CHANNELMASTER

HORIZONTAL ADCP GUIDE

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TABLE OF CONTENTS

EAR99 Technology Subject to Restrictions Contained on the Cover Page.

REVISION HISTORY

February 2024

- Updated Returning Systems to the TRDI Factory, page 61 Brokerage address.

September 2023

- Added Receiver Signal Strength Indicator (RSSI).

July 2023

- Updated website links.

April 2023

- Updated firmware installation procedure.

January 2023

- Updated EAR statement.
- Deployment Guides are now downloaded only.

April 2022

- Updated software download and installation section.

- 90Z-8001-00 replaced with 95Z-6007-00.

August 2021

- Updated contacting TRDI table.

- Updated Table 1, page 26.

- Updated PD0 Fixed Leader information from Reserved to include the transmit pulse length in bytes 35 and 36.

- Added silent install switch example.

- Added link to PD0Decoder.

September 2019

- Updated the PD0 battery voltage example on page 133 to include the 0.6 voltage drop.

July 2019

- Updated inventory list

- Updated SDI-12 outputs and SDI-12 guide

- Added WQ and WR commands and new output data formats

- Updated screen captures for *ChannelMaster Utilities*

- Updated Logo to Teledyne Marine

February 2019

- Corrected BIT fields on the variable leader

- Added caution that SDI-12 is disabled when the ADVM is connected to the ChannelMaster Utilities software

September 2018

- Updated screen captures for *ChannelMaster Utilities*

- Updated firmware update procedure

August 2018

- Documented using *ChannelMaster Utilities*

- Added a Deployment Guide, SDI-12 Guide, and Getting Started Guide to the documentation

- Updated SDI-12 communications setup and examples

- Added #CL - Binary Configuration command

- Added Diagnostic Ping Commands

- Added High-Resolution Diagnostic RSSI Data and Index Velocity Parameters to the Output Data Format chapter

- Updated the Outline Installation Drawings to rev C

- Added Export Administration Regulations (EAR) footers

November 2015

- Renamed manual from ChannelMaster Operation Manual to ChannelMaster Horizontal-ADCP Guide.

- Combined User's Guide into the ChannelMaster guide.

- Added corrections for ICN112 ChannelMaster Surface Track Amplitude.

- Added corrections for ICN143 WV Command Setting for ChannelMaster.

- Added corrections for ICN145 I/O Connector Lubricant.

- Added information from FSA020 ChannelMaster SDI-12 Setup using a Cambell CR10X Data Logger.

- Added the Vertical Beam expert commands.

- Corrected/updated the Index Velocity and Discharge commands.

- Removed the WE command.

- Updated specifications.

April 2008

- Initial release

HOW TO CONTACT TELEDYNE RD INSTRUMENTS

If you have technical issues or questions involving a specific application or deployment with your instrument, contact our Field Service group:

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

Menu items are printed in bold: click **Collect Data**. Items that need to be typed by the user or keys to press will be shown as **<F1>**. If a key combination were joined with a plus sign (**<ALT+F>**), press and hold the first key while pressing the second key. Commands that need to be entered will be shown as **PD0**, **0M0!**

Words printed in italics include program names (*ChannelMaster Utilities*) and file names (*Test.txt*).

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

```
Horizontal ADCP
Teledyne RD Instruments (c) 2017
All rights reserved.
Product Version: CM02.12

>
```

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 ChannelMaster H-ADCP).
	This paragraph format tells the reader where they may find additional information.
	Recommended Setting. This paragraph format indicates additional information that may help set command parameters.

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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.

Chapter 1

CHANNELMASTER OVERVIEW

In this chapter, you will learn:
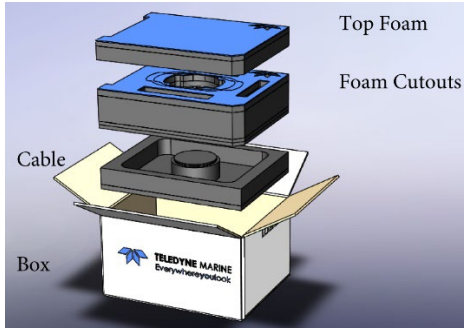
- System overview
- ChannelMaster Care

System Overview

The ChannelMaster is designed to measure real-time horizontal current profiles from a permanent fixed mount. The ChannelMaster system consists of a ChannelMaster H-ADCP, cables, and software.

Identifying what's in the Box

Included with the ChannelMaster system:

	Part Number	Name	Description
	CM300-I-xxx CM600-I-xxx CM1200-I-xxx	ChannelMaster 300/600/1200 kHz system with communication option indicated by xxx: RS422-> blank SDI-12->UG1 RS232->UG2	The ChannelMaster system includes the transducer, dummy plug, mounting plate, and protective cap. When unpacking, use care to prevent physical damage to the transducer face and connector. Use a soft pad to protect the transducer.
Accessories Kit (ordered with system) CM-A-UG5 kit shown	73B-3000-025 73B-3001-025	I/O cable (standard) I/O cable SDI12 (optional)	The I/O cable is used for serial communications and power. The type of I/O cable sent depends on what Personality Module (communications option) is installed. Note the cable is located under the foam in the shipping box.
	73B-6000-00	RS232 to RS422 Converter Cable	Used to convert RS232 to RS422. Not included with SDI-12 or RS232 systems.
	71BK6000-00	Stainless Steel Mounting Plate and hardware	Provides a strong method for mounting the Channel-Master near the middle of the water depth on the mounting structure location.
	71B-7011-00	Shipping box	Shipping box with custom foam cutouts.
	75BK6001-00	Tools and Spare Parts Kit	See Spare Parts for a list of parts included in the kit.
75BK6000-00 Documentation kit	95Z-6007-00	Download instructions	This sheet has instructions for downloading the software and manuals.
	95B-6126-00	Getting Started Sheet	A printed reference showing ChannelMaster operational overview.

Tools and Spare Parts

A set of tools and spare parts are included with the system (located in the canvas bag).

Part Number	Item Name	Where Used
5020	Silicone Lubricant	Housing
97Z-6046-00	O-RING, 2-254, DURO 60, EPDM	
M6WASHSPL	WASHER, SPLIT LOCK SST316	
M6WASHSPLTI	WASHER, 6MM SPLIT LOCK TITANIUM	
M6WASHSTD	WASHER, FLAT, 12.5MMOD SST 316	
M6WASHSTDTI	WASHER, FLAT, TITANIUM 12.5MM OD	
M6X1.0X16FHSH	SCREW, FLAT HEAD, SOCKET HEAD, SST 18-18	
M6X1.0X16HHTI	SCREW, TITANIUM	
M6X1.0X25HHTI	SCREW, TITANIUM	
M6X1.0X35HH	SCREW, HEX HEAD, SST 18-8	
6958A14	HEX KEY, 4MM, LONG ARM	
7299A25	WRENCH, NUT DRIVER, 10MM	
84Z-6000-00	TOOL BAG, CANVAS	
DES3	DESICCANT, SEALED BAG, 2 UN MIL PAK	Inside Housing
817-1067-00	SCREW, PRESSURE SENSOR	Pressure Sensor
75BK6004-00	KIT, FILL, SILICONE OIL	
3/16BLADE	SCREWDRIVER	

Optional Items

Part Number	Description
977-7003-00	Case, Shipping, WH, WHM, CM
71BK6092-00	Kit with 73B-3016-00 adapter cable and 81B-6090-00 adapter plate.
	The adapter cable is used to connect a ChannelMaster ADCP RS-232 + SDI-12 system to a Sontek Argonaut SL gen 2 underwater cable.
	The adapter plate is used for a ChannelMaster to Sontek Argonaut SL1500 Low Profile or 1500 and 3000SL, SL3000 Low Profile, and SL500 Low Profile hole pattern.

Computer Overview

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

Minimum Computer Hardware Requirements:

- Windows 10®, Windows 8.1®, Windows 7®, Desktop, Laptop, or Netbook computer
- Windows 10®, 8® Intel® compatible tablet
- Screen resolution above 1024x768
- Mouse or another pointing device
- One Serial Port

Installing Documentation and Software

The ChannelMaster system documentation and software are downloaded.

1. Follow the instruction sheet on downloading TRDI software and manuals.
2. Software is available on https://tm-portal.force.com/TMsoftwareportal. Install *TRDI Toolz* and *ChannelMaster Utilities*. Download application software *WinH-ADCP* or *PlanCV* as needed.
3. Manuals are available for download on RD Instruments Technical Support Information (teledynemarine.com). PDF versions of all ChannelMaster documentation are available for download.

ChannelMaster Deployment Guide   ChannelMaster SDI-12 Guide

Software Name	Purpose	Recommended for:
ChannelMaster Utilities	Single integrated application for maintenance, deployments, and reviewing data. Optimized for the USGS standardized workflow for setup and maintenance.	All users
TRDI Toolz	Utility software for testing and troubleshooting.	All users (as needed)
WinH-ADCP	Real-time discharge data collection program.	Real-Time data collection
PlanCV	Used to create a deployment configuration file for ChannelMaster and V-ADCP systems.	Special applications

All TRDI software can be installed using the "silent install" switches as needed. For example:
"%~dp0ChannelMaster Utilities v1.3.0.1 setup.exe" /exenoui /exelog
"%LogDir%\ChannelMaster Utilities v1.3.0.1 setup_install.log" /qn /norestart

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Power Requirements

The ChannelMaster requires a DC supply between 10.5 volts and 18 volts. Either an external DC power supply or battery can provide this power.

> Check that the battery voltage is above 10.5 Volts DC. ChannelMaster systems will work at 10 volts; however, batteries with voltages below 11 volts are at or near their end of life and are approaching uselessness.

> The ChannelMaster can be left in a non-responsive state should the voltage drop below 9 volts for a brief period, but not all the way to zero volts, and then recover.
>
> Voltage below nine volts is insufficient for the SDI-12 processor to function, but not low enough for it to be reset. This will result in the SDI-12 processor not responding to DSP communications or SDI-12 measurement requests.
>
> One way to determine if the SDI-12 processor not responding to DSP communications is to send a PS0 command. If the two lines below the Sensor Firmware text are partly or fully missing, then this is a symptom of the SDI-12 processor not responding due to a partial power failure.

```
>ps0
   Serial Number:  0
       Frequency:  1228800 Hz
   Configuration:  HADCP: 2-beam velocity + vertical stage.
 Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
         Sensors:  TEMP  PRESS  TILTS

 Product Version:  CM02.12
    CPU Firmware:  28.20
    FPGA Version:  2.00.003
     Sensor Boot:  32.02
 Sensor Firmware:  33.03
     SDI-12 Boot:  38.00    ←---- Part or all of this line will be missing
 SDI-12 Firmware:  2.04     ←-----Part or all of this line will be missing
```
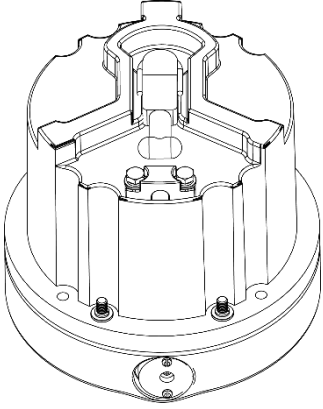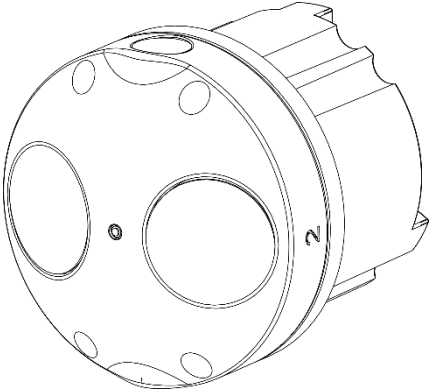
> A complete power failure would cause the processor to be reset and would allow normal operations after the power is restored. To recover from a partial power failure, remove the external power for two minutes and then reapply power.
>
> If left powered-down for a long period (more than a week), the unit may have trouble waking up from a break or SDI-12 (see Chapter 5 - Troubleshooting).

ChannelMaster Overview

The ChannelMaster instrument contains two horizontal and one vertical transducer ceramics and the electronics. The standard acoustic frequencies for the horizontal transducers are 1200 kHz, 600 kHz, and 300 kHz. The standard frequency for the vertical beam is 600 kHz. See Outline Installation Drawings for dimensions and weights.

Picture	Description
	The Input/Output (I/O) cable connects the ChannelMaster H-ADCP to the computer and external power supply. When the cable is not connected, use the dummy plug to protect the connector.
	The pressure sensor is filled with oil prior to deployment.
	The Thermistor measures the water temperature. The pressure sensor measures water pressure.
	The orange urethane faces cover the transducer ceramics. Never set the transducer on a hard surface. The urethane faces may be damaged.
	The ChannelMaster electronics and transducer ceramics are mounted to the transducer head. The numbers embossed on the edge of the transducer indicate the beam number.
	The electronics and transducer ceramics are mounted to the transducer head. The internal tilt sensor measures pitch and roll of the ChannelMaster.

> The ChannelMaster uses X-Y Instrument Coordinates. The positive X direction is from transducer Beam 2 to transducer Beam 1. The Y-axis is perpendicular to the X-axis (see Figure 10 and Figure 11).

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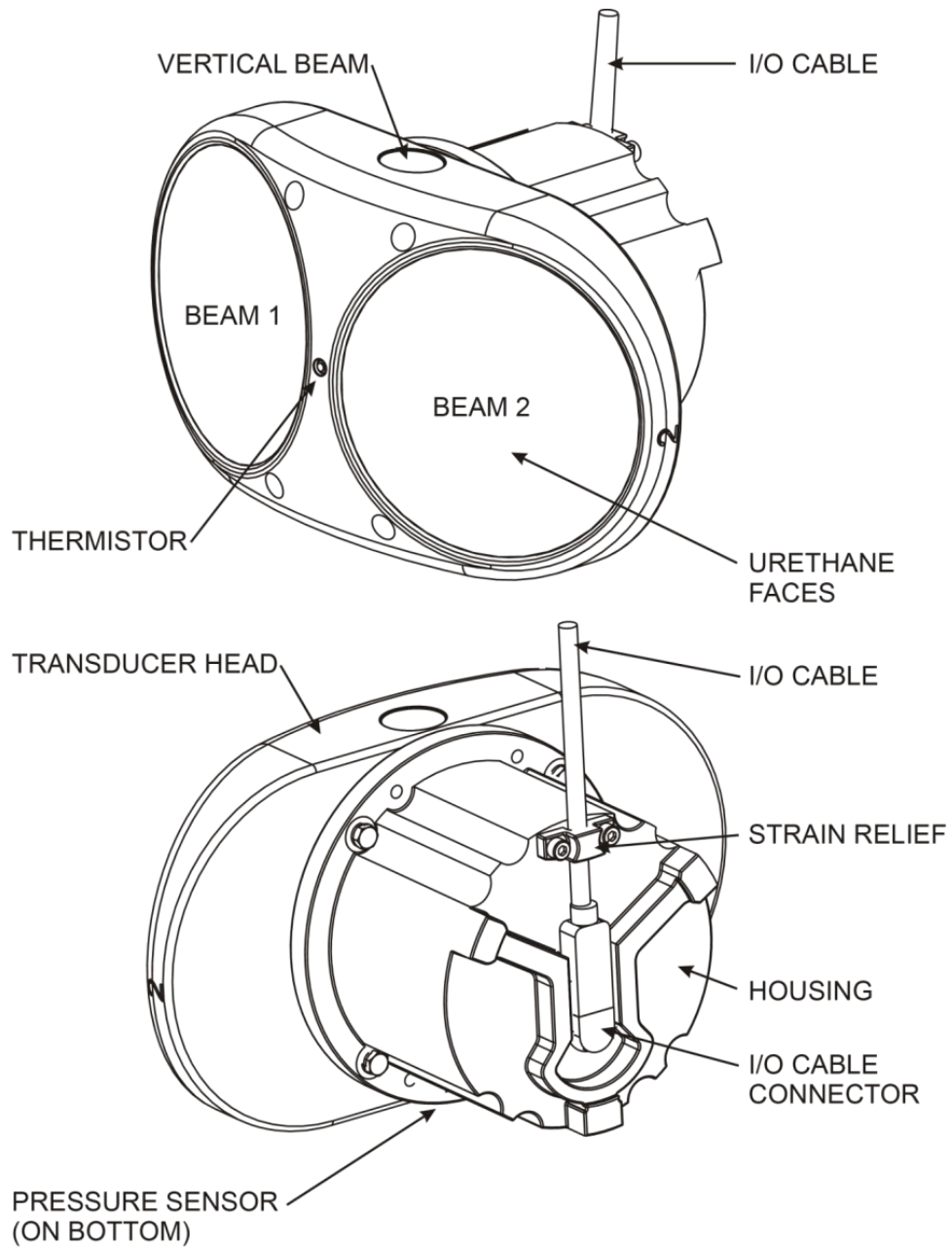
Figure 1.   ChannelMaster (300 kHz) Overview

ChannelMaster Care

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

General Handling Guidelines

- Never set the ChannelMaster on a hard or rough surface. **The urethane faces may be damaged.**

- Always remove the retaining strap on the end-cap underwater-connect cable and dummy plug when disconnecting them. **Failure to do so will break the retainer strap.**

- Disconnect the I/O cable by pulling it off in a straight in-line motion. **Stressing the end-cap connector may cause the ChannelMaster to flood.**

- Do not expose the transducer faces to prolonged sunlight. **The urethane faces may develop cracks.** Cover the transducer faces on the ChannelMaster if it will be exposed to sunlight.

- Do not expose the I/O connector to prolonged sunlight. **The plastic may become brittle.** Cover the connector on the ChannelMaster if it will be exposed to sunlight.

- Do not store the ChannelMaster in temperatures over 75 degrees C. **The urethane faces may be damaged.** Check the temperature indicator inside the shipping case. It changes color if the temperature limit is exceeded.

- 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 ChannelMaster to flood.** Do not risk a deployment with damaged O-ring surfaces.

- Do not lift or support a ChannelMaster by the external I/O cable. **The connector or cable will break.**

Assembly Guidelines

- Read the Maintenance section for details on ChannelMaster re-assembly. Make sure the housing assembly O-rings stay in their groove when you re-assemble the ChannelMaster. Tighten the hardware as specified. **Loose, missing, stripped hardware, or damaged O-rings can lead to water ingress and damage to the ChannelMaster.**

- The ChannelMaster uses Titanium hardware for the transducer housing and strain relief. These hardware sets are expensive and difficult to purchase locally. **Do not substitute other metal hardware.**

- Use light amounts of silicone lubricant on the male pins to help seat the cable connectors. Wipe off excessive silicone from the metal portions of the pins. Silicone lubricant is included in the Spare Parts kit. **Regular lubrication is required: Apply silicone lubricant prior to each connection.**

- Do not connect or disconnect the I/O cable with power applied. When you connect the cable with power applied, you may see a small spark. **The connector pins may become pitted and worn.**

- The cables may be connected while slightly wet; **do not connect under water.**

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Deployment Guidelines

- The instrument should be electrically isolated from any mounting structure to avoid electrolysis problems.

- The ChannelMaster must be mounted on a rigid structure in the channel, such as a solid wall, pier, or pile. **The mounting structure must be firm, stable, without settlement or displacement over time.**

- TRDI recommends the ChannelMaster be mounted **near the middle of the water depth** at the mounting structure location.

- It is important to **mount the ChannelMaster with the two horizontal acoustic beams in the same horizontal plane (zero roll).**

- The pressure sensor cavity is not filled with oil when shipped. **This must be done before deploying the ChannelMaster.**

- Before putting the ChannelMaster into the water, use *ChannelMaster Utilities* and **zero out the pressure sensor at the deployment site**.

NOTES

Chapter 2

INSTALLATION

In this chapter, you will learn:

- I/O Cable and Dummy Plug Connection

- Cable wiring diagrams

- Installation

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

To disconnect the cable:

1. Place the ChannelMaster on a soft pad to protect the transducer face.
2. Remove the strain relief. Save all hardware.
3. Release the retaining strap by pulling it over the connector.
4. Grasp the cable close to the housing.
5. 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. The ChannelMaster cable connectors must be lubricated **before each connection**. Use silicone lubricant on the male pins 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.

> To protect the connector from damage, place a light amount of silicone lubricant on the connector pins (rubber portion only). See **Cable Connector Lubrication**.
>
> Silicone lubricate is included in the Spare Parts kit.

3. Push the cable straight onto the connector.
4. Install the strain relief.

> In situations where an existing competitor cable is already installed, TRDI may be able to provide an adapter to use it. Inquire with TRDI Field service or TRDI sales for details.

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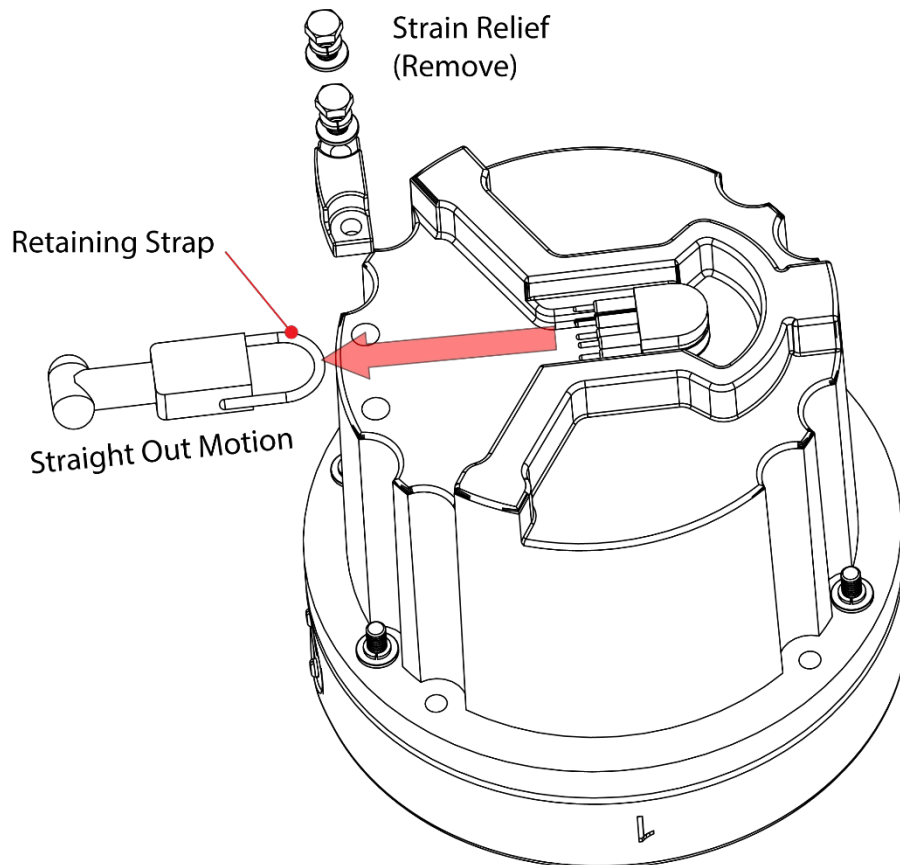
Figure 2.   Connecting and Disconnecting the I/O Cable

Apply silicone lubricant prior to each connection.

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

1. The neoprene rubber portion of the contact pin may tear from the metal pin.

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

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

When connecting the ChannelMaster 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 ChannelMaster will flood.

Set Up the ChannelMaster

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

To set up the ChannelMaster H-ADCP:

1. Connect the I/O cable to the ChannelMaster H-ADCP. Do so by pushing straight in against the connector. Roll the retaining strap over the connector.

> To protect the connector from damage, place a light amount of silicone lubricant on the connector pins (rubber portion only). Silicone lubricant is included in the Spare Parts kit. See I/O Cable and Dummy Plug for details.

2. Attach the I/O cable to the computer's communication port.

3. Connect a battery or DC power supply to the power connectors.

To COMPUTER
SERIAL PORT

I/O CABLE

RED = Pos (+)

BLACK = Neg (-)

ChannelMaster

12 VDC BATTERY
or POWER SUPPLY
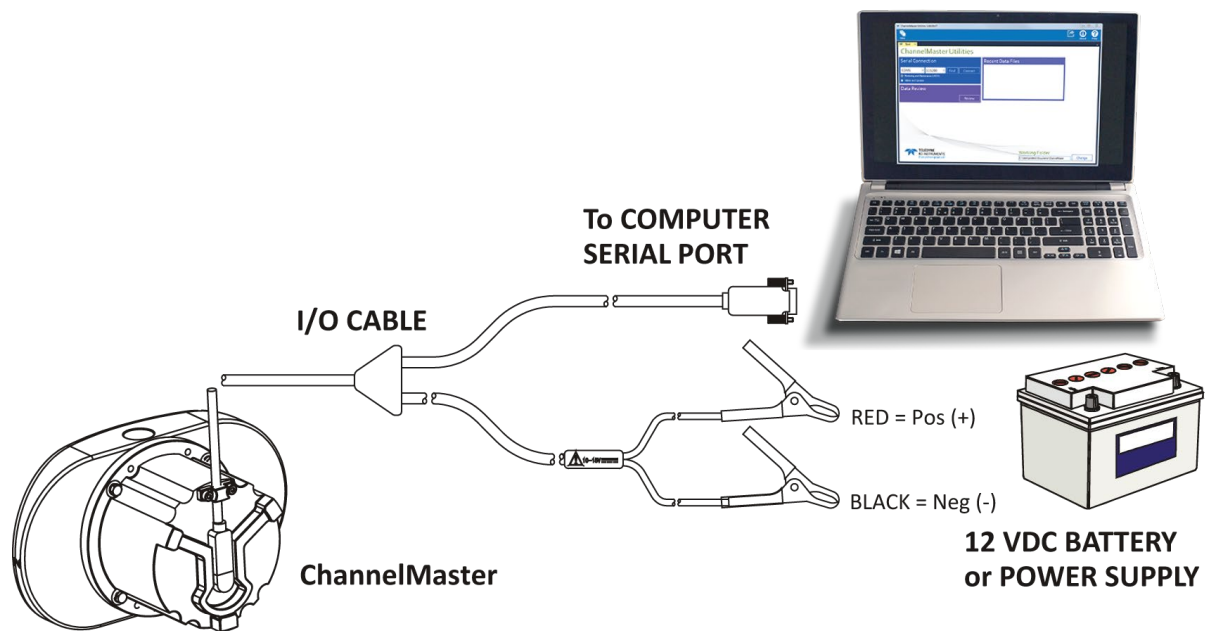
Figure 3.   ChannelMaster Connections with RS-232

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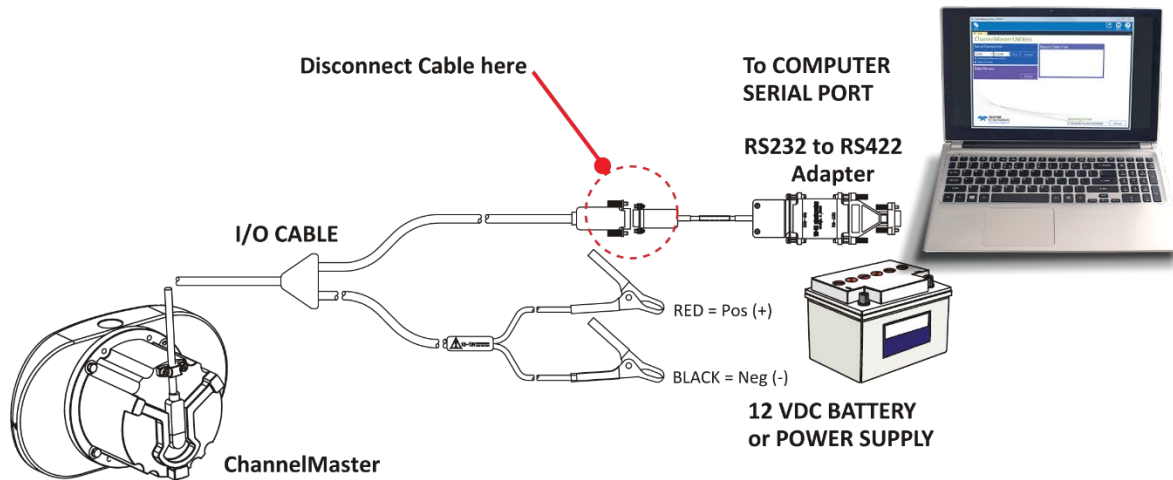
Figure 4.   ChannelMaster Connections with RS-232 to RS-422 Adapter

> If you ordered the RS-422 configuration, the ChannelMaster is supplied with a RS-232 to RS-422 converter. The RS-232 to RS-422 converter must be disconnected from the ChannelMaster when the cable has been disconnected from the computer. If left connected, the internal battery used to maintain ROM inside the ChannelMaster can be drained or false Breaks may be sent.

> The RS-232 to RS-422 converter supplied with the ChannelMaster is powered by the computer's COM port. It may be necessary to use a different converter when very long communication lines are used (maximum 1300 meters).
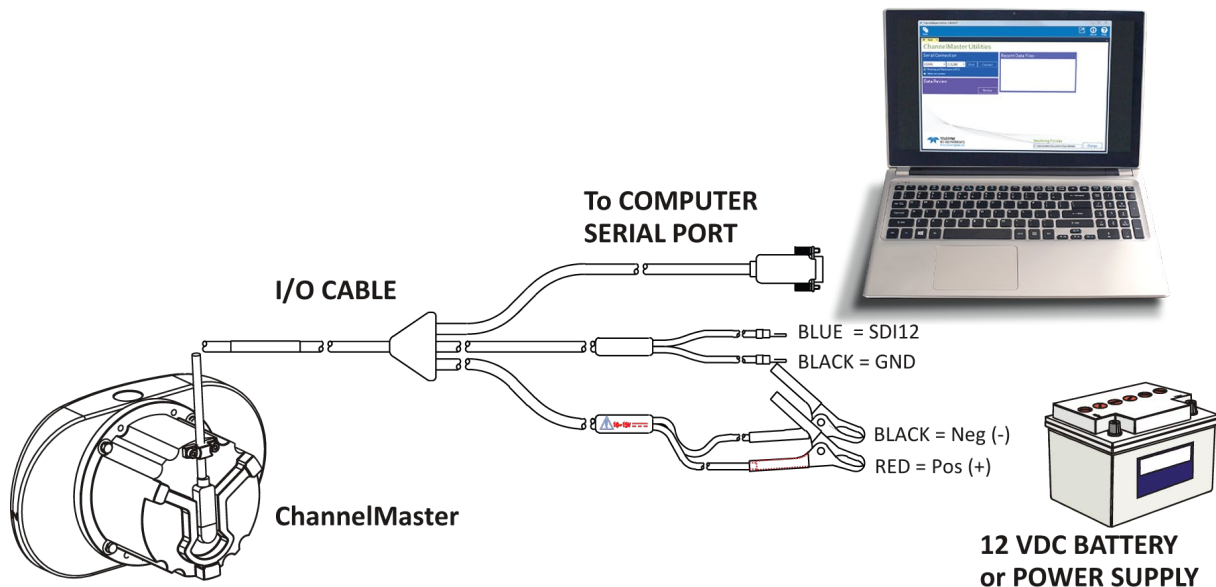
Figure 5.   ChannelMaster Connections with SDI12

Routing Cables

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

- The cable can be installed with the connectors attached.

- It does not have kinks or sharp bends.

- Protect the cables with hose if zip-ties are used to secure them to structures (see Figure 6).

- The cable can be easily replaced if it fails.

- The wet-end connector is 3.0cm (1.18 inches) long, 2.54cm (1.00 inches) wide, 1.27cm (0.5 inches) high. Model# Impulse LPMIL-7-FS.

