RIVERRAY ADCP GUIDE

TELEDYNE MARINE
Everywhereyoulook™

P/N 95B-6063-00 (March 2024)

https://www.teledynemarine.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

REVISION HISTORY

March 2024

- Updated available GPS systems, page 5 - 6.

February 2024

- Updated Returning Systems to the TRDI Factory, page 49 Brokerage address.

January 2024

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

October 2023

- Updated outline drawing 96B-6062.
- Removed outline drawing 96B-6059.
- 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.

September 2023

- Removed outline installation drawing 96B-6033.
- Updated outline drawings 96B-6059 and 96B-6062.
- Updated installing the mounting plate.

August 2023

- Updated installing the mounting plate.

July 2023

- Updated website address.
- Added Beam Width specification.

January 2023

- Updated the firmware and feature upgrade sections.
- Updated EAR statement.
- Deployment guide now download only.

April 2022

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

August 2021

- Updated Contacting TRDI table
- Replaced *BBTalk* with *TRDI Toolz*
- Changed float to Tethered Trimaran
- Added PD0Decoder link

November 2019

- Corrected Bottom Track output data format bytes 78 to 81 to reserved
- Updated logo to Teledyne Marine

September 2018

- Changed Receiver Signal Strength Indicator (RSSI) Scaling from 0.45 dB to 0.6 dB per count on pages 130 and 135

June 2018

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

February 2018

- Added a deployment guide to the system documentation
- Replaced the Quick Start Card with Getting Started with the RiverRay
- Updated Inventory list
- Updated Bluetooth connection
- Updated outline installation drawings

August 2015

- Updated graphics to show red transducer head, new end-cap and LEDs.
- Updated the Inventory section.
- Updated LED Behavior table.
- Updated the OL command.
- Added the manual water modes.
- Updated the Sensor commands to support the internal GPS.
- Updated the specifications and outline installation drawings.

September 2013

- Renamed the RiverRay Operation Manual to RiverRay ADCP Guide.
- Updated the RiverRay Quick Start Card.
- Updated the Inventory section.
- Updated Figure 7, page 22 to show a vertical beam system.
- Added the vertical beam commands, output data format, and specifications.
- Updated the Bluetooth connection section. For details and troubleshooting information on Bluetooth communications, use the *WinRiver II* and *SxS Pro* software user's guides.
- Updated the PT3 command to show linear output option.
- Updated the SF command with the GPS diagnostic output.
- Removed the WF command (the WF command was only available via a special TRDI use engineering mode and not visible to users).

- Corrected Variable Leader (Figure 19, page 120 and Table 17, page 121) bytes 13 and 14 - the BIT Count and BIT Fault fields and descriptions were reversed.
- Added the missing parameters Beam 2 Mode, Beam 3 Mode, and Beam 4 Mode to the Automatic Mode Setup Figure 27, page 140.

July 2012

- General update to styles and fonts used throughout manual.
- Combined the RiverRay User's Guide and RiverRay Operation Manual into one manual.
- Created new RiverRay Quick Start Card to replace User's Guide.
- Added command changes for Integrated Sensor Module (ISM) compass and firmware version 44.14.
- Added corrections from ICN-145.
- Added instructions for folding float assembly.
- Added information from FST-029 to the specifications chapter.

September 2009

- Initial release of the RiverRay Operation Manual.

EXCLUSIONS AND OMISSIONS

- This manual covers the RiverRay hardware and firmware. For instructions on using a laptop computer with Bluetooth 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
Phone +1 (858) 842-2600	Phone +33(0) 492-110-930
Sales – rdisales@teledyne.com	Sales – rdie@teledyne.com
Field Service – rdifs@teledyne.com	Field Service – rdiefs@teledyne.com

Client Services Administration – rdicsadmin@teledyne.com

Web: https://www.teledynemarine.com

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

Self-Service Customer Portal

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

Teledyne Marine Software Portal

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

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

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

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

CONVENTIONS USED IN THIS MANUAL

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

Software menu items are printed in bold: **File** menu, **Collect Data**. Items that need to be typed by the user or keys to press will be shown as **F1**. If a key combination were joined with a plus sign (**ALT+F),** 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:

```
RiverRay
Teledyne RD Instruments (c) 2013
All rights reserved.
Firmware Version: 44.xx
>
```

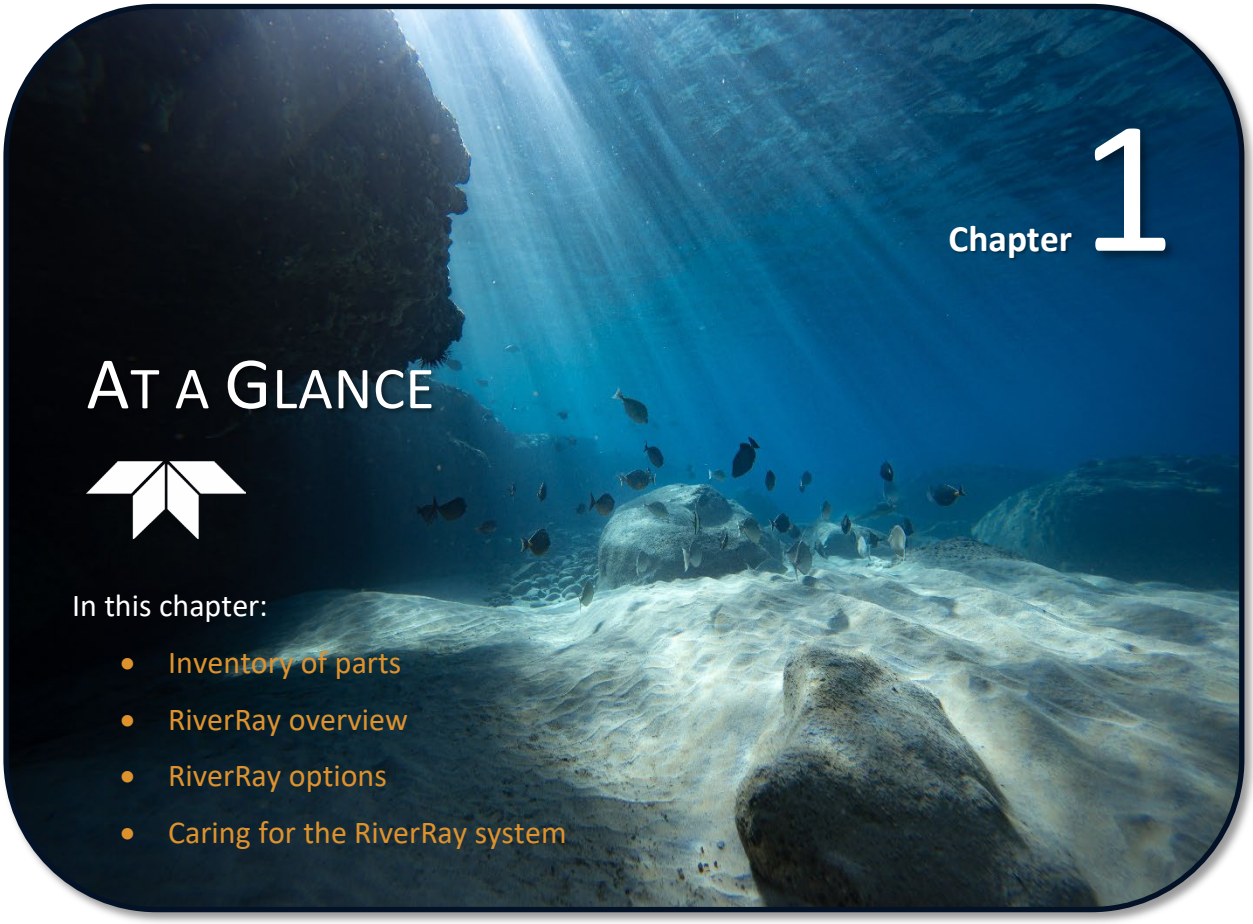
There are four visual aids to help:

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 RiverRay 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:

- Inventory of parts
- RiverRay overview
- RiverRay options
- Caring for the RiverRay system

Inventory

Included with the RiverRay system:

Part Number	Name	Description
RIVRAY600-I	RiverRay 600 kHz system	 The RiverRay system includes the transducer, dummy plug, protective cap, tools, and mounting hardware for the mounting plate. 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	RiverRay Tethered Trimaran	 Tri-hull Tethered Trimaran for tethered deployments (shown folded). Various GPS wiring configurations available (optional)

Included with the RiverRay Accessories Kit (RIVRAY600-A):

	Part Number	Name	Description
	73B-6020-005	I/O cable	The I/O cable is used for serial communications.
	UK821	Shipping case	Shipping case with custom foam cutouts.
75BK6066-00 RIVERRAY DOCUMENTATION KIT	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-6130-00	RiverRay Getting Started	A printed reference card showing how to get started with the RiverRay.
	957-6274-00	Serial Communications Setup Card	A printed quick reference card showing serial communications setup.
	957-6277-00	SD1000U Bluetooth Communications Setup Card	A printed quick reference card showing Bluetooth communications setup using the SD1000U.
	SD1000U DAT5-G01R	USB Bluetooth device	USB Bluetooth device SD1000U and the Sena DAT5-G01R antenna.
	75BK6068-00	Spare parts and tools	Includes spare mounting hardware for the Tethered Trimaran mounting plate.

For instructions on using the Bluetooth device, see the SD1000U Bluetooth Communications Setup Card, the WinRiver II or SxS Pro Software User's Guide, and the instructions and Bluetooth driver included with the device.

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.

RiverRay Overview

The RiverRay (see Figure 1 and Figure 2) is designed to measure real-time current profiles from temporary or permanent mounting in a vessel. The RiverRay system consists of a RiverRay ADCP, optional Tethered Trimaran, cables, and software. The input power requirements for the RiverRay are +12 VDC. The RiverRay system requires the addition of a Windows® compatible computer to collect data.

The transducer assembly contains the transducer ceramics and electronics. The standard acoustic frequency is 600 kHz. See the outline drawing for dimensions and weights.

I/O Cable – The Input/Output (I/O) cable connects the RiverRay to the computer and external power supply/battery.

Transducer Faces – The urethane face covers the transducer ceramic. Never set the transducer on a hard surface. The urethane face may be damaged.

Housing – The RiverRay is intended to be operated as a surface mounted system only. No depth rating is provided.

Temperature Sensor – The Thermistor measures the water temperature.

Transducer Head – The RiverRay electronics and transducer ceramics are mounted to the transducer head. The numbers embossed on the face of the transducer indicate the beam number.

Vertical Beam - In transducer head, allows for depth measurement directly under the ADCP.

End-Cap – The end-cap holds the I/O cable connector and LED. When assembling the unit, match the Beam 3 mark on the end-cap with beam 3 number on the transducer.

LEDs – The LEDs on the electronics housing indicates the status of the RiverRay system. See Troubleshooting for a full description of the LEDs.

Tethered Trimaran – The Tethered Trimaran is designed to maintain the transducer at a constant depth in the water with minimal water flow disturbance.

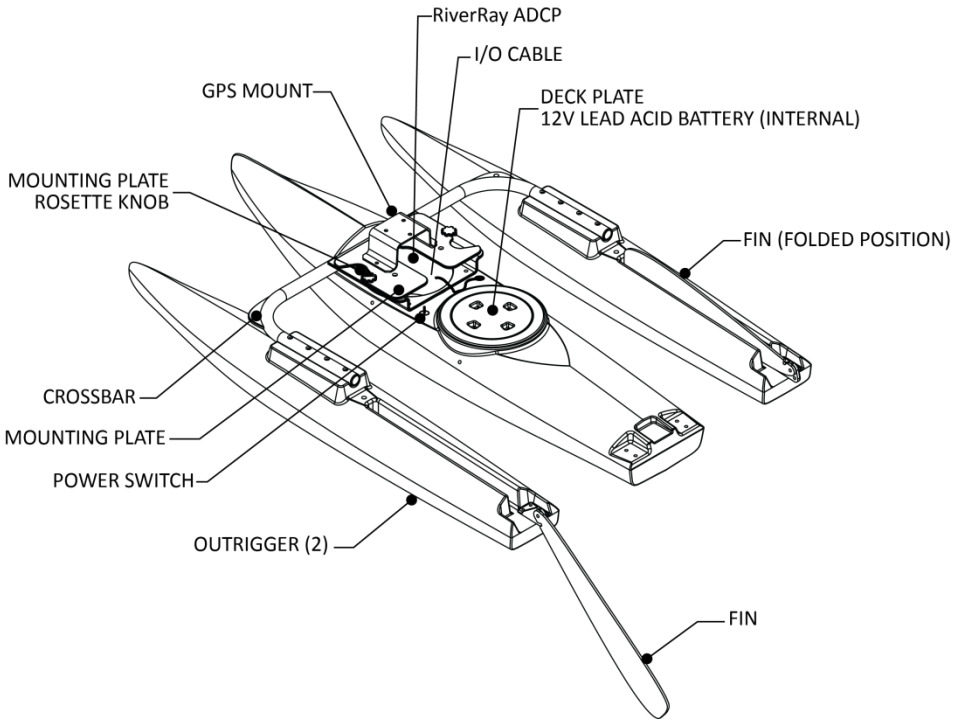


Figure 1. RiverRay Tethered Trimaran Overview

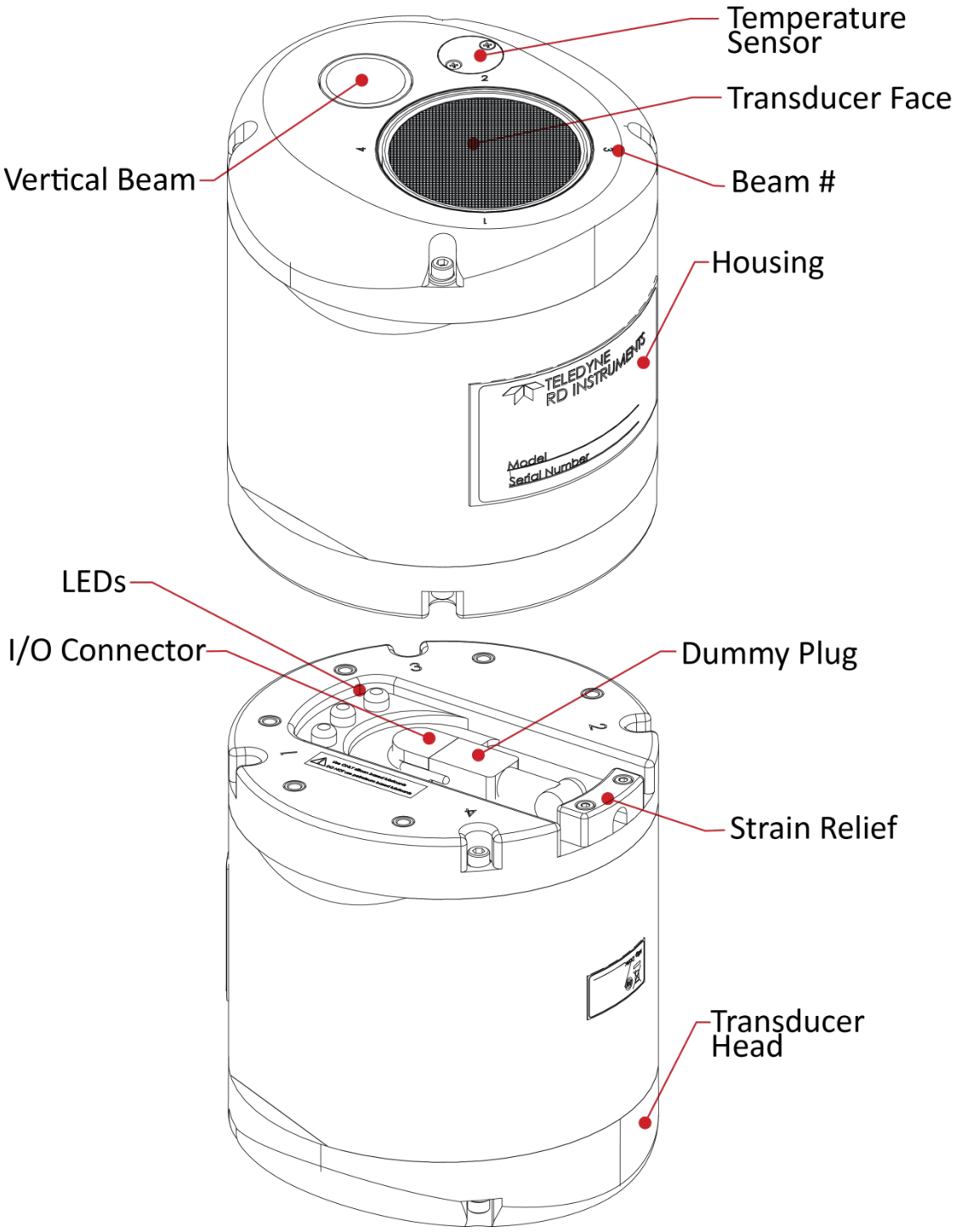


Figure 2. RiverRay ADCP Overview

Power Overview

The RiverRay ADCP requires a DC supply between 10.5 volts to 18 volts. Either an external DC power supply or 12V, 7A-hr lead acid gel cell battery can provide this power.

Check that the battery voltage is above 10.5 Volts DC. RiverRay ADCPs will work at 10.5 VDC with at least 400 milli amps; however, batteries with voltages below 11 VDC are nearly fully discharged.

Computer Overview

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

Minimum Computer Hardware Requirements:

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

RiverRay Options

RiverRay Options:

- **Maintenance Kit** – This kit (P/N 75BK6032-00) contains a complete set of O-Rings and close-up hardware (see Maintenance Kit).
- **Manual Profile Modes** – These modes allows the RiverRay to override the automatic profiling mode and adds additional water profiling commands (see Water Profiling Commands). To purchase a feature upgrade, please contact field service.
- **SxS Pro** – The *SxS Pro* software running on a laptop with a Bluetooth connection can be used in place of the *WinRiver II* software. For more information, see the SxS Pro User's Guide.

  SxS Pro software can be downloaded at: https://tm-portal.force.com/TMsoftwareportal

  To purchase a registration code to enable the software's full capability, please contact field service at: e-mail: rdifs@teledyne.com | Tel. +1-858-842-2700.
- **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.
- **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 RiverRay boat are available for a variety of GPS systems. GPS wiring and mounting kits are normally ordered in conjunction with new RiverRay 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 Tethered Trimaran does not provide stable operation. Can be used with RiverRay or Rio Grande ADCPs.
- **Carrying Cases** – Soft-sided carrying cases for the RiverRay Tethered Trimaran are available. Contact TRDI for more information.

