00 = Range invalid; 01 = Range valid from w-filter 10 = Range valid from leading-edge filter

Only present when there is a vertical range to report.

Vertical Beam Profile Leader Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	VERTICAL BEAM PROFILE LEADER ID								LSB 01
2									MSB 0F
3	NUMBER OF BINS								
4									
5	NUMBER OF PINGS PER ENSEMBLE								
6									
7	BIN SIZE								
8									
9	DISTANCE TO BIN 1 MIDDLE								
10									
11	RESERVED								
12									
13	TRANSMIT LENGTH								
14									
15	LAG LENGTH								
16									
17	NUMBER OF CODE ELEMENTS TRANSMITTED								
18									
19	RESERVED								
↓									↓
40									

Figure 40. Vertical Beam Profile Leader Format

Table 36: Vertical Beam Profile Leader Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile leader identification word (0x0F01h)
5-8	3,4	# Bins	Stores the number of bins (ZN – Vertical Beam Number of Bins). Scaling: LSD = 1 bin; Range = 1 to 200 bins
9-12	5,6	Ping/ensemble	Stores the number of pings to average together in each ensemble (ZP – Vertical Beam Number of Pings). If ZP = 0, the RiverPro/RioPro does not collect vertical beam profile data. Scaling: LSD = 1 ping; Range = 0 to 999 pings
13-16	7,8	Bin size	Stores the vertical beam profile bin size (cm) (ZS – Vertical Beam Bin Size) Scaling: LSD = 1 cm; Range 2 to 500 cm
17-20	9,10	Distance to bin 1 middle	Contains the distance to the middle of bin 1. The distance to the middle of bin 1 is determined by: blank + (xmtLength + lagLength + binSize)/2. Blank and bin size are affected by the speed of sound; xmt length and lag use a fixed speed of sound value. ZF – Vertical Beam Blanking Distance determines blank. ZS – Vertical Beam Bin Size determines bin size, which also determines xmt length, unless the ZT xmt override is used. ZV – Vertical Beam Ambiguity Velocity determines lag length by setting the ambiguity velocity. Scaling: LSD = 1 centimeter; Range = 0 to 500 cm
21-24	11-12	Reserved	Reserved
25-28	13-14	Xmit length	Stores the vertical beam Transmit Length in cm. Scaling: LSD = 1 centimeter; Range = 2 to 500 cm
29-32	15-16	Lag length	Lag Length in cm. The lag is the time period between sound pulses. This is varied as required by the RiverPro/RioPro.
33-36	17-18	# Code elements	Contains the number of code elements in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
37-160	19-40	Reserved	Reserved

Vertical Beam Profile Velocity Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VERTICAL BEAM PROFILEV ELOCITY ID								LSB 00
2									MSB 0A
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 200 CELLS)								↓
401	DEPTH CELL #200, VELOCITY 1								LSB
402									MSB

Figure 41. Vertical Beam Profile Velocity Data Format

Table 37: Vertical Beam Profile Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the vertical beam profile velocity identification word (LSB=00, MSB=0A).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
8-804	5-402	Cells 2 – 200 (if used)	These fields store the velocity data for depth cells 2 through 200 (depending on the setting of the ZN – Vertical Beam Number of Bins command). These fields follow the same format as listed above for depth cell 1.

Vertical Beam Profile Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

BYTE	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 #2, FIELD #1								
↓	(SEQUENCE CONTINUES FOR UP TO 200 CELLS)								↓
202	DEPTH CELL #200, FIELD #1								

See Table 38 through Table 41 for a description of the fields.

Figure 42. Vertical Beam Profile Correlation Magnitude, Echo Intensity, Percent-Good, and Status Data Format

Table 38: Vertical Beam Profile Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile correlation magnitude data identification word (LSB=00, MSB=0B).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store correlation magnitude data for depth cells 2 through 200 for all four beams. These fields follow the same format as listed above for depth cell 1.

Table 39: Vertical Beam Profile Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the vertical beam profile echo intensity data identification word (LSB=00, MSB=0C).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store echo intensity data for depth cells 2 through 200 for all four beams. These fields follow the same format as listed above for depth cell 1.