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

> ⚠ When attaching the ChannelMaster cables to a mount, do not zip-tie the cables directly to the structure. Zip-ties slowly cut through the cable's outer jacket and cause leaks.
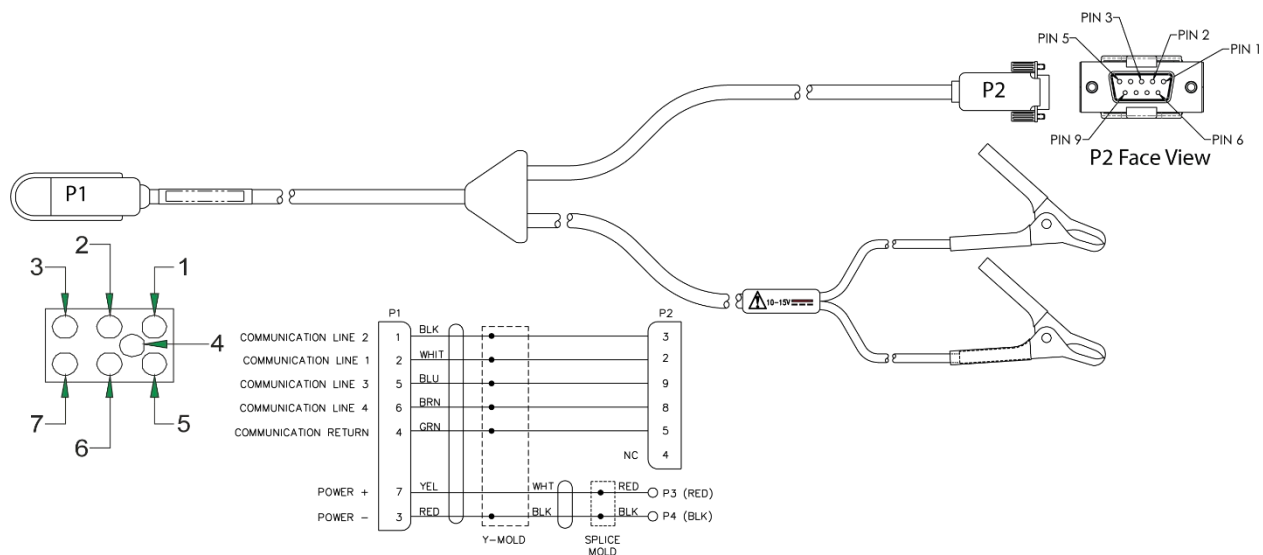
Figure 7.   RS232/RS422 I/O Cable Overview and Wiring Diagram
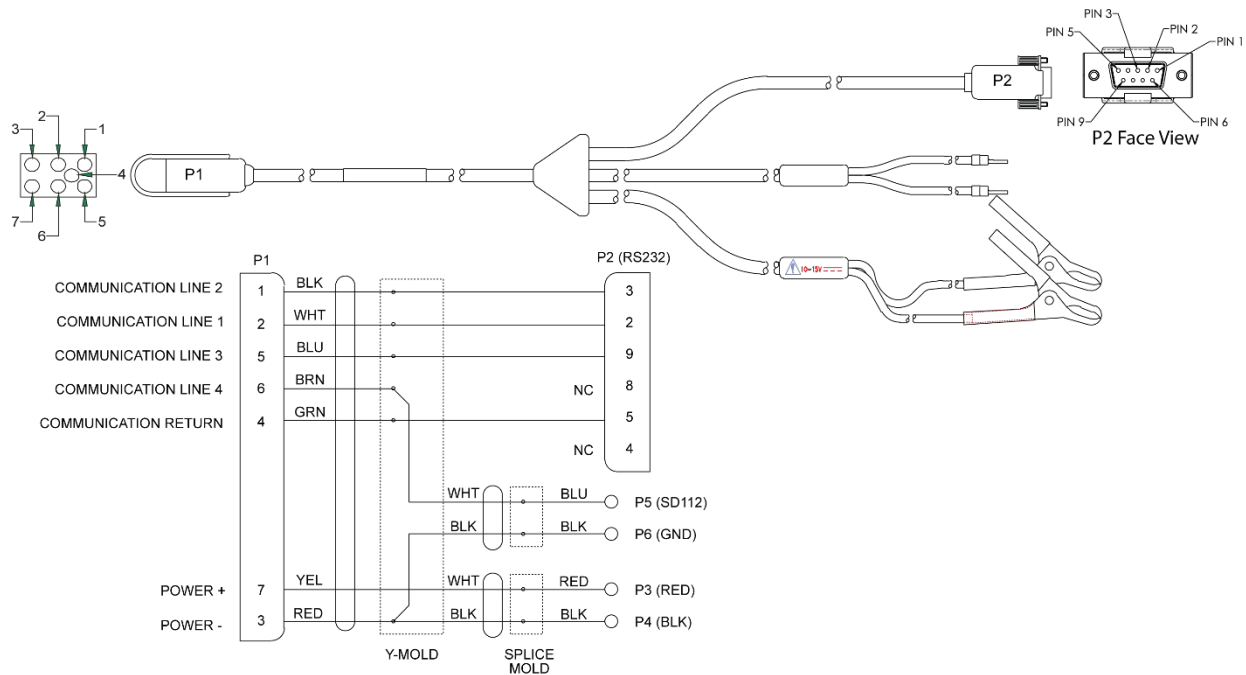
Figure 8.   SDI-12 I/O Cable Overview and Wiring Diagram

Communication lines 1 through 4 signal names depend on what personality module is installed. Use the following tables to identify the signal name.

RS232 Personality Module (P/N 72B2006)

Communication Line	Signal Name
Comm1	TX1 232
Comm2	RX1 232
Comm3	RS485A
Comm4	RS485B

RS422 Personality Module (P/N 72B2008)

Communication Line	Signal Name
Comm1	RS422TB
Comm2	RS422TA
Comm3	RS422RA
Comm4	RS422RB

SDI-12 Personality Module (P/N 72B 2005)

Communication Line	Signal Name
Comm1	TX1 232
Comm2	RX1 232
Comm3	TRIG IN
Comm4	SDI12

ChannelMaster Installation

Use this section to plan the ChannelMaster installation layout.

ChannelMaster 300 kHz located in Shanghai. Photo by H. Huang

Mounting Plate Assembly

Assemble the mounting plate by connecting the four standoffs to the base plate (see Figure 9). Mount the standoffs with the flat end toward the base plate. Use the provided M6x1.0x16 flat head screws. For dimensions, see Mounting Plate Drawing.

Photo by USGS

Figure 9.   Mounting Plate Assembly

> In cases where a mount for a competitor unit already exists, TRDI may be able to provide an adapter to use it. Contact TRDI Field service or TRDI sales for details.

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Orientation and Tilt

The ChannelMaster must be mounted with its transducer orientation in the horizontal direction. That is, the two larger transducers, which are for water velocity measurement, must be looking horizontally (also called side-looking). The third transducer, which is for water depth measurement, must be looking towards the water surface.

TRDI recommends the ChannelMaster be mounted with its Y-axis of the instrument coordinate perpendicular to the direction of the channel mean flow. The ChannelMaster X-axis (direction from Beam 2 to Beam 1) should be parallel to the channel main flow direction (Figure 10) (see IB – Bank command if the ChannelMaster is on the left bank so that the velocity polarities are as shown in the diagram).
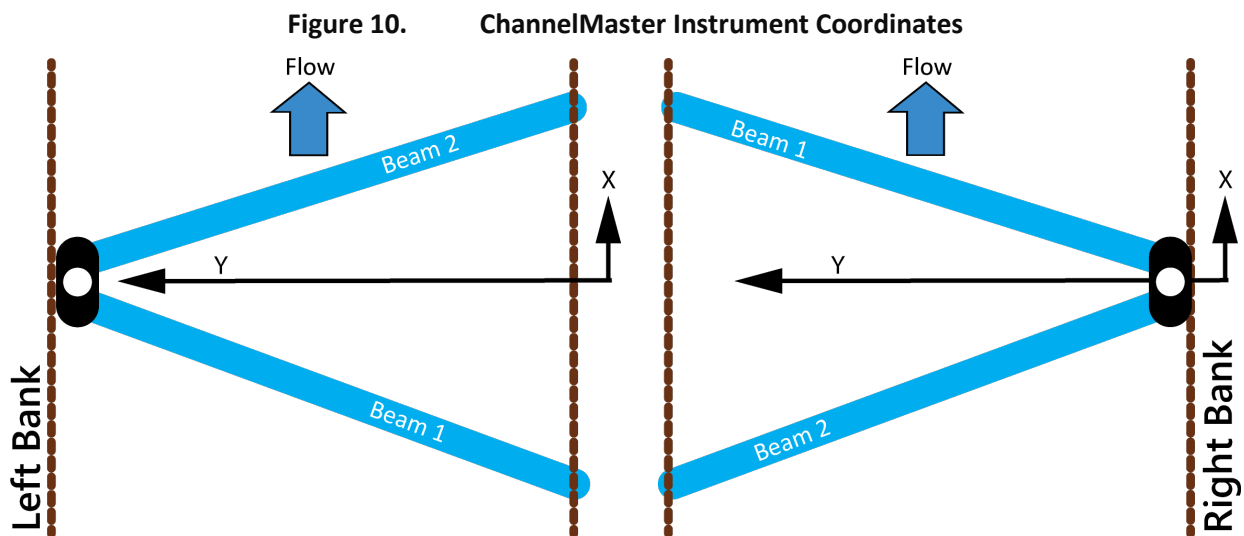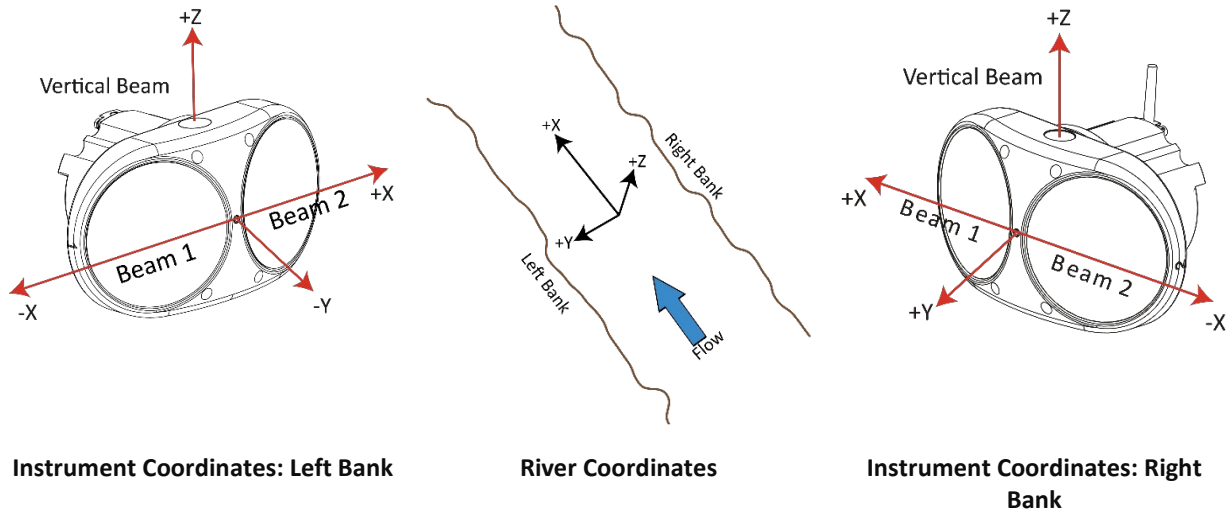
| **Instrument Coordinates: Left Bank** | **River Coordinates** | **Instrument Coordinates: Right Bank** |

Figure 10.   ChannelMaster Instrument Coordinates

It is important to mount the ChannelMaster with the two horizontal acoustic beams in the same horizontal plane (zero roll). A small tilt of the ChannelMaster may result in an interference of the acoustic beams with either the channel bottom or water surface (see Figure 11). The ChannelMaster is equipped with a tilt sensor that can be used to guide in mounting. During installation, the user can monitor the pitch and roll readings through the real-time program *ChannelMaster Utilities* and adjust the mounting fixture as needed.
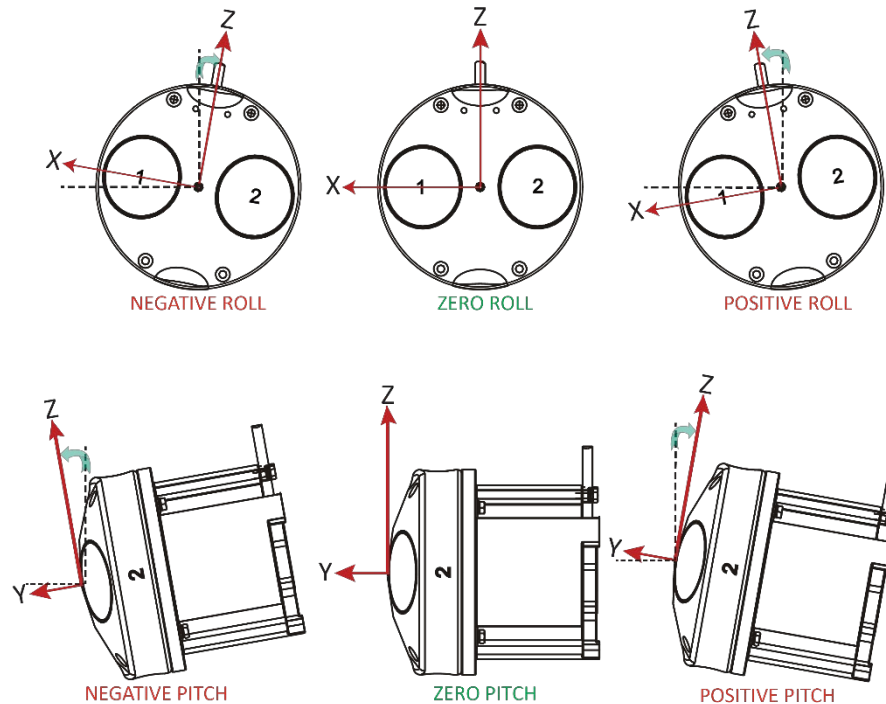
Figure 11. ChannelMaster Mounting Pitch and Roll

> Depending on the channel cross-section geometry, the user may want the ChannelMaster mounted with a small upward lean (positive pitch), or downward lean (negative pitch) to avoid any interference of the acoustic beams with either the river bottom or water surface. The lean must be determined by field tests. However, in any case, **the ChannelMaster must be mounted with zero roll.**

Mounting Location

To gain the maximum profiling range at a site, TRDI recommends the ChannelMaster be mounted near the middle of the water depth at the mounting structure location. For a site with a significant seasonal change of water level, the ChannelMaster may need to be mounted at different elevations according to seasonal water level change.

ChannelMaster Orientation

- _**X-Axis**_ - The X-axis should run parallel to the channel flow direction. Pitch is measured around the X-axis and **should be set to zero**.

- _**Y-Axis**_ - The Y-axis should be perpendicular to the channel flow. Roll is measured around the Y-axis and **should be set to zero**.

- _**Z-Axis**_ - Yaw (heading) is measured around the Z-axis.

Installing the ChannelMaster on Site

The ChannelMaster must be mounted on a rigid structure in the channel, such as a solid wall, pier, or pile. The mounting structure must be firm, stable, without settlement or displacement over time.

> To gain the maximum profiling range at a site, TRDI recommends the ChannelMaster be mounted near the middle of the water depth at the mounting structure location. For a site with a significant seasonal change of water level, the ChannelMaster may need to be mounted at different elevations according to the seasonal water level change.

> A diver may be needed for the installation work.

To install the ChannelMaster:

1. Assemble the mounting plate (see Mounting Plate Assembly).

2. Fill the pressure sensor with oil (see Pressure Sensor Cavity Oil Fill).

> ⚠ The pressure sensor cavity is not filled with oil when shipped. This must be done before deploying the ChannelMaster.

3. Install the mounting fixture on the structure with four screws embedded in or attached to the mounting base. See the Mounting Plate Drawing for the size and arrangement of the four screw holes.

> The four screws/bolts required to mount the base plate to your structure are not provided by Teledyne RD Instruments.

> For best results, select a mounting location so that the ChannelMaster X-axis (direction from Beam 2 to Beam 1) is parallel to the channel main flow direction (see Figure 10).

4. Connect the I/O cable to the ChannelMaster. Attach the cable strain relief. Start *ChannelMaster Utilities* (see Connecting to the ChannelMaster).

5. Before putting the ChannelMaster into the water, use *ChannelMaster Utilities* and zero out the pressure sensor at the deployment site.

6. Slide the ChannelMaster into the mounting fixture and secure the ChannelMaster by using the provided four M6 socket head screws, lock washers, and flat washers through the holes on the ChannelMaster transducer head (see Figure 12).

7. Adjust the mounting fixture to make the ChannelMaster zero pitch and roll or a desired lean pitch and zero roll. A slight upward or downward pitch may be required to avoid beam interference from the bottom or surface.

   The **Sensors** screen of the *ChannelMaster Utilities* software indicates the pitch and roll angles of the ChannelMaster.
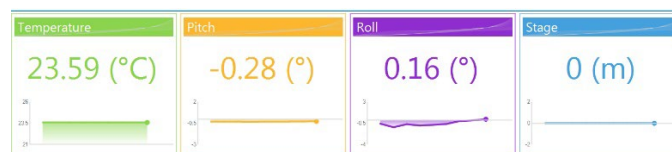
8. Secure the cable by attaching it to the structure. Use a plastic tube to protect the cable for permanent installations.

It should be emphasized that the Beam Check is the most important parameter for ChannelMaster data quality control and assurance. TRDI recommends the user examine the Beam Check during the installation to make sure the profile does not show any thing abnormal. The velocity data will be questionable if the Beam Check is abnormal. The Beam Check should also be monitored during the ChannelMaster operation.
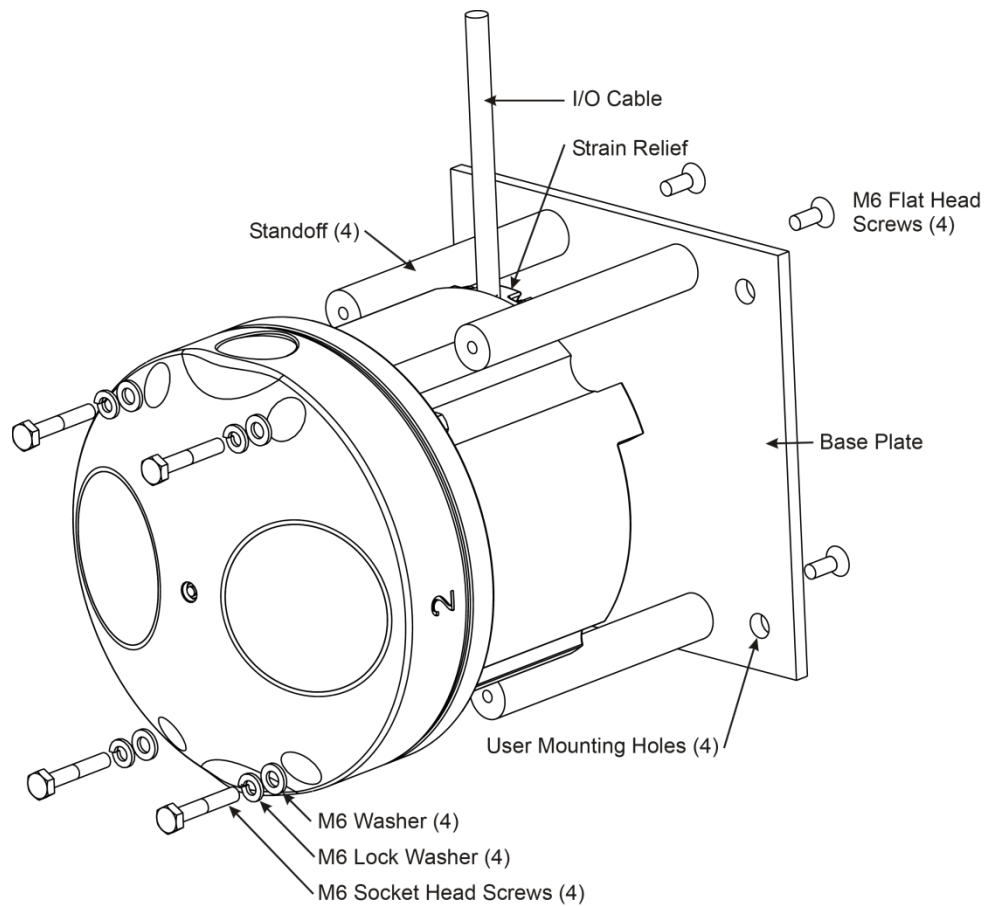
Figure 12.   ChannelMaster Mounting Plate Overview

Chapter 3

DATA COLLECTION

In this chapter, you will learn:

- System Software
- SDI-12 Communications
- Example SDI-12 Sutron Output
- Using a Campbell Scientific CR10X Data-Logger
- Data Review

ChannelMaster Software

Once the ChannelMaster is mounted in the water, it's time to communicate with it and make adjustments to the pitch and roll settings as well as to check for abnormalities in the acoustic backscattering intensity profile.

The ChannelMaster can use several software programs:

- *ChannelMaster Utilities* is designed for the USGS workflow.
- *WinH-ADCP* is a real-time discharge data collection program.
- *PlanCV* allows the user to create a deployment configuration file for a ChannelMaster.

> For more information on *ChannelMaster Utilities*, click the Help icon (Help) to open the ChannelMaster Utilities Software help file.
>
> *WinH-ADCP* and *PlanCV* include a manual that is installed with the software.

SDI-12 Communications

To use SDI-12 with *ChannelMaster Utilities*:

1. Start *ChannelMaster Utilities*. Click on the **Utilities and Updates** button.

2. Establish communications to the ChannelMaster by clicking on the **Connect** button.

3. On the **SDI-12** box, click **Turn ON**.

4. Set the ChannelMaster address and units, and then click **Turn On**.
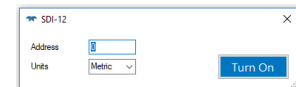
> ⚠ SDI-12 will not function while the *ChannelMaster Utilities* software is connected.

To use SDI-12 with *WinH-ADCP*:

1. Start *WinH-ADCP*. On the **Communications Settings** dialog box, select the COM Port, Baudrate, Databits, and Stopbits that the ChannelMaster is connected to.

2. Click **OK** to continue to the SDI-12 Configuration screen. Set the ChannelMaster's configuration and SDI-12 address and click **Start**.

3. Disconnect the SDI-12 Serial Cable. Click **OK** at each message box.
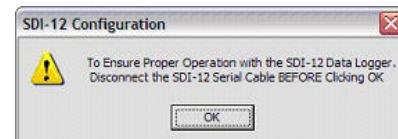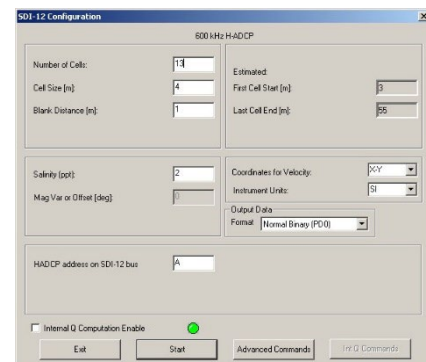
To use SDI-12 with a deployment configuration file created with *PlanCV*:

1. Edit the deployment configuration file with a text editor and add the CJ command.

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SDI-12 Overview

A ChannelMaster can communicate to a data logger using SDI-12 protocol. The ChannelMaster supports an output of up to 27 X and Y velocities using the standard measurement commands and up to 64 X component velocities and 64 Y component velocities (64 bins of data), and 64 bins Receiver Signal Strength Indicator (RSSI), using the concurrent measurement commands. Since the default number of bins for the ChannelMaster is 25, the below examples will correspond to that configuration. The below section corresponds to ChannelMaster Product v2.15 and higher.

- SDI-12 M commands support a maximum of ten commands (0-9) with up to nine values per command.

- SDI-12 C commands support a maximum of ten commands (0-9) with up to 99 values per command.

> *ChannelMaster Utilities* does not use the SDI-12 protocol and does not directly participate in SDI-12 data logging. See **Table 1**, **Table 2**, and Appendix B for a list of SDI-12 commands. See the SDI-12 specifications on the web – http://sdi-12.org/

> The following are some important notes about the SDI-12/ChannelMaster interface.
>
> - Configure the ChannelMaster prior to connecting to the SDI-12 network.
>
> - All measurements are controlled by the datalogger. If the datalogger never sends any commands, the ChannelMaster will never collect any data.
>
> - Each instrument on the SDI-12 network must have a unique address.
>
> - SDI-12 will not function while the *ChannelMaster Utilities* software is connected.

The basic protocol for using SDI-12 M measurement commands to collect a measurement from a ChannelMaster configured for address 0 (zero) is:

1. The data logger sends a **0M!** command to initiate a measurement.

> The full command would be **0M0!** The. The first "0" is the address, the "M" is the make a measurement command, the second "0" is understood, the "!" is the command termination.

2. The ChannelMaster sends a message back saying how long the measurement will take to complete and how many values will be returned (this is automatic and not seen by the user).

3. At the end of the measurement time, the data-logger sends a **0D0!** command to read the first portion of the data.

4. The ChannelMaster sends back four values; temperature, pressure, a placeholder, and vertical beam range to surface.

5. The data-logger then sends a **0D1!** command to read the remaining data.

6. The ChannelMaster then sends back the remaining five values; pitch, roll, Index velocity, voltage, and a Built in Test.

7. To get the X component velocity data, the user must program the data-logger to then send a **0M1!** command to request the first portion of the X velocity component data. The ChannelMaster will immediately reply with a message indicating that in two seconds, up to nine velocities from the first nine cells of the X velocity component profile data will be available. The logger will then send **0D0!** and **0D1!** commands to retrieve those values. To request the remaining X velocities, **0M3!** and **0M5!** commands each followed by **0D0!** and **0D1!** commands must be sent. These commands will return the X component velocity data for bins 10-18 and 19-27 respectively. The format of the data

is the format required by the SDI-12 protocol definitions; the data logger reads and stores the data.

8. To get the Y component velocity data, the user must program the data-logger to then send a **0M2!** command to request the Y velocity component data. The ChannelMaster will immediately reply with a message indicating that in two seconds, up to nine velocities from the first nine cells of the Y velocity component profile data will be available. The logger will then send **0D0!** and **0D1!** commands to retrieve those values. To request the remaining Y velocities, **0M4!** and **0M6!** commands each followed by **0D0!** and **0D1!** commands must be sent. These commands will return the Y component velocity data for bins 10-18 and 19-27 respectively.

9. To get internally computed discharge data the user must program the data-logger to then send a **0M9!** command. The ChannelMaster will immediately reply with a message indicating that in 2 seconds, 6 values will be available. The logger will then send **0D0!** and **0D1!** commands to retrieve those values.

> The 0M1! through 0M9! commands must be preceded by an 0M! command to obtain new measurement data

Table 1.   **SDI-12 M Command Output – 0M1! To 0M9!**

0M0! Command:		0M1!:	0M2!	0M3!	0M4!
Value #	Description	Description	Description	Description	Description
1	Temp	X-Vel 1	Y-Vel 1	Y-Vel 10 (or -100)	Y-Vel 10 (or -100)
2	Pressure	X-Vel 2	Y-Vel 2	Y-Vel 11	Y-Vel 11
3	<not used> (-100)	X-Vel 3	Y-Vel 3	Y-Vel 12	Y-Vel 12
4	Range to Surface	X-Vel 4	Y-Vel 4	Y-Vel 13	Y-Vel 13
5	Pitch	X-Vel 5	Y-Vel 5	Y-Vel 14	Y-Vel 14
6	Roll	X-Vel 6	Y-Vel 6	Y-Vel 15	Y-Vel 15
7	X Velocity (Index)	X-Vel 7	Y-Vel 7	Y-Vel 16	Y-Vel 16
8	Voltage (0.6 V lower than supply)	X-Vel 8	Y-Vel 8	Y-Vel 17	Y-Vel 17
9	BIT (Built-In Test)	X-Vel 9	Y-Vel 9	Y-Vel 18	Y-Vel 18

Table 1. continued

	0M5!	0M6!	0M7!	0M8!	0M9!
Value #	Description	Description	Description	Description	Description
1	X-Vel 19 (or -100)	Y-Vel 19 (or -100)	<not used> (-100)	<not used> (-100)	Mean X Velocity
2	X-Vel 20	Y-Vel 20			Stage
3	X-Vel 21	Y-Vel 21			Area
4	X-Vel 22	Y-Vel 22			Discharge
5	X-Vel 23	Y-Vel 23			Upper Accum Volume
6	X-Vel 24	Y-Vel 24			Lower Accum Volume
7	X-Vel 25	Y-Vel 25			
8	X-Vel 26	Y-Vel 26			
9	X-Vel 27	Y-Vel 27			

1. The voltage is 0.6 VDC less than the external voltage.

2. A single 'BadValueMarker' (-100, with variable number of decimal places) is returned for each **0Mn!** command without valid data. Bad Value Markers of -100 may be output where data was not successfully measured, e.g., for Range to Surface, individual bin velocities, Index Velocity, or internally computed discharge parameters.

3. The SDI-12 specification allows a variable number of values to be output in response to each **0Dx!** Command, with a limit on the number of characters which can be returned for each command. The logger will sequentially issue **0D0!** through **0D9!** commands until the expected number of values has been received. The above table indicates the expected values to be returned for the **0D0!** and **0D1!** Commands for each **0Mx!** command.

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Concurrent SDI-12

If the data-logger supports concurrent SDI-12, then instead of the **0M!** command, the data-logger may send **0C!** (A second **0** is implied; the full command is **0C0!**) and **0C1!** to **0C4!** commands each followed by **0Dx!** commands as needed. The ChannelMaster will return the same data as the **0M!** and **0M9!** commands plus additional data values for **0C!;** up to 64 X or Y velocities respectively for **0C1!** and **0C2!**, and up to 64 Beam 1 or Beam 2 Receiver Signal Strength Indicator (RSSI) values for **0C3!** and **0C4!**.

> The **0Dx!** send data commands can return data values totaling up to 75 characters each for concurrent measurements compared to the maximum of 35 characters for the standard **0Mx!** measurement commands.