Phased Array Transducer Overview

The RiverRay uses a phased array transducer rather than individual piston transducers found in other TRDI ADCPs. The phased array transducer and RiverRay electronics can synthesize four simultaneous acoustic beams or a single beam can be created, plus a separate vertical beam. This provides several benefits for the user:

1. Relative to the transducer face, water profile and bottom track velocity data are completely independent of the speed of sound in the water. The salinity of the water no longer needs to be input to obtain the correct velocity data. For rivers this is less important than in estuarine environments where the salinity may be time dependent and difficult to measure precisely.
2. The vertical beam allows for depth measurement directly under the ADCP. This provides a redundant depth measurement for applications with challenging bottom track conditions and better characterization of channels with irregularly sloped bottoms or similar features.
3. No beam transformation matrix is required to obtain accurate velocity data. The advantage of this is that beam coordinate data can be taken and recorded at all times, which preserves the maximum amount of information for later playback and analysis.
4. Since only one transducer is required, a lower frequency can be used for the transducer while maintaining a small physical package. For river applications in particular, the 600 kHz frequency of the RiverRay provides increased immunity to ‘water bias’ and ‘moving bed’ effects that can introduce error into the bottom track velocity data. This significantly reduces the requirement to have DGPS available to provide an independent measurement of ADCP velocity. The lower frequency also provides deeper profiling range and bottom tracking range than higher frequency ADCPs.
5. The transducer face is flat. This reduces the flow disturbance caused by the instrument, particularly when it is mounted in the RiverRay Tethered Trimaran. And since the transducer is recessed slightly into the hull of the Tethered Trimaran, it is protected from debris in the water and during deployment and recovery along stream banks or from a bridge.
6. When the bottom is sloped, it is advantageous to configure bottom tracking and water profiling individually for each beam. The phased array transducer and RiverRay electronics allow the best possible data to be taken when the bottom is sloped.

Auto-Adaptive Water Profiling Mode

The RiverRay introduces a new 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. For more details please refer to the chapter on Water Profiling Modes in the WinRiver II User Guide.

RiverRay Care

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

General Handling Guidelines

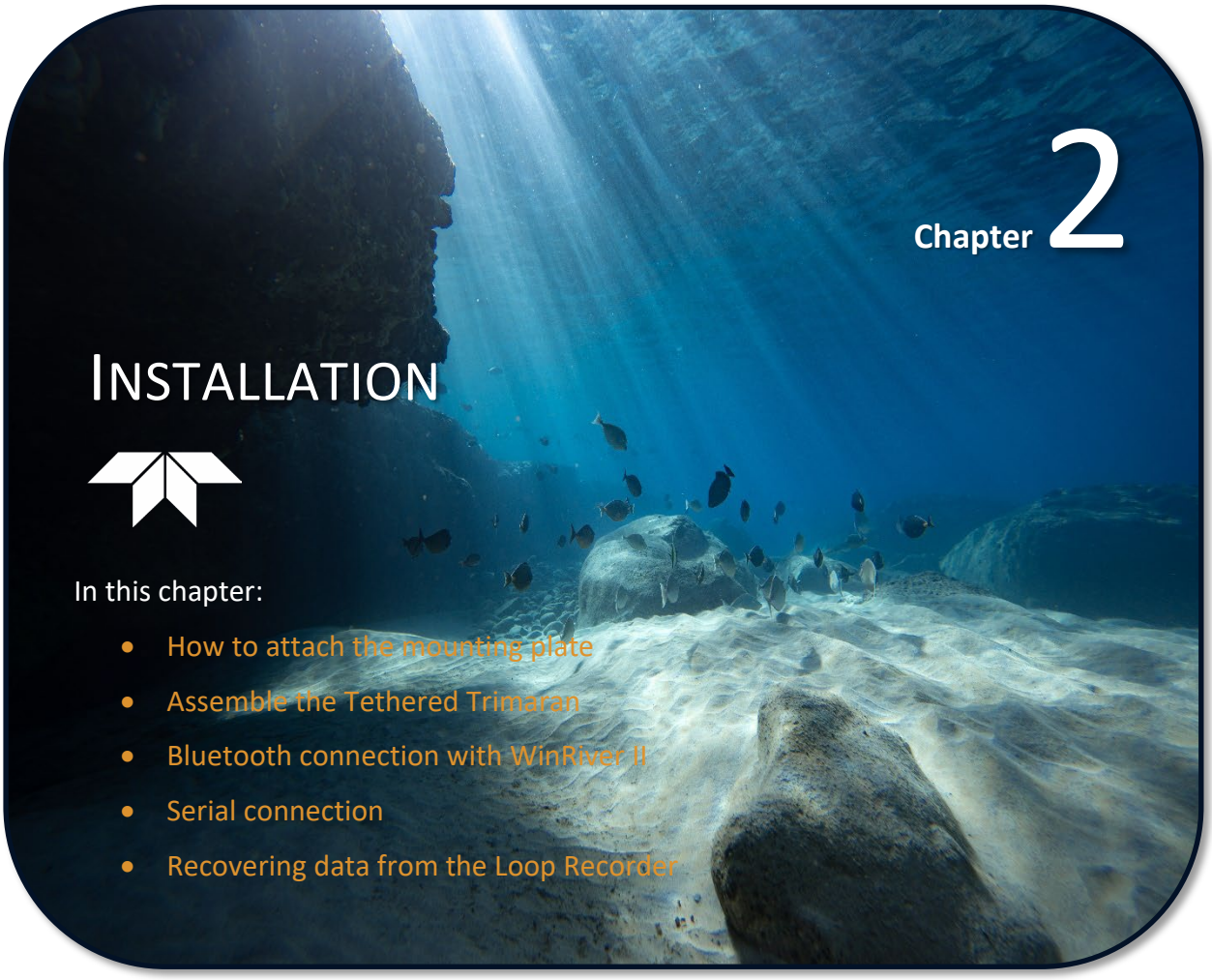
- Never set the transducer on a hard or rough surface. **The urethane faces may be damaged.**
- Always remove the retaining strap on the external I/O cable and dummy plug before disconnecting them. **Failure to do so will break the retainer strap.**
- Do not apply any upward force on the end-cap connector as the I/O cable is being disconnected. **Stressing the connector may cause the ADCP to flood.** Read the Maintenance section for details on disconnecting the I/O cable.
- Do not expose the transducer faces to prolonged sunlight. **The urethane faces may develop cracks.** Cover the transducer faces on the RiverRay if it will be exposed to sunlight.
- Do not expose the I/O connector to prolonged sunlight. **The rubber may become brittle.** Cover the connector on the RiverRay if it will be exposed to sunlight.
- Do not store the ADCP in temperatures over 60 degrees C. **The urethane transducer faces may be damaged.**
- Vent the system before opening by loosening the hardware on the housing. **If the ADCP flooded, there may be gas under pressure inside the housing.**
- Do not scratch or damage the O-ring surfaces or grooves. **If scratches or damage exists, they may provide a leakage path and cause the ADCP to flood.** Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support a RiverRay by the external I/O cable. **The connector or cable will break.**

Assembly Guidelines

- Read the Maintenance section for details on RiverRay re-assembly. Make sure the housing assembly O-ring stays in the groove when re-assembling the RiverRay. Tighten the hardware as specified. **Loose, missing, stripped hardware, or a damaged O-ring can cause the RiverRay transducer to flood.**
- Use light amounts of silicone lubricant (such as 3M™ Silicone Lubricant (Dry Type) ID No: 62-4678-4930-3) on the connector pins (rubber portion only). **This will make it easier to connect or remove the I/O cable and dummy plug.**
- Do not connect or disconnect the I/O cable with power applied.
- The RiverRay I/O cable can be connected when wet but not when it is underwater.

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.
- Calibrate the compass whenever any ferrous metals are relocated inside or around the RiverRay housing, or when moving to a new location. **Ferro-magnetic materials affect the compass, and different locations have different magnetic field characteristics**.
- Avoid using ferro-magnetic materials in the mounting fixtures or near the RiverRay. **Ferro-magnetic materials affect the compass.**



Chapter 2

INSTALLATION

In this chapter:

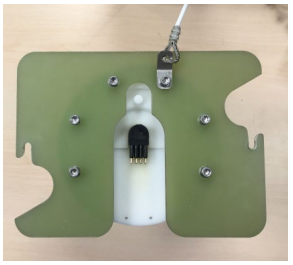
- How to attach the mounting plate
- Assemble the Tethered Trimaran
- Bluetooth connection with WinRiver II
- Serial connection
- Recovering data from the Loop Recorder

Attaching the Mounting Plate

RiverRay 600 kHz ADCPs offer holes in the base of the ADCP endcap to enable the user to affix a mounting plate using six M6-size screws with 8mm (0.314 inches) threaded inserts on the end-cap.

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

To attach the mounting plate:



1. Place the RiverRay 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).

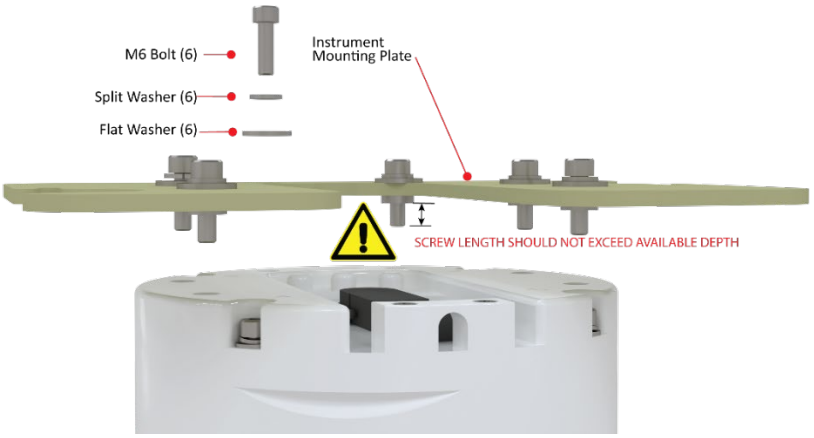
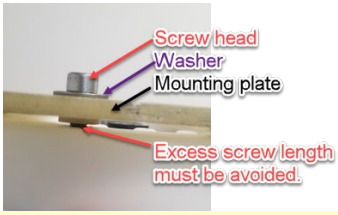


Figure 3. Mounting Plate Installation

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).

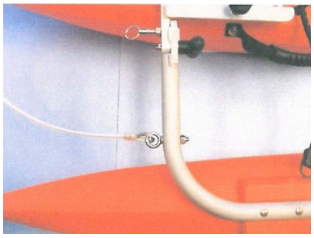
ENSURE THE SCREW LENGTH AFTER THE MOUNTING PLATE AND WASHERS DOES NOT EXCEED THE AVAILABLE DEPTH IN THE ENDCAP. Using longer bolts or high torque risks the 8mm threaded metal inserts on the end-cap being pulled out of the plastic end-cap 12mm deep hole.

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

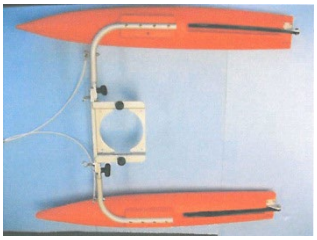
Tethered Trimaran Assembly

To assemble the Tethered Trimaran:

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.

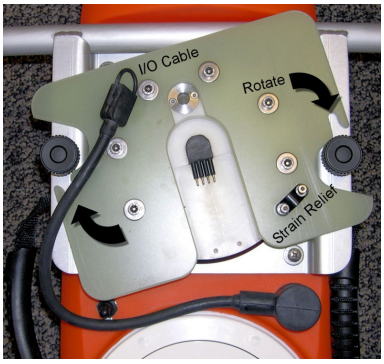


2. Next, attach the outriggers to the crossbar using the M6 x 35mm oval head screws provided.



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 Tethered Trimaran. Slide the mounting plate until the rosette knob screws are in the slot.



5. Attach the 'ADCP leash' cable from the wire rope bridle to one of the mounting plate screws.
6. Tighten the rosette knobs to hold the transducer in place.
7. Connect the power I/O cable to the end-cap connector (see I/O Cable and Dummy Plug).
8. Install the strain relief.

Battery Connection

The RiverRay system 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 Tethered Trimaran. Connect the battery and check the O-ring condition. 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 I/O cable is removed. Use the dummy plug when the RiverRay is in storage or is being handled.

To disconnect the cable:

1. Place the RiverRay on a soft pad to protect the transducer face. Use a 3mm Allen wrench to 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 4).
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 (included in the spare parts kit) on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone from the metal portions of the pins. **Regular lubrication is required: Apply silicone lubricant prior to each connection. Use ONLY silicone based lubricants. DO NOT use petroleum based lubricants.**
3. Push the cable straight onto the connector. Use a 3mm Allen wrench to install the Strain Relief.

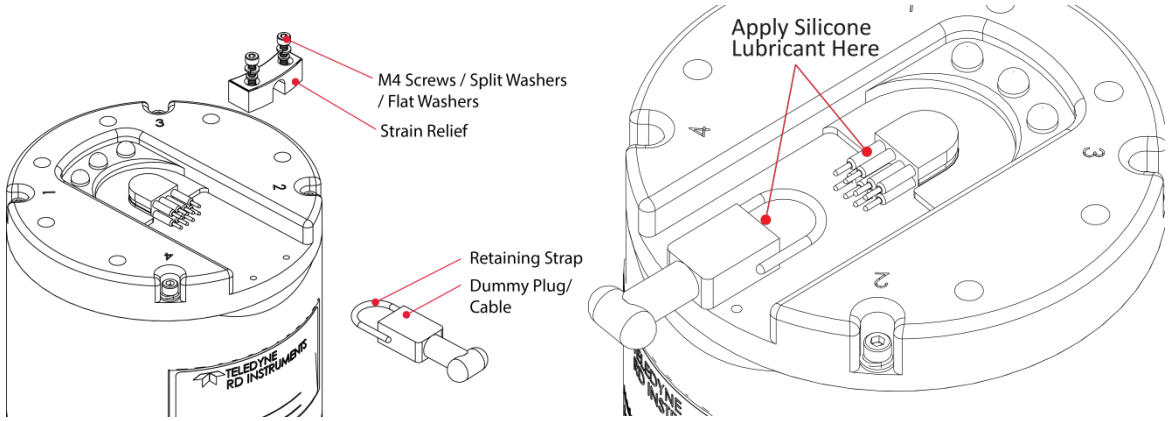


Figure 4. Removing the I/O Cable

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.

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

When connecting the RiverRay 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 RiverRay will flood.

Bluetooth Connection

Use these next steps to setup a Bluetooth connection to the RiverRay.

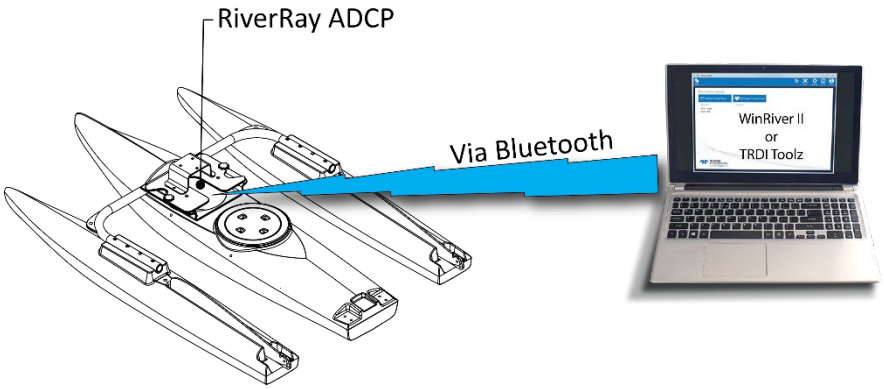


Figure 5. RiverRay Connections – Bluetooth Connection

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

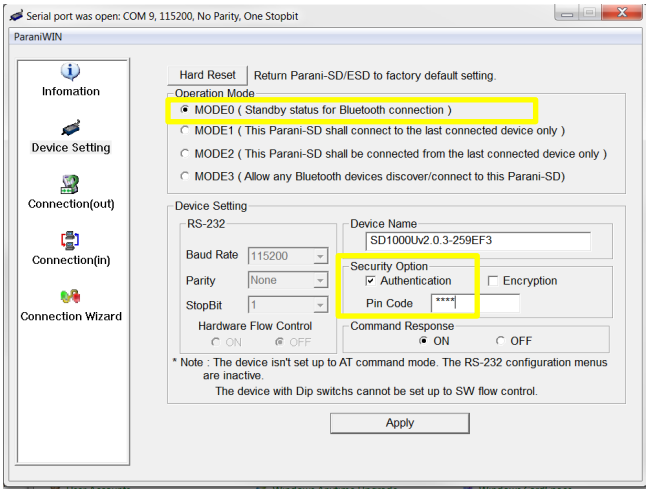
For RiverRay systems shipped after August 2017, the Microsoft® Bluetooth drivers work with *WinRiver II*. For best results, use the USB Bluetooth device with the driver supplied with the ADCP for *WinRiver II.*

To connect to a RiverRay ADCP using the Bluetooth port:

1. Turn on the Tethered Trimaran power switch.
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.

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) you may need to use **Mode 0** and **Authentication** (not Encryption). The code is 0000 (four zeros) and click **Apply**.

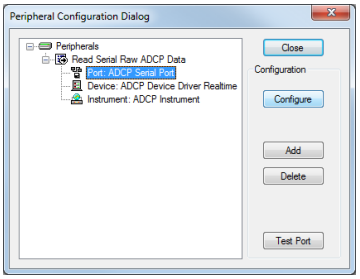


You may need to use either Authentication or no authentication when using *ParaniWin* with an SD100U. Try one, and if does not work try the other. Use whichever one works going forward.

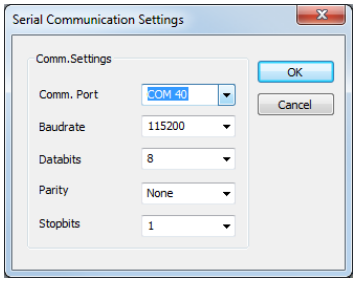
The selection of Mode 0 or Mode 1 is independent of Authentication/no Authentication:

- 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.



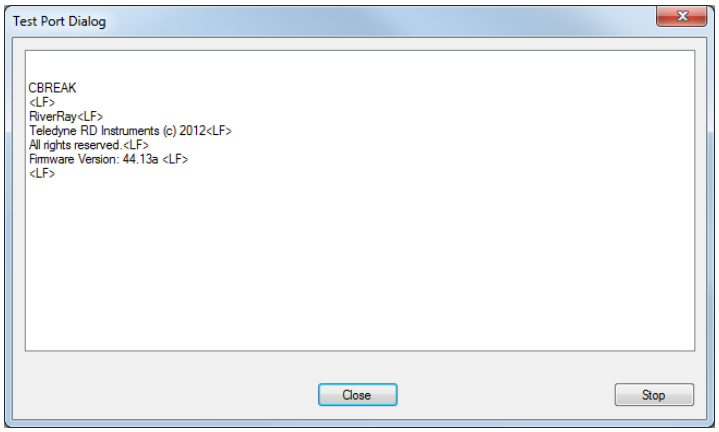
8. Select the **Comm. Port** number as noted in the Bluetooth screen from the drop-down list. The **Baudrate** must be set to 115200. Leave the **Databits**, **Parity**, and **Stopbits** as shown.