Table 40: Vertical Beam Profile Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile percent-good data identification word (LSB=00, MSB=0D).
5,6	3	Depth cell 1, Field 1	Stores percent-good data for depth cell #1, field 1. See above.
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store percent-good data for depth cells 2 through 200, following the same format as listed above for depth cell 1.

Table 41: Vertical Beam Profile Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the vertical beam profile status data identification word (LSB=00, MSB=0E).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, field 1. 1=good, 0=bad
7 – 404	4 – 202	Cells 2 – 200 (if used)	These fields store status data for depth cells 2 through 200, following the same format as listed above for depth cell 1.

NMEA PD0 Message Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	ID Code								LSB 22
2									MSB 20
3	Msg ID								
4									
5	Msg Size								
6									
7	Delta Time								
8									
9									
10									
11									
12									
13									
14									
15	ASCII NMEA message								
↓									
xx									

Figure 43. NMEA PD0 Data Message

Table 42: NMEA PD0 Data Messages

Hex Digit	Binary Byte	Field	Description
1-4	1-2	ID Code	Stores the status data identification word ID 2022h.
5-8	3-4	Msg ID	Internal GGA=4, VTG=5 External GGA=204, VTG=205,DBT=206,HDT=207, All others=200
9-12	5-6	Msg Size	word size of NMEA message
13-30	7-14	Delta Time	8 byte IEEE double floating point format - Difference between ensemble time and NMEA message receipt time.
31-	15-	ASCII NMEA message	The ASCII NMEA message received from the external device is inserted as received. The messages size is variable.

WinRiver II may add additional bytes.

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

Beam Correction Matrix Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1.	ID CODE								LSB 00
2.									MSB 32
3.	Row 1 Col 1								
4.									
5.	Row 1 Col 2								
6.									
7.	Row 1 Col 3								
8.									
9.	Row 1 Col 4								
10.									
11.	Row 2 Col 1								
12.									
13.	Row 2 Col 2								
14.									
15.	Row 2 Col 3								
16.									
17.	Row 2 Col 4								
18.									
19.	Row 3 Col 1								
20.									
21.	Row 3 Col 2								
22.									
23.	Row 3 Col 3								
24.									
25.	Row 3 Col 4								
26.									
27.	Row 4 Col 1								
28.									
29.	Row 4 Col 2								
30.									
31.	Row 4 Col 3								
32.									
33.	Row 4 Col 4								
34.									

Figure 44. Beam Correction Matrix Format

Table 43: Beam Correction Matrix Format

Hex Digit	Binary Byte	Field	Description
1-4	1-2	ID Code	Stores the Beam Correction Matrix identification word ID 0x3200h. LSB=00, MSB=32
	3-4	Row 1 Col 1	Beam Calibration Matrix scaled int 2 bytes per entry for 16 entries LSB=0.0001
↓	↓	↓	↓
	33-34	Row 4 Col 4	Beam Calibration Matrix

This data is output based on the setting of the WD command.

Reserved BIT Data Format

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

Figure 45. Reserved BIT Data Format

Table 44: Reserved for TRDI Format

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

Checksum Data Format

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

Figure 46. Checksum Data Format

Table 45: Checksum Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum Data	This field contains a modulo 65536 checksum. If the sum is 12345678, then it is divided by 65536, and the remainder is output; For example, 12345678 / 65536 = 188.3800964 = 188 + 24910/65536, so the number 24910, converted to hex as 614E would be output. An easier way to compute the checksum is using the sum 12345678; converted to hex it is the number 00BC614E. The least-significant four hex digits are output; i.e. 614E.

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 software portal: https://tm-portal.force.com/TMsoftwareportal

NOTES

Appendix A

NOTICE OF COMPLIANCE

In this chapter, you will learn:

- China RoHS requirements
- Material disclosure table

Date of Manufacture

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

Environmental Friendly Use Period (EFUP)

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

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

Some homogenous substance within the EIP contains toxic or hazardous substances or elements above the requirements listed in SJ/T 11363-2006. These substances are identified in Table 46.

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

CE

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

Material Disclosure Table

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

Table 46. Toxic or Hazardous Substances and Elements Contained in Product

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

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

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

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

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

NOTES