Table 2.   SDI-12 C Concurrent Command Output

Value #	0C0! Description	0C1! Description	0C2! Description	0C3! Description	0C4! Description
1.	Temp	X-Vel 1	Y-Vel 1	Bm1 RSSI 1	Bm2 RSSI 1
2.	Pressure	X-Vel 2	Y-Vel 2	Bm1 RSSI 2	Bm2 RSSI 2
3.	<not used> (-1000)	X-Vel 3	Y-Vel 3	Bm1 RSSI 3	Bm2 RSSI 3
4.	Range To Surface	X-Vel 4	Y-Vel 4	Bm1 RSSI 4	Bm2 RSSI 4
5.	Pitch	X-Vel 5	Y-Vel 5	Bm1 RSSI 5	Bm2 RSSI 5
6.	Roll	X-Vel 6	Y-Vel 6	Bm1 RSSI 6	Bm2 RSSI 6
7.	X Velocity (Index)	X-Vel 7	Y-Vel 7	Bm1 RSSI 7	Bm2 RSSI 7
8.	Voltage (0.6 V lower than supply)	X-Vel 8	Y-Vel 8	Bm1 RSSI 8	Bm2 RSSI 8
9.	BIT (Built In Test)	X-Vel 9	Y-Vel 9	Bm1 RSSI 9	Bm2 RSSI 9
10.	Mean X Velocity (vel model result)	X-Vel 10	Y-Vel 10	Bm1 RSSI 10	Bm2 RSSI 10
11.	Stage	X-Vel 11	Y-Vel 11	Bm1 RSSI 11	Bm2 RSSI 11
12.	Area	X-Vel 12	Y-Vel 12	Bm1 RSSI 12	Bm2 RSSI 12
13.	Discharge	X-Vel 13	Y-Vel 13	Bm1 RSSI 13	Bm2 RSSI 13
14.	Upper Accum Volume	X-Vel 14	Y-Vel 14	Bm1 RSSI 14	Bm2 RSSI 14
15.	Lower Accum Volume	X-Vel 15	Y-Vel 15	Bm1 RSSI 15	Bm2 RSSI 15
16.	Y Velocity (Index)	X-Vel 16	Y-Vel 16	Bm1 RSSI 16	Bm2 RSSI 16
17.	Bm1 Avg Corr (Index)	X-Vel 17	Y-Vel 17	Bm1 RSSI 17	Bm2 RSSI 17
18.	Bm2 Avg Corr (Index)	X-Vel 18	Y-Vel 18	Bm1 RSSI 18	Bm2 RSSI 18
19.	Avg Corr (Index)	X-Vel 19	Y-Vel 19	Bm1 RSSI 19	Bm2 RSSI 19
20.	Bm1 Avg RSSI (Index)	X-Vel 20	Y-Vel 20	Bm1 RSSI 20	Bm2 RSSI 20
21.	Bm2 Avg RSSI (Index)	X-Vel 21	Y-Vel 21	Bm1 RSSI 21	Bm2 RSSI 21
22.	Avg RSSI (Index)	X-Vel 22	Y-Vel 22	Bm1 RSSI 22	Bm2 RSSI 22
23.	Bm1 Noise	X-Vel 23	Y-Vel 23	Bm1 RSSI 23	Bm2 RSSI 23
24.	Bm2 Noise	X-Vel 24	Y-Vel 24	Bm1 RSSI 24	Bm2 RSSI 24
25.	Avg Noise	X-Vel 25	Y-Vel 25	Bm1 RSSI 25	Bm2 RSSI 25
26.	Bm1 Avg SNR (Index)	X-Vel 26	Y-Vel 26	Bm1 RSSI 26	Bm2 RSSI 26
27.	Bm2 Avg SNR (Index)	X-Vel 27	Y-Vel 27	Bm1 RSSI 27	Bm2 RSSI 27
28.	Avg SNR (index)	X-Vel 28	Y-Vel 28	Bm1 RSSI 28	Bm2 RSSI 28
29.		X-Vel 29	Y-Vel 29	Bm1 RSSI 29	Bm2 RSSI 29
30.		X-Vel 30	Y-Vel 30	Bm1 RSSI 30	Bm2 RSSI 30
31.		X-Vel 31	Y-Vel 31	Bm1 RSSI 31	Bm2 RSSI 31
32.		X-Vel 32	Y-Vel 32	Bm1 RSSI 32	Bm2 RSSI 32
33.		X-Vel 33	Y-Vel 33	Bm1 RSSI 33	Bm2 RSSI 33
34.		X-Vel 34	Y-Vel 34	Bm1 RSSI 34	Bm2 RSSI 34
35.		X-Vel 35	Y-Vel 35	Bm1 RSSI 35	Bm2 RSSI 35
36.		X-Vel 36	Y-Vel 36	Bm1 RSSI 36	Bm2 RSSI 36
37.		X-Vel 37	Y-Vel 37	Bm1 RSSI 37	Bm2 RSSI 37
38.		X-Vel 38	Y-Vel 38	Bm1 RSSI 38	Bm2 RSSI 38
39.		X-Vel 39	Y-Vel 39	Bm1 RSSI 39	Bm2 RSSI 39
40.		X-Vel 40	Y-Vel 40	Bm1 RSSI 40	Bm2 RSSI 40
41.		X-Vel 41	Y-Vel 41	Bm1 RSSI 41	Bm2 RSSI 41
42.		X-Vel 42	Y-Vel 42	Bm1 RSSI 42	Bm2 RSSI 42

	0C0!		0C1!	0C2!	0C3!	0C4!
Value #	Description		Description	Description	Description	Description
43.			X-Vel 43	Y-Vel 43	Bm1 RSSI 43	Bm2 RSSI 43
44.			X-Vel 44	Y-Vel 44	Bm1 RSSI 44	Bm2 RSSI 44
45.			X-Vel 45	Y-Vel 45	Bm1 RSSI 45	Bm2 RSSI 45
46.			X-Vel 46	Y-Vel 46	Bm1 RSSI 46	Bm2 RSSI 46
47.			X-Vel 47	Y-Vel 47	Bm1 RSSI 47	Bm2 RSSI 47
48.			X-Vel 48	Y-Vel 48	Bm1 RSSI 48	Bm2 RSSI 48
49.			X-Vel 49	Y-Vel 49	Bm1 RSSI 49	Bm2 RSSI 49
50.			X-Vel 50	Y-Vel 50	Bm1 RSSI 50	Bm2 RSSI 50
51.			X-Vel 51	Y-Vel 51	Bm1 RSSI 51	Bm2 RSSI 51
52.			X-Vel 52	Y-Vel 52	Bm1 RSSI 52	Bm2 RSSI 52
53.			X-Vel 53	Y-Vel 53	Bm1 RSSI 53	Bm2 RSSI 53
54.			X-Vel 54	Y-Vel 54	Bm1 RSSI 54	Bm2 RSSI 54
55.			X-Vel 55	Y-Vel 55	Bm1 RSSI 55	Bm2 RSSI 55
56.			X-Vel 56	Y-Vel 56	Bm1 RSSI 56	Bm2 RSSI 56
57.			X-Vel 57	Y-Vel 57	Bm1 RSSI 57	Bm2 RSSI 57
58.			X-Vel 58	Y-Vel 58	Bm1 RSSI 58	Bm2 RSSI 58
59.			X-Vel 59	Y-Vel 59	Bm1 RSSI 59	Bm2 RSSI 59
60.			X-Vel 60	Y-Vel 60	Bm1 RSSI 60	Bm2 RSSI 60
61.			X-Vel 61	Y-Vel 61	Bm1 RSSI 61	Bm2 RSSI 61
62.			X-Vel 62	Y-Vel 62	Bm1 RSSI 62	Bm2 RSSI 62
63.			X-Vel 63	Y-Vel 63	Bm1 RSSI 63	Bm2 RSSI 63
64.			X-Vel 64	Y-Vel 64	Bm1 RSSI 64	Bm2 RSSI 64

1. The voltage is 0.6 VDC less than the external voltage.

2. The **0C5!** through **0C9!** commands will return a value of 'a00000' indicating that no data is available for those commands, and the data logger thus should not issue any subsequent **0Dx!** send data commands.

3. Bad Value Markers of -100(with varying numbers of decimal places) may be output where data was not successfully measured, e.g., for Range to Surface, individual bin velocities, or Index Velocity.

4. The SDI-12 specification allows a variable number of values to be output in response to each **0Dx!** Command, with a limit on the number of characters which can be returned for each command. The logger will sequentially issue **0D0!** through **0D9!** commands until the expected number of values has been received. The above table indicates the expected values to be returned for the **0D0!** and **0D1!** Commands for each **0Cx!** command.

Example SDI-12 Output

> ChannelMaster setups will have different timing for the **0M!** command based on other deployment requirements. Comments (##) have been inserted to help explain what is happening. See **Table 1. SDI-12 M Command Output**.

Enter SDI-12 Command: **0M0!** ## Initiate a measurement.
```
> 00079
```
Wait 7 seconds and then 9 data fields will be available

Enter SDI-12 Command: **0D0!** ## Get the first 4 data fields
```
> 0+23.900+0.041-100.000+0.339
```
Address, Temperature, Pressure, a Placeholder, and Vertical Range returned

Enter SDI-12 Command: **0D1!** ## Get the 5 remaining data fields
```
> 0-28.110+27.830-1000.000+11.4+0
```
Address, Pitch, Roll, Index Velocity, Voltage, and a Built in Test returned (0 = Pass, >0 = Faults occurred; see BIT result field in variable leader data type for details)

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Enter SDI-12 Command: **0M1!**
```
> 00029
```
Wait two seconds for 9 X velocity values

Enter SDI-12 Command: **0D0!**
```
> 0-1.572-2.034+1.684-0.373+1.203
```
Address + first 5 values returned

Enter SDI-12 Command: **0D1!**
```
> 0+2.705-0.053+0.060-0.507
```
Address + remaining 4 values returned

Enter SDI-12 Command: **0M2!**
```
> 00029
```
Wait two seconds for 9 Y velocity values

Enter SDI-12 Command: **0D0!**
```
> 0-0.146-0.329+0.842-0.383+0.853
```
Address + first 5 values returned

Enter SDI-12 Command: **0D1!**
```
> 0+0.497+1.657+0.963+1.589
```
Address + remaining 4 values returned

Enter SDI-12 Command: **0M3!**
```
> 00029
```

Enter SDI-12 Command: **0D0!**
```
> 0+0.664-0.588+4.663+0.775+1.466
```

Enter SDI-12 Command: **0D1!**
```
> 0+2.336+2.839+2.699+1.941
```

Enter SDI-12 Command: **0M4!**
```
> 00029
```

Enter SDI-12 Command: **0D0!**
```
> 0+0.031+0.510+0.192+0.578+0.667
```

Enter SDI-12 Command: **0D1!**
```
> 0+0.706-0.410-0.896+0.664
```

Enter SDI-12 Command: **0M5!**
```
> 00027
```

Enter SDI-12 Command: **0D0!**
```
> 0+4.261+1.048+4.482-0.969+3.338
```

Enter SDI-12 Command: **0D1!**
```
> 0-0.599+4.655
```

Enter SDI-12 Command: **0M6!**
```
> 00027
```

Enter SDI-12 Command: **0D0!**
```
> 0-0.214-0.588+0.170+1.002-0.385
```

Enter SDI-12 Command: **0D1!**
```
> 0+1.175-0.073
```

Enter SDI-12 Command: **0M7!**

```
> 00021
```

Enter SDI-12 Command: **0D0!**
```
> 0-1000.000
```
A single 'BadValueMarker' is outputted for each **0Mn!** command without valid data

Enter SDI-12 Command: **0M8!**
```
> 00021
```

Enter SDI-12 Command: **0D0!**
```
> 0-1000.000
```
A single 'BadValueMarker' is outputted for each **0Mn!** command without valid data
Enter SDI-12 Command: **0M9!**
```
> 00026
```

Enter SDI-12 Command: **0D0!**
```
> 0-1000.000-100.000-100.000-100.000+0
```
Address, Average Velocity, Stage, Area, and Discharge (Q) returned

Enter SDI-12 Command: **0D1!**
```
> 0-100+2.0
```
Address, Upper Volume, and Lower Volume returned

> See Appendix B, SDI-12 Command Responses for a list of SDI-12 commands.
>
> Built in Test results are shown in the Variable Leader Data, bytes 13 and 14.

Example Concurrent SDI-12 Output

```
0C!      000728<CR><LF>
0D0!     0+76.568-0.186-100.000-100.000-31.600+2.300-100.000+11.6+0-100.000-0.057<CR><LF>
0D1!     0+0.000-100.000+0+0.0-100.000+5.0+8.7+6.8+29.0+29.6+29.3+0.0+0.0+0.0-100.0<CR><LF>
0D2!     0-100.0-100.0<CR><LF>
0C1!     000364<CR><LF>
0D0!     0-0.279+2.031-0.243-2.497+2.802-2.766+0.659+4.948+2.264+1.896-3.802-5.423<CR><LF>
0D1!     0-4.180+4.738-5.738-0.305-1.759+3.632+5.673+1.070-0.896+3.671+5.673-4.426<CR><LF>
0D2!     0-5.344+3.130+4.813+3.911+1.683-0.538+5.033+1.624-1.220-3.045+2.470-5.128<CR><LF>
0D3!     0+1.368+0.610-2.215+5.791-1.736-1.122+2.484-0.568-2.277+2.657-0.427-6.217<CR><LF>
0D4!     0-3.819+4.767-3.097-3.720+1.355+3.862-5.994+3.219-2.408-1.191-3.802+2.247<CR><LF>
0D5!     0+1.043-1.161-2.470+3.566<C
0C2!     000364<CR><LF>
0D0!     0+3.169+3.786+4.249+0.751-0.663+5.105-5.997+5.489-4.892-3.081-5.745+3.258<CR><LF>
0D1!     0+4.111+1.706+1.339+3.770+2.260-3.212-4.370+3.163-2.995+3.481-0.804-0.551<CR><LF>
0D2!     0-4.423+2.434+3.629+1.086+2.854-1.020+1.325+1.890+5.351+4.970+3.734+1.093<CR><LF>
0D3!     0+3.156-2.208-3.566+3.058-4.442+0.171-3.891+3.524+1.112-0.082-0.541+1.473<CR><LF>
0D4!     0-0.571-1.496+1.821-2.743-3.051+4.236+1.132-1.788+3.990-0.919-4.150-0.115<CR><LF>
0D5!     0-1.158-5.568-3.625-4.616<CR><LF>
0C3!     000364<CR><LF>
0D0!     0+29.0+28.9+29.1+29.3+29.2+28.8+28.7+28.9+28.8+28.1+28.6+28.9+29.0+28.7+28.8<CR><LF>
0D1!     0+29.0+28.8+28.5+29.0+29.4+28.9+29.0+28.9+28.9+28.9+29.3+28.7+29.3+29.0<CR><LF>
0D2!     0+29.2+28.3+28.7+29.0+28.8+28.7+29.4+29.1+29.0+29.4+28.9+28.8+29.4+29.0+28.8<CR><LF>
0D3!     0+29.3+29.1+28.6+29.0+29.0+29.2+28.7+29.2+29.0+29.1+28.7+28.5+29.2+28.8+29.1<CR><LF>
0D4!     0+29.2+28.6+28.7+28.8<CR><LF>
0C4!     000364<CR><LF>
0D0!     0+29.5+29.7+29.6+29.4+29.4+29.7+29.6+29.7+29.9+29.8+29.6+29.7+29.6+29.9+29.2<CR><LF>
0D1!     0+29.3+30.0+29.5+29.8+29.6+29.0+29.4+29.7+29.8+30.0+29.8+29.3+29.9+30.4+29.2<CR><LF>
0D2!     0+29.5+30.1+29.4+29.4+29.9+30.0+29.9+29.6+30.0+29.6+29.5+30.8+29.3+30.2+29.9<CR><LF>
0D3!     0+29.6+29.6+29.8+29.8+29.8+30.3+30.1+29.5+29.7+29.4+30.0+30.4+29.7+30.2<CR><LF>
0D4!     0+29.4+29.7+30.1+29.5<CR><LF>
0C5!     000000<CR><LF>
0C6!     000000<CR><LF>
0C7!     000000<CR><LF>
0C8!     000000<CR><LF>
0C9!     000000<CR><LF>
```

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Common SDI-12 Commands

The first character of all commands and responses is a device address "a". The last character of a command is the "!" character. The "!" can only be used in a command as the last character. For additional information on the SDI-12 protocol and the commands, please go to www.sdi-12.org.

Send Acknowledge Command

The Send Acknowledge Command returns a simple status response that includes the address of the sensor. Any measurement data in the sensor's buffer is not disturbed.

Command Response

```
a! a<cr><lf>
```

Where:

a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

Change Sensor Address

The Change Sensor Address Command allows the sensor address to be changed. The address is stored in non-volatile EEPROM within the sensor. The ChannelMaster will not respond if the command is invalid, the address is out of range, or the EEPROM programming operation fails.

Command format:

```
aAn! n<cr><lf>
```

Example to change sensor address from "a" to "2":

```
aA2! 2<cr><lf>
```

Where:

a	is the current (old) sensor address ("0-9", "A-Z", "a-z", "*", "?"). An ASCII "*" may be used as a "wild card" address if the current address is unknown and only one sensor is connected to the bus.
A	is an upper case ASCII character.
n	is the new sensor address to be programmed ("0-9", "A-Z", "a-z", "*", "?"). Note: To verify the new address, use the Send Identification Command.

Send Identification Command

The Send Identification Command responds with sensor vendor, model, and version data. Any measurement data in the sensor's buffer is not disturbed.

Command format:

```
aI! abbcccccccccmmmmmmvvvxx…xx<cr><lf>
```

Example of a ChannelMaster `aI!` command:

```
aI!     a13TRDI   28.37 208<CR><LF>
```

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

bb	is the SDI-12 version compatibility level (e.g., version 1.3 is represented as "13").
cccccccc	is an 8-character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation.
mmmmmm	is an optional 6-character field specifying the sensor model number.
vvv	is a 3-character field specifying the sensor firmware version number.
xx...xx	is an optional field of up to a maximum of 13 characters to be used for serial number or other specific sensor information not relevant to operation of the data recorder.

Using SDI-12 Data-Loggers

This section presents basic information on configuring data loggers to collect ChannelMaster data using the SDI-12 protocol. Please refer to the ChannelMaster SDI-12 Guide for more details and sample programs. Implementation of the SDI-12 protocol will vary between logger manufacturers and thus detailed instructions cannot be provided for every possible logger. Some general notes on implementation considerations are as follows: The ChannelMaster should be installed and configured, and the data quality verified using internally logged data, prior to initiating SDI-12 data logging. This can be accomplished using *ChannelMaster Utilities* and the Utilities and Updates workflow with SDI-12 operation disabled, or by using the Monitoring and Maintenance workflow and reviewing the data collected during the 'Discharge Measurement' portion of that workflow. In all cases, the Utilities and Updates workflow should be used to set the initial configuration of the ChannelMaster.

- Transmission of PD0 data over the serial port lines can create noise and/or interference on the SDI-12 data lines, interfering with proper SDI-12 operation. Therefore, *ChannelMaster Utilities* software will disable serial output (CF command) when SDI-12 operation is enabled.

- The SDI-12 protocol imposes additional overhead into the measurement and data logging process. The ChannelMaster will report a slightly conservative time interval required before data will be available, and the get data and additional measurement commands will add to the required time. Thus, the averaging interval in the ChannelMaster will need to be shorter than the data interval (scan rate) in the data logger. TRDI suggests allowing a timing buffer of at least 5% of the ChannelMaster averaging interval plus 30-45 seconds between the averaging interval and the data logger scan rate. Experimentation may be required to develop the optimum averaging interval for a given logger scan rate.

- Variable types used by the data logger must have sufficient range and resolution for the parameter being recorded. IEEE 4-byte floating point variables or the equivalent are recommended for most ChannelMaster output parameters as it corresponds closely to the 7-digit limitation for SDI-12 data. The Campbell Scientific FP2 data type does NOT have sufficient range and resolution for many ChannelMaster output parameters.

- The ChannelMaster in some configurations can be sensitive to the timing of SDI-12 commands, particularly when using the C (concurrent measurement) commands. A 1-second or longer delay between sequential C-measurement commands is recommended to improve reliability of operation.

- The SDI-12 concurrent measurement commands allow the logger to communicate with other SDI-12 devices, or perform other actions, while waiting for the ChannelMaster to complete its measurement. Some loggers, specifically the Campbell Scientific CR-300, by default will attempt to send multiple concurrent measurement commands to the ChannelMaster without waiting to obtain the results between each command. This obviously violates the intent of the concurrent

measurement commands (a sensor cannot be expected to execute multiple measurement commands simultaneously and per the specification, sending a new command cancels the prior one). The workaround for this issue is to set the 'WaitonTimeout' parameter to 1 in the SDI12Recorder() command, forcing the concurrent measurement command to behave identically to the standard measurement command.

- Please contact TRDI to discuss any additional SDI-12 logger issues identified

> ⚠️ SDI-12 will not function while the *ChannelMaster Utilities* software is connected.

NOTES

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Chapter 4

Maintenance

In this chapter, you will learn:

- Parts location
- Maintenance schedule
- Spare parts list
- Periodic Maintenance
- Long Term Maintenance

Parts Location Drawings

This section is a visual overview of the inside and outside parts of the ChannelMaster H-ADCP. Use the following figures to identify the parts used on the system.
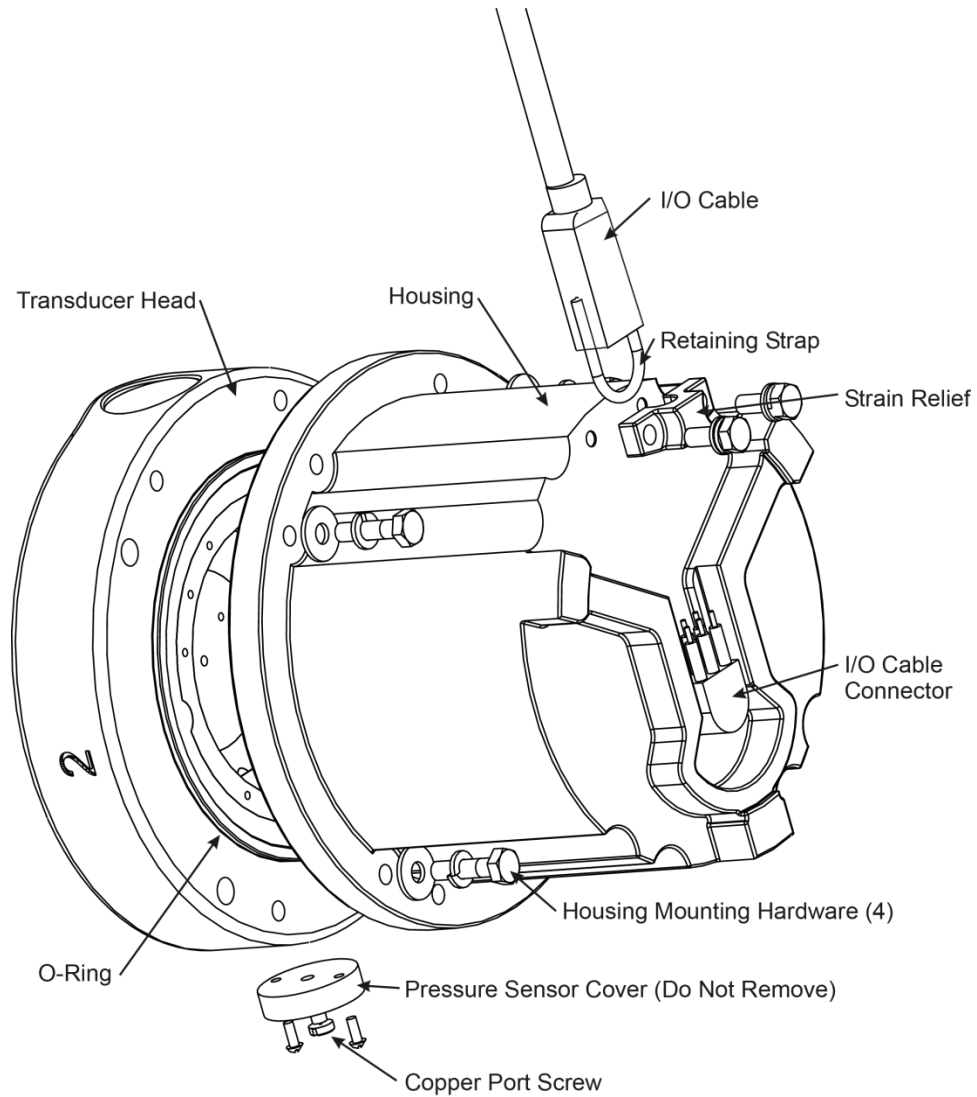
Figure 13.   ChannelMaster Assembly

Maintenance Schedule

To ensure continuous optimal results from the ChannelMaster, TRDI recommends that every H-ADCP 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.

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

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. TRDI recommends zeroing the pressure sensor prior to each deployment.
Pressure Sensor (Factory)	

> Pressure sensor 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.
>
> TRDI recommends zeroing the pressure sensor prior to each deployment.

Maintenance Items

Inspect the ChannelMaster to spot problems:

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

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Spare Parts

The following parts are included in the spare parts kit.

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

Table 3:   ChannelMaster Spare Parts

Part Number	Item Name	Where Used
5020	Silicone Lubricant, 4-Pack	Housing Tools
97Z-6046-00	O-RING, 2-254, DURO 60, EPDM	
M6WASHSPL	WASHER, SPLIT LOCK SST316	
M6WASHSPLTI	WASHER, 6MM SPLIT LOCK TITANIUM	
M6WASHSTD	WASHER, FLAT, 12.5MMOD SST 316	
M6WASHSTDTI	WASHER, FLAT, TITANIUM 12.5MM OD	
M6X1.0X16FHSH	SCREW, FLAT HEAD, SOCKET HEAD, SST 18-18	
M6X1.0X16HHTI	SCREW, TITANIUM	
M6X1.0X25HHTI	SCREW, TITANIUM	
M6X1.0X35HH	SCREW, HEX HEAD, SST 18-8	
3/16BLADE	SCREWDRIVER	
6958A14	HEX KEY, 4MM, LONG ARM	
7299A25	WRENCH, NUT DRIVER, 10MM	
84Z-6000-00	TOOL BAG, CANVAS	
DES3	DESICCANT, SEALED BAG, 2 UN MIL PAK	Inside Housing
817-1067-00	SCREW, PRESSURE SENSOR	Pressure Sensor
75BK6004-00	KIT, FILL, SILICONE OIL	

Periodic Maintenance Items

These maintenance items should be done prior to using the ChannelMaster.

Cable Connector Lubrication

The connector requires 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 the rubber portion of the male pins 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.

2. After lubricating, fully connect the male and 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 cable.

> Use **ONLY** silicone-based lubricants. **DO NOT** use petroleum-based lubricants.
>
> Silicone lubricant is included in the Spare Parts kit.

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

Apply Silicone Lubricant on all male pins (rubber portion)
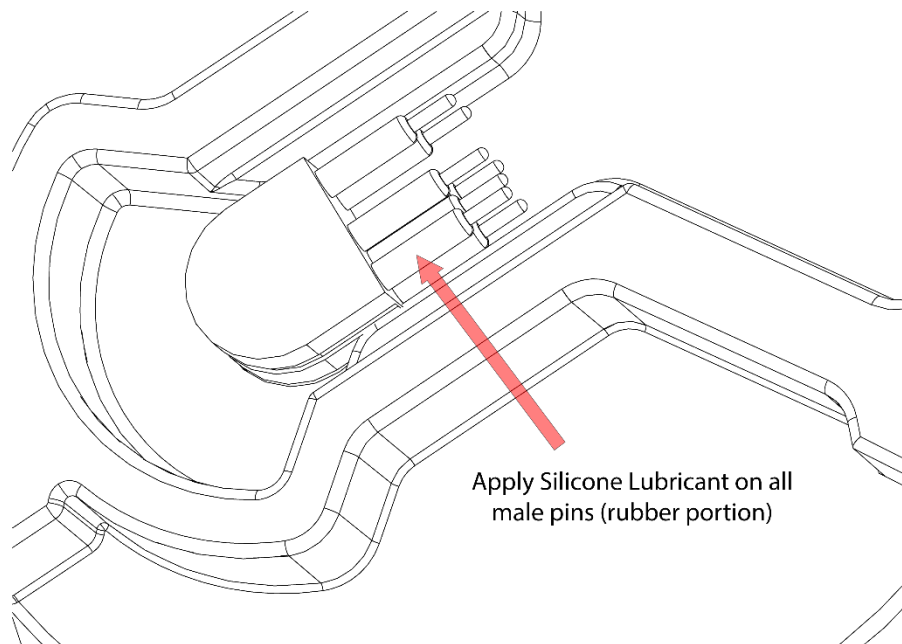
Figure 14.   Cable Connector Lubricant

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Cleaning the Cable Connector

After a deployment, clean and remove any accumulated sand or mud from the both the connector on the ChannelMaster and the socket on the 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 mating.

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

Transducer Inspection

> ⚠️ Never set the transducer face on a rough surface; always use foam padding to protect the transducer.

Based on experience, TRDI knows that ***most*** ChannelMasters need to have the urethane inspected after 2 to 3 years of field use. Many users are not familiar with the early signs of urethane failure. The primary damage to the urethane is from bio-fouling and long exposure to the water and sun. Damage occurs on the surface of the urethane and at the edge where the urethane bonds to the cup. By returning the system every 2 to 3 years, TRDI can inspect it for early signs of urethane failure and repair it through our Refurbishment Service. At the same time, TRDI will make any necessary upgrades to boards, assemblies, and firmware. If the Refurbishment Service is not needed, TRDI can upgrade the system as part of one of our Inspection Services. Proper care, general maintenance, and this routine service period ensures that the ChannelMaster system lasts for a minimum of 10 years with no loss in performance.

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

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 face 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 ChannelMaster 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 ChannelMaster to TRDI for repair. If the barnacles can not 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 ChannelMaster before placing it in the storage case to avoid fungus or mold growth. Do not store the ChannelMaster in wet or damp locations.

ChannelMaster 300 kHz after a three-month deployment. Photo by H. Huang

Applying Antifouling Paints

> ⚠️ TRDI recommends that any antifouling coating should be applied in as thin a layer as possible on the urethane faces. Applying a coating may reduce the measurement range of the ChannelMaster (though it will not affect its accuracy in the measurable range).

Follow the urethane faces application instructions. Apply an even, thin layer (0.1mm, 4mil per coat) of paint to the urethane faces. One thin coat can last for several months.

> 📌 Do not paint over the pressure sensor. The pressure sensor is located near the center of the transducer array, between the urethane-covered transducers. The sensor port is a small hole drilled through a screw (see **Pressure Sensor Maintenance**). You must tape off the screw during anti-fouling paint application.
>
> This means that the sensor port is not fully protected from bio fouling. The sensor port is surrounded by the antifouling paint, but bio fouling may build up on the screw, and eventually clog the sensor port. However, most organisms do not seem to find the small amount of unpainted surface attractive. If it is logistically possible to periodically inspect/clean the pressure sensor screw, it is highly recommended. This tradeoff situation must be analyzed for individual deployments. Unfortunately, the location of the deployment site usually dictates action in this regard.

Transducer Faces (urethane surfaces) and Plastic Housing

1. Preparation – Clean thoroughly with soapy water. Dry completely.

2. Mask off the Thermistor and Pressure Sensor copper screw.

3. Apply one or two coats of anti-fouling paint at four mil/coat. If applying a second coat, wait at least 12 hours to allow the first coat to dry. One coat lasts one season (3-4 months); two coats might last one year.

Thermistor Maintenance

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

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

Pressure Sensor Maintenance

To read the water pressure, water must be able to flow through the copper screw on the pressure sensor. The tiny hole in the copper screw may at times be blocked. Use the following procedure and Figure 13, page 36 to clean the screw.

1. Place the ChannelMaster on its' housing end. Use a soft pad to protect the ChannelMaster.

2. Use a straight-slot screwdriver to remove the copper screw.

3. Gently clean out the hole in the copper screw with a needle. If the hole becomes enlarged or the screw is corroded, replace the screw. A replacement copper screw is included in the spare parts kit (part number 817-1067-00).

4. Install the copper screw. Tighten the screw "finger tight" (0.226 N-m, 2 lbf-in). Do not over tighten the screw or you may strip the threads on the plastic cover disc. If this happens, return the ChannelMaster to TRDI for repair.

⚠️

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

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

Do not remove the pressure sensor. It is not field replaceable.

Pressure Sensor Cavity Oil Fill

The pressure sensor cavity needs to be filled with oil before deployment to deal with both trapped air and long-term reliability of the pressure sensor. The oil to be used is Dow Corning Q7-9120 Silicone fluid, 12,500 CST. This fluid is supplied with the ChannelMaster in the spare parts kit. The filling of the cavity can be completed any time before system installation however care should be taken to keep the Channel-Master from high temperature during this time.

The pressure sensor cavity is not filled with oil when shipped. This must be done before deploying the ChannelMaster.

To fill the pressure sensor with oil:

1. Place the ChannelMaster on its side with the vertical beam facing down and the pressure sensor port facing up. Use a soft pad to protect the ChannelMaster.

2. Use a straight-slot screwdriver to remove the copper port screw on the pressure sensor. Do not remove the pressure sensor cover.

3. A plastic bottle with silicone oil (part number 75BK6004-00) is included in the spare parts kit. Place the tip of the bottle over the screw hole. Ensure the plastic bottle tip is not inserted into the screw hole. Slowly administer the oil into the cavity through the hole. Allow time for the air to escape as you fill. Once the oil level is up into the port screw hole, then stop filling.