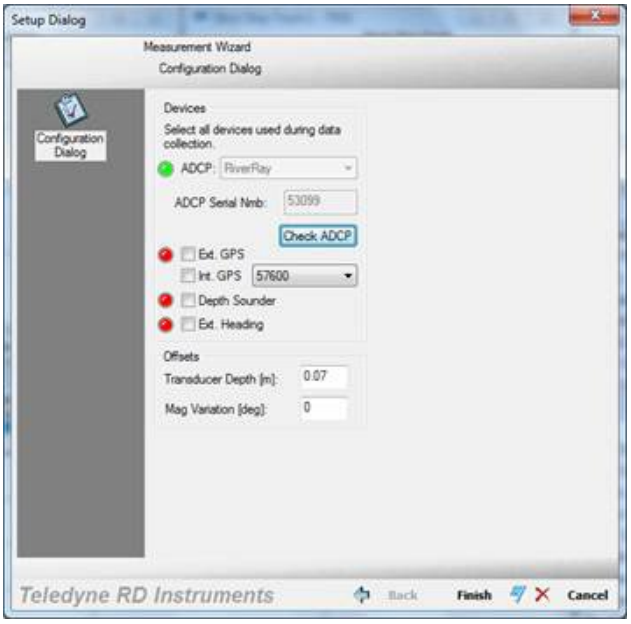
9. Click **OK** to close the Serial Communication Settings screen.

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 RiverRay wakeup message appears.



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 ADCP and the indicator next to the ADCP is green.



Serial Connection

To set up the RiverRay ADCP:

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

> Always apply silicone lubricant before connecting the I/O cable. See I/O Cable and Dummy Plug.

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 RiverRay self-test has passed.

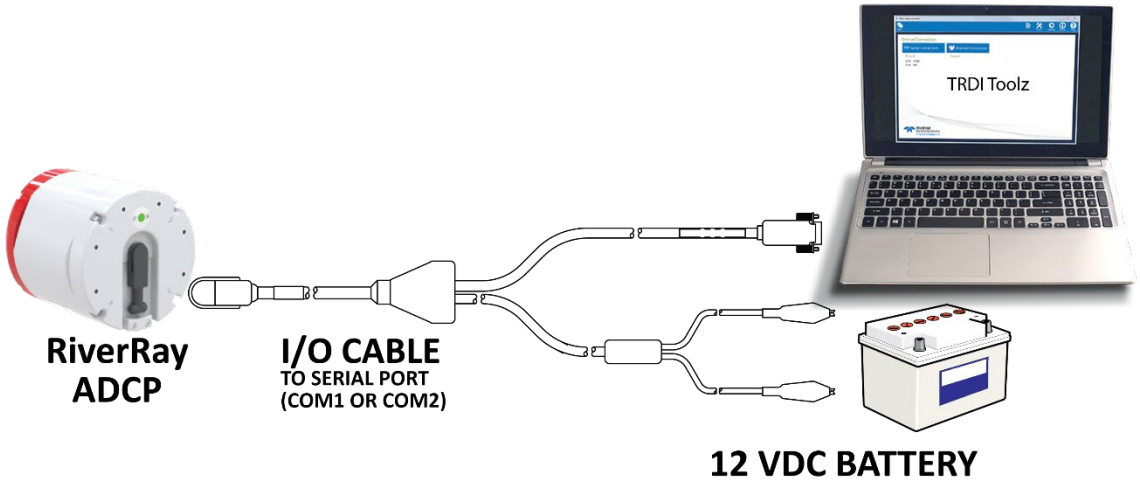


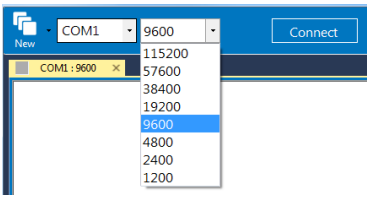
Figure 6. RiverRay Serial Connection

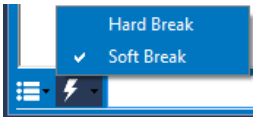
> For information on how to set up communications with *WinRiver II*, see the WinRiver II Serial Communications Setup Card or see Chapter 2 in the WinRiver II Software User's Guide.
>
> For Bluetooth connection, see Bluetooth Connection.

Connecting to the RiverRay

To connect to the RiverRay ADCP using the *TRDI Toolz* software:

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.






```
RiverRay
Teledyne RD Instruments (c) 2015
All rights reserved.
Firmware Version: 44.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
==
RiverRay
Teledyne RD Instruments (c) 2015
All rights reserved.
Firmware Version: 44.xx
>
```

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

Changing the Baud Rate in the RiverRay

The RiverRay 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 RiverRay. This procedure assumes using the program *TRDI Toolz* that is supplied by Teledyne RD Instruments.

```
RiverRay
Teledyne RD Instruments (c) 2015
All rights reserved.
Firmware Version: 44.xx
>
>cr1
[Parameters set to FACTORY defaults]
```

Connect the RiverRay to the computer and apply power.

Start the *TRDI Toolz* program.

Click the **Break** ( ) button.

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

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

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

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

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

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

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

Exit *TRDI Toolz*.

The RiverRay is now set for the new baud rate. The baud rate will stay at this setting until changed again with the CB command.

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

RiverRay Loop Recorder

The loop 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 ADCP (start pinging again).

See the TRDI Toolz User's Guide for details on using *TRDI Toolz.*

Enabling the Loop Recorder

The loop recorder is off by default.

To enable the loop recorder:

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

Using the loop recorder will slow down the RiverRay's ping rate.

4. When done recording data, send the MR0 command to turn the loop recorder off.

Recovering Data from the Loop 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 Loop Recorder

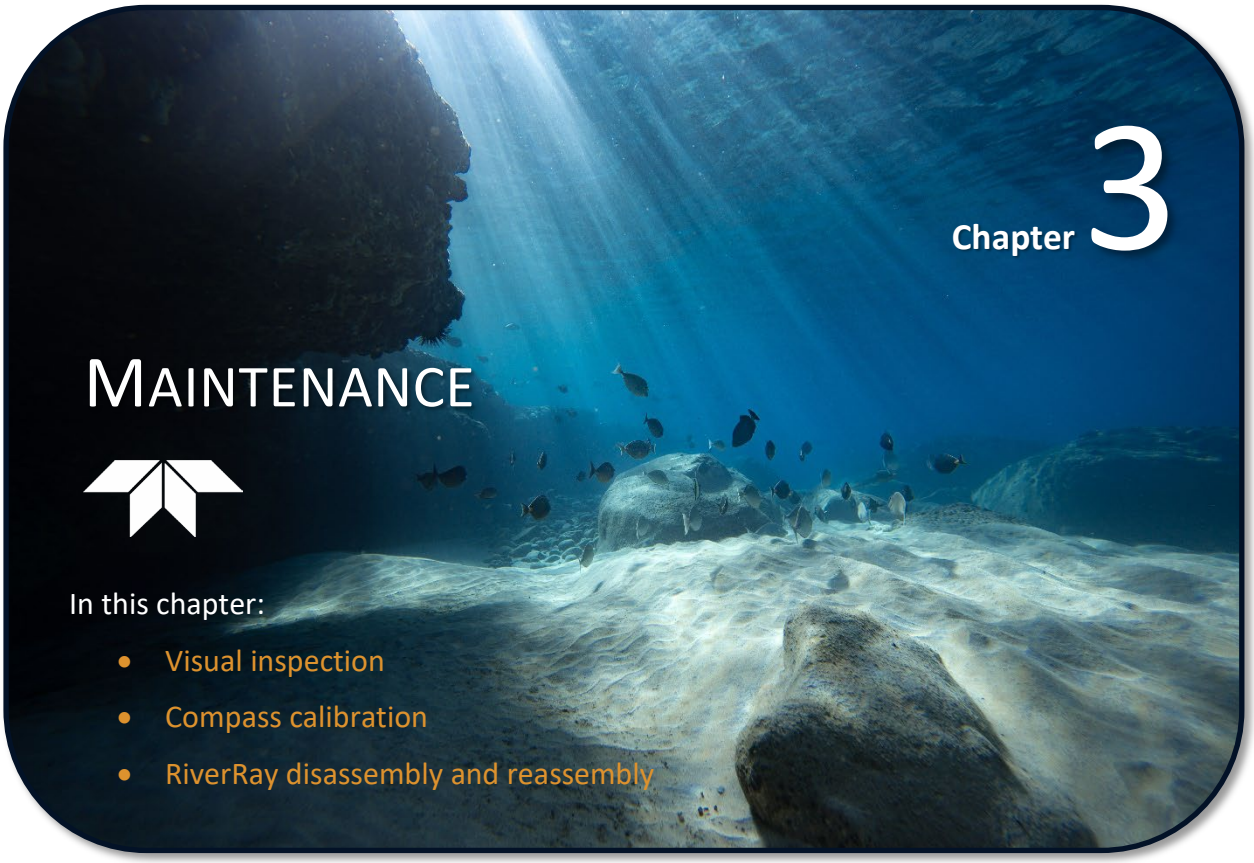
To erase data:

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 loop-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*.



Chapter 3

MAINTENANCE

In this chapter:

- Visual inspection
- Compass calibration
- RiverRay disassembly and reassembly

Parts Location Drawings

This section is a visual overview of the RiverRay ADCP. Use the following figure to identify the parts used on the system.

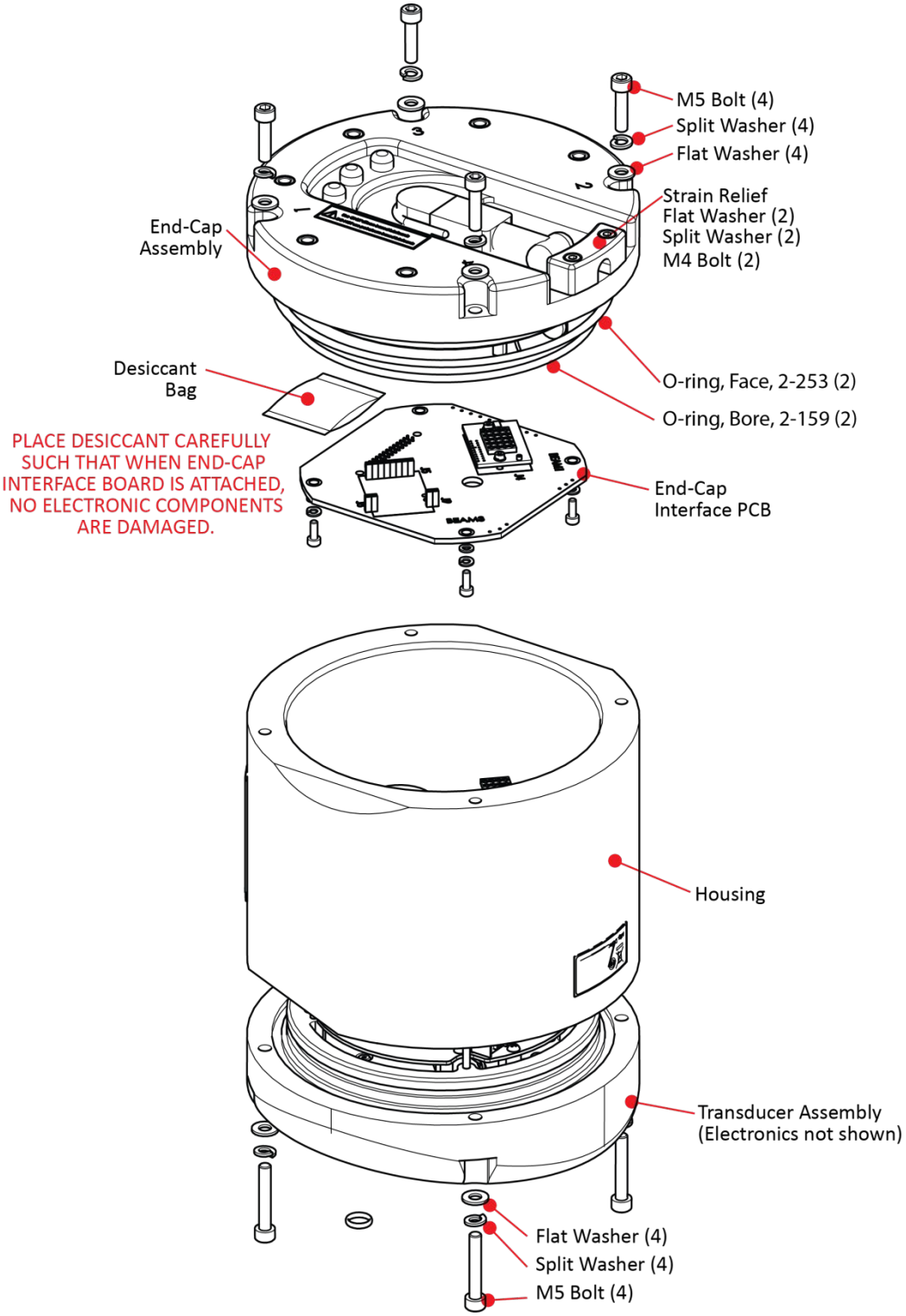


Figure 7. RiverRay Transducer Exploded View

Maintenance Schedule

To ensure continuous optimal results from the RiverRay, TRDI recommends that every RiverRay 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 RiverRay to spot problems:

Item	TRDI Recommended Period
Transducer Beams	The urethane coating is important to RiverRay 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. The deck plate O-ring should be cleaned whenever the deck plate is opened and replaced **BEFORE** it is showing any signs of wear and tear. **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 8) 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 RiverRay.

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 on both the male pins and female socket to help seat the cable connectors. Wipe off excessive silicone from the metal portions of the pins. **Regular lubrication is required**: Apply silicone lubricant prior to each connection. **Use ONLY silicone-based lubricants. DO NOT use petroleum-based lubricants.**
2. After lubricating, fully connect the male and I/O cable female connector 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 RiverRay is in storage or is being handled.

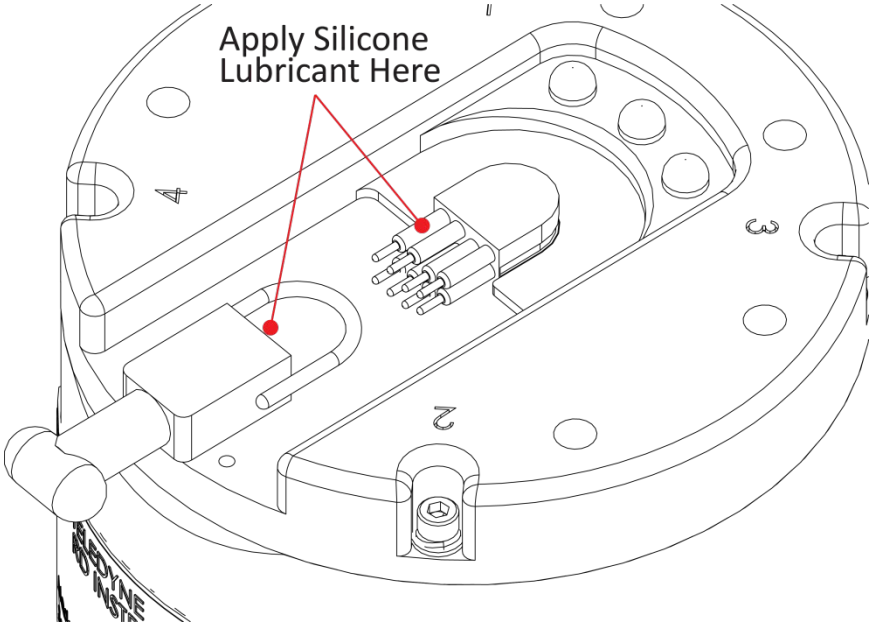


Figure 8. I/O Cable Connector Lubrication

Cleaning the I/O Cable Connector

After a deployment, clean and remove any accumulated sand or mud from the both the I/O connector on the RiverRay 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

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 2, page 4). 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 RiverRay 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 RiverRay 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 RiverRay before placing it in the storage case to avoid fungus or mold growth. Do not store the RiverRay in wet or damp locations.

RiverRay Tethered Trimaran Maintenance

The deck plate O-ring should be cleaned whenever the deck plate is opened and replaced **BEFORE** it is showing any signs of wear and tear.

To check the deck plate O-ring:

1. Be sure that the power switch is off.
2. Open the circular deck plate by turning it counter-clockwise.
3. Gently pry the rubber O-ring from the groove. Use a wood or plastic wedge to help lift the O-ring from the groove.
4. Clean the O-ring groove using a lint free cloth. Be sure the groove is free of foreign matter, dirt, and scratches.

5. Lubricate the O-ring with a thin coat of silicone lubricant. Use as little lubricant as possible; use just enough 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.

6. Lay the O-ring into the groove with the **RAISED EDGE UP**.

7. Check the deck plate lid for damage and clean the O-ring mating surface and threads using a lint free cloth.
8. Close the circular deck plate by turning it clockwise until fully tightened.

Final Storage or Shipping Preparation

Store the RiverRay in the original shipping crate whenever possible.

1. Remove the battery from the Tethered Trimaran and ensure the interior of the Tethered Trimaran is dry.
2. Disconnect the I/O cable and remove the transducer from the Tethered Trimaran. Place the dummy plug on the transducer cable connector.
3. Dissemble the Tethered Trimaran (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 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 RiverRay 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 RiverRay Tethered Trimaran for extended periods. The batteries may leak, causing damage to the Tethered Trimaran. Store the batteries in a cool, dry location (0 to 21 degrees C).

Compass Calibration

RiverRay compass calibration corrects for distortions in the earth's magnetic fields caused by permanent magnets or ferromagnetic materials near the RiverRay. These magnetic field distortions, if left uncorrected, will create errors in the heading data from the RiverRay. A compass calibration should be conducted at each measurement location, and whenever the mounting fixture, boat/Tethered Trimaran, 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 RiverRay 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 RiverRay 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.

Preparing for Calibration

1. Place the RiverRay mounted into the Tethered Trimaran in the water or on a piece of strong cardboard on top of a smooth, level wooden (non-magnetic) table. If a wooden table is not available, place the RiverRay on some cardboard as far away from ferromagnetic objects as possible. Use the cardboard to rotate the RiverRay during calibration to protect the RiverRay from scratches.
2. Connect the RiverRay as shown in Bluetooth Connection.