4. Install the copper port screw slowly, allowing time for the oil to pass through the port screw orifice. Tighten the screw "finger tight" (0.226 N-m, 2 lbf-in). Do not over tighten the screw or you may strip the threads on the plastic cover disc. If this happens, return the ChannelMaster to TRDI for repair.

The Pressure sensor cavity should be checked and if needed refilled between deployments. Only remove the copper port screw for this inspection and re-fill.

Figure 15.   Filling the Pressure Sensor Cavity with Oil

Zero the Pressure Sensor

Zero out the pressure sensor at the deployment site, prior to deploying the ChannelMaster in the water.

To zero the pressure sensor:

1. Start *ChannelMaster Utilities*. Click on the **Utilities and Updates** button.

2. Establish communications to the ChannelMaster by clicking on the **Connect** button.

3. Place the ChannelMaster in the water so that the vertical beam is at the water surface. Click **Zero It**. This will zero the pressure sensor. Click **OK** at the **Zeroed pressure sensor successfully** screen.
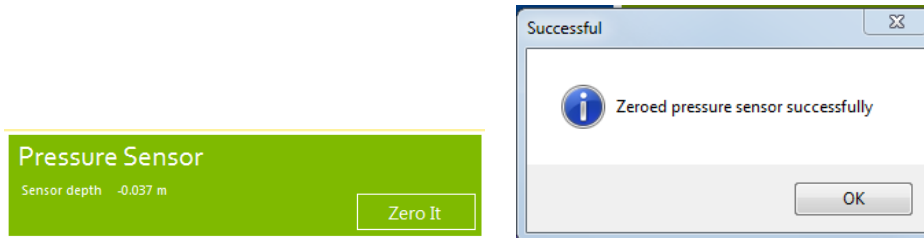
Testing the ChannelMaster

To test the ChannelMaster:

1. Start *ChannelMaster Utilities*. Click on the **Utilities and Updates** button.

2. Establish communications to the ChannelMaster by clicking on the **Connect** button.

3. Click on the System Tests **Run** button.

4. Click **OK** at the **All tests passed** screen. If a test fails, see the Troubleshooting section.

Long Term Maintenance Items

The O-Rings should be replaced every two years. Firmware updates may be done when needed.

Housing Assembly Removal

To remove the housing:

1. Remove all power to the ChannelMaster.

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. Set the transducer assembly (transducer face down) on a soft pad.

4. Loosen (do not remove) the four titanium bolts (M6) bolts to vent the system.

5. Once all four bolts have been loosened, remove the four bolts that attach the housing flange to the transducer head assembly.

6. Carefully lift the housing assembly straight up and away from the transducer assembly until you can gain access to the connector jack on the top PC board (see Figure 16). Use care; the plastic mating surfaces scratch easily. Do not damage the mating surfaces.

7. Squeeze the sides of the internal I/O cable connector to release it from the jack (see Figure 17). Set the housing assembly aside.
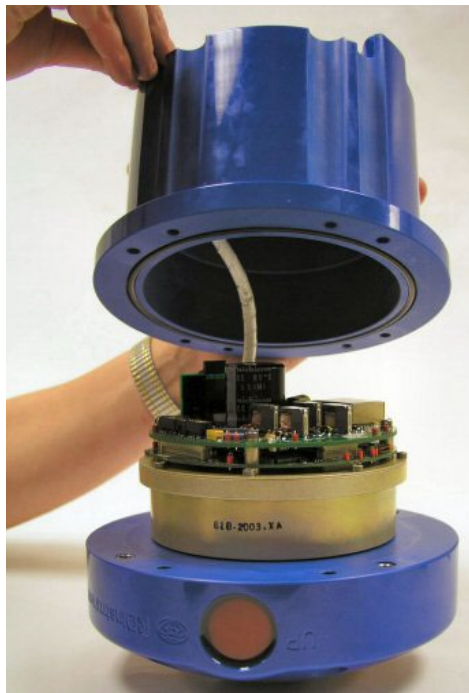
Figure 16.   Removing the Housing

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

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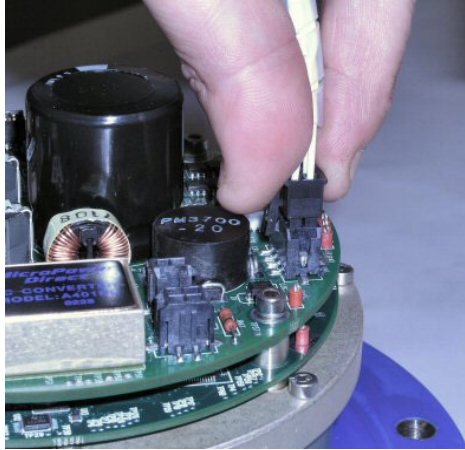
Figure 17.   Disconnecting the Internal I/O Cable

8.   Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see O-Ring Inspection and Replacement).

9.   When you are ready to re-assemble the ChannelMaster, see ChannelMaster Re-assembly.

ChannelMaster Re-assembly

To replace the housing, proceed as follows. Use Figure 13 for parts identification.

O-Ring Inspection and Replacement

This section explains how to inspect/replace the ChannelMaster O-ring. A successful deployment depends on the condition of O-ring and the retaining groove. See Figure 13 for the location of the O-ring. Read all instructions before doing the required actions.

TRDI strongly recommends replacing the O-ring whenever you disassemble the ChannelMaster. Inspecting and replacing the O-ring should be the last maintenance task done before sealing the ChannelMaster.

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

To replace the O-ring:

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

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

2.   Clean and inspect the O-ring groove. Be sure the groove is 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 ChannelMaster 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. 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.

Desiccant Bags

Desiccant bags are used to dehumidify the housing interior. Desiccant is essential in deployments with plastic housings. The factory-supplied desiccant lasts a year at specified ChannelMaster deployment depths and temperatures. Remember that desiccant rapidly absorbs moisture from normal room air.

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

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

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

To replace the desiccant:

1. Remove the housing (see Housing Assembly Removal).
2. Remove the new desiccant bags from the airtight aluminum bag.
3. Remove the old desiccant bags and install two new ones. Place the desiccant bags between the top circuit board and the housing.
4. Install the housing (see ChannelMaster Re-assembly).

Housing Assembly Replacement

To install the housing:

1. Set the Housing assembly on its end on a soft pad.
2. Make sure all printed circuit boards, spacers, cables, and screws have been installed.
3. Inspect, clean, and lubricate the O-ring on the housing (see O-Ring Inspection and Replacement).

> ⚠️ Follow all the steps for O-Ring Inspection and Replacement. The watertight integrity of the ChannelMaster depends on this seal.

4. Connect the internal I/O connector to the plug on the top PC Board.
5. Install two fresh bags of desiccant just before closing the ChannelMaster (see Desiccant Bags).
6. Gently lower the transducer head assembly into the housing assembly, aligning the mating holes and the making sure that the I/O cable connector pins on the housing are facing the vertical beam on the transducer head. 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 ChannelMaster will flood.

> 📌 Make sure the I/O cable connector pins are facing the vertical transducer beam.

7. Examine the titanium housing assembly bolts, split washer, and flat washers (M6) for corrosion: replace if necessary. Figure 13 shows the assembly order of the transducer mounting hardware. All hardware items are needed to seal the ChannelMaster properly.

8. Install all four sets of hardware but leave the housing hardware loose enough to not make an air-tight seal. You should be able to see a gap between the housing and transducer head. Slide a small wedge (a folded piece of paper or credit card) between the housing and transducer head to maintain the gap. Be careful not to dislodge the O-ring from the O-ring groove.

Pressure Sensor Calibration and Close-up

To calibrate the pressure sensor and close the system:

1. Interconnect and apply power to the ChannelMaster as described in <u>Setup the ChannelMaster</u>.

2. Start the *BBTalk* or *TRDI Toolz* program (for help on these programs, see the Help file).

3. On the **File** menu, click **Break** (you can also press the **End** key to send a break or use the Toolbar and press the **B** button). You should see the wakeup message appear on the log file window.

4. Leave the ChannelMaster powered up in a temperature-controlled area for at least one hour so that any temperature gradients within the system equalize.

5. At the > prompt, type **#sc**. The ChannelMaster will respond with:

```
>#sc
*** CAUTION: These commands are reserved for TRDI use
and may not be currently supported!
Input local barometric pressure in inches of mercury:
```

6. Determine the barometric pressure <u>at your location</u> as accurately as possible. Use barometric pressure (what your barometer reads, or your wrist watch barometer reads), not an airport weather forecasting service altimeter reading that is corrected for sea level pressure.

   For example, a barometer reading is 2984. The numbers represent barometric pressure in hundredths of inches of mercury. Divide this number by 100 so that it represents barometric pressure in inches of mercury (e.g., 29.84inHg).

   International users may be given the barometric pressure in millibars (mb) or hectopascals (hPa). The barometric pressure must be entered in inches of mercury (inHg). To convert between inches of mercury (inHg) and millibars (mb) or hectopascals (hPa), use the formula $P_{inHg} = 0.0295300 \times P_{mb}$.

   For example, to convert 1013hPa to inches of mercury (inHg), multiply 1013 x 0.0295300 so that it represents barometric pressure in inches of mercury (e.g., 29.92inHg).

7. Enter this number in inches of mercury (inHg) at the prompt and press enter.

8. The ChannelMaster should respond with:

```
"Make sure the unit is open to ambient pressure. Hit any key to continue...".
```

9. Press any key to continue.

10. The ChannelMaster should respond with the following message.

```
"Now close the unit and tighten the closeup hardware. After this, hit any key to continue...".
```

11. Remove any wedge between the housing and transducer head. 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 4 Newton-meters (34.4 pound-force inches).

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

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

> 📌 The recommended torque value for the housing M6 bolts is 4 Nm (34.4 lbf in).

12. If the calibration was successful, the unit should respond with:

```
"SUCCESS: Close up calibration complete. Execute PC2 to verify."
```

13. At the > prompt, type **PC2** and press return. Verify that the pressure reported by the PC2 Press (kPa) column is approximately +/- 0.050 kPa.

```
Temp(degC)   Press(kPa)   Press(m)  Pitch(deg)  Roll(deg)
/    23.15       -0.009     -0.001       0.31       0.67
```

> 📌 After a few samples the pressure will begin to change as a result of changes in ATM pressure or interior building pressure. Verify the test results within the first 20 seconds.

14. At the > prompt, type **CZ** and press return. Verify the "**going to sleep**" message is present.

15. Exit *ChannelMaster Utilities* and turn off power to the ChannelMaster.

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Firmware Upgrades

The ChannelMaster contains two processors (three if the SDI-12 personality module is present), each with two firmware modules. When new firmware is released, TRDI provides a firmware update package. The package contains *CMFlash*, all the firmware modules, and a readme file. It updates all out of date firmware to the latest version. The name of the update package is *CM_FW_xx.xx.exe* where *xx.xx* is the version number.

> The most recent firmware versions can be seen at TRDI's website. To see what versions a firmware package contains, see the readme file.
>
> A standard firmware package will only upload newer firmware than what is already in the ChannelMaster.
>
> The firmware versions in your ChannelMaster can be displayed using *TRDI Toolz* with the PS0 command (see **PS0 – System Configuration**).
>
> ChannelMaster firmware packages may contain updates to one or more of the following: CPU firmware, FPGA firmware, Sensor Boot firmware, or Sensor firmware. In addition, they may include SDI-12 Boot firmware and SDI-12 firmware. These are for the optional SDI-12 personality module.

To update the ChannelMaster firmware:

1. Firmware can be downloaded from TRDI's website:
   https://tm-portal.force.com/TMsoftwareportal
   Download the firmware update file to your computer's hard drive and unzip the file.

2. Run the *CM_FW_2.xx.exe* file (where *xx* is the firmware version) to install the firmware on a computer. This will place a shortcut on the desktop.

3. Start *ChannelMaster Utilities*. Click on the **Utilities and Updates** radio button.

4. Establish communications to the ChannelMaster by clicking on the **Connect** button.

5. Click on the **Update** button.

6. Point *ChannelMaster Utilities* to the desktop shortcut added in step 2 and click **Open**.

7. Click **I Agree** at the firmware EULA.

8. Click **Start**.

9. Click **Upgrade** to continue.

10. Wait for the *Firmware upload successful* message. Click **Exit**.

11. Verify the firmware version has been updated.

12. Use Windows Control Panel® to uninstall the firmware update file.
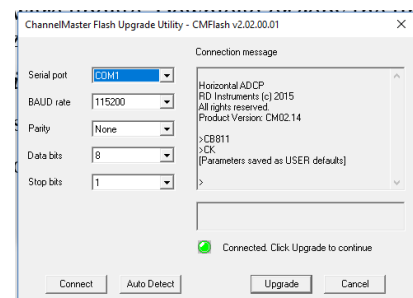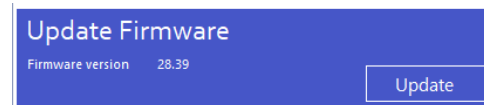
Personality Module Replacement

Personality modules can be replaced to change the ChannelMaster communication protocols (for example, switch from RS-422 to RS-232).

To replace the Personality module:

1. Remove all power to the ChannelMaster.

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. Set the transducer assembly (transducer face down) on a soft pad.

4. Remove the housing (see Housing Assembly Removal).

> ⚠️ Before handling any ChannelMaster PC boards, always wear an earth-grounding static protection strap. The electronics in the ChannelMaster are very sensitive to static discharge. Static discharge can cause damage that will not be seen immediately and will result in early failure of electronic components.
>
> TRDI assumes that a qualified technician or equivalent will perform all of the following work.

5. With your earth-ground static protection strap on, push the side of the black plastic board clamp toward the edge of the board far enough so the Personality Module can be removed (see Figure 18). Pull out the Personality Module and replace it with the new module. Make sure the board clamp is securely snapped over the new Personality Module.

6. Replace the housing (see ChannelMaster Re-assembly).

7. Test the ChannelMaster (see Testing the ChannelMaster).
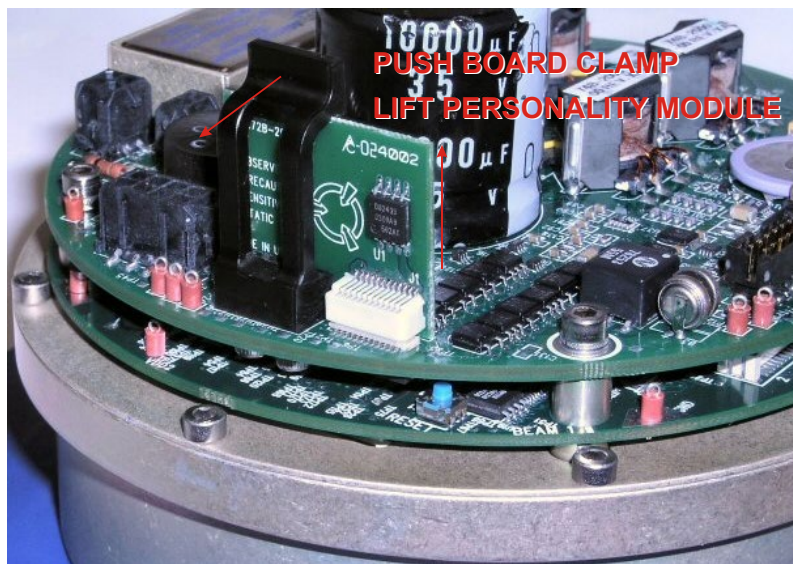
Figure 18. **Personality Module**

Chapter 5

Troubleshooting

In this chapter, you will learn:

- Troubleshooting Safety
- Troubleshooting a Communication Failure
- Troubleshooting a Built-In Test Failure
- Troubleshooting Data Problems

Although the ChannelMaster is designed for maximum reliability, it is possible for a fault to occur. Before troubleshooting, review the procedures, figures, and tables in this manual.

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

Troubleshooting Safety

Follow all safety rules while troubleshooting.

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

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

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

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

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

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

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

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Troubleshooting a Communication Failure

ChannelMaster units are pre-configured to use RS-232, RS-422, or SDI-12 communications protocols. To successfully communicate, both the host computer and the ChannelMaster must communicate using the same class of serial interface. Standard serial interfaces in IBM compatible computers are RS-232.

There are two types of communication failures; nothing happens when attempting to wake up the ChannelMaster or something happens, but not the correct wake up message is displayed.

Incorrect Wakeup Message

A baud rate or parity mismatch between the ChannelMaster and the computer can cause the data to be garbled when you send a break. See Incorrect Wakeup Messages for symptoms of garbled wakeup messages.

> Most communication problems are associated with incorrect cabling (i.e. the serial cable is connected to the wrong port) or data protocols (i.e. the wrong baud rate is set between the ChannelMaster and computer or no power applied to the instrument).

> A Channel Master that has been unplugged or deployed by not actively pinging for a long time (a week or more), may have difficulty waking from sleep reliably and need to have its internal batteries charged.

Nothing Happens

If you cannot talk to the ChannelMaster (i.e., no wakeup message), you need to isolate the problem to a computer fault, power, cable failure, or a ChannelMaster problem.

Check the following items:

1. Connect and power up the ChannelMaster unit. Check that all cable connections are tight.

2. If the ChannelMaster is running from a battery, check the battery voltage or try another battery. If necessary, use an external power supply (10.5 to 18 VDC).

3. Is the computer hooked up properly?

4. Use *BBTalk* or *TRDI Toolz* to troubleshoot communication problems. Make sure that your computer and the program are set up to use the communication port the serial cable is connected to on the computer.

Incorrect Wakeup Messages

The following conditions may indicate a communications mismatch.

- Sending a break causes unreadable text to appear on the screen. The text may keep scrolling. This happens when the computer is using RS-232 and the ChannelMaster is using RS-422.

- Sending a break causes unreadable text to appear on the screen. The text does not keep scrolling. Check that the ChannelMaster and computer are both using the same baud rate. In *BBTalk* or *TRDI Toolz*, use **Auto Detect**. Once the ChannelMaster is detected, change the baud rate using the CB command if desired.

Check the Power

The following test can be done with a voltmeter to check the power.

Check the power going into the ChannelMaster by measuring the voltage on the end of the cable that connects to the ChannelMaster at VIN+ and VIN- (GND) (see Figure 7). The voltage should be +10.5 to 18 VDC (using an external power supply).

Check the I/O Cable

This test will check the communication between the computer and ChannelMaster.

1. Disconnect both ends of the cable and measure the continuity using a DMM (see Figure 7). Correct any problems found.

2. Reconnect the I/O cable to host computer.

3. Start the *BBTalk* or *TRDI Toolz* program on your computer. Select the proper communications port.

4. Short TX1A and RX1A together on the cable connector that was plugged into the ChannelMaster.

5. Type any characters on the keyboard. The keys you type should be echoed on the screen. If you see characters, but not correctly (junk), the cable may be too long for the baud rate. Try a lower baud rate. If this works, disconnect the jumper and then push any keys on the keyboard. You should NOT see anything you type.

6. If the keys are echoed correctly on the screen, the computer and the communication cable are good. Re-connect the test cable to the ChannelMaster. The above loop-back test does not show if transmit and receive pairs are interchanged. Thus, it is important that you check the wiring diagrams provided in Figure 7.

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

ChannelMaster Checks

Once you have eliminated possible problems with the power, test cable, communications settings, and the computer, that leaves the ChannelMaster as the source of the problem.

If the unit shows a banner upon power-up but won't respond reliably to a break or SDI-12 command, it may require its internal batteries to be charged. This can happen when a system has been powered-off for a long period (a week or more) or has been powered but not actively pinging (asleep) for a similarly long period.

To charge the batteries:

Connect to the unit using a serial connection and *TRDI Toolz*. Send a break or remove and restore power in order to get a banner. Send a break after the banner and verify the response to the break, which is another banner, then send an enter key. This should stop any current deployment. Leave the unit in that state, powered on and awake, for 20 minutes or more. After this time, the unit should respond to commands, break and SDI-12 commands more reliably (while asleep).

If possible, remove the housing (see Housing Assembly Removal). Check for any loose cables.

Reseat the Personality Module (see Personality Module Replacement). Contact our field service for further troubleshooting.

Troubleshooting a Built-In Test Failure

The built-in tests check the major ChannelMaster modules and signal paths. If a built-in test fails, use the following steps to provide the needed information to the Teledyne RDI Field Service group to help reduce the investigation process.

Identify the ChannelMaster

Prepare a log file (see the *BBTalk* or *TRDI Toolz* Help file, and make sure the **Log results to File** box is selected) with the returns from the following commands:

- **BREAK**

- **PS0**

- **PA**

- **PT3** (ensure the transducer beams are fully submerged in water prior to performing this test)

> Always run the PT3 test with unit transducer beams submerged in water. A bucket of water is sufficient, but if possible run at least one PT3 at the deployment site.

The returns from these commands will display the unit firmware version, the system operating frequency, beam matrix information, and verify that the electronics are working as expected.

Built-in Tests Failure

If a test failed, repeat the test several times rotating the ChannelMaster by 90 degrees each time. By doing so, it may be determined that the failure is directional. Please be sure to log the results to a file. If other magnetic, acoustic, or high current systems are in the vicinity of the ChannelMaster, if possible, please power down the equipment and or remove the equipment (at least three meters away) during diagnostic testing; re-run the tests. Modify the log file by adding a note as to what has been done prior to the test such as: *"Turning 300KHz Sonar off"* for instance.

Troubleshooting Data Problems

This section contains the different tasks that should be performed on the site where you experience data quality issue(s).

Provide ChannelMaster Set-up

Provide a copy of the *BBTalk* or *TRDI Toolz* log file with the commands sent to the ChannelMaster during deployment. Include the following groups of commands:

```
>C?
>D?
>E?
>I?
>P?
>T?
>V?
>W?
```

Describe the Deployment and Environment

Provide a description of the environment where you are deploying; in particular, details on water description (for instance: highly concentrated sediment in water...). Additionally, provide a description of the intended deployment. Please provide details on environment commands, range expected, standard deviation expected, and goal of the mission.

Provide Raw Data

Recover the raw data from your instrument and send the complete deployment data together with a description of the issue that you are experiencing and if possible some screenshots or ensemble numbers to locate region(s) showing the unexpected data behavior.

As previously mentioned in Troubleshooting a Built-In Test Failure, if other devices are in the vicinity of the ChannelMaster and are suspected to be the origin of the data quality issue, if possible power the device down or remove it from the area (at least three meters) and re-deploy.

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Chapter 6

RETURNING SYSTEMS TO TRDI FOR SERVICE

In this chapter, you will learn:

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

Shipping the ChannelMaster

This section explains how to ship the ChannelMaster.

> ⚠️ Remove all customer-applied coatings or provide certification that the coating is nontoxic when shipping a ChannelMaster 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 ChannelMaster 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 ChannelMaster.

To ship the ChannelMaster 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 ChannelMaster 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 ChannelMaster 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 <u>one</u> 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

- If you need a new shipping container for shipment

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 telephone to TRDI.

Attention: Customer Service Administration

Phone: +1 (858) 842-2700

- Detailed descriptions of what you are shipping (number of packages, sizes, weights and contents).

- The name of the freight carrier

- Master Air bill number

- Carrier route and flight numbers for all flights the package will take

Returning Systems to TRDI Europe Factory

When shipping the system to TRDI Europe, the following instructions will help ensure the ChannelMaster 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 <u>one</u> 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

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Step 4 - Include Proper Customs Documentation

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

- Contents of the shipment

- Value

- Purpose of shipment (example: "American made goods returned for repair")

- Any discrepancy or inaccuracy in the Customs statement could cause the shipment to be delayed in Customs.

Step 5 - Send the Following Information by Telephone to TRDI

Attention: Sales Administration

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

- Detailed descriptions of what you are shipping (number of packages, sizes, weights and contents).

- The name of the freight carrier

- Master Air bill number

- Carrier route and flight numbers for all flights the package will take

NOTES

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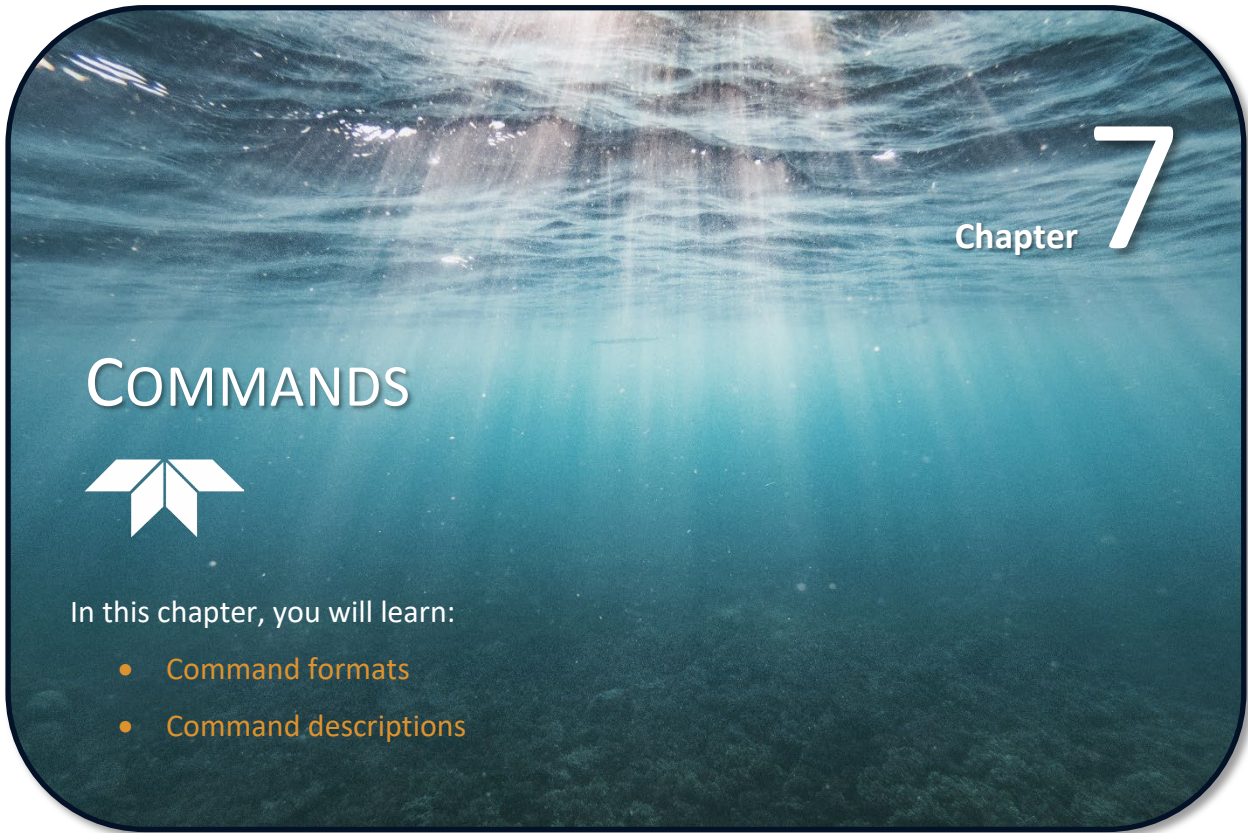
Chapter 7

COMMANDS

In this chapter, you will learn:

- Command formats
- Command descriptions

This section defines the commands used by the ChannelMaster. These commands let you set up and control the ChannelMaster without using an external software program such as our *ChannelMaster Utilities* program. However, we recommend you use our software to control the ChannelMaster because entering commands directly from a terminal can be difficult. Most ChannelMaster settings use factory-set values. If you change these values without thought, you could ruin your deployment. *Be sure you know what effect each command has <u>before</u> using it*. Call TRDI if you do not understand the function of any command.

Using *ChannelMaster Utilities* for real-time deployments to develop the command file will ensure that the ChannelMaster is set up correctly. The commands directly affect the range of the ChannelMaster and the standard deviation (accuracy) of the data.

> This chapter applies to ChannelMaster Product version CM02.17.
>
> When new firmware versions are released, some commands may be modified, added, or removed. Read the README file included with the firmware. When an addition or correction to this manual is needed, a new PDF version of the manual will be posted to our website. Please check TRDI's web site often at https://www.teledynemarine.com/support/RDI/technical-manuals.

Data Communication and Command Format

You can enter commands with an IBM-compatible computer running TRDI's *ChannelMaster Utilities*. The ChannelMaster communicates with the computer through an RS-422 serial interface. We initially set the ChannelMaster at the factory to communicate at 9600 baud, no parity, and one stop bit.

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

```
>
Horizontal ADCP
RD Instruments (c) 2019
All rights reserved.
Product Version: CM02.15

>
```

Command Input Processing

Input commands set ChannelMaster 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,

```
>WP0001<CR> [Your input]
```

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

```
>WP00001<CR>     [Your original input]
>                [ChannelMaster response to a valid, no-output command]
```

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

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

After correctly entering all the commands for your application, you would send the CS-command to begin the data collection cycle.

Data Output Processing

After the ChannelMaster completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected and averaged during the ensemble interval (see TE – Time Per Ensemble). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, status, surface track fields, and firmware version data.

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

> *ChannelMaster Utilities* supports PD0, PD14, and PD19 Output Data Formats (see **PD – Data Stream Select**).

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

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

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

Miscellaneous Commands

? – Help Menus

Purpose   Lists the major help groups.

Format   *x*? (see description)

Description   Entering **?** by itself displays all command groups. To display help for one command group, enter **x?**, where *x* is the command group you wish to view. When the ChannelMaster 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.

```
?
Available Commands:

C --------------------- Control Commands
D --------------------- Diagnostic Ping Commands
E --------------------- Environment Commands
I --------------------- Index Commands
M --------------------- Loop Recorder Commands
P --------------------- Performance Test Commands
S --------------------- Sensor Commands
T --------------------- Time Commands
V --------------------- Vertical Beam Commands
Y --------------------- Display Banner
W --------------------- Water Profiling Commands
? --------------------- Display Main Menu
>
>c?
Available Commands:

CB 811 ------------------ Serial Port Control {baud;parity;stop}
CF 11110 ---------------- Set Ctrl Flags {e;p;b;s;*}
CJ 0,0,0 ---------------- SDI-12 Configuration {En/Dis,Addr,E/M }
CK --------------------- Save Command Parameters to Flash
CL 1 -------------------- Sleep Enable ( 1=Enabled, 0=Disabled )
CR --------------------- Restore Cmd defaults [0=user,1=factory]
CS --------------------- Start Pinging
CT 0 -------------------- Turnkey (0 = OFF, 1 = ON)
CZ --------------------- Put the ADCP to sleep.
C? --------------------- Display C-Command Menu>
>
>CB?
CB 811 ------------------ Serial Port Control {baud;parity;stop}
>
```

Break

Purpose   Interrupts the ChannelMaster without erasing present settings.

Format   <BREAK>

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

Software Breaks can be used with *BBTalk* or *TRDI Toolz*. On the **Tools** menu, click **Options** and select the **Use Software Break** box. The ChannelMaster will use the "= = =" or "+++" strings instead of a break.

Y – Display Banner

Purpose   Displays the banner.

Format   Y

Description   Use the Y command to display the ChannelMaster banner.

```
>Y
Horizontal ADCP
Teledyne RD Instruments (c) 2019
All rights reserved.
Product Version: CM02.15
```

Control System Commands

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

```
>C?
Available Commands:

CB 811 ------------------ Serial Port Control {baud;parity;stop}
CF 11110 ---------------- Set Ctrl Flags {e;p;b;s;*}
CJ 0,0,0 ---------------- SDI-12 Configuration {En/Dis,Addr,E/M }
CK ---------------------- Save Command Parameters to Flash
CL 1 -------------------- Sleep Enable ( 1=Enabled, 0=Disabled )
CR ---------------------- Restore Cmd defaults [0=user,1=factory]
CS ---------------------- Start Pinging
CT 0 -------------------- Turnkey (0 = OFF, 1 = ON)
CZ ---------------------- Put the ADCP to sleep.
C? ---------------------- Display C-Command Menu
>
```

Control System Command Descriptions

This section lists the Control System commands.

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	CB 411

> ! Recommended Setting. The ChannelMaster defaults to CB411 (9600 baud) if this parameter has never been saved to non-volatile memory. Otherwise, it uses the value last saved (i.e. the last time a CK command was issued).

Description   The ChannelMaster can be set to communicate at baud rates from 300 to 115200 (see Changing the Baud Rate in the ChannelMaster). The ChannelMaster and your external device (computer software) MUST use the same communication parameters to *talk* to each other. After you enter valid CB parameters, the ChannelMaster responds with a ">" prompt. You may now change the external device's communication parameters to match the ChannelMaster parameters before sending another command.

Table 4:   Serial Port Control

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

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

CF – Flow Control

Purpose	Sets various ChannelMaster data flow-control parameters.
Format	CF *nnnnn*
Range	Firmware switches (see description)
Default	CF 11110

> (!) Recommended Setting. Set by ChannelMaster Utilities

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

Table 5:   Flow Control

Command	Description
CF 1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF 0xxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the ">" prompt and waits for a new command.
CF x1xxx	Automatic Ping Cycling – Pings immediately when ready.
CF x0xxx	Manual Ping Cycling – Sends a < character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the H-ADCP is not echoed. This feature manually controls ping timing within the ensemble. Note the prompt output by the H-ADCP when ready to ping is a less-than symbol (<), to distinguish it from the normal command prompt.
CF xx1xx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled (see below).
CF xx0xx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled (see below).
CF xxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/485/422 serial interface.
CF xxx0x	Disable Serial Output – No ensemble data are sent out the RS-232/485/422 interface.
CF xxxx1	Enable Loop Recorder – Records data ensembles on the Loop Recorder.
CF xxxx0	Disable Loop Recorder – No data ensembles are recorded on the Loop Recorder.
Example	CF 01010 selects manual ensemble cycling, automatic ping cycling, Hex-ASCII data output, enables serial output, and disables data recording.

CJ – SDI-12 Configuration

Purpose   This command is used to enable SDI-12 communications.

Format   CJ *x,y,z*

                x – Enable/Disable (0 = Disable, 1 = Enable)

                y – Address (The address can be any alphanumeric character)

                z – English/Metric Units for output (0 = Metric, 1 = English)

Default   CJ 0,0,0

![!] Recommended Setting. Use as needed. Set using *ChannelMaster Utilities*.

Description   This command is used to enable SDI-12 communications for data logging purposes only. It allows for configuration of the SDI-12 Address and the units of the stage, velocity, and other non-discharge data returned from the unit (English or Metric). The address, as specified by the SDI-12 Specification v1.3, can be any alphanumeric character. The data output can be in English or Metric Units. English units are °F, ft, and ft/s. Metric Units are °C, m, and m/s.

Example

```
>CJ?
CJ 0,0,0 ------------- SDI-12 Configuration {En/Dis,Addr,E/M }
>CJ1,0,1
>CJ?
CJ 1,0,1 ------------- SDI-12 Configuration {En/Dis,Addr,E/M }
```

The IU command controls the units for discharge data when reported through the serial port (for example, if PD19 or 23 is enabled), and for SDI-12 output.

The CJ command sets the units for all other data when reported by SDI-12 (M9/C0 command).
IU 1,1,1,1,1 sets the same units as CJ 1,0,0
IU 2,2,2,2,2 sets the same units as CJ 1,0,1

Channel Master Utilities will automatically send the appropriate IU command when SDI-12 operation is enabled.

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 ChannelMaster maintains data stored in the non-volatile memory (user settings) even if power is lost. It does not need a battery. You can recall parameters stored in non-volatile memory with the CR0-command.

CL – Battery Saver Mode

Purpose   Determines whether the ChannelMaster will attempt to conserve power.

Format   CL n

Range n = 0 to 1 (0 = do not conserve power, 1 = conserve power)

Default   CL 1

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

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

> In order for software breaks to work, the CL-command must be set to CL0.

CR – Retrieve Parameters

Purpose   Resets the ChannelMaster command set to factory or user settings.

Format   CR n

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

> Recommended Setting. **Use as needed.**

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

Table 6:   **Retrieve Parameters**

Format	Description
CR 0	Loads into RAM the command set last stored in non-volatile memory (user settings) using the CK-Command.
CR 1	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 ChannelMaster maintains communications with the terminal/computer.

CS – Start Pinging (Go)

Purpose	Starts the data collection cycle (same as the **Tab** key in *ChannelMaster Utilities*).
Format	CS

> ⚠ **Recommended Setting.** Use as needed. Use *ChannelMaster Utilities* 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 *ChannelMaster Utilities*) to tell the ChannelMaster to start pinging its transducers and collecting data as programmed by the other commands.

> After a CS-command is sent to the ChannelMaster, no changes to the commands can occur until a <BREAK> is sent (auto ensemble cycling or at the > prompt if using manual ensemble cycling).
>
> If you are using SDI-12 communications, the <BREAK> must be sent to the RS-232 port.

CT – Turnkey Operation

Purpose	Allows the ChannelMaster to initialize to predefined parameters and start pinging immediately after power is applied.
Format	CT *n*
Range	*n* = 0 to 1 (0 = Off, 1 = Turnkey)
Default	CT 0
Description	Setting the CT command to CT 1 lets the ChannelMaster automatically initialize to a predefined command set during any power up. To place the ChannelMaster in turnkey mode, you must first set all other commands to the desired configuration. You must then send the CT 1 and CK commands to save this configuration. When power is cycled, the ChannelMaster will start up with the desired configuration and begin the data collection process.

You can interrupt (not remove) this mode by sending a <BREAK>. This will place the ChannelMaster in the command mode, ready to accept input for another 10 seconds. If no valid command is received within 10 seconds, the ChannelMaster will restart the data collection process. Cycling the power will also restart the data collection process.

To turn off the turnkey mode, first send a <BREAK> to the ChannelMaster. Now send the CT 0 and CK commands to save this configuration. When power is cycled, the ChannelMaster will NOT begin the data collection process.

CZ – Power Down ChannelMaster

Purpose	Tells the ChannelMaster to power down.
Format	CZ

> ⚠ Recommended Setting. **Use as needed.**

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

> 1. When powered down using the CZ-command, the ChannelMaster still draws up to 30μa, but wakes up periodically (every 8 to 12 hours) for a few seconds to maintain RAM.
>
> 2. This command should be used whenever batteries have been installed and you do not send commands to start a deployment. If you do not use the CZ-command, the ChannelMaster will

> draw up to 80 milli-amps of current. *A new battery can be discharged in a few days, depending on capacity*.

Expert Control System Command Descriptions

#CL - Binary Configuration

Purpose   Sets a binary configuration block for setting multiple commands.

Format   #cl <CR> <LF> <binary data block> <CR> <LF>

> **Recommended Setting.** For TRDI use only.

Range   See below

Default   N/A

Description   This command accepts a binary configuration block that contains data to set the following commands:

EA, EB, EX, EZ, TP, WA, WB, WC, WF, WM, WN, WP, and WS.

The <binary data block> is defined by the following table:

Bytes	Parameter	Command	Comments
1-2	Coordinate Transform	EX	
3-4	Available Sensors	EZ	
5	Time between Pings (hrs)	TP	
6	Time between Pings (min)	TP	
7	Time between Pings (sec)	TP	
8-9	False Target Threshold	WA	
10-11	Bandwidth	WB	
12-13	Correlation Threshold	WC	
14-15	Blank Distance	WF	
16-17	Number of Bins	WN	
18-19	Pings per Ensemble	WP	
20-21	Bin Size	WS	
22-23	Ambiguity Velocity	WV	
24-25	checksum	n/a	Sum of bytes #1 through #23, plus 1

Here is an example BBTalk script that shows how to use this command:

```
; BBTalk script file to send a binary configuration command (#CL) to a
; ChannelMaster.
;
; Each field should be in Little-Endian byte order
;
; EX   EZ    TP       WA  WB   WC    WF   WN  WP    WS   WV
; 0    0   00:05:00   255  0   192   80   33  16    150  220   cs
```

```
;0200 0000 00050000 ff00 0000 c000 5000 2100 1000 9600 dc00 b803
#CL
$S0200000000050000ff000000c0005000210010009600dc00ba03

$W">"
$PDone.
```

Diagnostic Ping Commands

The ChannelMaster uses the following commands to run the beam diagnostics.

```
>d?
Available Commands:

DA    1 ---------------- Diag Period (#ens)
DE    1 ---------------- Diag Pings per Ensemble
DJ    1    1 ----------- Diag Rcvr Gain:            <Jan> [<vb>]
DN  1024 1024 ----------- Number of Bins [1-1024]:   <Jan> [<vb>]
DP    0 ---------------- Number of Pings to Avg
DS    0    0 ----------- Bin Size (cm):              <Jan> [<vb>]
DT    0   50 ----------- Transmit Length (cm):       <Jan> [<vb>]
DV    0 ---------------- Enable VBeam [0=off, 1=on]
D? --------------------- Display W-Command Menu
```

Diagnostic Ping Commands Descriptions

DA – Set Diagnostic Measurement Period

Purpose   Sets the diagnostic measurement period.

Format   DA <n>

> **!**   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <n> is number of ensembles

Default   DA 1

Description   Diagnostic pings will be accumulated until the set number has been collected, then the average will be output in the ensemble in which the last ping occurs. The diagnostic pings will start again with the next measurement period, after <n> ensembles have elapsed since the start of the previous measurements period. For example, if <n> is set to 10, then a new measurement period will start every 10th ensemble. Diagnostic pings will occur during that period until the set number have been collected, and the average will be output. No more diagnostic pings will occur until the start of the next measurement period (i.e. the next 10th ensemble).

DE – Maximum Number of Diagnostic Pings per Ensemble

Purpose   Sets the maximum number of diagnostic pings per ensemble.

Format   DE <n>

> **!**   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <n> = 1 to 999

Default   DE 1

Description   Diagnostic pings will be accumulated over each measurement period but may be spread
                   out over several ensembles to keep from impacting the normal profiling schedule. Set
                   <n> to the maximum number of diagnostic pings to execute per ensemble.

DJ – Set Receive Gain

Purpose   Sets the receiver gain to use for each diagnostic ping.

Format   DJ <jan> [<vb>]

> (!)   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <jan> is 0 for low gain, or 1 for high gain, for the Janus beams

                   <vb> is 0 for low gain, or 1 for high gain, for the vertical beam

                   The [ ] indicate that the second parameter is optional.

Default   DJ 1 1

Description   Sets the receiver gain to use for each diagnostic ping.

DN – Set the Number of RSSI Bins to Collect

Purpose   Sets the number of Received Signal Strength Indicator (RSSI) bins to collect during the
                   diagnostic ping.

Format   DN <jan> [<vb>]

> (!)   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <jan> is the number of RSSI bins to collect for the Janus beams, in [1..1024]

                   <vb> is the number of RSSI bins to collect for the vertical beam, in [1..1024]

                   The [ ] indicate that the second parameter is optional.

Default   DN 1024 1024

Description   Sets the number of RSSI bins to collect during the diagnostic ping.

DP – Set the Number of Diagnostic Pings to Average

Purpose   Sets the number of diagnostic pings to average for each output.

Format   DP <n>

> (!)   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <n> = 1 to 9999 (0 = Off)

Default   DP 0

Description   Diagnostic pings will be accumulated over each measurement period but may be spread
                   out over several ensembles to keep from impacting the normal profiling schedule. Set
                   <n> to the total number of diagnostic pings to average for each output. These pings may
                   be spread out across a number of ensembles according to the DE command setting. If it
                   takes three ensembles to do all the diagnostic pings for one average, for example, then the
                   third ensemble output after the start of a measurement interval will contain the averaged
                   diagnostic ping data. Setting this command to zero disables the diagnostic pings.

DS – Set the RSSI Bin Size for the Diagnostic Ping

Purpose   Sets the Receiver Signal Strength Indicator (RSSI) bin size.

Format   DS <jan> [<vb>]

> ⓘ   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <jan> is the RSSI bin size, in cm, for the Janus beams

                 <vb> is the RSSI bin size, in cm, for the vertical beam

                 The [ ] indicate that the second parameter is optional.

Default   DS 0 0

Description   Sets the RSSI bin size (i.e. the spacing between samples) for the diagnostic ping. By default, this parameter is set to zero, which divides the maximum range of the ChannelMaster (according to system frequency) 1024 RSSI bins, which automatically sets the bin spacing.

DT – Set the Transmit Length for the Diagnostic Ping

Purpose   Sets the Receiver Signal Strength Indicator (RSSI) bin size.

Format   DT <jan> [<vb>]

> ⓘ   **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range   <jan> is the transmit length, in cm, for the Janus beams

                 <vb> is the transmit length, in cm, for the vertical beam

                 The [ ] indicate that the second parameter is optional.

Default   DT 0 50

Description   Sets the RSSI bin size (i.e. the spacing between samples) for the diagnostic ping. By default, this parameter is set to zero for the Janus beams, which uses the bin size setting for the profile ping (WS command) to set the transmit length. The transmit length for the vertical beam defaults to 50 cm.

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DV – Enable Vertical Beam

Purpose	Disables or enables Receiver Signal Strength Indicator (RSSI) collection for the vertical beam in the diagnostic ping.
Format	DV <n>

> ❗ **Recommended Setting.** Use *ChannelMaster Utilities* to run the beam diagnostics.

Range	<n> = 0 (disable the vertical beam), or <n> = 1 (enable the vertical beam).
Default	DV 0
Description	Set this command to 1 to enable RSSI collection for the vertical beam in the diagnostic ping. Otherwise, if this is set to zero, then the diagnostic RSSI data will only be collected for the Janus beams. The default for this command is zero (i.e. vertical beam disabled).
Example #1:	The following configuration sets the ChannelMaster to average five diagnostic pings, including the vertical beam, with up to two diagnostic pings per ensemble (i.e. the five pings are spread out over three ensembles), and with a measurement period of ten ensembles:

```
DA 10
DP 5
DE 2
DT 0
DV 1
```

During the first ensemble period, two diagnostic pings are executed and accumulated. The first ensemble output does not contain diagnostic ping data.

During the second ensemble period, once again, two diagnostic pings are executed, and tossed into the same accumulators. The second ensemble output does not contain diagnostic ping data.

During the third ensemble period, one diagnostic ping is executed and thrown into the same accumulators. The third ensemble output contains the average of the five diagnostic pings.

Ensembles #4 through #10 do not do any diagnostic pings, nor do they output any diagnostic ping data.

Ensemble #11 starts the cycle over again.

Example #2:	The following configuration sets the ChannelMaster to execute and output one diagnostic ping per ensemble, with no averaging, and does not include the vertical beam. The diagnostic ping uses the profile bin size (WS command) for the transmit length.

```
DA 1
DP 1
DE 1
DT 0
DV 0
```

Environmental Commands

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

```
>E?
Available Commands:

EC 1500 ----------------- Speed Of Sound (m/s)
ED 00000 ---------------- Xdcr Depth (deci-meters)
ES 00 ------------------- Salinity (ppt)
ET 2100 ----------------- Water Temperature (.01 deg C)
EX 01010 ---------------- Coordinate Transformations
EZ 1101101 -------------- Sensor Source {c;d;h;p;r;s;t}
E? ---------------------- Display E-Command Menu
```

Environmental Command Descriptions

This section lists the Environmental commands.

EC – Speed of Sound

Purpose	Sets the speed of sound value used for ChannelMaster data processing.
Format	EC *nnnn*
Range	*nnnn* = 1400 to 1600 meters per second
Default	EC 1500

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

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

> If the EZ Speed of Sound field = 1, the ChannelMaster 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 ChannelMaster transducer depth.
Format	ED *nnnnn*
Range	*nnnnn* = 0 to 65535 decimeters (meters x 10)
Default	ED 00000

> (!) Recommended Setting. Use the EZ-command (set by *ChannelMaster Utilities*).

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

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

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ES – Salinity

Purpose	Sets the water's salinity value.
Format	ES *nn*
Range	*nn* = 0 to 50
Default	ES 00

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

Description   ES sets the water's salinity value. The ChannelMaster uses ES in its speed of sound calculations. The ChannelMaster 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* = -5.00 C to +40.00 C
Default	ET 2100

> Recommended Setting. Use the EZ-command.

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

EX – Coordinate Transformation

Purpose	Sets the coordinate transformation processing flags.
Format	EX *nnnnn*
Range	*nnnnn* = Firmware switches (see description)
Default	EX 01010

> (!) **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 7:   Coordinate Transformation Processing Flags

Setting	Description
EX 00xxx	Output beam radial velocities
EX 01xxx	Transform velocities to instrument coordinates (X, Y where X is parallel to the transducer face; Y is normal to the transducer face)
EX xx0xx	Reserved, must be zero
EX xxx1x	Reserved, must be one
EX xxxx0	Reserved, must be zero

> Bit 2 is reserved and must be set to one for the ChannelMaster systems to get any velocity solution.
>
> The ChannelMaster will not transform the data with only one good beam.

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EZ – Sensor Source

Purpose   Selects the source of environmental sensor data.
Format   EZ *cdhprst*
Default   EZ 1101101

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

Table 8:   Sensor Source Switch Settings

	Field	Value = 0	Value = 1	Value = 2	Value = 3
c	Speed of Sound	Manual EC	Calculate using ED, ES, and ET	N/A	N/A
d	Depth	Manual ED	Depth Sensor	N/A	N/A
h	Heading	N/A	N/A	N/A	N/A
p	Pitch (Tilt 1)	Force 0	Internal Transducer Sensor	N/A	N/A
r	Roll (Tilt 2)	Force 0	Internal Transducer Sensor	N/A	N/A
s	Salinity	Manual ES	N/A	N/A	N/A
t	Temperature	Manual ET	Internal Transducer Sensor	N/A	N/A

Example   EZ 1101101 means calculate speed of sound from readings, use pressure sensor, internal tilt sensors, and the transducer temperature sensor.

> 📌 If the bits for Pitch (Tilt 1) or Roll (Tilt 2) sensor are set to zero, then a pitch or roll value of zero will be output.

Index Velocity and Discharge Commands

The Index Velocity and Discharge Commands allow the user to input data and scale outputs to obtain average velocity, stage, cross-sectional area, discharge, and integrated volume directly from the Channel-Master either via serial RS-232/RS-422 or via SDI-12.

Rather than describe the commands in alphabetic order, it will be clearer to describe them by functional grouping and logical order of their application. The commands can be grouped into three distinct groups:

- See Channel Description Commands (IA, IC, ID, IE, IP, and IW)
- See Computation Commands (IB, IS, and IV)
- See Output Commands (IF, IO, IT, IU, and IZ)

Command Summary

If you send 'I?' to the ChannelMaster you will receive back:

```
>I?
Available Commands:

IA  1.000, 1.000, 1.000 - Area Rating Constants (-10000000 to 10000000)
IB 1 -------------------- Bank 0=left,1=right
IC 1 -------------------- Channel 0=cir,1=tra,2=rec,3=arb,4=rated
ID  1.000 -------------- Diameter (0.5 to 100m)
IE    0.000,   0.000 ---- Xdcr Elev.(-200 to 5000m), Bot Elev. (-100 to 5000m)
IF  10 ------------------ Flag Counter (1 to 100)
IO 0 -------------------- Q Calc. 0=off, 1=on
IP ---------------------- XY pairs IP0=help
IS ---------------------- Select Velocity Bins IS0=help
IT   0,  0 -------------- Output Exponent Dis,Vol (0 to 6)
IU   1,  1,  1,  1,  1 -- Output Units Vel,Dis,Vol,Area,Stage 0=help
IV  1.000, 1.000,  1.000  V. Equation Const. (-5to5,-5to5,-10to10)
IW  1.000,  1.000 ------ BotWidth (0 to 500 m), SideSlope (run/rise)
IZ  +0, -329.95 ------ ------- ZeRo Volume Accumulator
I? ---------------------- Display I-Command Menu
```

Channel Description Commands

To compute cross-sectional area from stage, the shape of the channel needs to be described. The IA, IC, ID, IE, IP, and IW commands are used for this purpose. ChannelMaster Utilities does not currently set any channel description commands other than the Transducer Elevation (IE) command.

IA – Area Rating Constants

Purpose	Used to compute area of a rated channel using a rating equation.
Format	IA *a.aaa*, *b.bbb*, *c.ccc*
Range	-10000000 to 10000000
Default	IA 1.000, 1.000, 1.000

> Recommended Setting. Set using *ChannelMaster Utilities*.

Description   These three parameters are used to compute area using a rating equation for cross-sectional area of a rated channel where

Area = a.aaa + b.bbb * H + c.ccc * H²

H is the stage in meters

H = range to surface + H-ADCP mounting elevation

Range to surface is the range measured by the vertical acoustic beam and mounting elevation is from the first parameter of the IE command.

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IC – Channel Type

Purpose	Sets the shape of the channel.
Format	IC *n*
Range	*n* = 0 (circular), 1 (trapezoidal), 2 (rectangular), 3 (arbitrary), 4 (rated)
Default	IC 3

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description	The IC command is used to select the overall shape of the channel.

ID – Diameter

Purpose	Sets the diameter of a circular channel.
Format	ID *n.nnn*
Range	*n.nnn* = 0.5 to 100 meters
Default	ID 1.000

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description	The ID commands sets the diameter of a circular channel in meters. Diameters from 0.5 to 100 meters are allowed.

IE – Transducer Elevation

Purpose	Sets the mounting elevation of the ChannelMaster.
Format	IE *m.mmm*, *n.nnn*
Range	*m.mmm* = -200 to 5000 meters, *n.nnn* = -100 to 5000 meters
Default	IE 1.000, 0.000

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description	the first value is the mounting elevation of the ChannelMaster. The second value is the elevation of the bottom of the channel (for circular, trapezoidal and rectangular channels). Both values are in meters. The range of allowed values for the first parameter is -200 to 5000 meters and the allowed range for the second parameter is -100 to 5000 meters.

IP – XY pairs

Purpose	Used to provide the geometric details of the channel shape for an arbitrary channel.
Format	IP *n*, *x.xxx*, *y.yyy*
Range	*n* = 1 to 99, *x.xxx*, *y.yyy* = -9999 to 9998 meters, (IP0 = help)
Default	N/A

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description	The initial position command is a list of up to 99 x, y pairs describing the cross-section of the channel. The first value '*n*' is the number of the coordinate pair in order from one side to the other. The next two values are the horizontal distance across the channel and then the elevation of the bottom at that distance, both in meters. To end the list enter 9999,

9999 for x and y. Entries below this are disregarded. Each n, x, y triplet must be entered on a separate line. For example, a channel with six x, y pairs would be entered as:

```
IP 1, 0.0, 8
IP 2, 2, 3
IP 3, 6, 0.0
IP 4, 11, 0.0
IP 5, 15, 3
IP 6, 17, 8
IP 7, 9999, 9999
```
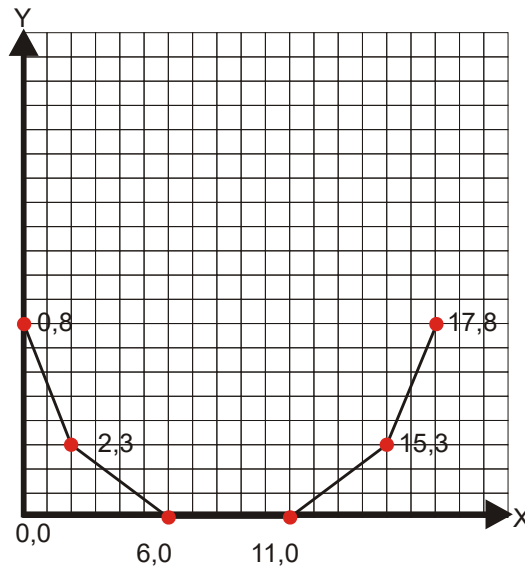

Figure 19.   Channel X – Y Pairs

IW – Bottom Width and Side Slope

Purpose	Used to provide the geometric details of the channel shape for a trapezoidal channel.
Format	IW *m.mmm*, *n.nnn*
Range	*m.mmm* = Bottom Width (0 to 500 m), *n.nnn* = Side Slope (run/rise)
Default	IW 5.000, 1.000

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   the first value is the width of the bottom of the channel in meters. The second value is the slope of the sides as run/rise. The first value is used for trapezoidal and rectangular channels. The second value applies only for trapezoidal channels.

Computation Commands

Computation commands IB, IS, and IV are used for the index velocity model to calculate discharge. ChannelMaster Utilities currently does not set the Velocity Equation (IV) command.

IB – Bank

Purpose	Used to indicate whether the ChannelMaster is mounted on the left bank or right bank.
Format	IB *n*
Range	*n* = 0 (left), 1 (right)
Default	IB 1

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   the IB command is used to indicate whether the ChannelMaster is mounted on the left bank or right bank of the channel. This is necessary since the ChannelMaster outputs negative velocity for downstream flow if the ChannelMaster is mounted on the left bank.

> 📖 See Orientation and Tilt for more information.

IS – Select Velocity Bins

Purpose	Used to select the cells whose velocities are averaged as the Index-Velocity.
Format	IS *n*, *B* (IS0 = help)
Range	*n* = 1 to 99 *B* = desired Bin number (1 to 255) last entry B = 9999
Default	IS 1,9999

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The IS command is used to select the cells whose velocities are to be averaged as the Index-Velocity. It is possible to select a range of cells or a list of individual cells.

To select a continuous range of cells, use the command IS 100, B1, B2. Here, 100 indicates that a range of cells from B1 to B2 are to be used. Therefore, the command IS 100, 1, 20 selects all cells from 1-20 to be averaged together.

To select a list of cells, the list is input using IS n, B where 'n' is the position in the list and B is the cell number. Input the list one cell at a time. The last cell is designated by entering 9999 for the bin number. For example, entering the following will select cells 1, 3, 5, and 7 to be averaged.

```
IS 1, 1
IS 2, 3
IS 3, 5
IS 4, 7
IS 5, 9999
```

IV – Velocity Equation Constant

Purpose   Sets the constants for the index velocity rating.

Format   IV *C1, C2, C3*

Range   *C1* = -5 to 5, *C2* = -5 to 5, *C3* = -10 to 10

Default   IV 0.000, 1.000, 0.000

> $\bigcirc\!\!\!\!!$ Recommended Setting. **Set using *ChannelMaster Utilities*.**

Description   The IV command is used to enter the constants for the index velocity rating using the equation:

$$V_{avg} = C1 + (C2 + C3 * H) * V_{index}$$

Where H is the stage in meters and V_{index} is the arithmetic mean of the individual cell velocities for the cells selected using the IS command. V_{index} and V_{avg} are in m/s. That is, the Index Rating must be developed with H in meters and velocities in m/s units.

Output Commands

The following commands set parameters used to control the output of the computed flow, area, etc.

IF – Flag Counter

Purpose   Sets how long to use the last good velocity and vertical range data for discharge calculation when invalid data is measured.

Format   IF*n*

Range   *n* = 1 to 100

Default   IF10

> $\bigcirc\!\!\!\!!$ Recommended Setting. The default setting for this command is recommended for most applications.

Description   The ChannelMaster calculates cumulative volume by calculating a volume for each ensemble and adding it to the total. If a momentary problem causes a few ensembles to have invalid data, the volume is calculated from the last good data. The IF command sets the number of ensembles to hold the last good data. If the problem persists longer than this, the cumulative volume and other discharge values are not calculated or updated until more valid data is measured.

IO – Q Calculation

Purpose   The IO commands enables and disables flow computation.

Format   IO *n*

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

Default   IO 1

> $\bigcirc\!\!\!\!!$ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The IO commands enables/disables computation and output of flow, area, volume, and stage. The IO command must also be enabled in order to compute index velocity and any other output parameters that depend on the index velocity bin range, such as SNR.

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IU – Output Units

Purpose	Selects the output units to be used for discharge data.
Format	IU Velocity, Discharge, Volume, Area, Stage
Range	See description
Default	IU 1, 1, 1, 1, 1

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The IU command selects the units to be used for the output of velocity, discharge, volume, area, and stage via RS-232/422 ASCII output (PD19/PD23), as well as SDI-12 output of discharge data. Discharge data recorded internally in PD0 format will always be in metric units (IU 1, 1, 1, 1, 1). The various possible selections are:

Velocity Units:
1 = Meters per second
2 = Feet per second
3 = Centimeters per second

Discharge Units:
1 = Cubic meters per second
2 = Cubic feet per second (cfs)
3 = Liters per second
4 = Gallons per minute
5 = Million gallons per day (mgd)
6 = Million liters per day

Volume Units:
1 = Cubic meters
2 = Cubic ft
3 = Gallons
4 = Acre-ft
5 = Liters
6 = Thousand gallons
7 = Million gallons

Area Units:
1 = Square meters
2 = Square ft

Stage Units:
1 = meters
2 = ft

> 📌 The IT command can modify some of the volume units.

IT – Output Exponent

Purpose	The IT command allows a scaling factor to be applied to the output of discharge and volume, respectively.
Format	IT *n1,n2*
Range	*n1,n2* = 0 to 6
Default	IT 0,0

> (!)   Recommended Setting. Set using *ChannelMaster Utilities*.

Description   Volume and discharge can be inconveniently large numbers. For example, the SDI-12 protocol does not permit more than seven digits in a single number. The scale factors shifts the decimal point up to six places to the left. This effectively provides more units than the IU command alone does. For example, suppose the volume is 12345678.9 cubic feet. If the IT command is set to 3, this would become 12345.67 kilo cubic feet.

The IT command depends on the IU command (see IU - Output Units). The IT command only changes the volume if IU has set the volume unit to:

1 = Cubic meters
2 = Cubic ft
3 = Gallons

The discharge exponent is applied for all discharge units.

> To be able to correctly interpret output at a later time, you should make careful records of the units and scale factors that you selected above.

IZ – Zero Volume Accumulator

Purpose	Resets or displays the cumulative volume.
Format	IZ ZeRo (Reset to zero) IZ ? (Display cumulative volume)
Range	N/A
Default	N/A

> (!)   Recommended Setting. Not implemented.

Description   IZ ZeRo resets the cumulative volume to zero. This command is case sensitive and must be entered exactly as shown. Use "IZ ?" to display the cumulative volume in cubic meters.

Some instruments cannot handle values larger than one million. For this reason, the cumulative volume is split into two numbers. The first number is the millions part of the volume. The second part is the rest of the volume.

For example, a volume of 12,345,678.90 cubic meters would be reported as the following:

```
iz 12, 345678.90 ------ -----. zeRo Volume Accumulator
```

Loop Recorder Commands

The loop recorder contains approximately four megabytes of solid-state nonvolatile memory, which can be used to continuously record data. If more data is collected than fits in the memory, the oldest data will be overwritten with the newest data. You always have up to the last four megabytes of data available for download.

```
>m?
Available Commands:

ME --------------------- ErAsE recorder
MM --------------------- Show memory usage
MN XYZ - Set file name [1..32 characters]
MR 0 ------------------- Set recorder on/off [0=off,1=on]
MY --------------------- Y-Modem output
MS --------------------- Show recorder size
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.
	While erasing the loop-recorder, the ChannelMaster will output a "." for every successfully block erased. If the ChannelMaster can not erase one block an "x" will be outputted.

```
>me ErAsE  ............... Recorder erased.
>
```

> ⚠️ 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 CM_

!	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 "CH_" is used. The deployment name is used as part of the file name for data files when downloaded to the computer using *ChannelMaster Utilities*.

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

For example, the file *CH_3281997475.000* would contain data for the deployment named "CH_" (the *3281997475* in the filename is the number of seconds since January 1st, 1900). The file extension is always ".000". If you wait 25 seconds and download the same data again, the file name will change to *CH_3281997500.000*.

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   MR 0

!	Recommended Setting. Use as needed. Automatically turned on by ChannelMaster Utilities

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
```

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MY – Y-Modem output

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

> (!) Recommended Setting. Use ChannelMaster Utilities, *TRDI Toolz*, or *BBTalk* to recover data.

Description   Use the MY command to recover data from the recorder only when *ChannelMaster Utilities* 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 as DOS files.