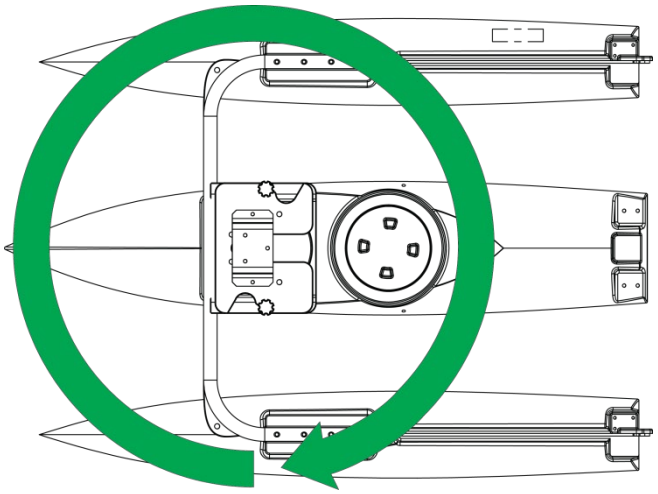


Figure 9. Compass Calibration

Compass Calibration Procedure

Two compass modules have been used in the RiverRay ADCP: current production systems include an Integrated Sensor Module (ISM) compass and prior production systems use the Honeywell HMR3300 module. Calibration using the *WinRiver II* software is recommended as the software will automatically detect the installed compass and configure the calibration process appropriately.

To calibrate the compass:

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

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

Calibration of the ISM compass can only be done through *WinRiver II*.

Yearly Maintenance Items

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

Maintenance Kit

Table 1 lists the items in the maintenance kit. This kit is required when the RiverRay has been opened. The maintenance kit includes the following tools and spare parts.

The maintenance kit is not included with the RiverRay system. It is required to properly close the system. Order kit number 75BK6032-00.

Table 1: RiverRay Maintenance Kit

Item #	Part #	Qty	Description
1.	01AP18J12	1	Desiccant
2.	5020	1	Silicone lubricant, 4-pack
3.	6565A11	1	Tool bag
4.	972-6001-00	2	O-ring, bore, 2-159
5.	972-8044-00	2	O-ring, face, 2-253
6.	M4ALLENDRIVER	1	M4 ball wrench
7.	M5WASHSPL	8	Split-Washer, SST
8.	M5WASHSTD	8	Flat Washer, 10MM OD, SST
9.	M5X0.8X20SHCS	4	Socket head cap screw, 316SS
10.	M5X0.8X30SHCS	4	Socket head cap screw, 316SS

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 then remove the transducer head assembly (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 RiverRay.
2. Stand the RiverRay on its transducer face on a soft pad.
3. Remove all power to the RiverRay.
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 RiverRay flooded, there may be gas under pressure inside the housing. As a precaution, loosen the four end-cap bolts (5-mm) to vent the system.

6. To avoid any possible injury it is ALWAYS recommended to loosen but do not remove the four end-cap bolts (5-mm) 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 (5-mm) 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 RiverRay.
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 (5-mm) 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 RiverRay, see RiverRay Re-assembly.

RiverRay Re-assembly

To replace the end-cap and transducer head, proceed as follows. Use Figure 7 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 RiverRay (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 RiverRay 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 four screws holding the end-cap interface board to the end-cap assembly.
4. Remove the old desiccant bag and install a new one. Place the desiccant bag between the end-cap interface board and the end-cap. Replace the screws holding the end-cap interface board to the end-cap assembly.

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

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

O-ring Inspection and Replacement

This section explains how to inspect/replace the RiverRay 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.

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

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

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 ADCP to flood.

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

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

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

5. Stand the RiverRay housing on its end.
6. 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.

7. 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 ADCP will flood.

8. Examine the 316 stainless steel transducer assembly bolts and washers (5-mm) for corrosion; replace if necessary. Use Figure 7 for parts identification. All hardware items are needed to seal the RiverRay properly.
9. Install all four sets of hardware until “finger tight.”
10. Tighten the bolts in small increments in a “cross” pattern until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value of 1.7 Newton-meters (15 pound-inches).

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 hardware to the recommended torque value of 1.7 Newton-meters (15 pound-inches).

End-cap Replacement

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

To replace the end-cap:

1. Stand the RiverRay 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.

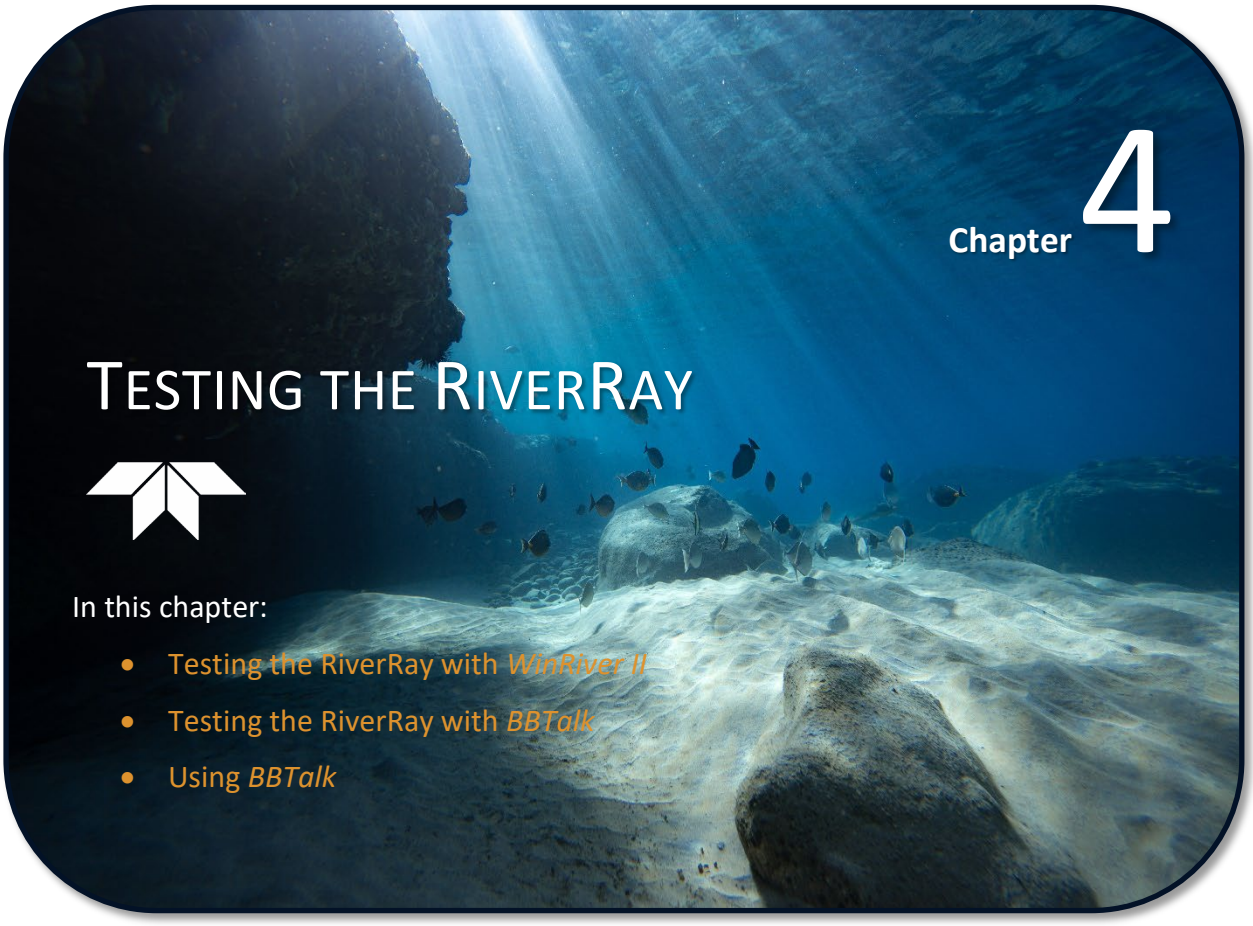
   Check that no wires or any other object is pinched between the end-cap and the housing. Use rubber bands to hold the wiring in place as necessary. If the O-ring is not in the groove or if a wire or other object is pinched, the ADCP will flood.

5. Examine the 316 stainless steel end-cap assembly bolts and washers (5-mm) for corrosion; replace if necessary. Use Figure 7 for parts identification. All hardware items are needed to seal the RiverRay properly.
6. Install all four sets of hardware until “finger-tight.”
7. Tighten the bolts in small increments in a “cross” pattern until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value of 1.7 Newton-meters (15 pound-inches).

   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 hardware to the recommended torque value of 1.7 Newton-meters (15 pound-inches).

NOTES



Chapter 4

TESTING THE RIVERRAY

In this chapter:

- Testing the RiverRay with *WinRiver II*
- Testing the RiverRay with *BBTalk*
- Using *BBTalk*

This chapter explains how to test the RiverRay using the *TRDI Toolz* program. These tests thoroughly check the RiverRay in a laboratory environment but are no substitute for a practice deployment.

Test the RiverRay:

- When the RiverRay is first received.
- Before each deployment or every six months.
- When instrument problems are suspected.
- After each deployment.

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

Testing the RiverRay with *WinRiver II*

To test the RiverRay using *WinRiver II*:

1. Connect and apply power to the system as described in Serial Connection.
2. Start the *WinRiver II* program.
3. On the **Acquire** menu, click **Execute ADCP Test**. *WinRiver II* will send the PS0, PS3, PA, and PC2 commands.

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

Testing the RiverRay with *TRDI Toolz*

To test the RiverRay using *TRDI Toolz*:

1. Interconnect and apply power to the system as described in Serial Connection.
2. Start the *TRDI Toolz* program.
3. Click the **Break** () button.
4. Using *TRDI Toolz*, send the RiverRay the following commands: PS0, PS3, PA, and PC2.

For help on using *TRDI Toolz*, see the TRDI Toolz help file.

Test Results

This section shows an example of the test commands.

Display System Parameters

This tells the ADCP to display specific information about the ADCP. For example:

```
>ps0
   Serial Number:  109
       Frequency:  614400 Hz
 Transducer Type:  PHASEDARRAY
      Beam Angle:  30 Degrees
    Beam Pattern:  CONVEX
         Sensors:
             Temperature:           DS18b20 1-Wire
             Heading/Pitch/Roll:    RDI

    CPU Firmware:  44.14
    FPGA Version:  7.00.002 [0x7002]

Board Serial Number Data:
 DB 00 00 00 DB B6 32 28   DS18B20 TMP SNS
 2F 00 00 00 3D 09 08 23   DSP72B-2203-00X
 7B 00 00 00 3D 8D AC 23   END72B-2246-00X
 4F 00 00 00 7B 5A D1 23   PIO72B-2201-00X
 F9 00 00 00 51 DB 65 23   PER72B-2244-00A
 8D 00 00 00 3D 8C C7 23   RCV72B-2243-03C
 D5 00 00 00 35 0C 9F 23   XDR72B-1001-00X

>
```

Verify the information is consistent with the setup of the system.

The Heading/Pitch/Roll sensor may be RDI (Integrated Sensor Module) or HMR3300 (Honeywell) depending upon the hardware configuration.

An updated version of the FPGA code (0x7002) was released in June 2012 and is installed on all factory upgraded and new production systems.

- *WinRiver II* will work with 44.14 and FPGA code version 0x7000.
- *WinRiver II* will work with 44.14 and FPGA code version 0x7002.
- Upgrading to firmware version 44.14 in the field will not update the older FPGA code (7.00.000) [0x7000] to the newer FPGA code (7.00.020) [0x7002].
- A RiverRay with FPGA code version 0x7002 should not be downgraded to any RiverRay version that is older than 44.14 as *WinRiver II* will not run successfully.
- Contact TRDI for information on upgrading the FPGA code.

Instrument Transformation Matrix

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

```
>ps3

Last Save Time: 09/05/15,08:40:55.90
Profiling Beams: 4
Freq(Hz) 614400
Dia (mm) 76
Beam Positions:
 Bm        X         Y         Z         P         R         E
  1   0.0000    0.0000    0.0000    0.0000    0.0000   30.0000
```

```
  2   0.0000   0.0000   0.0000   0.0000   0.0000  30.0000
  3   0.0000   0.0000   0.0000   0.0000   0.0000  30.0000
  4   0.0000   0.0000   0.0000   0.0000   0.0000  30.0000
Instrument Transformation Matrix:
  1.0000 -1.0000  0.0000  0.0000
  0.0000  0.0000 -1.0000  1.0000
  0.2887  0.2887  0.2887  0.2887
  0.7071  0.7071 -0.7071 -0.7071

>
```

If the RiverRay 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 RiverRay 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
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.

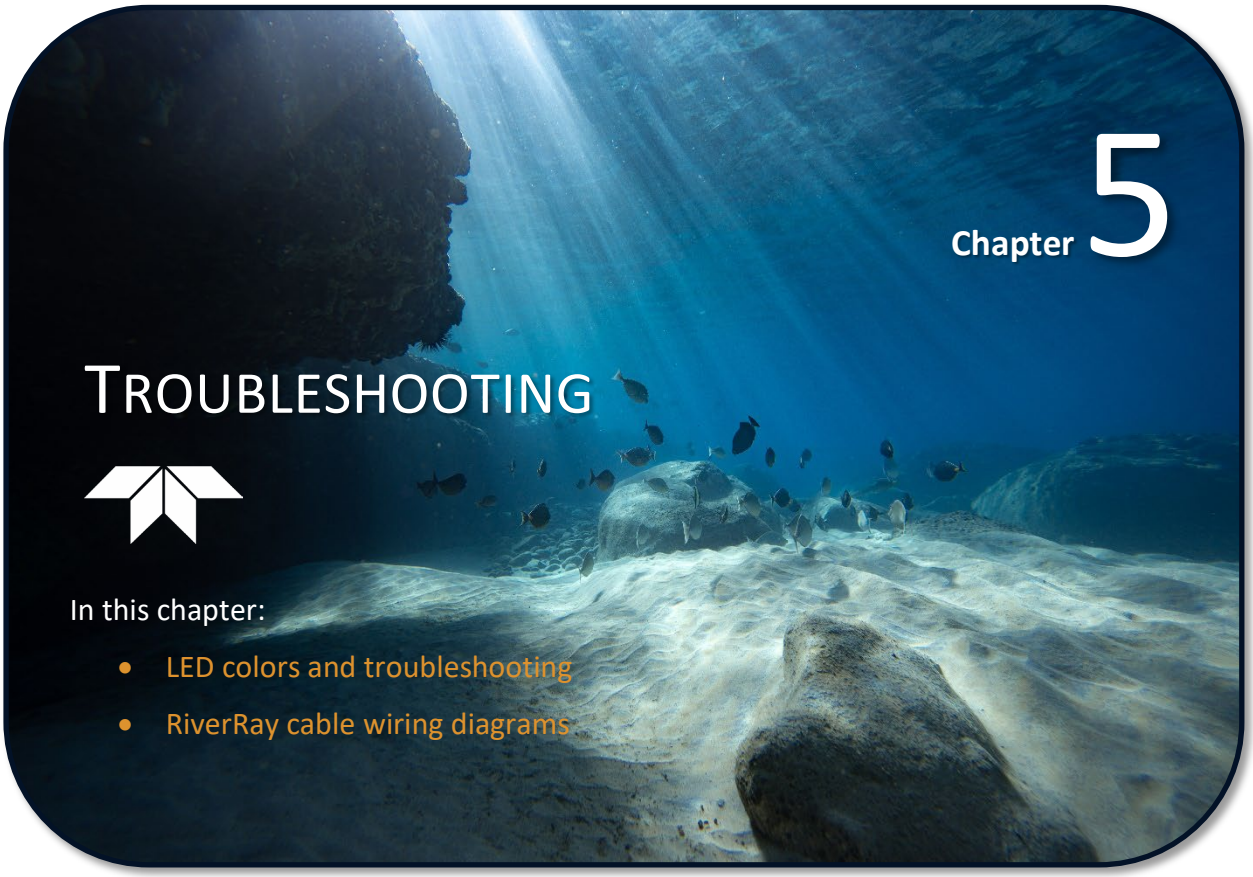
```
>pc0
PC0   = Help
PC2   = Display Sensor Data
PC4   = Display Voltage Monitor ADC Data
PC20  = Display Scrolling Sensor Data
PC40  = Display Scrolling Voltage Monitor Data

>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
```



Chapter 5

TROUBLESHOOTING

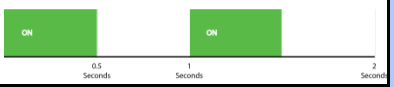
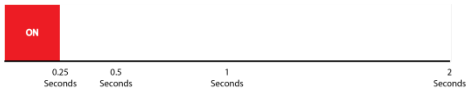
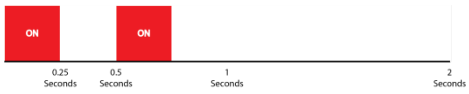
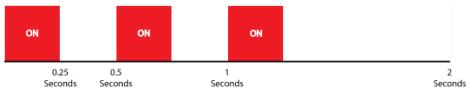
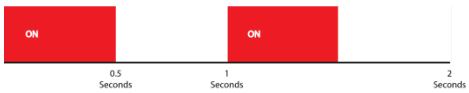
In this chapter:

- LED colors and troubleshooting
- RiverRay cable wiring diagrams

System Status and LED Behavior

The RiverRay LED behavior is illustrated in Table 2. The blue LED indicates Bluetooth connection status. The green and red LEDs depict the system status and diagnostic information respectively.

Table 2. 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="10">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 Fail-ure</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></tr>
<tr><td>Pinging</td><td>Blinks 0.1 sec/ensemble</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 will 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.

RiverRay systems with the single tri-color LED, the LED will be green until part way through the initialization, after which it should flash yellow. Once the power up self-test is complete the LED will be solid yellow (Serial) or blue (Bluetooth) to indicate the **LAST** connection, or red if there is a failure. When a **NEW** connection is established, then the LED color will match the type of connection (blue for Bluetooth, yellow for Serial).

Sensor Failure may be due to an internal sensor or an external sensor such as a GPS. PC2 will check internal sensors.

To check external sensors, disconnect the GPS to see if LED behavior changes. A GPS 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 3: Troubleshooting the RiverRay

Problem / Indication	Possible Solution
LEDs do not light	Check the 12V Lead Acid battery connection. Turn on power switch on Tethered Trimaran. Check fuse in Tethered Trimaran.
System Error: Red LED on solid or blinking	Send a === (soft break) or use *TRDI Toolz* to wake the RiverRay. Cycle power. If this does not help, check 12V Lead Acid battery. System error has been detected. Use *TRDI Toolz* to Test the RiverRay. Replace the 12V Lead Acid battery.
Blue LED off	Send a === (soft break) or use *TRDI Toolz* to wake up the RiverRay. Try connecting to RiverRay 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 RiverRay. RiverRay internal temperature may be above 50° C. Move the RiverRay 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 Trimaran that protects the RiverRay 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).