Performance and Testing Commands

The ChannelMaster uses the following commands for calibration and testing.

```
P?
Available Commands:

PA ---------------------- Run Go/No-Go Tests
PC ---------------------- Built In Tests [0=help]
PD  0 ------------------- Data Stream Select
PS ---------------------- System Info [0=config,1=fldr,2=vldr,4=pings]
PT ---------------------- Built In Tests, PT 0 = Help
P? --------------------- Display P-Command Menu
```

Performance and Testing Command Descriptions

This section lists the Performance and Testing commands.

PA – Pre-deployment Tests

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

Format   PA

> ! Recommended Setting. Use as needed.

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

- CPU - CPU RAM and real-time clock.
- DSP - RAM, registers, and DSP-to-CPU Communications.

Example
```
>PA
RAM test...........PASS
GO
>
```

PC – User-Interactive Built-In Tests

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

Format   PC*nnn*

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

> ! Recommended Setting. Use as needed.

Description   These diagnostic tests check beam continuity and sensor data.

Examples   See below.

PC0 – Help Menu

Sending **PC0** displays the help menu.
```
>PC0
PC0         = Help
PC2         = Display Sensor Data
PC4         = Surface Track Ping – Advanced
>
```

PC2 – Display Sensor Data

PC2 makes measurements once a second. Lines of data end with a carriage return so *ChannelMaster Utilities* prints successive lines on top of each other. PC20 is just like PC2 except that lines end with a carriage return and a line feed. *ChannelMaster Utilities* scrolls with this command.

```
>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.

Temp(degC)  Press(kPa)  Press(m) Pitch(deg) Roll(deg)   Batt(V)
\     18.21      4.202     0.429      5.66     -0.42      9.281
/     18.21      4.206     0.429      5.66     -0.42      9.289
\     18.21      4.187     0.427      5.66     -0.42      9.281
/     18.21      4.193     0.428      5.67     -0.43      9.281
```

Use the ST command to change the units for the temperature.

```
>ST?
ST C ------------------- Set temperature units (0=c; 1=f; 2=k)
>ST1
>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.

Temp(degF)  Press(kPa)  Press(m) Pitch(deg) Roll(deg)   Batt(V)
\     64.78      4.189     0.427      5.66     -0.43      9.281
/     64.78      4.179     0.426      5.67     -0.43      9.281
\     64.78      4.197     0.428      5.66     -0.43      9.281
/     64.78      4.192     0.428      5.66     -0.42      9.281

>ST2
>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.

Temp(degK)  Press(kPa)  Press(m) Pitch(deg) Roll(deg)   Batt(V)
\    291.36      4.204     0.429      5.66     -0.42      9.289
/    291.36      4.199     0.428      5.67     -0.43      9.281
\    291.36      4.194     0.428      5.66     -0.42      9.281
/    291.36      4.192     0.428      5.66     -0.42      9.281
```

PC4 – Surface Track Ping

PC4 displays the corrected/uncorrected range. Normally the corrected/uncorrected ranges are the same. In some cases, the range may be corrected for a frequency offset in an internal oscillator.

```
>PC4
Uncorrected/Corrected Range =   2330    2330
>
```

PD – Data Stream Select

Purpose: Selects the type of ensemble output data structure.

Format: PD*n*

Range   *n* = 0, 14, 19, 23 (see description)

Default   PD0

> ! **Recommended Setting**. The default setting for this command is recommended for most applications. PD14, PD19, and PD23 are typically used for integration of the ChannelMaster with other systems or data loggers.

Description: The PD command selects the normal output data structure, a special application data structure, or a fixed data set for transmission/display as the data ensemble (see Chapter 8 – Output Data Format for details on each format).

Table 9:   Data Stream Selections

Format	Description
PD0	Sends The real water-current data set
PD14	Send the ChannelMaster Condensed 2D Output Format
PD19	Sends discharge data in an NMEA-like ASCII format
PD23	Sends discharge data in an NMEA-like ASCII format

> *ChannelMaster Utilities* supports PD0, PD14, and PD19 only.

PS – Display System Parameters

Purpose   Sends/displays ChannelMaster system configuration data.

Format   PS*n*

Range   n = 0, 1, 2, 4 (0=config, 1=fldr, 2=vldr, 4=pings)

> ! **Recommended Setting.** Use as needed.

Description   See below.

PS0 – System Configuration

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

```
>PS0
   Serial Number:  5813
       Frequency:  1228800 Hz
   Configuration:  HADCP: 2-beam velocity + vertical stage.
 Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
         Sensors:  TEMP  PRESS  TILTS

 Product Version:  CM02.12
    CPU Firmware:  28.28f
    FPGA Version:  2.00.003
     Sensor Boot:  32.02
 Sensor Firmware:  33.03
```

```
Board Serial Number Data:
 24 00 00 00 32 23 40 23   SNS72B-1000-00A
 15 00 00 00 31 65 DC 23   PIO72B-2001-00B
 A8 00 00 00 10 66 B6 23   XDR71B-1007-00A
 E3 00 00 00 1F CD 99 23   PER72B-2006-00X
 DC 00 00 00 31 CA 43 23   RCV72B-2003-09A
 90 00 00 00 31 AB 7F 23   DSP72B-2002-00A
>
```

PS1 – Fixed Leader

PS1 sends the Fixed Leader parameters (i.e., fixed system commands and hardware/firmware information) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first. For example, a Hex-ASCII output may look like this:

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

>cf11010
>ck
[Parameters saved as USER defaults]

>ps1
3B00001C1C4C2100350219010064003200014809000E80300003C0A941100006D2D9F006B000101FF
000C00F5F5F5D4F5F5F5F500000000B516000084C5
>ps1
3B00001C1C4C2100350219010064003200014809000E80300003C0A941100006D2D9F006B000101FF
000C00F5F5F5D4F5F5F5F500000000B51600000FC5
>
```

> The output format of the PS1 command is determined by the CF command.

PS2 – Variable Leader

PS2 sends the Variable Leader parameters (i.e., variable system commands and sensor readings) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first. For example, a Hex-ASCII output may look like this:

```
>PS2
3D8000130004031E10320352000000D005000000000505A40D0000BD0833005F00000000000000000000000000000000000000FFFFFFFF0000000000000000000FA14
>
```

> The output format of the PS1 command is determined by the CF command.

PS4 – Ping Sequence

PS4 sends an ASCII representation of the ping sequence generated by the WP, TP, and VP commands. For example:

```
>PS4
Ping Sequence:  WV

>WP?
WP 001 ----------------- Number of Pings
>VP?
VP 001 ----------------- Number of Pings per Ensemble (<100)
>PS4
Ping Sequence:  WV

>WP5
```

```
>VP3
>PS4
Ping Sequence:  W WV WV W WV

>WP3
>VP0
>PS4
Ping Sequence:  W W W
```

PT – Built-In Tests

Purpose   Sends/displays results of ChannelMaster system diagnostic test.
Format   PT*nnn*
Range   *nnn* = PT0, PT103, PT200, PT3 (see below)

> Recommended Setting. Use as needed.

PT0 – Help

Displays the test menu (shown below). Sending PT103 will repeat the PT3 test continually until the ChannelMaster receives a <BREAK>.

```
>PT0
Built In Tests
---------------
PT0 = Help
PT3 = Receive Path
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT3 – Receive Path

This test displays receive path characteristics. This test is for expert users. The test is done once for each combination of high and low gain and high and low bandwidth. Even though there are only three transducers, the ChannelMaster contains electronics to support four beams. Beams 1 and 2 are the horizontal water profiling beams. Beam 4 is the vertical beam. Beam 3 is unused electronics. The test contains four parts.

Part 1 - The ChannelMaster pings without transmitting and displays the result of an autocorrelation function performed on the received ambient sound and internal electrical noise over 15 lag periods. Lag time can be calculated from the sample rate at the bottom line of the output. Lag = 1/sample rate.

The receive path contains a band-pass filter that limits the correlation time of the received signal for beams 1 and 2 to a few lag times. Longer correlation times indicate a problem such as interference from a radio station. Beams 3 and 4 cannot be so easily interpreted because of electrical and frequency differences.

Part 2 - The received signal is split into two parts and hard limited into 1's and 0's. A random signal should have about 50% of each. A duty cycle much different from 50% is an indication of a problem.

Part 3 - Random electrical noise sampled at two different times have some level of correlation. This correlation is called the noise floor. It can be seen at the tail end of the 15 lags.

A higher than usual noise floor may indicate the presence of a signal that self correlates better than random noise or a hardware problem. The noise floor should be higher at high gain and lower at low gain. Too small a difference can indicate a problem in the demodulator, receiver, or Receiver Signal Strength Indicator (RSSI) switching circuitry.

Part 4 - For beams 1 and 2, the bandwidth of the band-pass filter can be calculated by integrating correlation over lag times.

```
>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  83  83  86  85     80  79  79  90     79  81  81  93     78  77  78  93
  2  51  51  55  70     46  41  41  71     43  44  45  79     42  41  41  77
  3  24  26  28  49     18  15  16  49     16  18  19  61     16  16  15  57
  4   9  13  12  33      6   2   3  28      3   3   7  43      6   5   5  38
  5   5   8   6  20      2   0   4  14      2   3   6  30      5   3   6  22
  6   5   6   5  10      4   2   5   4      1   4   6  20      3   3   7  10
  7   5   6   5   6      4   1   3   3      3   3   6  13      1   1   6   3
  8   4   5   4   4      2   3   1   6      4   1   5  10      2   2   3   4
  9   3   3   4   4      1   4   2   6      4   4   1   8      5   2   2   7
 10   2   2   4   3      2   4   3   7      3   5   2   8      7   1   2   8
 11   3   3   4   6      2   5   3   8      0   5   2   9      6   1   2   7
 12   1   5   4   5      4   6   3   8      2   3   3  11      6   3   3   5
 13   0   4   3   4      5   6   3   7      2   1   2  12      6   5   3   3
 14   2   3   3   4      6   8   2   6      2   1   3  12      6   3   5   1
 15   1   3   2   5      5   7   3   5      4   1   4  13      3   3   6   1
Sin Duty Cycle (percent)
     44  49  50  54     51  52  51  54     46  51  52  65     51  52  51  54
Cos Duty Cycle (percent)
     51  48  50  54     51  49  50  51     49  48  53  62     51  52  53  58
RSSI Noise Floor (counts)
     66  50  66  62     57  41  57  52     73  58  74  70     57  41  57  52
BandWidth (kHz)
    369 350 347 293    379 383 394 291     99  97  94  60     94 100  95  70
Sample Rate (Hz)
          1228800            1228800             307200             307200
```

Sensor Commands

The following commands let you set the sensor functions.

```
>S?
Available Commands:

ST C -------------------- Set temperature units (0=c; 1=f; 2=k)
SZ ---------------------- Zero Pressure Sensor
S? ---------------------- Display S-Command Menu
```

Sensor Command Descriptions

This section lists the sensor commands.

ST – Temperature Units

Purpose   Sets the units for the temperature sensor in the PC2 test.

Format   ST *n*

Range   *n* = 0 (Celsius), 1 (Fahrenheit), 2 (Kelvin)

Default   ST 0

> (!) Recommended Setting. Set using *ChannelMaster Utilities*.

Description   Sets the units for the temperature sensor as output by the PC2 command.

> This command does not change the temperature units in the Variable Leader Data.

SZ – Zero Pressure Sensor

Purpose   Zeros the pressure sensor.

Format   SZ

> (!) Recommended Setting. Set using *ChannelMaster Utilities*.

Description   This command zeros the pressure sensor at the specific location where the ChannelMaster will be used.

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Timing Commands

The following commands let you set the timing of various profiling functions.

```
>T?
Available Commands:

TD 00:20:00.00 ---------- SDI-12 Watchdog timer reset
TE 00:00:05.00 ---------- Time Between Ensembles
TF 00/00/00,00:00:00 ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TP 00:00.60 ------------- Time Between Pings
TS 06/01/24,10:45:57.95 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
   06/01/24,10:45:57.95 - Stored Time
T? -------------------- Display T-Command Menu
```

Standard Timing Command Descriptions

This section lists the Timing commands.

TD – Built-In Watchdog Timer

Purpose:	Sets the reset time period (TD) from the user-entered time on the command line. The user must enter the TD time as eight digits, with or without delimiters.
Format:	TD *hh*:*mm*:*ss*.*ff* (acceptable formats include: TD *hhmmssff*, TD*hh*:*mm*:*ss*.*ff*, or TD *hh 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:	TD 00:20:00.00

> ⚠ Recommended Setting. Set TD to a duration longer than the SDI-12 measurement interval. Do not set it close to the actual SDI-12 measurement interval as this could possibly cause unwanted resets just at the time the next measurement request is occurring.

Description:	If the ChannelMaster fails to respond to an SDI-12 measurement request, the TD command will reset the Dual UART circuitry in the ChannelMaster. This will allow the ChannelMaster to continue responding to subsequent measurements although the last missed request will be lost.
	The TD command should be set to an interval that's a few minutes longer than the expected time between SDI-12 measurements. If the SDI-12 measurement interval is 15 minutes, set the TD value to 20 to 25 minutes; do not set the timer to 15 minutes.

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TE – Time Per Ensemble

Purpose   Sets the time interval between data collection cycles (data ensembles).

Format   TE *hh: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   TE 00:00:05.00

> (!) Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The TE command sets the time between the start of one ensemble and the start of the next. If TE is very short, the ChannelMaster will generate the next ensemble as soon as the last ensemble completes. The time needed to complete an ensemble is controlled by the number of pings (WP, VP) and time between pings (TP).

               Min Ensemble time = (WP + VP - 1) x TP + Overhead

               = WP x TP (approximately)

               Overhead is the time needed to process and save the data. It is typically less than a second, especially for high BAUD rates or few cells. The time needed to complete a ping may be longer than the TP command; For example, setting the TP command to TP 00:00.00 will cause the next ping to be transmitted immediately after the last ping completes.

Example   TE 01:15:30.00 tells the ChannelMaster 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, not the time of output.
>
> For SDI-12, the data logger tells the ChannelMaster when to generate an ensemble. TE is ignored.

TF – Time of First Ping

Purpose   Sets the time and date the ChannelMaster 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. Set using *ChannelMaster Utilities*.

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

Example   If you want the <u>exact</u> time of the first ping to be on November 23, 2014 at 1:37:15 pm, you
                 would enter **TF14/11/23, 13:37:15**. If you want the ChannelMaster to begin pinging imme-
                 diately after receiving the CS command (see notes), do <u>not</u> enter a TF command value.

> 1. Although you may send a TF command to the ChannelMaster, you also must send the CS
> command before deploying the ChannelMaster.
>
> 2. If the entry is not valid, the ChannelMaster 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 time interval between pings in an ensemble.

Format   TP *mm:ss.ff*

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

Default   TP 00:00.60

> Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The TP command sets the time interval between the start of one ping and the start of the
                 next within an ensemble. If TP is very short, the ChannelMaster will generate the next
                 ping as soon as the last ping completes.

                 The time needed to complete a ping may not be easy to predict. It is controlled by sound
                 propagation time (speed of sound x max range x 2), processing overhead, and other fac-
                 tors. The max range is controlled by commands (WF, WN, WS) and the environment (for
                 example, range to the surface for the vertical beam). The vertical beam ping consists of
                 multiple sub-pings.

Example   TP 00:00.10 sets the time between pings to 0.10 second.

> The ChannelMaster automatically increases TE if WP x TP > TE.

TS – Set Real-Time Clock

Purpose   Sets the ChannelMaster'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 *ChannelMaster Utilities*.

Description   Use the TS command to set the ChannelMaster's internal clock. Sending TS? displays two
                   times. Usually they are identical, but the first time after power up, TS? displays the cur-
                   rent time and the time power was removed.

```
>ts?
TS 06/01/30,10:29:41.14 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
   06/01/30,10:29:24.00 - Stored Time
>ts?
TS 06/01/30,10:29:46.39 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
   06/01/30,10:29:46.39 - Stored Time
```

Example   TS 18/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2018.

> When the ChannelMaster 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.
>
> The internal clock *does* account for leap years.
>
> If the entry is not valid, the ChannelMaster sends an error message and does not update the
> real-time clock.

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Vertical Beam Commands

The following commands define the criteria used to set the Vertical Beam data.

```
>V?
Available Commands:

VD 111000000 ------------ Data Out {a;c;s;*;*;*;*;*;*}
VF 0005 ----------------- Blank (cm)
VP 001 ------------------ Number of Pings per Ensemble (<100)
V? ---------------------- Display V-Command Menu
```

Vertical Beam Command Descriptions

This section lists the Vertical Beam commands.

VD – Vertical Beam Data Out

Purpose   Selects the vertical beam data types included in a PD0 ensemble.

Format   VD *abcdefghi*

Range   Firmware switches (see description)

Default   VD 111000000

> ❗ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The VD command uses firmware switches to tell the ChannelMaster the types of vertical beam data to include in a PD0 ensemble. PD0 ensembles always contain a header, fixed and variable leader, and checksum. The bits are described as follows:

a = surface track amplitude	*d* = Reserved	*g* = Reserved
b = surface track commands	e = Reserved	*h* = Reserved
c = surface track status	*f* = Reserved	*I* = Reserved

Example   VD 111000000 (default) tells the ChannelMaster to include surface track amplitude, surface track commands, and surface track status.

> 1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
>
> 2. IF **VP** = zero, the ChannelMaster does not collect vertical beam data, and VD has no effect. No vertical beam data is included.
>
> 3. The VD command does not affect the contents of PD14, PD19, or SDI-12 data.
>
> 4. See the **WD command** for water profile and firmware version data.

VF – Vertical Beam Blank after Transmit

Purpose   Moves the start of the search away from the transducer head.

Format   VF *nnnn*

Range   *nnnn* = 5 to 9999 cm (328 feet)

Default   VF 0005

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   Set the VF command to start the search for the surface to some distance after transmit to avoid adjacent structures or to allow transmit recovery.

VP – Vertical Beam Number of Pings per Ensemble

Purpose   Sets the number of pings per ensemble.

Format   VP *nnn*

Range   *nnn* = 0 to 99 pings

Default   VP 001

> ⚠ Recommended Setting. Set using *ChannelMaster Utilities*.

Description   This is similar to the WP command. Unlike horizontal beam pings, vertical beam pings contain multiple sub-pings. This means vertical beam pings take longer, but produce higher resolution and better averaged data than they otherwise would.

The vertical pings are spaced evenly throughout the WP pings. For example, if VP = VP3 and WP = WP6, the ChannelMaster will spread the Vertical pings evenly throughout the Water Pings (WP WP **VP** WP WP **VP** WP WP **VP**).

> 📌 If VP = zero, the ChannelMaster does not collect vertical beam data, and the **VD command** will have no effect. No vertical beam data (Surface track amplitude, surface track commands, and surface track status) will be included in the output data.

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Expert Vertical Beam Commands

The following expert commands define the criteria used to set the Vertical Beam data.

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

VC 0 0  25 -------------- Detect mode (0-2), Use Press (0=no) , Range Screen (%)
VE 030 00003 ------------ Edge Detect Thres (cnts), Width (samples)
VO 00000 00000 ---------- Set Offset (.1mm) and Scale (ppm)
VR 1000 ----------------- Set Max Range for Search (<=2000cm)
VS 016 ------------------ Set Number of Sub pings in a burst (<18)
VT 0001 ----------------- Transmit Length (code elements)
VW 030 00016 ------------ W Filter Thres (cnts), Width (samples)
VX 0 -------------------- Xmit Power Duty Cycle (1/8, 1/4/ 3/4th)
V? ---------------------- Display #V-Command Menu
```

> ⚠️ These commands are reserved for Teledyne RDI use. Contact TRDI field service before changing any of the expert vertical beam commands.

#VC – Detect Mode

Purpose	1. Controls the surface detection filter that is applied to average Receiver Signal Strength Indicator (RSSI) data.
	2. Controls whether the pressure sensor will be used as a first guess in detecting the surface.
	3. Controls the percent of range used in screening pings within a burst.
Format	#VC *m p rrr*
Range	*m* = 0 to 2
	p = 0 or 1
	rrr = 0 to 100 %
Default	#VC 0 0 25

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

Description: See below.

If m = 0, the 'W' filter is used on average data. If m = 1, the leading-edge filter is used on average data. If m = 2, the 'W' filter and then the leading-edge filter is used on average data.

If p = 0, then the pressure sensor is not used. If p = 1, then the pressure sensor is used. Using the pressure sensor can reduce ping time and avoid false detection. Set the #VS command to 1 or 2 sub-pings for an improved ping rate if the pressure sensor is used.

The value set by the rrr digits determines the allowable difference of individual pings' range from the average range over a burst. The allowable difference is ±rrr, so the window is twice rrr. Screening the individual pings in this way is an effective means of avoiding false detection.

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#VE – Leading Edge Detection Filter Parameters

Purpose   Sets the leading edge filter detection threshold counts and filter width.

Format   *#VE tt wwwww*

Range   *tt* = 0 to 255 counts
                wwwww = 0 to 65535 samples

Default   #VE 030 00003

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

Description   Only applies when the leading-edge filter is selected by the #VC command. The filter calculates the difference between the current sample and the sample *wwwww* samples prior to the current sample. The maximum detected output of this filter must be greater than '*tt*' counts for successful detection.

#VO – Set Offset

Purpose   Sets the offset and scale of the vertical beam transducer.

Format   *#VO xxxxxx yyyyy*

Range   *xxxxxx* = 0-65535 (related to the thickness of the transducer in 1/10mm)
                yyyyy = 0-65535 (related to the ClockOscCalMeasuredPPM)

Default   #VO 00000 00000

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

Description   Reserved for Teledyne RDI use.

#VR – Set Max Range for Search

Purpose   Limits the number of samples to collect based on max range command and pressure depth, in that order of precedence.

Format   *#VR nnnn*

Range   *nnnn* = 0 to 2000cm

Default   #VR 1000

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

Description   Note that if the pressure sensor fails, this command will fall through to search the entire record.

#VS – Number of Sub Pings in Burst

Purpose   Sets the number of sub pings in a burst.

Format   *#VS pp*

Range   pp = 0 to 18 pings

Default   #VS 016

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

Description   Set the pings per burst to one or two to improve ping time. Up to 16 pings is recommend to screen the data for false detects.

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#VT – Transmit Length

Purpose	Sets the transmit length in code elements.
Format	#VT *tttt*
Range	*tttt* = 0 to 9999 code elements
Default	#VT 0001

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

Description   There are four cycles per code elements. The phase of all code elements are the same if '*tttt*' > 1.

#VW – W Filter Parameters

Purpose	Sets the 'W' filter detection threshold counts and filter width.
Format	#VW *tt wwwww*
Range	*tt* = 0 to 255 counts, *wwwww* = 0 to 65535 samples
Default	#VW 030 00016

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

Description   Only applies when the 'W' filter is selected by the #VC command. The maximum detected output of this filter must be greater than '*tt*' counts for successful detection. The width of the filter is set by the *wwwww* parameter.

#VX – Transmit Power

Purpose	Sets the transmit power (duty cycle control).
Format	#VX *p*
Range	*p* = 0 to 2
Default	#VX 0

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

Description   See table below.

Table 10:   **Vertical Beam Transmit Power**

'p'	Transmit Duty Cycle
0	1/8
1	1/4
2	3/4

Water Profiling Commands

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

```
>w?
Available Commands:

WA 255 ------------------ False Target Amplitude Threshold [0-255]
WB 0 -------------------- Bandwidth 0=High, 1=low
WC 072 ------------------ Correlation Threshold [0-255]
WD 111100000 ------------ Data Out {v;c;a;p;s;*;*;*;*}
WF 0050 ----------------- Blanking Distance (cm)
WN 010 ------------------ Number of Bins [1-255]
WP 001 ------------------ Number of Pings
WQ 1 -------------------- Sample Ambient Sound (0=OFF,1=ON)
WR 1,  1,  5 ------------ Enhanced RSSI Enable (0-1) First/Last bins (0-255)
WS 0200 ----------------- Bin Size (cm)
WV 0175 ----------------- Ambiguity Velocity (cm/s)
W? ---------------------- Display W-Command Menu

>
```

Water Profiling Command Descriptions

This section lists the Water Profiling commands.

WA – False Target Threshold Maximum

Purpose   Sets a false target (fish) filter.

Format   WA *nnn*

Range   *nnn* = 0 to 255 counts (255 disables this filter)

Default   WA 255

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

Description   The ChannelMaster uses the WA command to screen water-track data for false targets (usually fish). WA sets the maximum difference between echo intensity readings among the profiling beams. If the WA threshold value is exceeded, the ChannelMaster rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.

> A WA value of 255 turns off this feature.

WB – Mode 1 Bandwidth Control

Purpose	Sets profiling mode 1 bandwidth (sampling rate). Low bandwidth allows the ChannelMaster to profile farther, but the standard deviation is increased by as much as 2.5 times.
Format	WB *n*
Range	*n* = 0 (High), 1 (Low)
Default	WB 0

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

Description	The *WB* command influences profiling range. If you narrow the bandwidth of the system, the profiling range is increased. See table below.

Table 11:   Bandwidth Control

Bandwidth	Sample rate	Data variance	Profiling range
0 = High	High	Low	Low
1 = Low	Low	High	High

WC – Low Correlation Threshold

Purpose	Sets the minimum threshold of water-track data that must meet the correlation criteria.
Format	WC *nnn*
Range	*nnn* = 0 to 255 counts
Default	WC 072

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

Description	The ChannelMaster uses WC to screen water-track data for the minimum acceptable correlation requirements. WC sets the threshold of the correlation below, which the ChannelMaster flags the data as bad and does not average the data into the ensemble.

> 📌 The default threshold for all frequencies is 72 counts. A solid target would have a correlation of 255 counts.

WD – Data Out

Purpose   Selects the water profile data types included in a PD0 ensemble.
Format   WD *abcdefghi*
Range   Firmware switches (see description)
Default   WD 111110000

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

Description   The WD command uses firmware switches to tell the ChannelMaster the types of velocity profile data and firmware version data to include in a PD0 ensemble. PD0 ensembles always contain a header, fixed and variable leader, and checksum.

a = Velocity	*d* = Percent good	*g* = Reserved
b = Correlation	*e* = Status and Firmware Version	*h* = Reserved
c = Echo Intensity	*f* = Reserved	*I* = Reserved

Example   WD 111110000 (default) tells the ChannelMaster to include velocity correlation, echo intensity, percent good, status, and firmware version.

> 1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
> 2. The **WD command** does not affect the contents of PD14, PD19, or SDI-12 data.
> 3. IF **WP** = zero, the ChannelMaster does not collect water track data, and therefore WD would only affect the firmware version output. No water track data is included.
> 4. See the **VD command** for vertical beam data.
> 5. If the Status bit is set to zero, this disables both the status data and the **firmware version** data format.

WF – Blank after Transmit

Purpose   Moves the location of first cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.
Format   WF *nnnn*
Range   see table

Frequency	Minimum	Maximum
300 kHz	10 cm	9999 cm (328 feet)
600 kHz	5 cm	9999 cm (328 feet)
1200 kHz	5 cm	9999 cm (328 feet)

Default   WF 0050 (1200 kHz), WF 0100 (600 kHz), WF 0200 (300 kHz)

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

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

> 1. The distance to the middle of cell #1 is a function of blank after transmit (WF), cell size (WS), and speed of sound. The fixed leader data contains this distance.
>
> 2. Small WF values may show ringing/recovery problems in the first cells that cannot be screened by the ChannelMaster.

WN – Number of Cells

Purpose	Sets the number of cells over which the ChannelMaster collects data.
Format	WN *nnn*
Range	*nnn* = 001 to 255 cells
Default	WN 025

> Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The range of the ChannelMaster is set by the number of cells (WN) times the size of each cell (WS).

WP – Pings per Ensemble

Purpose	Sets the number of pings to average in each data ensemble.
Format	WP *nnn*
Range	*nnn* = 0 to 999 pings
Default	WP 001

> Recommended Setting. Set using *ChannelMaster Utilities*.

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

> If WP = zero the ChannelMaster does not collect water-profile data.
>
> The WP command affects the minimum ensemble interval (**TP command**).

WQ – Sample Ambient Sound

Purpose	Samples ambient sound.
Format	WQ *n*
Range	*n* = 0, 1 (0=Off, 1=On)
Default	WQ 0

> Recommended Setting. Set using *ChannelMaster Utilities*. Note this command was added in CM02.15 firmware or higher.

Description   When WQ is set to 1, the ChannelMaster samples Receiver Signal Strength Indicator (RSSI) before the water ping and enables the output of the leader in which the data it is contained. WQ uses a four-meter blank and four-meter depth cell before sending water profile pings. This also enables SNR calculations; however, the SNR calculations are made over the range of Index cells as selected by the IS command.

Signal-to-Noise (SNR) calculation depends on the Ambient Noise value, and SNR is output in the same Leader as Ambient Noise (see Ambient Noise Measurement Output).

The IO command must be turned on for calculation of SNR. For example, if WQ is set to 1, but the IO command is set to 0, the leader will be output, but not all the fields will have valid data.

The SNR values in the leader are Signed 8-bit values (-128 to +127). Normal SNR values should vary from slightly negative to a larger positive value. As such, an SNR of -128 indicates a BAD SNR value. This is the value that would be put in the leader under the WQ1/IO0 case described above.

Turn off noise collection when ping timing is critical. Adding a separate Receiver Signal Strength Indicator (RSSI) and noise calculation adds processing time and can minimally slow ping timing.

WR – Enhanced RSSI Enable

Purpose   Enables or disables the output of the High-resolution Receiver Signal Strength Indicator (RSSI) Leader.

Format   WR n, n, n

Range   Enable (0-1), First/Last bins (0-255)

Default   WR 0, 0, 0

Recommended Setting. Set using *ChannelMaster Utilities*. Note this command was added in CM02.15 firmware or higher.

Description   The WR command provides outputting RSSI in higher resolution. The first parameter enables or disables the output of High-resolution RSSI Leader. The second parameter sets the starting cell and the third parameter sets the last cell over which to output the High-resolution RSSI.

The range of bins set by the 2nd and 3rd parameter of the WR command will specify which bins will output the enhanced resolution in a separate leader (see Enhanced Resolution RSSI Output). RSSI output in the Echo Intensity Leader (0x0300) leader will be calculated only to the original resolution.

WS – Cell Size

Purpose   Selects the volume of water for one measurement cell.

Format   WS *nnnn*

Range   see table

Default   see table

Frequency	Range	Default
300 kHz	1 to 8 meters	WS 0400
600 kHz	0.5 to 4 meters	WS 0200
1200 kHz	0.2 to 2 meters	WS 0100

Recommended Setting. Set using *ChannelMaster Utilities*.

Description   The ChannelMaster collects data over a variable number of cells. WS sets the size of each cell in centimeters.

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WV – Ambiguity Velocity

Purpose	Sets the radial ambiguity velocity.
Format	WV *nnn*
Range	*nnn* = 000 to 999 cm/s
Default	WV 175

> (!) **Recommended Setting**. It is strongly recommended that the WV command be left at the default value of 175 or set higher as required by the application. Values below 100 are not recommended.

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

Set WV as low as possible to attain better precision, but not too low or ambiguity errors will occur. The following table may be used as a guide to set the WV command.

Table 12.   WV Command Recommended Setting

Maximum apparent velocity relative to H-ADCP	WV setting
5 m/s	WV 175 (default setting)
6 m/s	WV 210
7 m/s	WV 245
8 m/s	WV 280
9 m/s	WV 315
10 m/s	WV 350
15 m/s	WV 525
20 m/s	WV 700

> ⚠ This table does not include any factor of safety against ambiguity errors due to the single-ping standard deviation, transverse velocities, or instrument misalignment. A safety factor ranging between 1.1 and 2.0 is recommended. Larger safety factors should be used with smaller bin sizes, lower WV settings, lower water temperatures, and higher transverse velocity components.

NOTES

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Chapter 8

OUTPUT DATA FORMAT

In this chapter, you will learn:

- PD0 Output data format
- PD14 Output data format
- PD19 Output data format
- PD23 Output data format
- How to Decode a ChannelMaster Ensemble

This section shows the output data format of the ChannelMaster. ChannelMaster output data can be in either hexadecimal-ASCII or binary format. You can select this option through the CF command. We explain the output data formats in enough detail to let you create your own data processing or analysis programs (see How to Decode a ChannelMaster Ensemble).

The following description is for the standard PD0 ChannelMaster output data format. Figure 21 through Figure 31 shows the ASCII and binary data formats for the ChannelMaster PD0 mode. Table 14 through Table 31 defines each field in the output data structure.

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

The ChannelMaster by default is set to collect velocity, correlation data, echo intensity, percent good data, and status. The data, preceded by ID code 7F7F, contains header data. The fixed and variable leader data is preceded by ID codes 0000 and 0080. The ChannelMaster always collects Header and Leader data. The table below shows some of the most common IDs.

Table 13:   Data ID Codes

ID	LSB	MSB	Description
0x7F7F	7F	7F	Header
0x0000	00	00	Fixed Leader
0x0002	02	00	Firmware Version
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
0x0500	00	05	Status Profile Data
0x4000	00	40	Surface Track Status
0x4001	01	40	Surface Track Commands
0x4002	02	40	Surface Track Amplitude
0x11A0	A0	11	Discharge data
0x8001	01	80	High-Resolution Diagnostic RSSI Data
0x8002	02	80	Index Velocity Parameters

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

When discharge calculations are enabled using the IO command, the ChannelMaster adds a PD19 formatted data block in the PD0 data. The header ID that indicates that the discharge data is about to be sent is 0x11A0. The data values in the 0x11A0 block are always in metric units regardless of the IU command setting.

The format is ASCII:

```
'\n'PRDIQ,+"High Volume","Low Volume","Stage","Flow rate","Average Velocity","Area","Tempera-
ture","Pitch","Roll","Fault Count"'\n'
```

If any of those values are missing or invalid, they are left empty. For example, if Roll is not valid then:

```
'\n'PRDIQ,+"High Volume","Low Volume","Stage","Flow rate", "Average Velocity","Area","Tempera-
ture","Pitch",,"Fault Count"'\n'
```

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (58 BYTES)
	VARIABLE LEADER DATA (60 BYTES)
WD-command WP-command	**VELOCITY** (2 BYTES + 8 BYTES PER RANGE CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER RANGE CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER RANGE CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER RANGE CELL)
	STATUS (2 BYTES + 4 BYTES PER RANGE CELL)
	FIRMWARE VERSION (39 or 50 BYTES)
VD-command VP-command	**SURFACE TRACK AMPLITUDE** $16 + ((((2 * N_{Ping}) -1) + (N_{Ping} - 1)) + (N_{Ping} - 1)) + (N_{Ping} - 1)$
	SURFACE TRACK COMMANDS (28 BYTES)
	SURFACE TRACK STATUS (46 BYTES)
PD19 formatted data block	**PD19 ASCII TEXT** (Byte count is not constant. It changes with the type, and validity of data)
Index Velocity Parameters	**Index Velocity Parameters** (42 BYTES)
DP command DE command DA command	**High-Resolution Diagnostic RSSI Data** (38 BYTES + 4 BYTES PER SAMPLE)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 20.   PD0 Standard Output Data Buffer Format

Some data outputs are in bytes per range cell. For example, if the WN-command (number of range cells) = 30, and the following data are selected for output, the required data buffer storage space is 1068 bytes per ensemble.