RiverRay Cables

This section has information on RiverRay cabling. Special user-requests may cause changes to the basic wiring system and may not be shown here. TRDI provided these drawings only as a guide in troubleshooting the RiverRay. If there is a conflict, contact TRDI for specific information about the system. The following figures show various RiverRay cable locations, connectors, and pin-outs.

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

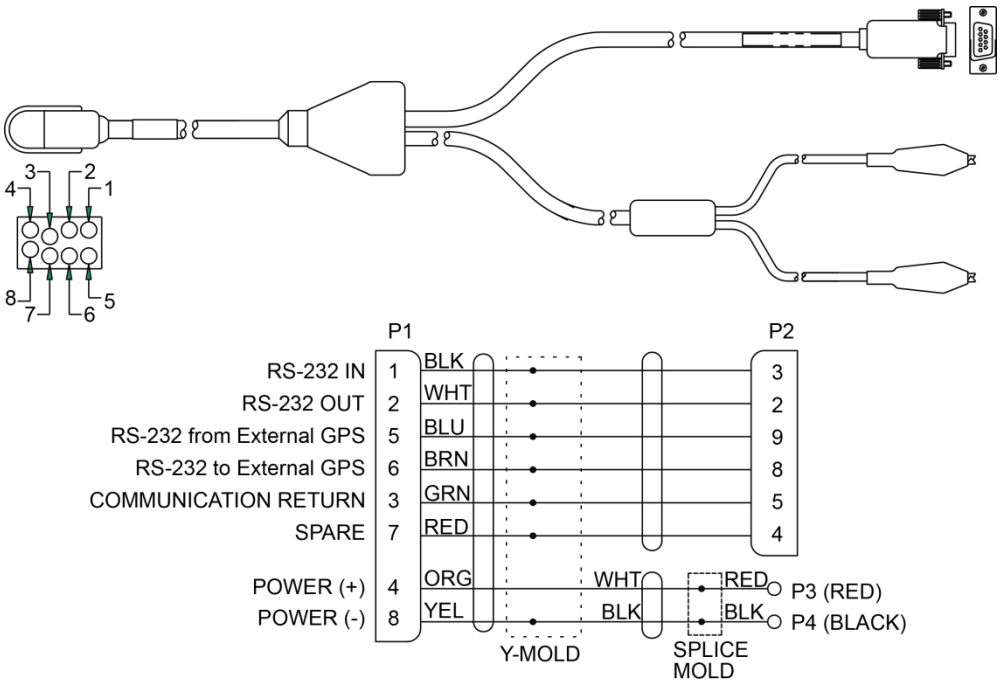


Figure 10. RiverRay I/O Cable Wiring

If the RiverRay 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 RiverRay electronics.

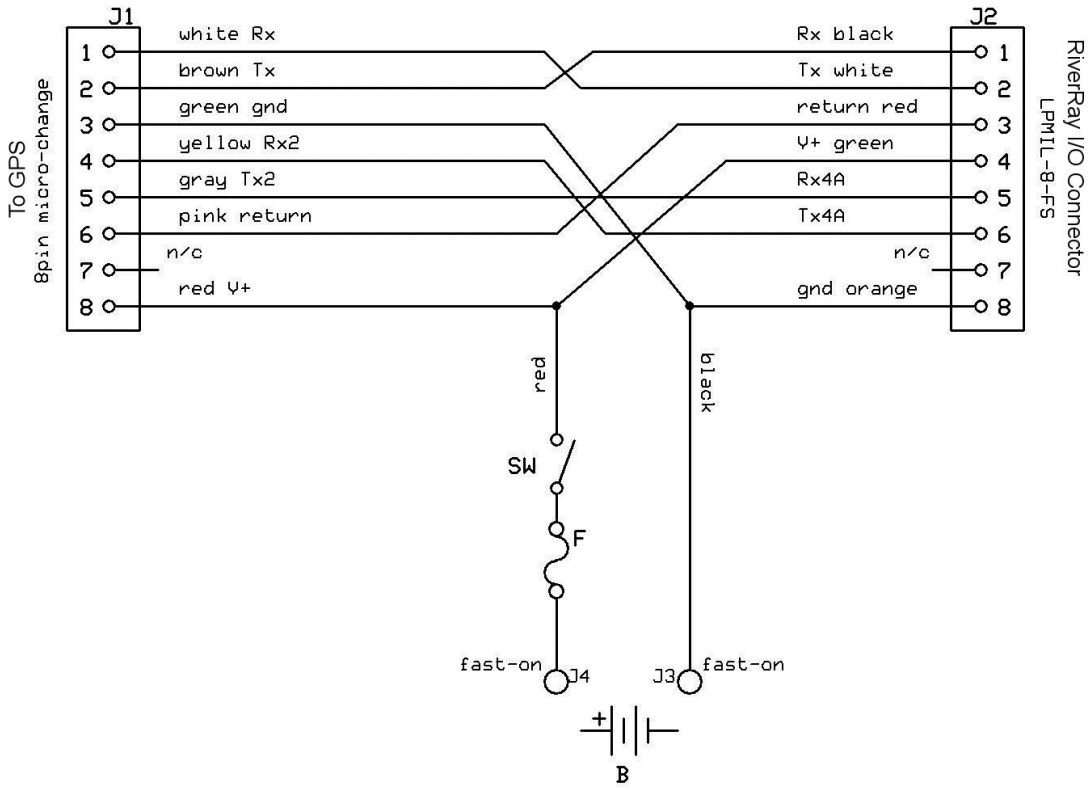
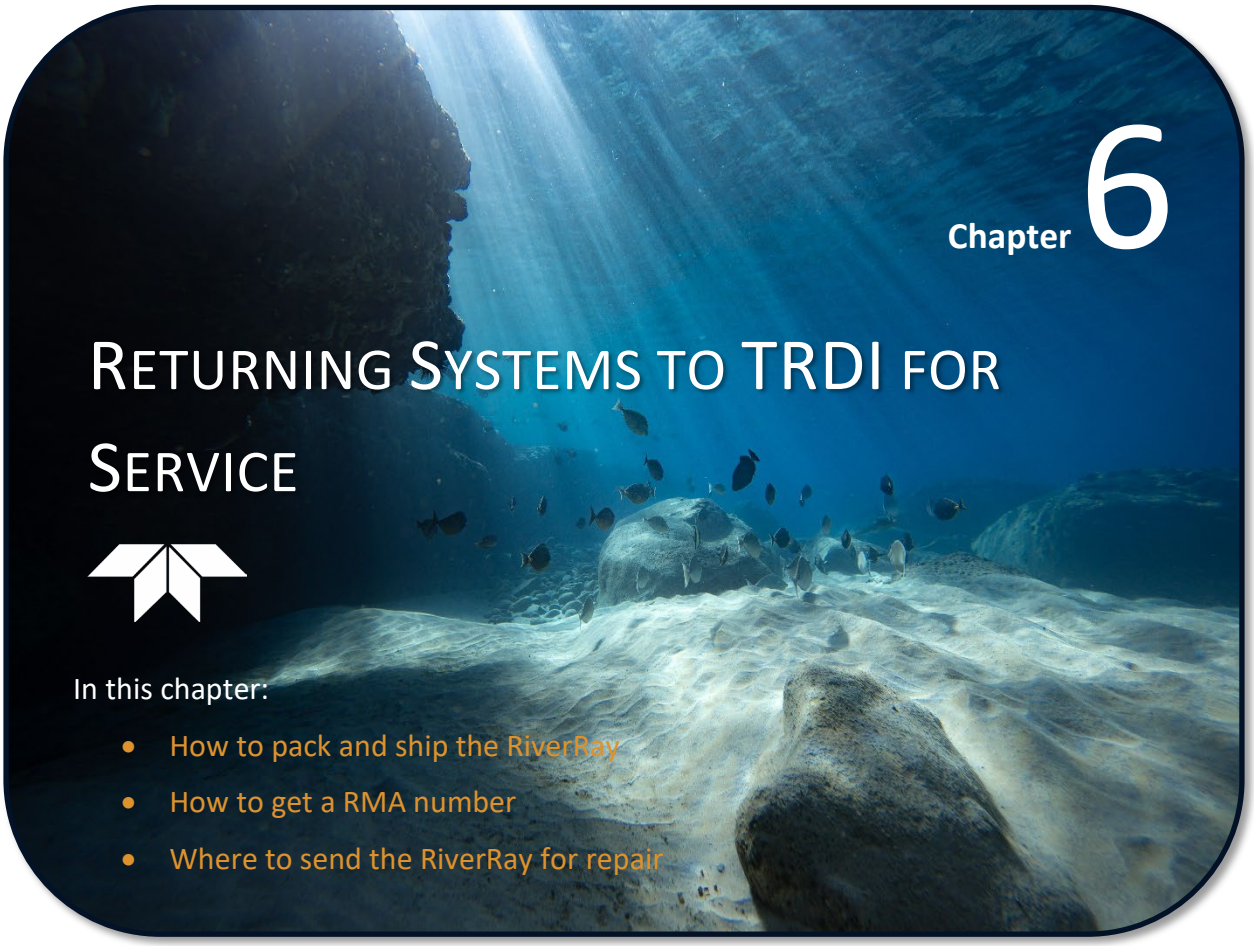


Figure 11. RiverRay Tethered Trimaran Wiring Diagram

Table 4: RiverRay Tethered Trimaran 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

NOTES



Chapter 6

RETURNING SYSTEMS TO TRDI FOR SERVICE

In this chapter:

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

Shipping the RiverRay

This section explains how to ship the RiverRay.

Remove all customer-applied coatings or provide certification that the coating is nontoxic when shipping a RiverRay to TRDI for repair or upgrade. This certification must include the name of a contact person who is knowledgeable about the coating, the name, manufacturer of the coating and the appropriate telephone numbers. If the equipment is returned without meeting these conditions, TRDI has instructed our employees not to handle the equipment and to leave it in the original shipping container pending certification. If certification cannot be provided, TRDI 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 RiverRay 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 RiverRay.

To ship the RiverRay system, 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 RiverRay 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 RiverRay arrives with the minimum possible delay. Any deviation from these instructions increases the potential for delay.

Step 1 - Request a Return Material Authorization

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

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

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship via air freight, prepaid

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

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

Mark the Package(s)

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

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

Step 4 - Urgent shipments

Send the following information by fax or telephone to TRDI.

Attention: Customer Service Administration

Fax: +1 (858) 842-2822

Phone: +1 (858) 842-2700

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

Returning Systems to TRDI Europe Factory

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

Step 1 - Request a Return Material Authorization

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

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

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

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

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

Step 2 – Provide a MSDS as necessary

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

Step 3 - Ship Via Air Freight, Prepaid

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

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

Mark the package(s) as follows:

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

Step 4 - Include Proper Customs Documentation

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

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

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

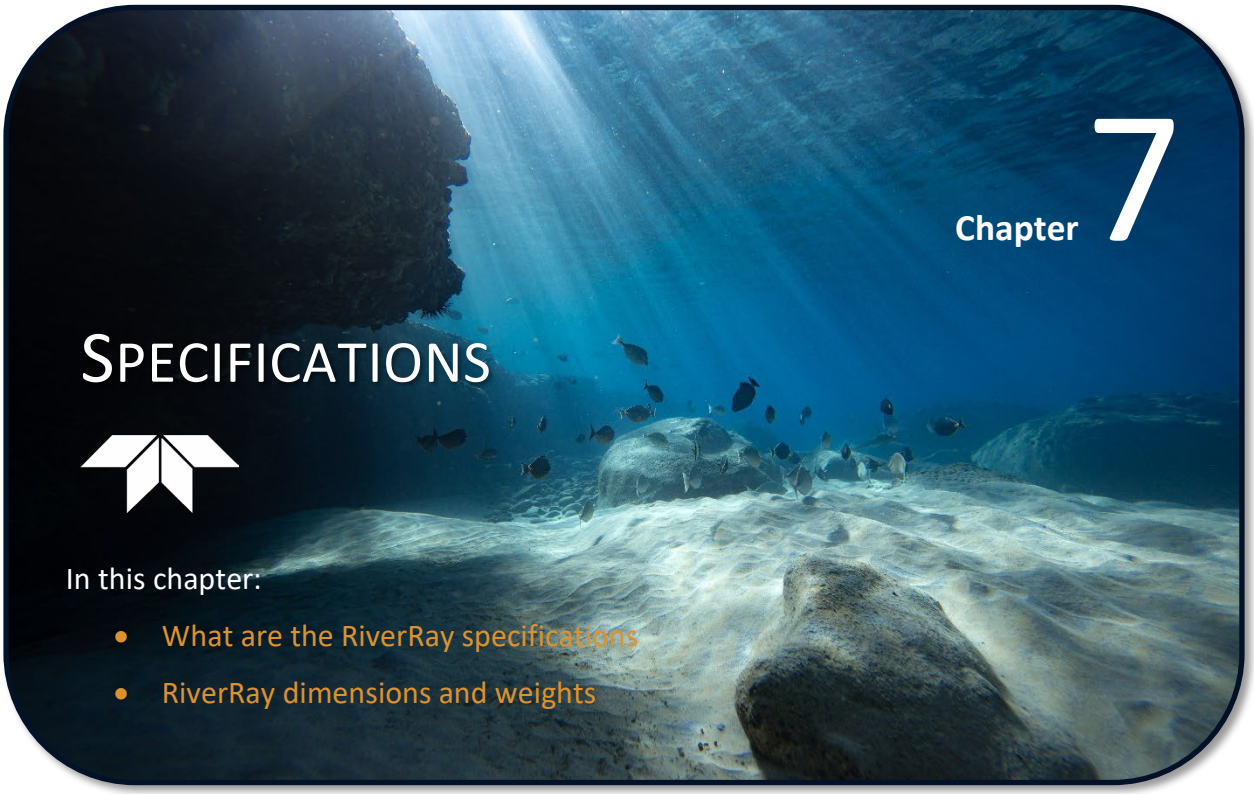
Attention: Sales Administration

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

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

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

NOTES



Chapter 7

SPECIFICATIONS

In this chapter:

- What are the RiverRay specifications
- RiverRay dimensions and weights

A brief review of RiverRay 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 RiverRay 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 RiverRay 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 RiverRay 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. In the case of the RiverRay, the beams are produced by a phased array. The array is flat and the angle of the beams is controlled by the phase delay of the channels. This phase delay is produced by fixed circuitry, which does not need any initial calibration and whose components do not show any aging effects.

The speed of sound in the water is another factor that linearly contributes to the RiverRay velocity calculation. This parameter can be provided to the RiverRay 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 RiverRay 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 RiverRay 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 beam angles are produced by a phased array and any residual error is compensated by an initial factory calibration; no further re-calibration is necessary. 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 RiverRay has undergone its original factory calibration, its measurements should remain within specification for the lifetime of the device.

Table 5: RiverRay Specifications

Water Velocity Profiling	Operation mode	Broadband or pulse-coherent, automatic / manual
	Velocity range	±5m/s default, ±20m/s max.
	Profiling range	0.4m (See note 1) to 60m (See note 2)
	Accuracy	±0.25% of water velocity relative to ADCP, ±2mm/s
	Resolution	1mm/s
	Number of cells	25 typical, 200 max. (automatic selection)
	Cell size:	10cm min. (automatic selection)
	Surface cell range	25cm (See note 3)
	Data output rate	1-2Hz (typical)
Bottom Tracking	Operation mode	Broadband
	Velocity range	±9m/s
	Depth range	0.4m to 100m (See note 2)
	Accuracy	±0.25% of bottom velocity relative to ADCP, ±2mm/s
	Resolution	1mm/s
Depth Measurement	Range	0.3m to 100m (See note 2)
	Accuracy	±1% (with uniform water temperature and salinity profile)
	Resolution	1mm (See note 4)
Vertical Beam	Range	0.2m to 80m
	Accuracy	±1% (with uniform water temperature and salinity profile)
	Resolution	1mm
Transducer and Hardware	System frequency	600 kHz
	Configuration	Phased array (flat surface), Janus four beams at 30° beam angle
	Beam Width	2.1° (See note 6)
	Internal memory	16MB
Communications	Standard	RS-232, 1200 to 115,200 baud. Bluetooth, 115,200 baud, 200m range.
	Optional	Radio modem, range >30km (line of sight)
Power	Input voltage	10.5–18V DC Power consumption
	Battery (inside Tethered Trimaran)	12V, 7A-hr lead acid gel cell (rechargeable)
	Battery capacity	>40 hrs continuous operation
Environmental	Operating temperature	-5°C to 45°C
	Storage temperature	-20°C to 50°C
Tethered Trimaran (included)	Configuration	Three hulls (trimaran)
	Material	Polyethylene
	Dimensions	Length 120cm, width 80cm, height 18cm

Table 5: RiverRay Specifications

Standard Sensors	Temperature	Tilt (pitch and roll)	Compass
Range	-5°C to 45°C	±90°	0-360°
Accuracy	±0.4°C	±0.3°	±2° (See note 5)
Resolution	0.01°C	0.02°	0.01°
GPS Integration (optional)	Integration with GPS (customer supplied) through RS-232 to RR data stream		

1. Assumes one good cell (10cm); range measured from the transducer surface.
2. Assume fresh water; actual range depends on temperature and suspended solids concentration.
3. Distance measured from the center of the first cell to the transducer surface.
4. For averaged depth data.
5. For combined tilt <+/-70° and dip angle <70°.
6. The -3dB beam width (opening angle) for the four slant beams on a RiverRay phased array system is 2.1 degrees. RiverRay beams are orthogonal in plan and inclined 30 degrees off vertical.
   The -3dB beam width (opening angle for the vertical beam on RiverRay is 9 degrees.

Outline Installation Drawings

The following drawings show the standard RiverRay dimensions.

Table 6: Outline Installation Drawings

Description	Drawing #
600 kHz RiverRay Vertical Beam, GPS	96B-6062

Outline Installation Drawings are subject to change without notice. Contact TRDI before building mounts or other hardware to verify the latest version of the drawing.

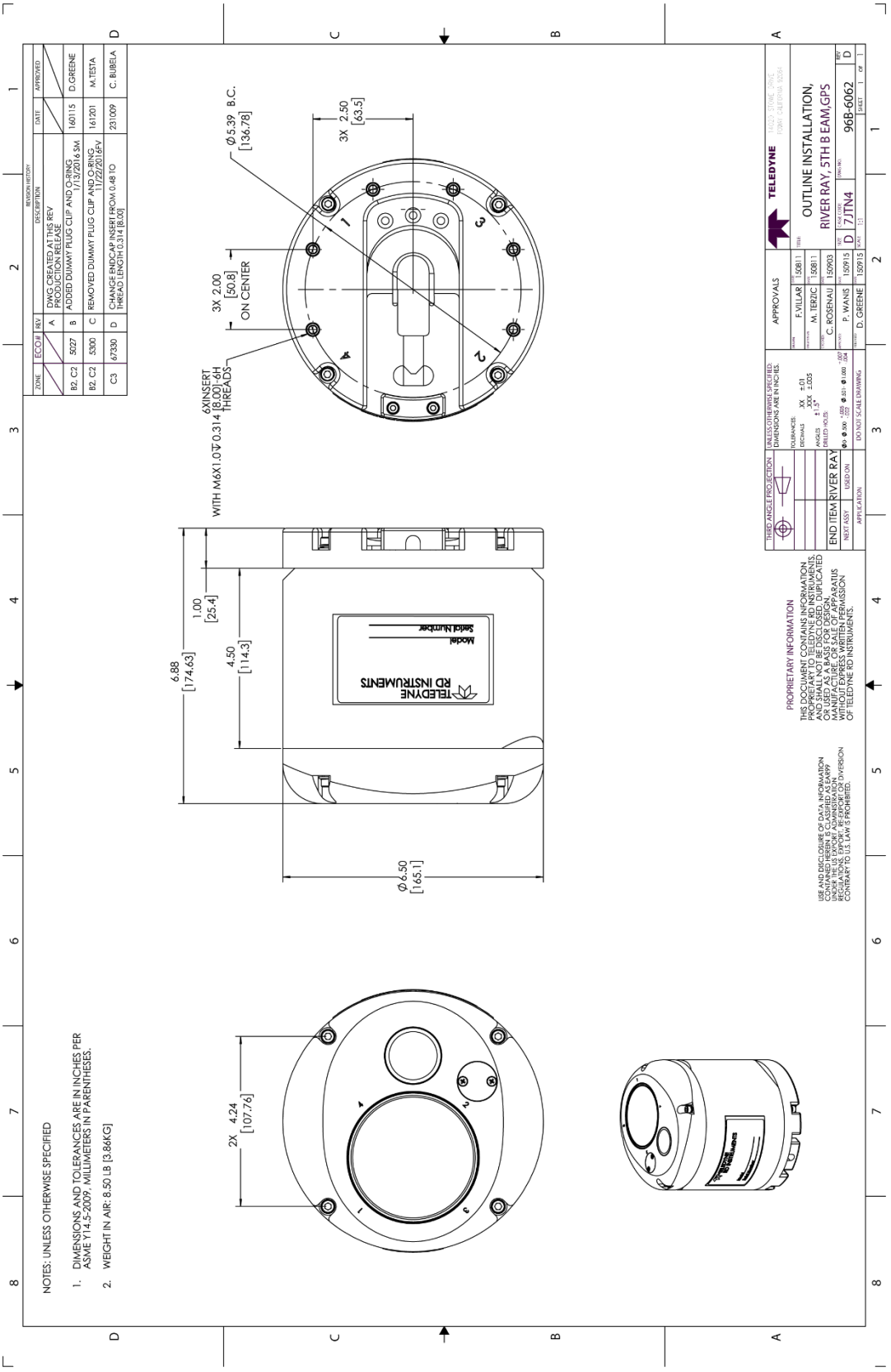
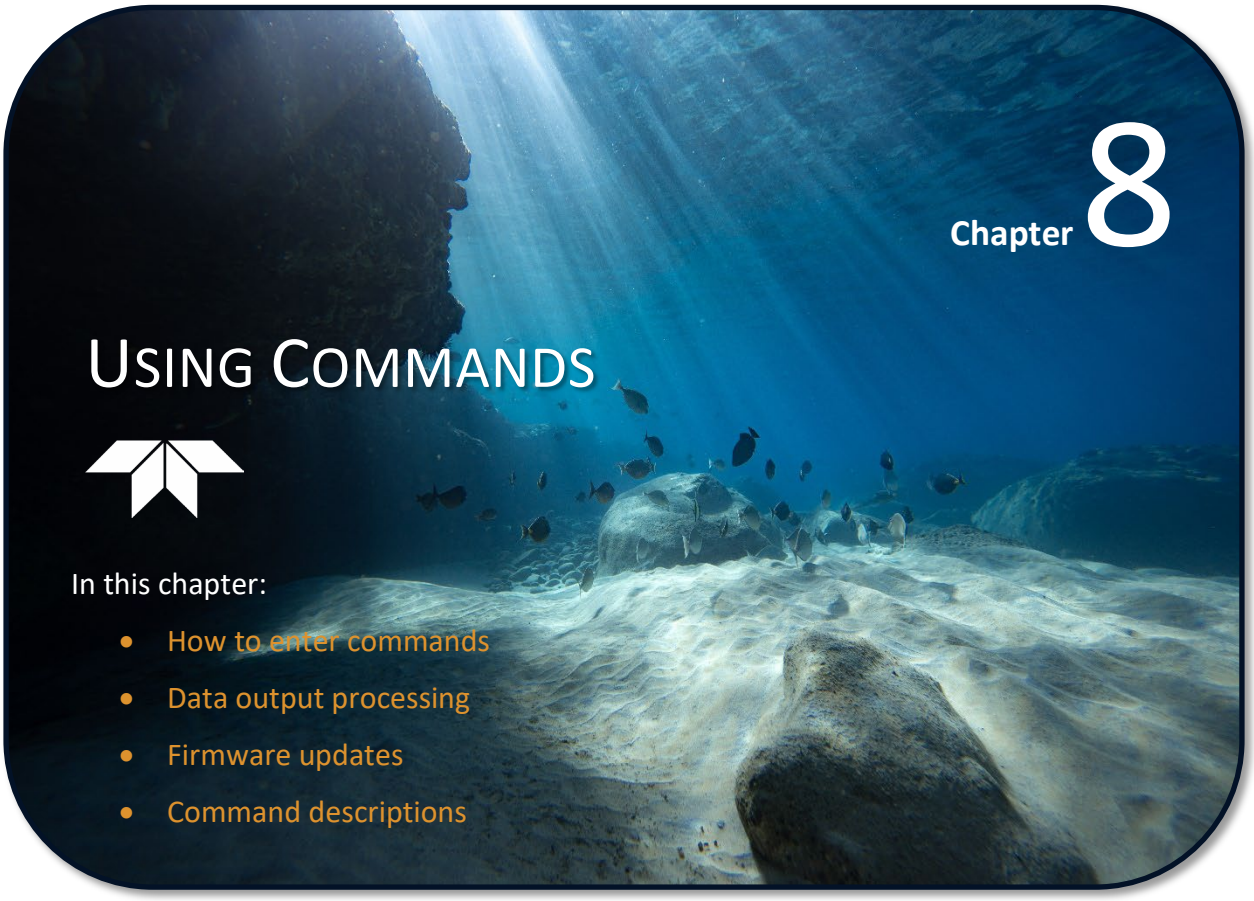


Figure 12. RiverRay Outline Installation Drawing – Vertical Beam, GPS

NOTES



Chapter 8

USING COMMANDS

In this chapter:

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

This guide defines the commands used by the RiverRay. These commands (Table 7) set up and control the RiverRay without using an external software program such as our *WinRiver II* or *SxS Pro* programs. However, TRDI recommends using our software to control the RiverRay because entering commands directly from a terminal can be difficult. Most RiverRay settings use factory-set values. 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 RiverRay is set up correctly. The commands shown in Table 7 directly affect the range of the RiverRay, the standard deviation (accuracy) of the data, and battery usage.

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 RiverRay communicates with the computer through the Bluetooth interface or the RS-232 serial interface I/O cable. TRDI initially sets the RiverRay at the factory to communicate at 115200 baud, no parity, and one stop bit.

Immediately after power is applied to the RiverRay, it enters the Command mode. When the RiverRay receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The RiverRay is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
RiverRay
Teledyne RD Instruments (c) 2013
All rights reserved.
Firmware Version: 44.xx

>
```

Command Input Processing

Input commands set RiverRay 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 RiverRay executes the command. If the command is one that does not provide output data, the RiverRay 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]
>            [RiverRay response to a valid, no-output command]
```

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

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

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

Data Output Processing

After the RiverRay 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.

RiverRay 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 RiverRay. 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.

All of Teledyne RD Instruments' software supports binary Output Data Format only.

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

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

Firmware Updates

RiverRay firmware can be downloaded from https://tm-portal.force.com/TMsoftwareportal.

To update the firmware:

Firmware updates using the m0 file require TRDI Toolz version 1.03.00.15 or higher software.

1. Set up the RiverRay as shown in Serial Connection.
2. On *TRDI Toolz*, click **Tools**, **Firmware Update**.
3. Navigate to where the firmware file was downloaded. Unzip the file. The file name will be *RiverRay_xx.xx.m0*, where *xx.xx* is the firmware version.
4. Click **OK**. The firmware will install. It takes several minutes to load the new firmware and the screen may be blank during the update process. Do not close *TRDI Toolz* while the firmware is updating.
5. Once the firmware update is complete, the RiverRay will reboot. Close *TRDI Toolz* and reconnect to the RiverRay.
6. If the new firmware does not install, contact Customer Service.
7. After successfully upgrading the firmware, use *TRDI Toolz* to test the RiverRay.

To update the firmware using the batch file:

1. Set up the RiverRay as shown in Serial Connection.
2. Double-click the *RiverRay Upgrade Script.bat* file. Click the **Setup** button.
3. Click the **View README.TXT** button to view the *Readme.txt* file for details on what is new in this version of firmware.
4. Click **Next** and follow the on-screen prompts.
5. If the new version of firmware will not install, contact Customer Service for assistance.
6. After successfully upgrading the firmware, use *TRDI Toolz* to test the RiverRay.

The RiverRay uses FPGA code to perform some of its functions. An updated version of the FPGA code (0x7004) was released January 25, 2023, and is installed on all factory upgraded and new production systems.

- *WinRiver II* will work with 44.25 or higher and FPGA code version 0x7004.
- *WinRiver II* will work with 44.14 to 44.25 or higher and FPGA code version 0x7002 or 0x7000.
- Upgrading to firmware version 44.25 in the field will not update the older FPGA code [0x7000 or 0x7002] to the newer FPGA code (7.00.040) [0x7004].
- A RiverRay with FPGA code version 0x7004 should not be downgraded to any RiverRay version that is older than 44.25 as *WinRiver II* will not run successfully.
- Contact TRDI for information on upgrading the FPGA code.

Feature Upgrades

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

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 ADCP. Update the firmware before installing a feature upgrade (see Firmware Updates).

To install a feature upgrade:

1. Set up the RiverRay as shown in Serial Connection.
2. Save the *RR_xxxxx.feature* file to your computer. On *TRDI Toolz*, click **Tools**, **Activate Features** to enable the Section-By-Section features.

If this feature was ordered with the system, it will already be installed. For field upgrades, the file can be renamed by TRDI, for example to *RR_SNxxx.feature* where *xxx* is the RiverRay ADCP's serial number and will be e-mailed.

3. The installation program will start. The feature file is encoded with the RiverRay's serial number and the requested feature upgrade. It takes several minutes to load the new feature and the screen may be blank during the update process. Do not close *TRDI Toolz* while the feature is installing.
4. Once the feature install is complete, the RiverRay will reboot. Close *TRDI Toolz* and reconnect to the RiverRay.
5. Using *TRDI Toolz* send the OL command (see OL – Display Feature List) to verify the feature upgrade has been installed.

Command Summary

Table 7 gives a summary of the RiverRay input commands, their format, default, and a brief description of the parameters they control.

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

Table 7: RiverRay Input Command Summary

Command/Default	Description
?	Shows command menu (deploy or system)
<BREAK> End	Interrupts or wakes up RiverRay and loads last settings used
Y	Display banner
OI	Install New Feature
OL	Display Feature List
BX1000	Maximum Tracking Depth (40 to 65535 dm)
CA0	Communication Timeout (0=Off,10-65536 sec)
CB811	Serial port control (baud rate/parity/stop bits)
CF11111	Flow control
CK	Keep parameters as user defaults
CO	Collect and Output A Sample
CR	Restore command defaults (0=user, 1=factory)
CS	Start pinging
CSTATE	Pinging State Query
CSTOP	Stop pinging
CT	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)
EC1485	Speed of Sound (1400 to 1600 m/s)
ED00000	Transducer Depth (0 to 65535 dm)
EH+0000	Heading (000.00 to 359.99 degrees)
EP+0000	Pitch (-70.00 to +70.00 degrees)
ER+0000	Roll (-70.00 to +70.00 degrees)

Table 7: RiverRay Input Command Summary

Command/Default	Description
ES00	Salinity (0 to 45)
ET+2100	Temperature (-5.00 to +35.00 degrees C)
EU 0	System Orientation 1=up,0=down
EX00000	Coordinate Transformation (Xform:Type; Tilts; 3Bm; Map)
EZ1011101	Sensor Source (C;D;H;P;R;S;T)
ME	ErAsE recorder
MM	Show memory usge
MN RR	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
PF	Results from most recent PA tests
PS0	Display System Configuration
PS3	Display Instrument Transformation Matrix
PT	Built-In test (0 to 200)
SA	Compass/Pitch/Roll calibration [0=help]
SF	GPS Baud -1=disable, 0=help, 3=4800, 4=9600
SZ	Sensors Installed [Compass, Temperature, CTD]
TE00:00:00.00	Time per ensemble (hours:minutes:seconds.100th of seconds)
TFyy/mm/dd, hh:mm:ss	Time of first ping (year/month/day, hours:minutes:seconds)
TP00:00.00	Time between pings (minutes:seconds.100th of seconds)
TSyy/mm/dd, hh:mm:ss	Set real-time clock (year/month/day, hours:minutes:seconds)
VG0	Vertical beam depth guess (0 to 10000 cm)
VP1	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 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)

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 RiverRay 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 RiverRay 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.

```
>
RiverRay
Teledyne RD Instruments (c) 2012
All rights reserved.
Firmware Version: 44.xx

>?
Available Commands:

B ----------------------- Bottom Mode Commands
C ----------------------- Control Commands
E ----------------------- Environment Commands
M ----------------------- Loop Recorder Commands
P ----------------------- Performance Test Commands
S ----------------------- Sensor Control
T ----------------------- Time Commands
V ----------------------- Vertical Beam Commands
Y ----------------------- Display Banner
? ----------------------- Display Main Menu

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

Break

Purpose Interrupts the RiverRay without erasing present settings.

Format <BREAK>

Recommended Setting. Use as needed.

Description A BREAK signal interrupts RiverRay 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 RiverRay 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 RiverRay will use the "= = =" string instead of a break.

Example <BREAK>

```
QBREAK A
RiverRay
Teledyne RD Instruments (c) 2012
All rights reserved.
Firmware Version: 44.xx
>
```

```
CBREAK
RiverRay
Teledyne RD Instruments (c) 2012
All rights reserved.
Firmware Version: 44.xx
>
```

When a break is sent, the first line of the Wakeup Messages indicates the RiverRay's communication configuration:

- **QBREAK A -** RiverRay response to a hard break on the serial RS-232 I/O cable.
- **CBREAK** - RiverRay 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]
RiverRay
Teledyne RD Instruments (c) 2012
All rights reserved.
Firmware Version: 44.xx
>
```

If this message appears after a break, it is advised not to deploy the RiverRay 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 RiverRay.

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 RiverRay.

>
```

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 RiverRay 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 RiverRay banner.

Format Y

Recommended Setting. Use as needed.

Description

Example Y

```
>y
RiverRay
Teledyne RD Instruments (c) 2015
All rights reserved.
Firmware Version: 44.xx
```

Bottom Track Commands

The RiverRay uses these commands for bottom-tracking applications. Bottom track commands tell the ADCP 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?
BX = 00300 --------------- Maximum Depth (10-65535 dm)
```

Bottom Track Command Descriptions

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 01000

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 ADCP during bottom tracking. This prevents the ADCP from searching too long and too deep for the bottom, allowing a faster ping rate when the ADCP loses track of the bottom.
Example	If 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 1000 dm. Now if the ADCP loses track of the bottom, it will stop searching for the bottom at 210-dm (21 m) rather than spend time searching down to 1000-dm (100 m), which is the maximum bottom-tracking range.

Control System Commands

The RiverRay 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

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

Description — The CA command sets the activity timeout period, in seconds. The activity timer is reset when a valid command is received. If no valid command is received within the timeout period, the RiverRay will go to sleep or deploy itself, depending on the setting of the CT (Turnkey) command. If Turnkey mode is enabled (CT1) then the RiverRay 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 RiverRay and the computer MUST use the same communication parameters to *talk* to each other (see Changing the Baud Rate in the RiverRay). After valid CB parameters are entered, the RiverRay responds with a ">" prompt. Then change the external device's communication parameters to match the RiverRay parameters before sending another command.

Table 8: 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 RiverRay returns to the communication parameters stored in non-volatile memory (user settings).

CF - Flow Control

Purpose Sets various RiverRay 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 RiverRay: 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 9: Flow Control

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF0xxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the ">" prompt and waits for a new command.
CFx1xxx	Automatic Ping Cycling – Pings immediately when ready.
CFx0xxx	Manual Ping Cycling – Sends a < character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the RiverRay is not echoed. This feature manually controls ping timing within the ensemble. Note the prompt output by the RiverRay 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 - Keep Parameters

Purpose Stores present parameters to non-volatile memory.

Format CK

Recommended Setting. Use as needed.

Description CK saves the present user command parameters to non-volatile memory on the CPU board. The RiverRay 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 CRo-command (see CR – Retrieve Parameters).

Always use the CK command in the configuration files.

The RiverRay 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 RiverRay 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 RiverRay (Note that this battery will recharge as soon as power is reapplied). If the RiverRay is stopped by removing the power while pinging, it will restart pinging and output data next time power is applied.

CR – Retrieve Parameters

Purpose Resets the RiverRay command set to factory settings.

Format CR*n*

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

Recommended Setting. Use as needed.

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

Table 10: Retrieve Parameters

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

CR keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the RiverRay 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 RiverRay 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 RiverRay waits until it reaches the TF time before beginning the data collection cycle.

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

CState – Status

Purpose Displays the status of the RiverRay.

Format CState

Recommended Setting. Use as needed.

Description Displays either "Pinging" or "Not Pinging", depending on the state of the RiverRay.

CStop – Stop Pinging

Purpose Stops the current deployment.

Format CStop

Recommended Setting. Use as needed.

Description Stops autonomous sampling without resetting the RiverRay.