```
WD-COMMAND = WD 111 110 000 (default), WP-COMMAND = 1 (default)
VD-COMMAND = VD 111 000 000 (default), VP-COMMAND = 1 (default)
    28   BYTES OF HEADER DATA (6 + [2x Number Of Data Types])
    58   BYTES OF FIXED LEADER DATA (FIXED)
    60   BYTES OF VARIABLE LEADER DATA (FIXED)
   242   BYTES OF VELOCITY DATA (2 + 8 x 30)
   122   BYTES OF CORRELATION MAGNITUDE DATA (2 + 4 x 30)
   122   BYTES OF ECHO INTENSITY (2 + 4 x 30)
   122   BYTES OF PERCENT-GOOD DATA (2 + 4 x 30)
   122   BYTES OF STATUS DATA (2 + 4 x 30)
    50   BYTES OF FIRMWARE VERSION (with SDI)
    22   BYTES OF SURFACE TRACK AMPLITUDE DATA 16 + ((((2 * 2) -1) + (2 - 1)) + (2 - 1)) + (2 - 1)
    28   BYTES OF SURFACE TRACK COMMANDS DATA
    46   BYTES OF SURFACE TRACK STATUS DATA
    42   BYTES OF INDEX VELOCITY PARAMETERS
     2   BYTES OF RESERVED FOR TRDI USE (FIXED)
     2   BYTES OF CHECKSUM DATA (FIXED)
  1068   BYTES OF DATA PER ENSEMBLE (plus PD19 ASCII Text bytes)
```

If the WD command Status bit is set to zero (WD xxx x0x xxx, then the status and firmware version outputs will be disabled. The required data buffer storage space will be reduced to 969 bytes per ensemble.

The order of data types in an ensemble is not fixed. For example, there is no guarantee that velocity data will always be output before correlation data (see **How to Decode a ChannelMaster Ensemble**).

The WQ command Ambient Noise will be output via a new shared Leader type that also includes SNR data. See **Ambient Noise Measurement Output**.

The WR command High Resolution Receiver Signal Strength Indicator (RSSI) will specify which bins will output the enhanced resolution in a separate leader. See **Enhanced Resolution RSSI Output**.

Header Data Format

BIT POSITIONS									
BYTE	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
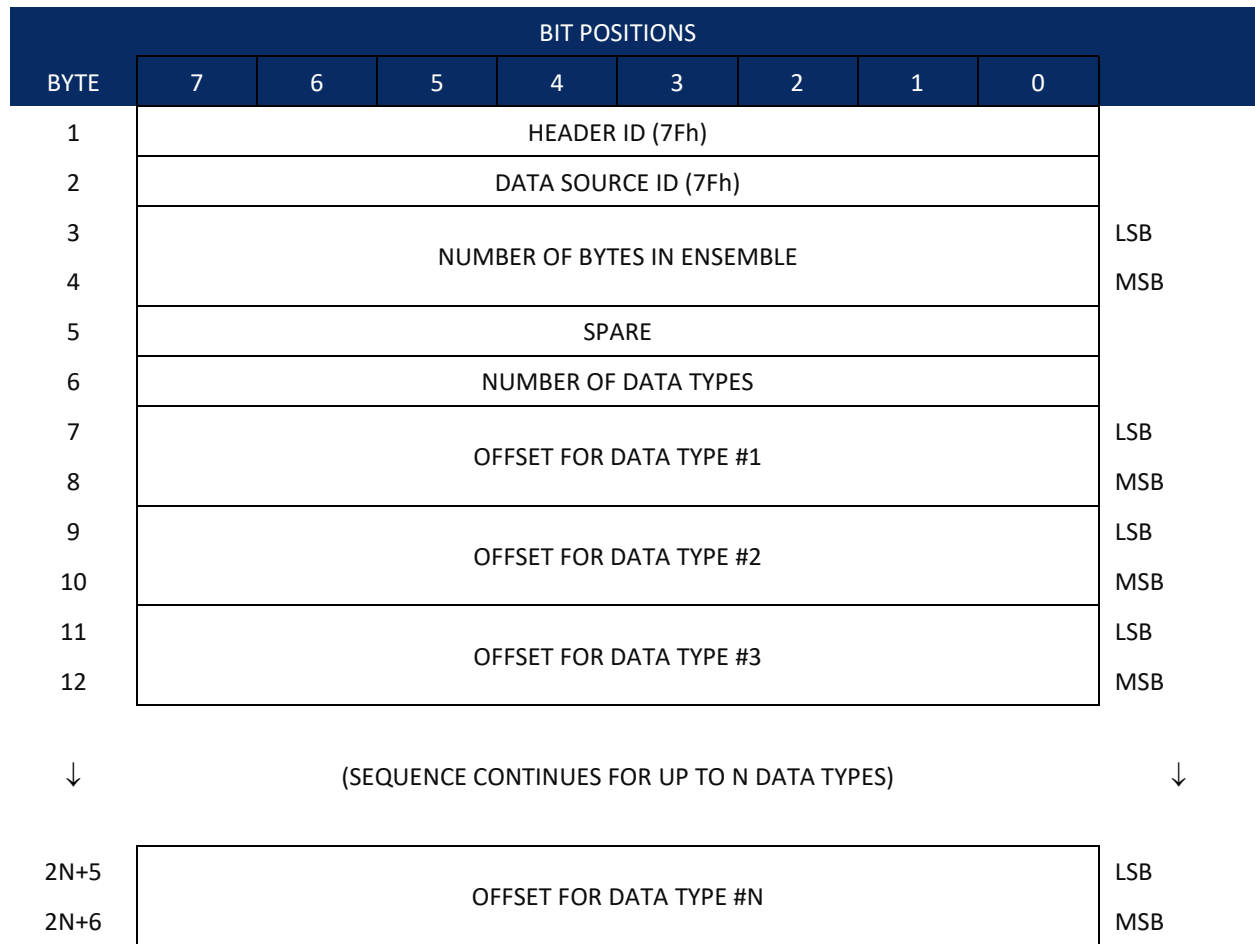
See Table 14 for a description of the fields.

Figure 21.   Header Data Format

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

Table 14:   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 ChannelMaster).
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.
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 ChannelMaster 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 ChannelMaster 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 ChannelMaster 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 = 0000								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	RESERVED								
8									
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS {WN}								
11	PINGS PER ENSEMBLE {WP}								LSB
12									MSB
13	RANGE CELL LENGTH {WS}								LSB
14									MSB
15	BLANK AFTER TRANSMIT {WF}								LSB
16									MSB
17	RESERVED								
18	LOW CORR THRESH {WC}								
19	NO. CODE REPS								
20	RESERVED								
21	RESERVED								LSB
22									MSB
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS {TP}								
26	COORDINATE TRANSFORM {EX}								
27	RESERVED								
28									

BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0
29	RESERVED							
30								
31	SENSOR SOURCE {EZ}							
32	SENSORS AVAILABLE							
33	BIN 1 DISTANCE							
34								
35	TRANSMIT PULSE LENGTH							
36								
37	RESERVED							
38								
39	FALSE TARGET THRESH {WA}							
40	RESERVED							
41	TRANSMIT LAG DISTANCE								LSB
42									MSB
43	CPU BOARD SERIAL NUMBER								LSB
↓									↓
50									MSB
51	SYSTEM BANDWIDTH {WB}								LSB
52	RESERVED								MSB
53								
54								
55	CHANNELMASTER SERIAL NUMBER							
↓								
58								

See Table 15 for a description of the fields

Figure 22.   Fixed Leader Data Format

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Fixed Leader data refers to the non-dynamic ChannelMaster data that only changes when you change certain commands. Fixed Leader data also contain hardware information. The ChannelMaster always sends Fixed Leader data as output data (LSBs first).

Table 15:   Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word 0000 (00 00h). LSB is sent first.
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 ChannelMaster 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`
			`        - - - - - 1 1 0    38-kHz SYSTEM`
			`        - - - - 0 - - -  CONCAVE BEAM PAT.`
			`        - - - - 1 - - -  CONVEX BEAM PAT.`
			`        - - 0 0 - - - -  RESERVED`
			`        - - 0 1 - - - -  RESERVED`
			`        - - 1 0 - - - -  RESERVED`
			`        - 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  25E BEAM ANGLE`
			`        0 0 1 0 - - - -  2-BEAM + VERT. STAGE`
			`        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 - 16	7-8	Reserved	Reserved
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The ChannelMaster uses two beams to calculate horizontal velocity and one vertical beam to calculate stage.
19,20	10	WN / Number of Cells	Contains the number of range cells over which the ChannelMaster collects data (WN-command). Scaling: LSD = 1 range cell; Range = 1 to 128 range cells

Table 15:   Fixed Leader Data Format

| Hex Digit	Binary Byte	Field	Description
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP-command). If WP = 0, the ChannelMaster does not collect the WD water-profile data. Note: The ChannelMaster automatically extends the ensemble interval (TE) if the product of WP and time per ping (TP) is greater than TE (i.e., if WP x TP > TE). Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
25-28	13,14	WS / Range cell Length	Contains the length of one range cell (WS-command). Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)
29-32	15,16	WF / Blank after Transmit	Contains the blanking distance used by the ChannelMaster to allow the transmit circuits time to recover before the receive cycle begins (WF-command). Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Reserved	Reserved
35,36	18	WC / Low Corr Thresh	Contains the minimum threshold of correlation that water-profile data can have to be considered good data (WC-command). Scaling: LSD = 1 count; Range = 0 to 255 counts
37,38	19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	Reserved	Reserved
41-44	21,22	Reserved	Reserved
45,46	23	Minutes	These fields, set by the TP-command, contain the amount of time between ping groups in the ensemble. NOTE: The ChannelMaster automatically extends the ensemble interval (set by TE) if (WP x TP > TE).
47,48	24	Seconds	
49,50	25	Hundredths	

51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX-command). These firmware switches indicate how the ChannelMaster collected data.
			
			`xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES)`
			`xxx01xxx = INSTRUMENT COORDINATES`
			`xxx10xxx = RESERVED`
			`xxx11xxx = RESERVED`
			`xxxxx1xx = TILTS (PITCH AND ROLL) USED IN`
			`           TRANSFORMATION`
			`xxxxxx1x = RESERVED`
			`xxxxxxx1 = BIN MAPPING USED`

53-60	27-30	Reserved	Reserved

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Table 15:   Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description

61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ-command). These firmware switches indicate the following.
			
			``FIELD DESCRIPTION
			  1xxxxxx = CALCULATES EC (SPEED OF SOUND) FROM
			            ED, ES, AND ET
			  x1xxxxx = USES ED FROM DEPTH SENSOR
			  xx1xxxx = USES EH FROM TRANSDUCER HEADING
			            SENSOR
			  xxx1xxx = USES EP FROM TRANSDUCER PITCH SENSOR
			  xxxx1xx = USES ER FROM TRANSDUCER ROLL SENSOR
			  xxxxx1x = USES ES (SALINITY) FROM CONDUCTIVITY
			            SENSOR
			  xxxxxx1 = USES ET FROM TRANSDUCER TEMPERATURE
			            SENSOR```
			
			NOTE: If the field = 0, or if the sensor is not available, the Channel-Master uses the manual command setting. If the field = 1, the ChannelMaster uses the reading from the internal sensor.

63,64	32	Sensor Avail	This field reflects which sensors are available. The bit pattern is the same as listed for the EZ-command (above).
65-68	33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first range cell (bin). This distance is a function of range cell length (WS), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-72	35-36	transmit pulse length	This field contains the transmit pulse length. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
72-76	37-38	Reserved	Reserved
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	Reserved	Reserved
81-84	41,42	LagD / Transmit lag distance	This field contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters
85-100	43-50	CPU Board Serial Number	Contains the serial number of the CPU board.
101-102	51	WB / System Bandwidth	Contains the WB-command setting. Range = 0 to 1
103-108	52-54	Reserved	Reserved.
109-116	55-58	Serial #	ChannelMaster serial number.

Variable Leader Data Format

BYTE	7	6	5	4	3	2	1	0	
	BIT POSITIONS								
1	VARIABLE LEADER ID = 0080								LSB 80h
2									MSB 00h
3	ENSEMBLE NUMBER								LSB
4									MSB
5	RTC YEAR {TS}								
6	RTC MONTH {TS}								
7	RTC DAY {TS}								
8	RTC HOUR {TS}								
9	RTC MINUTE {TS}								
10	RTC SECOND {TS}								
11	RTC HUNDREDTHS {TS}								
12	ENSEMBLE # MSB								
13	BIT RESULT								LSB
14									MSB
15	SPEED OF SOUND {EC}								LSB
16									MSB
17	DEPTH OF TRANSDUCER {ED}								LSB
18									MSB
19	RESERVED								LSB
20									MSB
21	PITCH								LSB
22									MSB
23	ROLL								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	RESERVED								

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BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0
33	PITCH STD							
34	ROLL STD							
35	BATTERY VOLTAGE TENTHS AND HUNDREDTHS PLACE							
36	BATTERY VOLTAGE IN VOLTS							
37 ↓ 48	RESERVED							
49	PRESSURE								LSB
50								
51								
52									MSB
53 ↓ 60	RESERVED							

See Table 16 for a description of the fields.

Figure 23.   Variable Leader Data Format

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

Table 16:   Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VID / Variable Leader ID	Stores the Variable Leader identification word 0080 (80 00h). LSB is sent first.
5-8	3,4	Ens / Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply. Scaling: LSD = 1 ensemble; Range = 1 to 65,535 ensembles NOTE: The first ensemble collected is #1. At "rollover," we have the following sequence: `1 = ENSEMBLE NUMBER 1` `       ↓` `65535 = ENSEMBLE NUMBER 65,535	ENSEMBLE` ` 0 = ENSEMBLE NUMBER 65,536	#MSB FIELD` ` 1 = ENSEMBLE NUMBER 65,537	(BYTE 12) INCR.`
9,10	5	RTC Year	These fields contain the time from the ChannelMaster's real-time clock (RTC) that the current data ensemble began. The TS-command (Set Real-Time Clock) initially sets the clock. The ChannelMaster <u>does</u> account for leap years.
11,12	6	RTC Month	
13,14	7	RTC Day	
15,16	8	RTC Hour	
17,18	9	RTC Minute	
19,22	10	RTC Second	
21,22	11	RTC Hundredths	

Table 16: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
23-24	12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3,4) "rolls over." This allows ensembles up to 16,777,215. See Ensemble Number field above.

25-28	13,14	BIT / BIT Result	This field contains the results of the ChannelMaster's Built-in Test function. The LSB (Byte 13) designates the error and the MSB (Byte 14) designates the number of BIT error types that have been logged. A zero code indicates a successful BIT result.
			
			```LSB BYTE 13```
			```76543210```
			```xxxxxxx1 = transmitter shutdown```
			```xxxxxx1x = transmitter over current```
			```xxxxx1xx = transmitter under current```
			```xxxx1xxx = transmitter under voltage```
			```xxx1xxxx = FIFO interrupt missed```
			```xx1xxxxx = FIFO ISR Re-entry```
			```x1xxxxxx = Sensor module failure```
			```1xxxxxxx = Watchdog disabled```

29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters -1 = Unknown (Hex FFFF)
37-40	19- 20	Reserved	Reserved
41-44	21-22	Pitch	For pitch, roll, and temperature, a value of –32768 indicates no measurement (Hex 8000).
45-48	23-24	Roll	
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt -1 = Unknown (Hex FFFF)
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 C.
57,58	29	MPT minutes	This field contains the <u>M</u>inimum <u>P</u>re-<u>P</u>ing Wait <u>T</u>ime between ping groups in the ensemble.
59,60	30	MPT seconds	
61,62	31	MPT hundredths	
63 - 64	32	Reserved	Reserved
65 - 66	33	Pitch STD	Pitch standard deviation. Scaling: LSB = 0.1 degree

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Table 16: **Variable Leader Data Format**

Hex Digit	Binary Byte	Field	Description
67 - 68	34	Roll STD	Roll standard deviation. Scaling: LSB = 0.1 degree
69 - 70	35	Battery Volts	Battery voltage tenths and hundredths place in volts. The re-ported voltage is 0.6 volts less than the battery voltage.
70 - 71	36	Battery Volts	Battery voltage in volts
72 - 96	37 - 48	Reserved	Reserved
97-104	49-52	Pressure	Contains the pressure of the water at the transducer head rela-tive to one atmosphere (sea level). Output is in deca-pascals. Scaling: LSD=1 deca-pascal; Range = -2,147,483,648 to +2,147,483,648 deca-pascals. Output is -2,147,483,648 when pressure is invalid.
105-120	53-60	Reserved	Reserved

How to Determine the Battery Voltage

For information on how to decode the PD0 format, see PD0 Data Format Rules. Once the PD0 format is de-coded, read the corresponding byte in the Variable Leader.

- The voltage output is located in bytes 35 and 36 (ADC1).

- Voltage = byte 36 + byte 35 /100 + 0.6 cable voltage drop.

Another way to decode the PD0 format is to use *BBconv* (included with *RDI Tools*). Shown below is a de-coder file for use with *BBconv*. For information on how to use decoder files, see the *RDI Tools* Help file.