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 RiverRay 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 RiverRay 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 - Sleep

Purpose Tells the RiverRay 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 RiverRay 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

> **Recommended Setting.** For systems that are stationary, EA is typically set to zero (default), since Beam 3 is used as the heading reference. This command is added to the command file using *WinRiver II*.

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

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

EB - Heading Bias

Purpose — Corrects for electrical/magnetic bias between the ADCP 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 ADCP and the heading source. Use the EA-command to correct for physical heading misalignment between the ADCP and a vessel's centerline.

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

EC - Speed of Sound

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

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

ED - Depth of Transducer

Purpose Sets the ADCP transducer depth.

Format ED*nnnnn*

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

Default ED00000

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

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

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

EH - Heading

Purpose Sets the ADCP 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 ADCP heading angle of beam 3. When mounted on a stationary platform, the ADCP assumes beam 3 points north (0).

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

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

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

EP - Pitch (Tilt 1)

Purpose Sets the ADCP 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 ADCP pitch (tilt 1) angle.

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

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

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

ER - Roll (Tilt 2)

Purpose Sets the ADCP 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 ADCP 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 ADCP overrides the manually set ER value and uses roll from the transducer's internal tilt sensor. If the sensor is not available, the ADCP 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 RiverRay uses ES in its speed of sound calculations. The RiverRay 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 ADCP uses ET in its speed of sound calculations (see the primer). The ADCP assumes the speed of sound reading is taken at the transducer head.

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

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

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

EU – System Orientation

Purpose Sets the ADCP 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 ADCP system orientation, up or down.

If the EZ Roll field is not zero, the ADCP overrides the manually set EU value and uses orientation from the transducer's internal tilt sensor. If the sensor is not available, the ADCP 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 11: 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 ADCP. Heading/Pitch/Roll not applied.
EX10xxx	Ship coordinates (Note 1) X, Y, Z vectors relative to the ship. Heading not applied. EA-command used, but not the EB-command. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EX11xxx	Earth coordinates (Note 1) East, North, Vertical vectors relative to Earth. Heading applied. EA and EB-commands used. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EXxx1xx	Use tilts (pitch and roll) in transformation (see Note 2)
EXxxx1x	Allows 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 RiverRay 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 RiverRay 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 13). When you look at the face of the transducer head, the transducers are labeled clockwise in the order 3-1-4-2 (see Figure 14). 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.

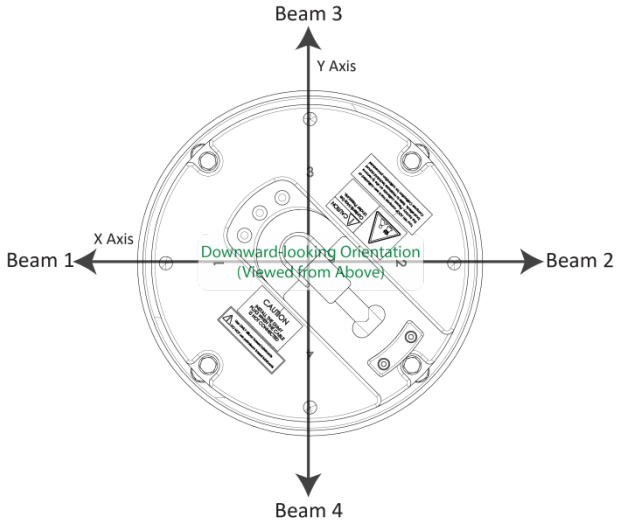


Figure 13. X, Y, and Z Velocities

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.

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:

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

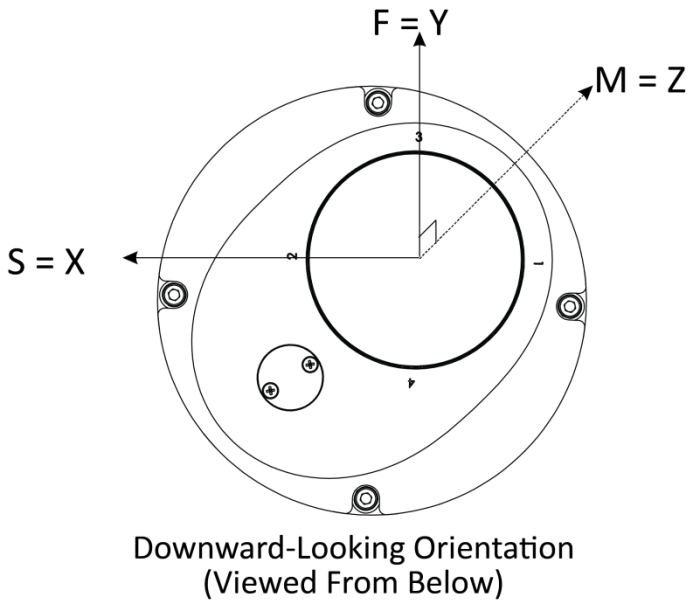


Figure 14. RiverRay Coordinate Transformation

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 15).

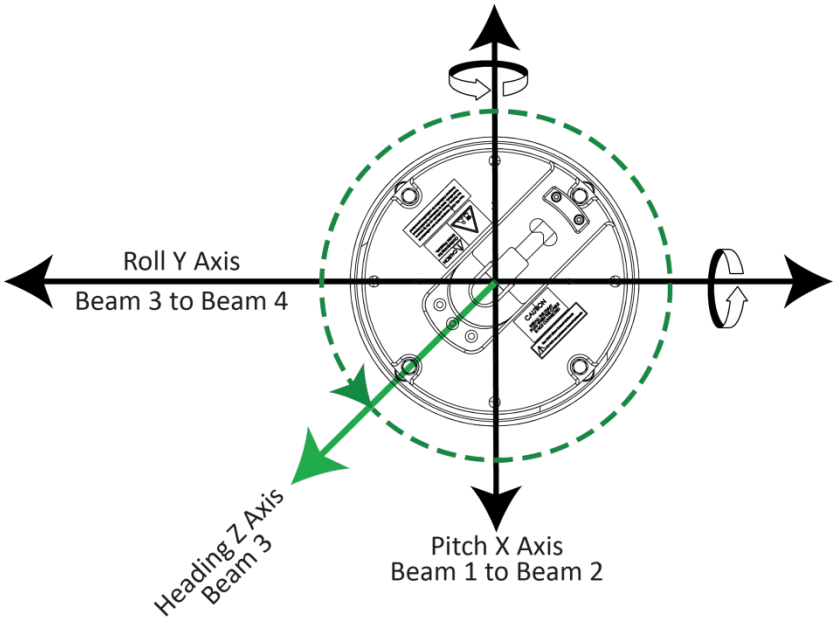


Figure 15. RiverRay Pitch and Roll Angles

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

Table 12: 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.

Loop Recorder Commands

The loop 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 ADCP (start pinging again).

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

Available Loop Recorder Commands

This section lists the available Loop Recorder commands.

```
>m?
Available Commands:

ME ---------------------- ErAsE recorder
MM ---------------------- Show memory usage
MN RR ------------------- 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
```

Loop Recorder Command Descriptions

This section lists the Loop Recorder commands.

ME – Erase Recorder

Purpose Erase the contents of the loop recorder.

Format ME ErAsE

Recommended Setting. Use as needed.

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

Erasing the loop-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.

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  Loop Recorder : Used = 0.072M Bytes, Free = 1.990M Bytes
>
```

MN – Set File Name

Purpose Sets the file name for the recorder.

Format MN *xxx*

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

Default MN RR

Recommended Setting. Use as needed.

Description The MN command sets the deployment name to be used for any future deployments. The deployment name can be up to 32 characters long, and may contain letters, numbers, or the underscore (i.e. "_") character. If no deployment name is specified, a default of "RR" 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 Loop Recorder).

In order 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** dialog box.

For example, the file *RRM3281997475.000* would contain data for the deployment named "RR" (the *3281997475* in the filename is the number of seconds since January 1st, 1900). The file extension is always ".000". Waiting 25 seconds and downloading the same data again will change the file name to *RR3281997500.000*.

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.

MS - Show Recorder Size

Purpose The MS command shows the size of the loop-recorder chip.

Format MS

Recommended Setting. Use as needed.

Description Shows the size of the loop-recorder in Megabytes.

```
>ms  2.062M Bytes
```

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 Loop 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 RiverRay 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]
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 RiverRay system diagnostic tests.

Format PA

Recommended Setting. Use as needed.

Description These diagnostic tests check the major RiverRay 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 RiverRay system diagnostic tests.

Format PC*nnn*

Range *nnn* = 0, 2, 4, 20, 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
PC20  = Display Scrolling Sensor Data
PC40  = Display Scrolling Voltage Monitor 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 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.

```
>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
>
```

PS – Display System Parameters

Purpose Displays the RiverRay 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 RiverRay hardware/firmware information. For example, the output may look like this:

```
>ps0
   Serial Number:  109
       Frequency:  614400 Hz
 Transducer Type:  PHASEDARRAY
      Beam Angle:  30 Degrees
    Beam Pattern:  CONVEX
         Sensors:
             Temperature:           DS18b20 1-Wire
             Heading/Pitch/Roll:    RDI

    CPU Firmware:  44.14
    FPGA Version:  7.00.002 [0x7002]

Board Serial Number Data:
 DB 00 00 00 DB B6 32 28   DS18B20 TMP SNS
 2F 00 00 00 3D 09 08 23   DSP72B-2203-00X
 7B 00 00 00 3D 8D AC 23   END72B-2246-00X
 4F 00 00 00 7B 5A D1 23   PIO72B-2201-00X
 F9 00 00 00 51 DB 65 23   PER72B-2244-00A
 8D 00 00 00 3D 8C C7 23   RCV72B-2243-03C
 D5 00 00 00 35 0C 9F 23   XDR72B-1001-00X
```

The Heading/Pitch/Roll sensor may be RDI (Integrated Sensor Module) or HMR3300 (Honeywell) depending upon the hardware configuration.

The RiverRay uses FPGA code to perform some of its functions. An updated version of the FPGA code (0x7002) was released in June 2012 and is installed on all factory upgraded and new production systems.

- *WinRiver II* will work with 44.14 and FPGA code version 0x7000.
- *WinRiver II* will work with 44.14 and FPGA code version 0x7002.
- Upgrading to firmware version 44.14 in the field will not update the older FPGA code (7.00.000) [0x7000] to the newer FPGA code (7.00.020) [0x7002].
- A RiverRay with FPGA code version 0x7002 should not be downgraded to any RiverRay version that is older than 44.14 as *WinRiver II* will not run successfully.

Contact TRDI for information on upgrading the FPGA code.

PS3 – Instrument Transformation Matrix

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

```
>ps3

Last Save Time: 09/05/15,08:40:55.90
Profiling Beams: 4
Freq(Hz) 614400
Dia (mm) 76
Beam Positions:
 Bm        X         Y         Z         P         R         E
  1   0.0000    0.0000    0.0000    0.0000    0.0000   30.0000
  2   0.0000    0.0000    0.0000    0.0000    0.0000   30.0000
  3   0.0000    0.0000    0.0000    0.0000    0.0000   30.0000
  4   0.0000    0.0000    0.0000    0.0000    0.0000   30.0000
Instrument Transformation Matrix:
  1.0000 -1.0000  0.0000  0.0000
  0.0000  0.0000 -1.0000  1.0000
  0.2887  0.2887  0.2887  0.2887
  0.7071  0.7071 -0.7071 -0.7071

>
```

If the RiverRay 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 ADCP Coordinate Transformation booklet (https://www.teledynemarine.com/support/RDI/technical-manuals).

PT - Built-In Tests

Purpose Sends/displays results of ADCP system diagnostic test.

Format PT*nnn*

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

Recommended Setting. Use as needed.

Description These diagnostic tests check the major RiverRay modules and signal paths.

```
>pt0
Built In Tests
---------------
  PT0  = Help
  PT3 [mode] = Receive Path Test, mode 0 = hard limited (default), 1 = linear
  PT11 = FRAM Test
  PT12 = RAM Test
  PT13 = ROM Test
  PT14 = Recorder Test
  PT15 = Communications Test
  PT16 = Clock Test
  PT17 = Compass Test
  PT18 = Temperature 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 ADCPs 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 ADCP pings without transmitting and displays the result of an auto-correlation 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 50 for lag greater than two indicates interference or hardware problems. For the PT3 1 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
Receive Path Test (Hard Limited):
        H-Gain W-BW        L-Gain W-BW        H-Gain N-BW        L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4
  0 100 100 100 100    100 100 100 100    100 100 100 100    100 100 100 100
  1  79  80  81  84     80  80  81  83     88  85  87  86     84  80  84  83
  2  45  47  54  61     42  43  45  50     63  54  59  56     53  44  53  50
  3  32  29  35  46     10  18  19  20     38  27  34  32     25  19  29  23
  4  25  20  23  34      5   3   7   9     21   9  19  17     11   3  16   7
  5  18  14  18  23      7   3   2   8     12   6  14   8      6   5  13   5
  6  15  13  17  20      3   3   5  10      7   6  13   6      7  10  13   7
  7  15  12  17  18      2   2   3  10      6   6  12   7      6   9  10   7

Sin Duty Cycle (percent)
     52  51  55  51     49  48  49  44     49  53  52  48     55  47  51  51
Cos Duty Cycle (percent)
     49  47  57  43     49  46  48  50     53  44  46  45     52  47  48  49
RSSI Noise Floor (counts)
     62  59  59  61     61  57  59  60     50  50  50  51     50  49  49  50

>pt3 0
Receive Path Test (Hard Limited):
        H-Gain W-BW        L-Gain W-BW        H-Gain N-BW        L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4
  0 100 100 100 100    100 100 100 100    100 100 100 100    100 100 100 100
  1  82  82  83  85     82  79  81  80     87  86  87  87     80  81  82  83
  2  50  47  55  59     47  39  48  47     58  58  60  62     42  46  49  53
  3  29  29  40  43     21  13  21  21     33  31  33  38     15  17  25  28
  4  18  20  29  33      5   4   8   6     16  14  13  23      1   4  14  15
  5   9  11  18  23      7   7   8   2      9   6   6  14      7  10  12   8
  6   8  12  13  19      6   6  10   8      7   5   9   9     10   9  16   6
  7  12  21  16  18      6   4   6   8      8   9  14  10      9   9  13   3

Sin Duty Cycle (percent)
     50  46  51  56     43  49  46  49     52  50  51  49     48  51  46  48
Cos Duty Cycle (percent)
     47  47  51  47     46  50  44  52     45  44  49  49     54  49  46  50
RSSI Noise Floor (counts)
     60  59  60  61     60  58  59  60     51  50  50  51     50  49  50  50

>pt3 1
Receive Path Test (Linear):
        H-Gain W-BW        L-Gain W-BW        H-Gain N-BW        L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4    Bm1 Bm2 Bm3 Bm4
  0 100 100 100 100    100 100 100 100    100 100 100 100    100 100 100 100
  1   2   3   1   3      0   4   1   4      4   2   5   1      4   3   0   0
  2   2   3   5   4      3   5   4   2      3   1   5   5      2   3   3   3
  3   0   3   3   3      1   2   4   1      4   1   1   3      4   3   3   4
  4   1   3   5   1      2   3   2   5      3   3   2   1      2   3   3   6
  5   1   3   6   3      3   3   2   4      3   3   5   1      4   3   3   4
  6   3   3   2   3      3   3   3   2      3   2   1   5      3   3   3   3
  7   2   3   1   2      3   2   4   2      1   1   3   2      1   1   5   5

RSSI Noise Floor (counts)
     61  59  61  62     61  59  60  61     50  50  50  51     50  49  50  50

>
```

PT11

```
>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 ]

>
```

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 for ISM, 0 to 8 for HMR3300 (0 = help)
Default	N/A

Recommended Setting. Use *WinRiver II* to calibrate the compass. The compass must be calibrated if the boat/Tethered Trimaran and/or mounting has changed or the ADCP 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-1048-52
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
```

HMR3300 Examples

```
>sa0

Honeywell HMR3300 Compass Calibration & Test Menu

Options:
    0:  Help
    1:  Calibration Mode
    2:  set factory default cal offsets
    3:  zero pitch & roll
    4:  get status
    5:  get configuration parameter data
    6:  set factory default config
    7:  reset compass
    8:  set factory Z cal offset

>
>sa1

Honeywell HMR3300 Compass Calibration & Test Menu

HMR3300 Calibration:

Current Cal Offsets X=   0, Y=   0, Z=   0

Rotate unit at a steady rate for 360 degrees 1 or more times.
Each turn should take at least 1 minute for best accuracy.

Enter 'S' key to start calibration or 'Q' to quit.
Quitting compass calibration!

>sa2

Honeywell HMR3300 Compass Calibration & Test Menu

Setting Factory Default Calibration Offsets, wait...

Done setting Default Offsets!

>sa3

Honeywell HMR3300 Compass Calibration & Test Menu

Zero Pitch, wait...
Zero Roll, wait...
done
```

```
>sa8

Honeywell HMR3300 Compass Calibration & Test Menu

Set Factory Cal Z Offset

>
```

SF - External NMEA Menu

Purpose Sets the RiverRay 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.

Example See below

SF Command	Description
SF0	Help menu
SF1	Disable
SF1	N/A
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 ADCP 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

>
```

On a RiverRay with the single LED end-cap (no internal GPS), the SI command will respond with:

```
>SI?
SI 1 -------------------- Internal GPS Menu 0=help
>SI 0
Internal GPS NOT initialized
```

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?
SZ 220 ------------------ Sensors Installed [Compass, Temperature, CTD]
>
```

The ISM compass will return 220. The HMR3300 compass will return 320. If any other output results, contact TRDI field service.

Timing Commands

The following commands sets 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 00/00/00,00:00:00 ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TP 00:00.00 ------------- Time Between Pings
TS 09/05/18,07:35:53.27 - 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 RiverRay collects one automatic ensemble. If TE = 00:00:00.00, the RiverRay starts collecting the next ensemble immediately after processing the previous ensemble.
Example	TE01:15:30.00 tells the RiverRay 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 RiverRay 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 RiverRay 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 RiverRay to start pinging, TF is tested for validity. If valid, the RiverRay 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 RiverRay, the CS command must also be sent before deploying the RiverRay.
2. If the entry is not valid, the RiverRay 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 59 minutes
ss	= 00 to 59 seconds
ff	= 00 to 99 hundredths of seconds

Default — TP00:00.00

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

Description — The RiverRay 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 RiverRay'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 RiverRay 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 RiverRay sends an error message and does not update the real-time clock.

Vertical Beam Commands

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

Standard Vertical Beam Commands

This section lists the Vertical Beam commands.

```
>v?
VG = 0 ---------------- Depth Guess (0 to 10000 cm)
VP = 1 ---------------- Enable Vertical Beam Pings
>
```

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*n*

Range: *n* = 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 – Enable Vertical Beam Pings

Purpose: Enables the vertical beam ping in the ensemble.

Format: VP*n*

Range: *n* = 0, disabled; *n* = 1, enabled)

Default: VP1

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

Description: VP1 enables the vertical beam ping and causes the vertical beam data type to be included in the PD0 ensemble; VP0 disables the vertical beam ping.

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 RiverRay 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 RiverRay 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 RiverRay.

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 RiverRay the types of data to collect. The RiverRay always collects header data, fixed and variable leader data, and checksum data. Setting a bit to one tells the RiverRay 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 RiverRay 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 RiverRay 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

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 RiverRay 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 RiverRay.

Format WM*nnnn*

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

Default WM0003

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 13: 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 RiverRay collects data.

Format WN*nnn*

Range *nnn* = 1 to 200 depth cells

Default WN200

Recommended Setting. Set using *WinRiver*.

Description The range of the RiverRay 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 RiverRay does not collect water-profile data.
2. The RiverRay 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 RiverRay 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

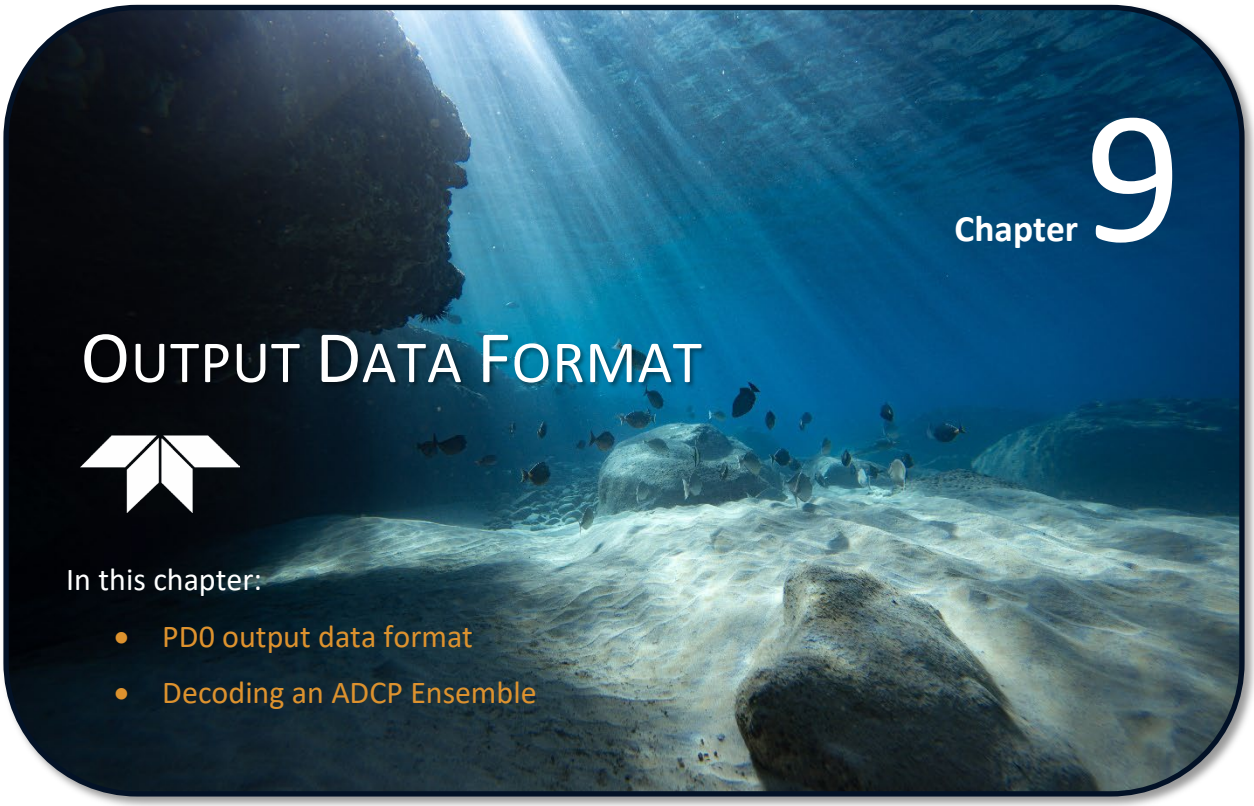
Recommended Setting. Set using the WinRiver II wizard.

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 RiverRay 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 (RiverRay 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.

NOTES



Chapter 9

OUTPUT DATA FORMAT

In this chapter:

- PD0 output data format
- Decoding an ADCP Ensemble

PD0 Output Data Format

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

The following description is for the standard PD0 RiverRay output data format. Figure 17 through Figure 32 shows the ASCII and binary data formats for the RiverRay PD0 mode. Table 15 through Table 35 defines each field in the output data structure.

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

The RiverRay 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 15). The fixed and variable leader data is preceded by ID codes 0000 and 8000, (explained in Table 16 and Table 17). The RiverRay 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, RiverRay 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 14: 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
0x0041	00	41	Vertical Beam Range 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

The RiverRay always sends the Least Significant Byte (LSB) first.

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** (85 BYTES)
Vertical Beam	**VERTICAL BEAM RANGE** (9 BYTES)
SURFACE LAYER DATA (as selected)	**SURFACE LAYER LEADER** (5 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)
ALWAYS OUTPUT	**MODE 3 SETUP DATA** (101 BYTES)
	FIRMWARE STATUS DATA (22 BYTES)
	NMEA GPS MESSAGES – if present (55 BYTES – GGA or 35 BYTES - VTG)
	RESERVED (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 16. 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.

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 15 for a description of the fields.

Figure 17. Header Data Format

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

Table 15: 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 RiverRay).
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 32).
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 RiverRay 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 RiverRay 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 RiverRay 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								
↓									
58									
59	BEAM ANGLE								

See Table 16 for a description of the fields

Figure 18. Fixed Leader Data Format

In Mode 3 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 RiverRay always sends Fixed Leader data as output data (LSBs first).

Table 16: 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 RiverRay hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows. LSB BITS 7 6 5 4 3 2 1 0 - - - - - 0 0 0 75-kHz SYSTEM - - - - - 0 0 1 150-kHz SYSTEM - - - - - 0 1 0 300-kHz SYSTEM - - - - - 0 1 1 600-kHz SYSTEM - - - - - 1 0 0 1200-kHz SYSTEM - - - - - 1 0 1 2400-kHz SYSTEM - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - SENSOR CONFIG #1 - - 0 1 - - - - SENSOR CONFIG #2 - - 1 0 - - - - SENSOR CONFIG #3 - 0 - - - - - - XDCR HD NOT ATT. - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 0 15E BEAM ANGLE - - - - - - 0 1 20E BEAM ANGLE - - - - - - 1 0 30E BEAM ANGLE - - - - - - 1 1 OTHER BEAM ANGLE 0 1 0 0 - - - - 4-BEAM JANUS CONFIG 0 1 0 1 - - - - 5-BM JANUS CFIG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD) Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).
13,14	7	PD / Real/Sim Flag	This field is set by default as real data (0).
15,16	8	Lag Length	Lag Length. The lag is the time period between sound pulses. This is varied as required by the RiverRay.
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The RiverRay 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 RiverRay does not make this validity check. Table 21 (Percent-Good Data Format) has more information.
19,20	10	Number of Cells	Contains the number of depth cells over which the RiverRay 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 RiverRay. 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 16: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
29-32	15,16	Blank after Transmit	Contains the blanking distance used by the RiverRay 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 RiverRay 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 RiverRay 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 RiverRay 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 RiverRay 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 RiverRay uses the manual command setting. If the field = 3, the RiverRay 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 RiverRay 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 16: 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 RiverRay. 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 RiverRay. 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 RiverRay, 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
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 17 for a description of the fields.

Figure 19. Variable Leader Data Format

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

Table 17: 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 RiverRay's real-time clock (RTC) that the current data ensemble began. The TS-command (Set Real-Time Clock) initially sets the clock. The RiverRay 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 River-Ray'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 17: 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 RiverRay 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 RiverRay 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 RiverRay roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing RiverRays, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing RiverRays, 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 RiverRay'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 RiverRay 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 18 for description of fields

Figure 20. 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 RiverRay 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 RiverRay 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 RiverRay 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 ADCP

Table 18: 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 19 through Table 22 for a description of the fields.

Figure 21. 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 RiverRay 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 19: 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 0.6 dB per RiverRay count. The RiverRay does not directly check for the validity of echo intensity data.

Table 20: 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 RiverRay 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				

1. Shows the percentage of successful velocity calculations (50%) using 3-beam solutions.
2. Shows percent of error velocity (5%) that was higher than the WE-command setting.

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the RiverRay 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 RiverRay to reject some of its depth cell data. This causes the RiverRay to calculate velocities with three beams instead of four beams. When the RiverRay does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further depth cell, the RiverRay 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 RiverRay 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 21: 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 22: 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 22. Bottom-Track Data Format

This data is output only if the BP-command is > 0. See Table 23 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 23: 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 ADCP does not collect bottom-track data. The ADCP automatically extends the ensemble interval (TE) if BP x TP > TE. Scaling: LSD = 1 ping; Range = 0 to 999 pings
9-12	5,6	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 sea bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes (Table 5).
73-80	37-40	BTEA/Beam #1-4 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 ADCP's bottom-track validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
89-92 93-96 97 – 100	45,46 47,48 49,50	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.

Table 23: Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
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 ≈ 0.6 dB per count; Range = 0 to 255 counts
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 ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range=0. Scaling: LSD = 1 cm, Range = 1 to 255 cm

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 23. Vertical Beam Range Format

Table 24: 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.

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 24. Surface Layer Leader Format

Table 25: 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 26 for description of fields

Figure 25. Surface Layer Velocity Format

Table 26: 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 27 through Table 29 for a description of the fields.

Figure 26. 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 RiverRay 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 27: 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 RiverRay count. The RiverRay does not directly check for the validity of echo intensity data.

Table 28: 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 RiverRay 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				

1. Shows the percentage of successful velocity calculations (50%) using 3-beam solutions.
2. Shows percent of error velocity (5%) that was higher than the WE-command setting.

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, the RiverRay 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 RiverRay to reject some of its depth cell data. This causes the RiverRay to calculate velocities with three beams instead of four beams. When the RiverRay does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further

depth cell, the RiverRay 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 RiverRay 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 29: 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 30: 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 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 27. Automatic Mode Setup Data

Table 31: 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 31: 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

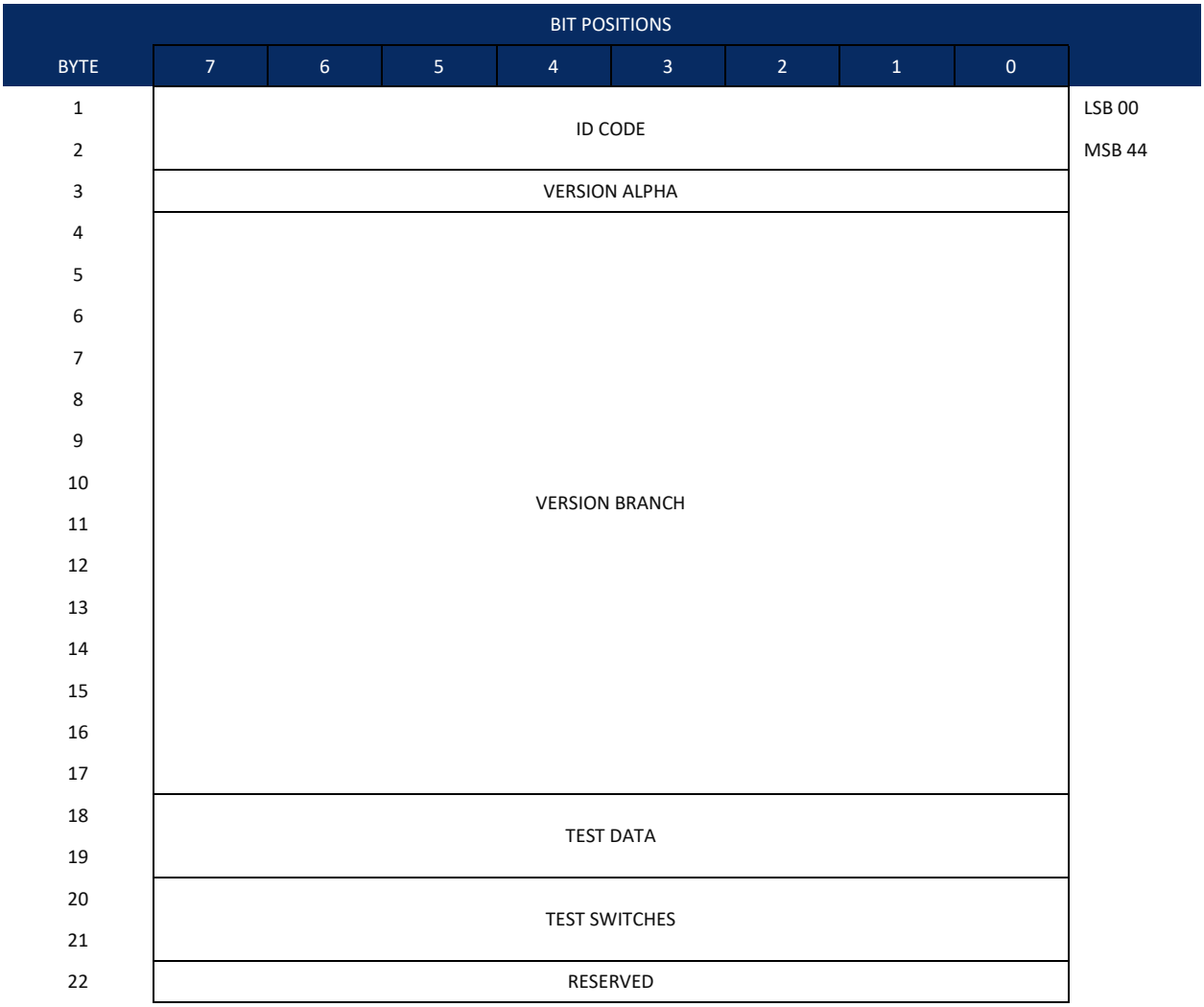


Figure 28. Firmware Status Data

Table 32: 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

NMEA GPS Data Messages

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	ID Code								LSB 22
2									MSB 20
3	Msg ID = 104								
4									
5	Msg Size								
6									
7	Delta Time								
8									
9									
10									
11									
12									
13									
14									
15	GGA NMEA Message								
↓									
55									

Figure 29. NMEA GPS Data Message – GGA Format

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.

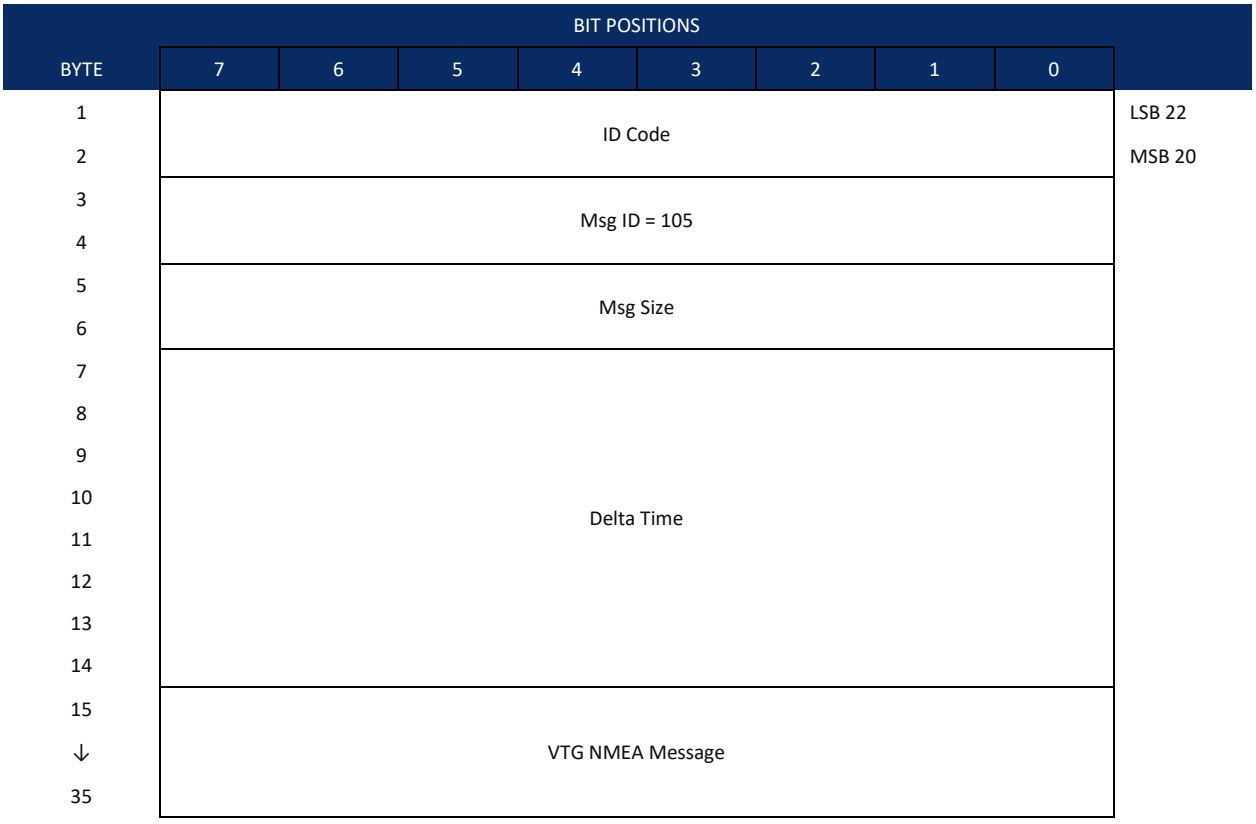


Figure 30. NMEA GPS Data Message – VTG Format

Table 33: NMEA GPS 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	word NMEA Message Type, 104=GGA, 105=VTG
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.
31-110	15-55	GGA NMEA Message	Retains GGA NMEA message format
	or		
31-74	13-35	VTG NMEA Message	Retains VTG NMEA message format

Reserved BIT Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	RESERVED FOR TRDI USE								LSB
2									MSB

Figure 31. Reserved BIT Data Format

Table 34: 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 32. Checksum Data Format

Table 35: 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 portal: https://tm-portal.force.com/TMsoftwareportal

NOTES

Appendix A

NOTICE OF COMPLIANCE

In this chapter:

- China RoHS requirements
- Material disclosure table

Date of Manufacture

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

Environmental Friendly Use Period (EFUP)

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

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

Some homogenous substance within the EIP contains toxic or hazardous substances or elements above the requirements listed in SJ/T 11363-2006. These substances are identified in Table 36.

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

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 36: 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 End-Cap 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