```
;  Binary Fixed & Variable Leader Decode File
0080,35,1          ; Battery Voltage tenths place and hundredths place +0.6 cable voltage drop
0080,36,1          ; Battery Voltage
0080,37,1          ; Not used
0080,38,1          ; Not used
0080,39,1          ; Not used
0080,40,1          ; Not used
0080,41,1          ; Not used
$L
```

Velocity Data Format

BYTE	BIT POSITIONS								
	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID = 0100								LSB 00h
2									MSB 01h
3	RANGE CELL #1, VELOCITY 1								LSB
4									MSB
5	RANGE CELL #1, VELOCITY 2								LSB
6									MSB
7	RESERVED								
8									
9									
10									
11	RANGE CELL #2, VELOCITY 1								LSB
12									MSB
13	RANGE CELL #2, VELOCITY 2								LSB
14									MSB
15	RESERVED								
16									
17									
18									
↓	(SEQUENCE CONTINUES FOR UP TO 255 CELLS)								↓
1019	RANGE CELL #255, VELOCITY 1								LSB
1020									MSB
1021	RANGE CELL #255, VELOCITY 2								LSB
1022									MSB
1023	RESERVED								
1024									
1025									
1026									

See Table 17 for description of fields

Figure 24.   Velocity Data Format

The number of range cells is set by the WN-command.

The ChannelMaster packs velocity data for each range cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The ChannelMaster 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.

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

EX-CMD	COORD SYS	VEL 1	VEL 2
xxx00xxx	BEAM	TO BEAM 1	TO BEAM 2
xxx01xxx	INST	Bm2-Bm1	FROM TRANSDUCER

POSITIVE VALUES INDICATE WATER MOVEMENT

Table 17:   Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word 0100 (00 01h). LSB is sent first.
5-8	3,4	Range cell 1, Velocity 1	Stores velocity data for range cell #1, velocity 1. See above.
9-12	5,6	Range cell 1, Velocity 2	Stores velocity data for range cell #1, velocity 2. See above.
13-16	7,8	Reserved	Reserved
17-20	9,10	Reserved	Reserved
21-2052	11-1026	Cells 2 – 255 (if used)	These fields store the velocity data for range cells 2 through 255 (depending on the setting of the WN-command). These fields follow the same format as listed above for range cell 1.

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

BIT POSITIONS									
BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB 00h
2	Correlation Magnitude = 0200, Echo Intensity = 0300, Echo Intensity = 0400, Status = 0500								MSB 02 – 05h
3	RANGE CELL #1, FIELD #1								
4	RANGE CELL #1, FIELD #2								
5	RESERVED								
6									
7	RANGE CELL #2, FIELD #1								
8	RANGE CELL #2, FIELD #2								
9	RESERVED								
10									
↓	(SEQUENCE CONTINUES FOR UP TO 255 BINS)							↓	
511	RANGE CELL #255, FIELD #1								
512	RANGE CELL #255, FIELD #2								
513	RESERVED								
514									

See Table 18 through Table 21 for a description of the fields.

Figure 25.   Correlation Magnitude, Echo Intensity, Percent-Good Data, and Status Format

The number of range cells is set by the WN-command.

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Correlation magnitude data give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The ChannelMaster 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 18:   Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word 0200 (00 02h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores correlation magnitude data for range cell #1, beam #1. See above.
7,8	4	Range cell 1, Field 2	Stores correlation magnitude data for range cell #1, beam #2. See above.
9,10	5	Reserved	Reserved
11,12	6	Reserved	Reserved
13 – 1028	7 – 514	Cells 2 – 255 (if used)	These fields store correlation magnitude data for range cells 2 through 255 (depending on the WN-command) for all beams. These fields follow the same format as listed above for range cell 1.

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

Table 19:   Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the echo intensity data identification word 0300 (00 03h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores echo intensity data for range cell #1, beam #1. See above.
7,8	4	Range cell 1, Field 2	Stores echo intensity data for range cell #1, beam #2. See above.
9,10	5	Reserved	Reserved
11,12	6	Reserved	Reserved
13 – 1028	7 – 514	Cells 2 – 255 (if used)	These fields store echo intensity data for range cells 2 through 255 (depending on the WN-command) for all beams. These fields follow the same format as listed above for range 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 range cell of the velocity profile. The setting of the EX-command (Coordinate Transformation) determines how the ChannelMaster references percent-good data as shown below.

EX-Command	Coord. Sys	Velocity 1	Velocity 2	Velocity 3	Velocity 4
		Percentage Of Good Pings For:			
xxx00xxx	Beam	Beam 1	BEAM 2	RESERVED	RESERVED
		Percentage Of:			
xxx01xxx	Inst	Partial Solution Transformation (note 1)	Transformations Rejected (note 2)	% No Solution Available in Bin	Full Solution Transformations

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

At the start of the velocity profile, the backscatter echo strength is typically high on both beams. Under this condition, the ChannelMaster uses both beams to calculate the orthogonal and error velocities. As the echo returns from far away range cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the ChannelMaster to reject some of its range cell data. This causes the ChannelMaster to stop calculating velocities. As an example, let us assume range cell 60 has returned the following percent-good data.

`FIELD #1 = 50, FIELD #2 = N/A, FIELD #3 = 0, FIELD #4 = 0`

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% and beam 2=5%. These are <u>not</u> typical nor desired percentages. Typically, you would want both beams to be about equal and greater than 25%.

On the other hand, if velocities were collected in INSTRUMENT coordinates and bin 60 returned the following percent-good, the results would be interpreted differently.

`FIELD #1 = 50, FIELD #2 = N/A, FIELD #3 = 45, FIELD #4 = 0`

FIELD 1 - Percentage of Partial Solutions - Shows percentage of successful velocity calculations (50%) resulting in Partial Solutions. A Partial Solution is a solution that does not result in an error velocity. This occurs because there is not enough information to compute the error velocity.

FIELD 3 - Percentage of No Solution Transformations - 45% of the velocity data were rejected because there was insufficient information (velocity Data) to attempt a transformation.

FIELD 4 - Percentage of Full Solutions - 0% of the velocity data collected during the ensemble for range cell 60 generated a Full Solution. A Full Solution indicates that an error velocity is available. The Channel-Master is not capable of generating Full Solutions because 2-beams do not provide sufficient information to generate a Full Solution.

Table 20:   **Percent-Good Data Format**

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word 0400 (00 04h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores percent-good data for range cell #1, field 1. See above.
7,8	4	Range cell 1, Field 2	Stores percent-good data for range cell #1, field 2. See above.
9,10	5	Range cell 1, Field 3	Stores percent-good data for range cell #1, field 3. See above.
11,12	6	Range cell 1, Field 4	Stores percent-good data for range cell #1, field 4. See above.
13-1028	7-514	Range cell 2 – 255 (if used)	These fields store percent-good data for range cells 2 through 255 (depending on the WN-command), following the same format as listed above for range cell 1.

These fields contain information about the status and quality of the H-ADCP data. A value of 0 means the measurement was good. A value of 1 means the measurement was bad.

Table 21: **Status Data Format**

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word 0500 (00 04h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores status data for range cell #1, field 1. See above.
7,8	4	Range cell 1, Field 2	Stores status data for range cell #1, field 2. See above.
9,10	5	Range cell 1, Field 3	Stores status data for range cell #1, field 3. See above.
11,12	6	Range cell 1, Field 4	Stores status data for range cell #1, field 4. See above.
13-1028	7-514	Range cell 2 – 255 (if used)	These fields store status data for range cells 2 through 255 (depending on the WN-command), following the same format as listed above for range cell 1.

Firmware Version Data Format

The firmware version field is a short section of ASCII text in the middle of the binary ensemble data. It contains the version numbers of all the firmware in the ChannelMaster. The same version numbers are listed by the PS0 command.

Version numbers in the field are separated by line feed characters (0Ah). The text section is terminated with a NUL character (00h). The length of this field is determined by the number of characters in each version number, and the number of firmware modules. Given TRDI's version number formats, this field should be either 39 or 50 bytes long with release version firmware. Table 22 illustrates the format for release firmware with an SDI-12 personality module present. If there is no SDI-12 personality module, the SDI-12 firmware versions and their line feeds will not be present.

Table 22: **Firmware Version Data Format**

Binary Byte	Field	Description
1,2	Firmware ID	Stores the Variable Leader identification word 0002 (02 00h). LSB is sent first.
3	Line Feed	0Ah
4-11	Product Version	Product Version number plus line feed. When any firmware changes version, the new set of the latest firmware modules are assigned a new product version.
12-17	CPU Firmware	Firmware version number for the main CPU plus line feed.
18-26	FPGA Firmware	Low level firmware version number for the main CPU plus line feed.
27-32	Sensor Boot	Low level firmware version number for the sensor board processor plus line feed.
33-38	Sensor Firmware	Firmware version number for the sensor board processor plus line feed.

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Binary Byte	Field	Description
39-44	SDI-12 Boot	Low level firmware version number for the SDI-12 personality module plus line feed.
45-49	SDI-12 Firmware	Firmware version number for the SDI-12 personality module plus line feed.
50	Terminal NUL	00h

Turning off the Status bit on the WD command will disable the output of the Firmware Version Data Format.

Surface Track Status Output

BYTE	7	6	5	4	3	2	1	0	
1				Vertical Beam Status ID = 4000					LSB 00h
2									MSB 40h
3									
4									
5				Depth (Corrected Surface Track)					
6									
7									
8									
9				Depth (Uncorrected Surface Track)					
10									
11				Evaluation Amplitude					
12				Amplitude at the Surface					
13				%Good of Surface Track					
14									
15									
16				STD Surface Track					
17									
18									
19									
20				Min Surface Track					
21									
22									
23									
24				Max Surface Track					
25									
26									
27									
28				Pressure Depth Correction					
29									

BYTE	BIT POSITIONS							
	7	6	5	4	3	2	1	0
30	Depth (Uncorrected Pressure)							
31								
32								
33								
34	Percent Good of Depth based on Pressure							
35	STD of Depth based on Corrected Pressure							
36								
37								
38								
39	Min of Depth based on Corrected Pressure							
40								
41								
42								
43	Max of Depth based on Corrected Pressure							
44								
45								
46								

Figure 26.   Surface Track Status Output

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For Evaluation Amplitude, Amplitude at the Surface, Standard Deviation, Max Surface Track and Min Surface Track the following applies: If number of bursts per ensemble is 1, then this is based on the good pings in the ensemble. If the number of bursts per ensemble is greater than 1, then this is based on the output from each burst which could be from individual pings or from average Receiver Signal Strength Indicator (RSSI) data.

Table 23:   Surface Track Status Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_STATUS_ID / Vertical Beam Status ID	Stores the Vertical Beam Status ID word 4000 (00 40h). LSB is sent first.
5-12	3-6	Depth (Corrected Surface Track)	Depth based on surface track output with corrections applied. Units: 0.1mm
13-20	7-10	Depth (Uncorrected Surface Track)	Depth based on raw surface track output. Units: 0.1mm
21,22	11	Evaluation Amplitude	Maximum detection filter evaluation amplitude. Units: Counts
23,24	12	Amplitude at the Surface	Signal amplitude at Surface. Units: Counts
25,26	13	%Good of Surface Track	Percentage of surface track pings in an ensemble burst that are marked good based on signal strength and a comparison with burst average depth (see VC command). Units: %
27-34	14-17	STD Surface Track	Standard deviation of good depths from corrected surface track pings. Units: 0.1mm
35-42	18-21	Min Surface Track	Minimum depth of good corrected surface track. Units: 0.1mm pings
43-50	22-25	Max Surface Track	Maximum depth of good corrected surface track pings Units: 0.1mm
51-58	26-29	Pressure Depth Correction	Last good difference between pressure depth and vertical beam depth ensemble outputs. Units: 0.1mm
59-66	30-33	Depth (Uncorrected Pressure)	Depth based on raw pressure output. Units: 0.1mm
67,68	34	%Good of Depth based on Pressure	Percentage of corrected pressure measurements good in the ensemble. Units: %
69-76	35-38	STD of Depth based on Corrected Pressure	Standard deviation of good depths based on corrected pressure measurements in the ensemble. Units: 0.1mm
77-84	39-42	Min of Depth based on Corrected Pressure	Minimum depth of corrected pressure measurements in the ensemble. Units: 0.1mm

Hex Digit	Binary Byte	Field	Description
85-92	43-46	Max of Depth based on Corrected Pressure	Maximum depth of corrected pressure measurements in the ensemble. Units: 0.1mm

Surface Track Amplitude Output

BYTE	BIT POSITIONS								
	7	6	5	4	3	2	1	0	
1	Vertical Beam Amp ID = 4002								LSB 02h
2									MSB 40h
3	Pings in Burst (NPing)								
4	Bin Location of Surface (Avg.)								
5									
6	Filter Evaluation Amp (Avg.)								
7	Amplitude at Surface (Avg.)								
8	W Filter Bin Location of Surface (Avg.)								
9									
10	W Filter Evaluation Amp (Avg.)								
11	W Filter Amplitude at Surface (Avg.)								
12	Leading Edge Filter Bin Location of Surface (Avg.)								
13									
14	Leading Edge Filter Evaluation Amp (Avg.)								
15	Leading Edge Amplitude at Surface (Avg.)								
a*	W Filter Bin Location (Individual Pings)								
b*	W Filter Evaluation Amplitude (Individual Pings)								
c*	W Filter Amplitude (Individual Pings)								
d*	Status of Individual Pings								

Figure 27.   Surface Track Amplitude Output

* See note below.

a = 16 + ((2 * N_{Ping}) -1)
b = 16 + ((2 * N_{Ping}) -1) + ($N_{Ping} - 1$)
c = 16 + (((2 * N_{Ping}) -1) + ($N_{Ping} - 1$)) + ($N_{Ping} - 1$)
d = 16 + ((((2 * N_{Ping}) -1) + ($N_{Ping} - 1$)) + ($N_{Ping} - 1$)) + ($N_{Ping} - 1$)

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The data in this structure is from the last burst in an ensemble.

Table 24:   **Surface Track Amplitude Output**

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_AMP_ID / Vertical Beam Amp ID	Stores the Vertical Beam Amplitude ID word 4002 (02 40h). LSB is sent first.
5,6	3	Pings in Burst (NPing)	Number of surface track pings in an ensemble burst
7-10	4,5	Bin Location of Surface (Avg)	Final bin location of the surface based on either averaged RSSI data or averages of detected bin locations from single pings. Units: Samples
11,12	6	Filter Evaluation Amp (Avg)	Final filter evaluation amplitude based on either averaged RSSI data or averages of evaluation amplitudes from single pings. Units: Counts
13,14	7	Amplitude at Surface (Avg)	Final amplitude based on either averaged RSSI data or averages of amplitudes from single pings. Units: Counts
15-18	8,9	W Filter Bin Location of Surface (Avg)	W filter bin location of the surface from averaged RSSI data. Units: Samples
19,20	10	W Filter Evaluation Amp (Avg)	Evaluation amplitude output of the W Filter where the filter detects the surface using averaged RSSI data. Units: Counts
21,22	11	W Filter Amplitude at Surface (Avg)	RSSI amplitude at the bin location where the W filter detects the surface using averaged RSSI data. Units: Counts
23-26	12,13	Leading Edge Filter Bin Location of Surface (Avg)	Leading edge filter bin location of the surface from averaged RSSI data. Units: Samples
27,28	14	Leading Edge Filter Evaluation Amp (Avg)	Evaluation amplitude output of the leading edge filter where the filter detects the surface using averaged RSSI data. Units: Counts
29,30	15	Leading Edge Amplitude at Surface (Avg)	Leading edge amplitude at the bin location where the Filter detects the surface using averaged RSSI data. Units: Counts
31 to 31+4*NPing	16 to 16+2*NPing-1	W Filter Bin Location (Individual Pings)	W filter bin location where the filter detects the surface for individual pings in the ensemble burst. Units: Samples
31+4*NPing+1 to 31+6*NPing	16+2*NPing to 16+5*NPing-1	W Filter Evaluation Amplitude (Individual Pings)	W filter evaluation amplitude where the filter detects the surface for individual pings in the ensemble burst. Units: Counts
31+6*NPing-1 to 31+8*NPing	16+5*NPing to 16+6*NPing-1	W Filter Amplitude (Individual Pings)	W filter amplitude where the filter detects the surface for individual pings in the ensemble burst.

Hex Digit	Binary Byte	Field	Description
31+8*NPing-1 to 31+10*NPing	16+6*NPing to 16+7*NPing-1	Status of Individual Pings	Final status of each ping after data quality checks.

Surface Track Commands Output

BYTE	7	6	5	4	3	2	1	0	
1				Vertical Beam Commands ID = 4001					LSB 01h
2									MSB 40h
3				VM_Blank					
4									
5				VM_Pings					
6									
7				VM_BW					
8				VM_DetectMode					
9				VM_PressScreen					
10				VM_RangeScreen					
11				VM_EdgeDetectThres					
12				VM_EdgeDetectDelta					
13									
14				VM_RcvrGain					
15				VM_OffsetTenthsMM					
16									
17				VM_ScalePPM					
18									
19				VM_MaxRange					
20									
21				VM_MaxRange					
22									
23				VM_XmtLength					
24									
25				VM_WThreshold					
26				VM_WWidth					
27									
28				VM_XmitPwr					

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Table 25:   Surface Track Commands Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_CMD_ID / Vertical Beam Commands ID	Stores the Vertical Beam Commands ID word 4001 (01 40h). LSB is sent first.
5-8	3,4	VM_Blank	See VF command
9-12	5,6	VM_Pings	See VP command
13,14	7	VM_BW	See #VB command.
15,16	8	VM_DetectMode	
17,18	9	VM_PressScreen	See #VC command
19,20	10	VM_RangeScreen	
21,22	11	VM_EdgeDetectThres	See #VE command.
23-26	12,13	VM_EdgeDetectDelta	See #VE command.
27,28	14	VM_RcvrGain	See #VJ command.
29-32	15,16	VM_OffsetTenthsMM	See #VO command.
33-36	17,18	VM_ScalePPM	See #VO command.
27-40	19,20	VM_MaxRange	See #VR command.
41-44	21,22	VM_SubPings	See #VS command.
45-48	23,24	VM_XmtLength	See #VT command.
49,50	25	VM_WThreshold	See #VW command.
51-54	26,27	VM_WWidth	See #VW command.
55,56	28	VM_XmitPwr	See #VX command.

> For information on other expert level vertical beam commands, see Expert Vertical Beam Commands.

High-Resolution Diagnostic RSSI Data

This Receiver Signal Strength Indicator (RSSI) data is output if the diagnostic ping is enabled; i.e. DP > 0, and the DE and DA commands are set appropriately.

BYTE	BIT POSITIONS	
	7	6	5	4	3	2	1	0	
1	\multicolumn{8}{c}{High-Resolution Diagnostic RSSI Data ID = 0x8001}	LSB 01h
2									MSB 80h
3	Data Format Version	
4									
5	Reserved	
6									
7	Number of Janus Beams	
8									
9	Number of Vertical Beams	
10									
11	Number of Janus Beam RSSI Bins	
12									
13									
14									
15	Number of Vertical Beam RSSI Bins	
16									
17									
18									
19	Janus Beam RSSI Bin Size	
20									
21									
22									
23	Vertical Beam RSSI Bin Size	
24									
25									
26									
27	Samples per Meter	
28									
29									
30									
31	RESERVED	
32									
33									
34									

BIT POSITIONS									
BYTE	7	6	5	4	3	2	1	0	
35									
36									
37									
38									
39	Sample 1 RSSI Janus Beam #1								
40	Sample 1 RSSI Janus Beam #2								
41	RESERVED								
42	Sample 1 RSSI Vertical Beam								
43	Sample 2 RSSI Janus Beam #1								
44	Sample 2 RSSI Janus Beam #2								
45	RESERVED								
46	Sample 2 RSSI Vertical Beam								
. . .	. . .								. . .
4131	Sample 1024 RSSI Janus Beam #1								
4132	Sample 1024 RSSI Janus Beam #2								
4133	Reserved								
4134	Sample 1024 Vertical Beam								

Figure 28.   High-Resolution Diagnostic RSSI Data

Table 26.   High-Resolution Diagnostic RSSI Data

Bytes	Name	Value	Units
1-2	ID	0x8001	n/a
3-4	Data Format Version	2	n/a
5-6	Reserved		n/a
7-8	Number of Janus Beams		n/a
9-10	Number of Vertical Beams		n/a
11-14	Number of Janus Beam RSSI Bins		n/a
15-18	Number of Vertical Beam RSSI Bins		n/a
19-22	Janus Beam RSSI Bin Size		samples
23-26	Vertical Beam RSSI Bin Size		samples
27-30	Samples per Meter		s/m x1000
31-34	Reserved		n/a
35-38	Reserved		n/a

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Bytes	Name	Value	Units
39	Sample 1 RSSI Janus Beam #1		counts
40	Sample 1 RSSI Janus Beam #2		counts
41	Reserved		n/a
42	Sample 1 RSSI Vertical Beam		counts
43	Sample 2 RSSI Janus Beam #1		counts
44	Sample 2 RSSI Janus Beam #2		counts
45	Reserved		n/a
46	Sample 2 RSSI Vertical Beam		counts
. . .	. . .		. . .
4131	Sample 1024 RSSI Janus Beam #1		counts
4132	Sample 1024 RSSI Janus Beam #2		counts
4133	Reserved		n/a
4134	Sample 1024 Vertical Beam		counts

Index Velocity Parameters

	BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0	
1	Index Velocity Parameters ID = 0x8002								LSB 02h
2									MSB 80h
3	Version								
4									
5	Accumulated Q (MSW)								
6									
7									
8									
9	Accumulated Q (LSW)								
10									
11									
12									
13	Stage								
14									
15									
16									

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BYTE	BIT POSITIONS							
	7	6	5	4	3	2	1	0
17	Flow Rate							
18								
19								
20								
21	Average Velocity							
22								
23								
24								
25	Area							
26								
27								
28								
29	Count							
30								
31								
32								
33	Min Bin #							
34	Max Bin #							
35	Transducer Elevation Offset							
36								
37								
38								
39	Bottom Elevation Offset							
40								
41								
42								
43	Bank Setting							
44								

Figure 29.   Index Velocity Parameters

Table 27.   **Index Velocity Parameters**

Bytes	Name	Value	Units	Comments
1-2	ID	0x8002	n/a	
3-4	Version	2	n/a	Version of this data structure.
5-8	Accumulated Q (MSW)		10^6 m^3	
9-12	Accumulated Q (LSW)		m^3 x1000	
13-16	Stage		meters x1000	
17-20	Flow Rate		M^3/s x1000	
21-24	Average Velocity		mm/s	Computed from the Index velocity and the programmed Index-Velocity model
25-28	Area		m^2 x1000	
29-32	Count		n/a	
33	Min Bin #		Bin #	From IS command
34	Max Bin #		Bin #	
35-38	Transducer Elevation Offset		Mm	The mounting elevation of the ChannelMaster (From IE command)
39-42	Bottom Elevation Offset		Mm	The elevation of the bottom of the channel (From IE command)
43-44	Bank Setting		n/a	0 = left bank, 1 = right bank (from IB command)

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Ambient Noise Measurement Output

When the WQ command is enabled, the ChannelMaster will perform a listening ping without transmit prior to every scheduled ping. The ping is setup to have 1x 4m bin with a 4m blank, in high-gain. After the listening ping, the unit will then immediately switch to and perform the user-selected, scheduled ping.

Ambient Noise will be output via a new shared Leader type that also includes SNR data. Ambient noise will consist of the following:

Average SNR (combo of Beams 1 & 2) – 1 byte

In the table below, byte offset calculations are calculated with the variable N (indicating number of profile beams), and b (indicating the beam number from 1 to N)

For Channel Master, $N = 2$.

Table 28.   Ambient Noise Measurement Output

Byte	Value
1 - 2	Leader ID Code (0x8004) LSB: 0x04, MSB: 0x80
3	Number of Beams (N)
4 - 5	LSB, Ambient Noise RSSI (10ths of counts), Beam 1 MSB
…	…
2b + 2 2b + 3	LSB, Ambient Noise RSSI, Beam b MSB
2N+4 2N+5	Average Noise RSSI, LSB (Beams 1 to N) MSB
2N+5+1	Noise Correlation Beam 1
…	…
2N+5+b	Noise Correlation Beam b
3N+6	Average Noise Correlation (Beams 1 to N)
3N+6+1	SNR Beam 1
…	…
3N+6+b	SNR Beam b
4N+7	Average SNR (Beams 1 to N)

> The IO command must be turned on for calculation of SNR. For example, if WQ is set to 1, but the IO command is set to 0, the leader will be output, but not all the fields will have valid data. The IS command must also be set to indicate the index interval over which the SNR is calculated.
>
> The SNR values in the leader are Signed 8-bit values (-128 to +127). Normal SNR values should vary from slightly negative to a larger positive value. As such, an SNR of -128 indicates a BAD SNR value. This is the value that would be put in the leader under the WQ1/IO0 case described above.

Enhanced Resolution RSSI Output

When the WR command is enabled, the full resolution average will be reported in a new Leader type. The calculated average Receiver Signal Strength Indicator (RSSI) will be reported in *tenths* of a count. In the table below, byte offset calculations are calculated with the following variables:

- X, (indicating the starting bin, as specified by WR command and echoed in Byte #3, starting from Bin 0)
- N (indicating the number of bins, as specified by the WR command and echoed in Byte #4).
- b (indicating the beam number from 1 to the number of profile beams B, echoed in Byte #5)

For Channel Master, $N = 2$.

RSSI Values will be output in the following manner:

- Cell X, Beams 1 through B
- Cell X+1, Beams 1 through B
- …
- Cell N, Beams 1 through B

Thus, the Byte Offset for a given beam *b* and cell number *n* can be calculated as follows:

LSB: $((B * n) + (b-1)) * 2 + 2$
MSB: $((B * n) + (b-1)) * 2 + 3$

Table 29.   Enhanced Resolution RSSI Output

Byte	Value
1 - 2	Leader ID Code (0x8003)
3	Starting Bin (2nd Parameter of WR command) (Cell Index *X*)
4	Last Bin (3rd Parameter of WR command) (Cell index X+N)
5	Number of Beams, B
6 - 7	LSB, Cell *X* RSSI (10ths of counts), Beam 1 MSB, Cell *X* RSSI
8 - 9	LSB, Cell *X* RSSI (10ths of counts), Beam 2 MSB, Cell *X* RSSI
…	…
$((B * 1) + (b-1)) * 2 + 2$ $((B * 1) + (b-1)) * 2 + 3$	LSB, Cell X RSSI, Beam b MSB
…	…
$((B * 2) + (0)) * 2 + 2$ $((B * 2) + (0)) * 2 + 3$	LSB, Cell *X*+1 RSSI (10ths of counts), Beam 1 MSB, Cell *X*+1 RSSI
$((B * 2) + (1)) * 2 + 2$ $((B * 2) + (1)) * 2 + 3$	LSB, Cell *X*+1 RSSI (10ths of counts), Beam 2 MSB, Cell *X*+1 RSSI
…	…
$((B * N) + (0)) * 2 + 2$ $((B * N) + (0)) * 2 + 3$	LSB, Cell *N* RSSI (10ths of counts), Beam 1 MSB
…	…
$((B * N) + (b-1)) * 2 + 2$ $((B * N) + (b-1)) * 2 + 3$	LSB, Cell *N* RSSI (10th of counts), Beam *b* MSB

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Reserved BIT Data Format

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

Figure 30.   Reserved BIT Data Format

Table 30:   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

BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0
1	CHECKSUM DATA							LSB
2								MSB
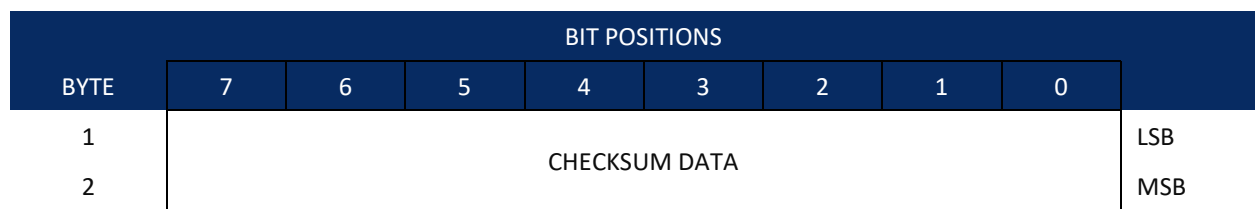
Figure 31.   Checksum Data Format

Table 31:   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.

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ChannelMaster PD14 Output Data Format

This section details the specification of an output format for data consisting of a header (with timestamp), a two dimensional profile of velocity, acoustic intensity, and standard error data, tilt sensor data, stage data, and a checksum. This format is primarily intended for integrating the ChannelMaster with other systems or data loggers. Data will be output in this format when PD14 is selected as the output format.

> 📌 PD14 is a fixed format.

Table 32 below summarizes the PD14 format. The number of bytes in the ensemble, not including the checksum is reported in the NBytes field and is equal to 10 * NBins + 23 bytes, where NBins is the number of range cells in the profile. The NEnsemble field shows the number of ensembles since the start of a deployment and provides for tracking sequences of ensembles and distinguishing one ensemble from another. Tilts are reported as signed quantities in the interval −180.00 to +180.00 degrees. Stage measurements are reported as unsigned quantities in units of 1/10th mm. Velocities are reported as signed quantities in mm/sec. Acoustic intensities are reported in unsigned units of counts. Standard error will be reported as unsigned quantities in mm/sec. The checksum will be calculated as described by the CRC-16 algorithm using the polynomial $x^{16}+x^{15}+x^2+1$ with an initial register value of 0xFFFF.

Invalid Data

Several quantities may on occasion be out of range or may not pass quality checks. In such cases, an invalid result will be indicated. For tilts, an invalid result will be indicated by a value of −327.68 degrees. Invalid velocities are indicated by a value of −32768 mm/s. Invalid standard error will be indicated by a value of 65535 (all bits set). Invalid stage measurements are indicated by a value of 42949.67295 meters (all bits set). No provision will be made for any other invalid quantities in this format.

Table 32:   ChannelMaster PD14 Output Data Format

Position	Size	Name	Description
0	2	SOE	Start of ensemble - always 0x8F8F
2	2	NBytes	Number of bytes
4	2	NEnsemble	Number of ensembles since start of deployment
6	2	Year	4-digit year
8	1	Month	Month
9	1	Day	Day of month
10	1	Hour	Hour of day since midnight
11	1	Minutes	Number of minutes since the last hour
12	1	Seconds	Number of seconds since the last minute
13	1	Hundredths	Hundredths of a second since the last second
14	2	Tilt 1	Tilt 1 measurement in 1/100th degree
16	2	Tilt 2	Tilt 2 measurement in 1/100th degree
18	4	Vertical	Vertical stage measurement in 1/10th millimeter
22	1	NBins	Number of profile bins
23	2	X1	X component of velocity for bin 1

Position	Size	Name	Description
25	2	Y1	Y component of velocity for bin 1
-	-	-	-
4n+19	2	Xn	X component of velocity for bin n
4n+21	2	Yn	Y component of velocity for bin n
4N+23	1	I11	Beam 1 intensity for bin 1 (NBins = N)
4N+24	1	I21	Beam 2 intensity for bin 1 (NBins = N)
-	-	-	-
4N+2m+21	1	I1m	Beam 1 intensity for bin m (NBins = N)
4N+2m+22	1	I2m	Beam 2 intensity for bin m (NBins = N)
6N+23	2	SX1	Standard error of X component of velocity for bin 1 (NBins = N)
6N+25	2	SY1	Standard error of Y component of velocity for bin 1 (NBins = N)
-	-	-	-
6N+4m+19	2	SXm	Standard error of X component of velocity for bin m (NBins = N)
6N+4m+21	2	SYm	Standard error of Y component of velocity for bin m (NBins = N)
10N+23	2	Checksum	CRC-16

ChannelMaster PD19 Output Data Format

PD19 output data format outputs ASCII data on the serial port and records PD0 data internally, if recording is enabled. The output of PD19 is a comma delimited format similar to a NEMA format. Units for data included in the serial output are set using the IU command. A typical output would appear as:

```
PRDIQ, 12, 432456.123, 2.45, 234.45, 0.65, 345.33, 15.12, 2.56, -0.32, 0
```

In order from left to right, the fields are described in Table 33.

Table 33:   PD19 Output Data Format

Field	Description
Header	"PRDIQ" which is the unique identifier that the following data is in PD19 ASCII format
High Volume	The first numeric field is always an integer which represents the millions portion of accumulated volume.
Low Volume	The second data field is the lower part of the total volume. So, in the above output, the total volume is 12432456.123. The volume has been split into two separate fields because many devices like RTUs or PLCs can only accept values up to 999999.999 in a single field.
Stage	The water surface elevation (reference to a local datum) based on the vertical acoustic beam measurement. If the vertical beam goes bad, the ChannelMaster will use the stage from the pressure sensor.
Flow rate	The computed flow using the average velocity and area computed from the channel geometry.

Field	Description
Average velocity	Average channel velocity calculated from the index velocity and the programmed Index-velocity model.
Area	Area computed from stage and the channel geometry.
Temperature	Temperature from the internal sensors of the ChannelMaster
Pitch	Pitch from the internal sensors of the ChannelMaster
Roll	Roll from the internal sensors of the ChannelMaster
Fault Count	The number of successive readings for which vertical range to surface are not valid. This will count up to the value set in IF. Until this value is reached, the last good velocity or stage data will be used to compute the other quantities.

> The SDI-12 output now includes pitch, roll, and index velocity as additional fields of the output available following the aM! command. The SDI-12 command aM9! (where "a" is the ChannelMaster SDI-12 address) will output average velocity, stage, area, discharge, high volume, and low volume in the units set using the CJ and IU commands and with the scaling set using the IT command.

The ChannelMaster adds a PD19 formatted data block in the `PD0` data. The header ID that indicates that the discharge data is about to be sent is 0x11A0. Units for data in the 0x11A0 block are always metric, as if IU = 1,1,1,1,1.

The format is ASCII:

```
'\n'PRDIQ,+"High Volume","Low Volume","Stage","Flow rate","Average Velocity","Area","Tempera-
ture","Pitch","Roll","Fault Count"'\n'
```

If any of those values are missing or invalid, they are left empty. For example, if Roll is not valid then:

```
'\n'PRDIQ,+"High Volume","Low Volume","Stage","Flow rate", "Average Velocity","Area","Tempera-
ture","Pitch",,"Fault Count"'\n'
```

ChannelMaster PD23 Output Data Format

PD23 output data format outputs ASCII data on the serial port and records `PD0` data internally, if recording is enabled. The output of PD23 is a comma delimited format similar to a NEMA format. Units for data included in the serial output are set using the IU command. In order from left to right, the fields are described in Table 33.

Table 34.   PD23 Output Data Format

Field	Description
Header	PRDIQ23 is the unique identifier that the following data is in PD23 ASCII format
Date & time	Ensemble date and time. Date format =YY/MM/DD, Time format = hh:mn:ss
Q High Volume	The first numeric field is always an integer which represents the millions portion of accumulated volume. For example, if the total volume is 12432456.12, the value of the Q High Volume will be +1. Format = x

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Field	Description
Q Low Volume	The second data field is the lower part of the total volume. So, in the above example, the Q Low Volume is 2432456.12. The volume has been split into two separate fields because many devices like RTUs or PLCs can only accept values up to 999999.99 in a single field. Format = x.xx
Fault Count	The number of successive readings for which either vertical range to surface or more than 50% of velocity cells are not valid. This will count up to the value set in the IF command. Until this value is reached, the last good velocity or stage data will be used to compute the other quantities. Format = x
StageA	The water surface elevation (reference to a local datum) based on the vertical acoustic beam measurement. Primary choice for flow calculation. Format = x.xxx
StageP	The water surface elevation (reference to a local datum) based on the pressure sensor measurement (always calibrated with the last good vertical acoustic beam measurement). Secondary choice for flow calculation. It is to be used if the vertical acoustic beam measurement is bad. Format = x.xxx
Flow rate	The computed flow using the average velocity and area computed from the channel geometry. Format = x.xx
Average velocity	Average channel velocity calculated from the Index velocity and the programmed Index-velocity model. Format = x.xxx
Area	Area computed from stage and the channel geometry. Format = x.xx
Temperature	Temperature from the internal sensors of the ChannelMaster. Format = x.xx
Pitch	Pitch from the internal sensors of the ChannelMaster. Format = x.xx
Roll	Roll from the internal sensors of the ChannelMaster. Format = x.xx
Battery Voltage	The voltage of the ChannelMaster. Format = x.x

Here is an example of PD23 output:

```
PRDIQ23,08/03/18,12:56:09,+0,566.22,0,1.279,1.279,3.21,0.506,6.35,17.62,0.93,0.09,12.7
PRDIQ23,08/03/18,12:56:43,+0,675.37,0,1.280,1.280,3.24,0.509,6.36,17.63,0.92,0.40,12.7

PRDIQ23,08/03/18,12:56:09,+0,566.22,0,1.279,,,3.21,0.506,6.35,17.62,,,,12.7
PRDIQ23,08/03/18,12:56:43,+0,675.37,0,1.280,,,3.24,0.509,6.36,17.63,,,,12.7
```

> When there is invalid info to be displayed, the data field is blank as shown in red.

Notes regarding the stage:

1. If the vertical beam and pressure sensor are good, the ChannelMaster will calculate the difference and save it.
2. If the vertical beam goes bad, the ChannelMaster will use the stage from the pressure + the difference (last time vertical-beam and pressure were good).
3. The field for StageA will be empty (,,) if the vertical beam goes bad, but the area and discharge will be calculated using stage from the pressure sensor.

The ChannelMaster adds a PD19 (NOT PD23!) formatted data block in the PD0 data. The header ID that indicates that the discharge data is 0x11A0. Units for data in the 0x11A0 block are always metric, as if IU = 1,1,1,1,1.

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. The definition and details of the PD0 format can be found in any of the manuals under the section, Output Data Format.

Available for download from the Teledyne portal at https://tm-portal.force.com/TMsoftwareportal

Chapter 9

SPECIFICATIONS

In this chapter, you will learn:

- Specifications
- Outline installation drawings
- Mounting plate dimensions

Table 35:   Water Velocity Profiling (Broadband Mode) Specifications

Model Name Frequency	CM300 300kHz	CM600 600 kHz	CM1200 1200 kHz
Profiling range	4m[a] to 300m[b]	2m[a] to 90m[b]	1m[a] to 25m[b]
Velocity range	±5m/s default, ±20m/s maximum		
Accuracy	±0.5% of water velocity relative to H-ADCP, ±2mm/s		
Resolution	1mm/s		
Number of cells	1 to 128		
Cell size	1m to 8m	0.5m to 4m	0.2m to 2m
Blanking distance	1m	0.5m	0.2m
Data output rate	User-programmable		
Aspect Ratio Limitation (range/total depth)	10/1	12/1	12/1

[a] Assume one good cell (minimum cell size); range measured from the transducer surface.

[b] Assume fresh water; actual range depends on temperature and suspended solids concentration.

Notes on Aspect Ratio Limitation

The Aspect Ratio Limitation (ARL) is determined by the spreading of the beam. Some notes on this:

- When calculating ARL do not use the specified beam width, because that is the -3dB beam width. Since the concern here is the beam hitting extremely bright reflectors (namely the water's surface or the bottom), the effective beam width for these calculations needs to be wide enough to completely clear the first null of the beam. Ideally, the two-way beam power should be down 40dB or more.

- There also needs to be some allowance for mounting tolerances; typically, roughly 0.5 degrees for pitch/roll and 0.5 degrees for pointing error.

- The ARL calculations presume that the ChannelMaster is mounted in the middle of the water column, i.e. equal vertical distance to the water's surface or the bottom.

The B2,1(-40dB) beam width (two-way, one-sided, 40dB attenuation from peak) is used to calculate the ARL and a 0.5° tolerance is added to account for mounting errors. For example, a 300 kHz ChannelMaster needs approximately 2.83 degrees of allowance both above and below the center line. So the aspect ratio limit is calculated as 1/tan(2.83 deg) = 20.2, which is the range/(distance to closest surface). The ARL uses the total depth (water surface to bottom) and assumes that the system is mounted in the center of the water column, so this number is divided by 2 to give the ARL of 10.1.

ARL = Range / Total Depth

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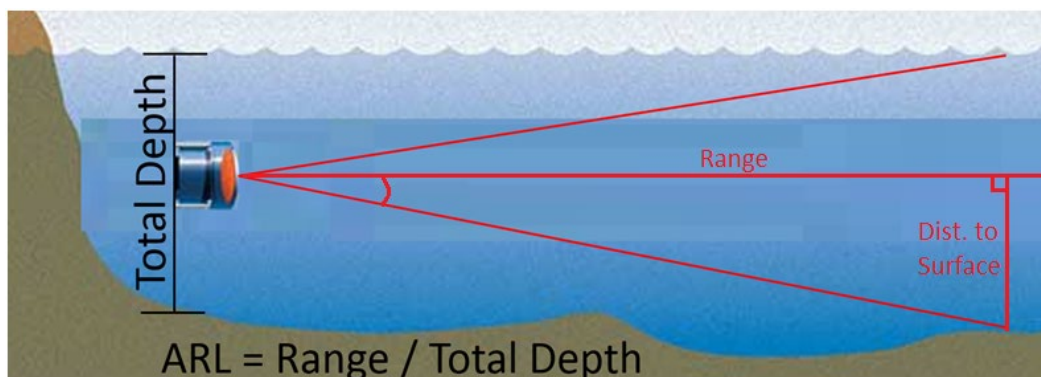
Table 36:   Transducer Specifications

Geometry	2 beams, ±20° beam angle
Beam Width	1.5° for 1200 kHz& 600 kHz, 2.2° for 300 kHz (one way, two sided, -3dB)
Construction	Cast polyurethane with titanium hardware. Stainless steel Mounting plate included.
Recorder	4mb internal recorder
Environmental	Operating temperature: -5°C to 45°C
	Storage temperature: -20°C to 50°C

Table 37:   Power Specifications

Voltage	10.5 to 18 VDC
Maximum Current	1.5A
Power consumption	0.1W @ 10% duty cycle (typical)

> Energy consumption depends on velocity profiling parameters. Contact Teledyne RD Instruments or a representative for an accurate prediction for your application.

Table 38:   Standard Sensors Specifications

Sensor	Temperature	Tilt (pitch and roll)	Pressure	Acoustic Stage
Range:	-4°C to 40°C	±10°	0.1m to 10m	0.1m to 10m*
Accuracy:	±0.2°C	±0.2°@2°, ±0.5°@10°	0.5%	±0.1%, ±3mm
Resolution:	0.01°C	0.01°	1mm	0.1mm

* User-programmable to 18m maximum.

Table 39:   Communications Specifications

RS-232 with SDI-12, or RS-422
SDI-12 supports v 1.3 (concurrent).
Simultaneous SDI-12, and internal logging supported.
Serial Baud Rates: 300-115,200 bps

Outline Installation Drawings

Drawing Number	Description
96B-6000	Outline/Installation 1200KHZ ChannelMaster
96B-6001	Outline/Installation 600KHZ ChannelMaster
96B-6002	Outline/Installation 300KHZ ChannelMaster

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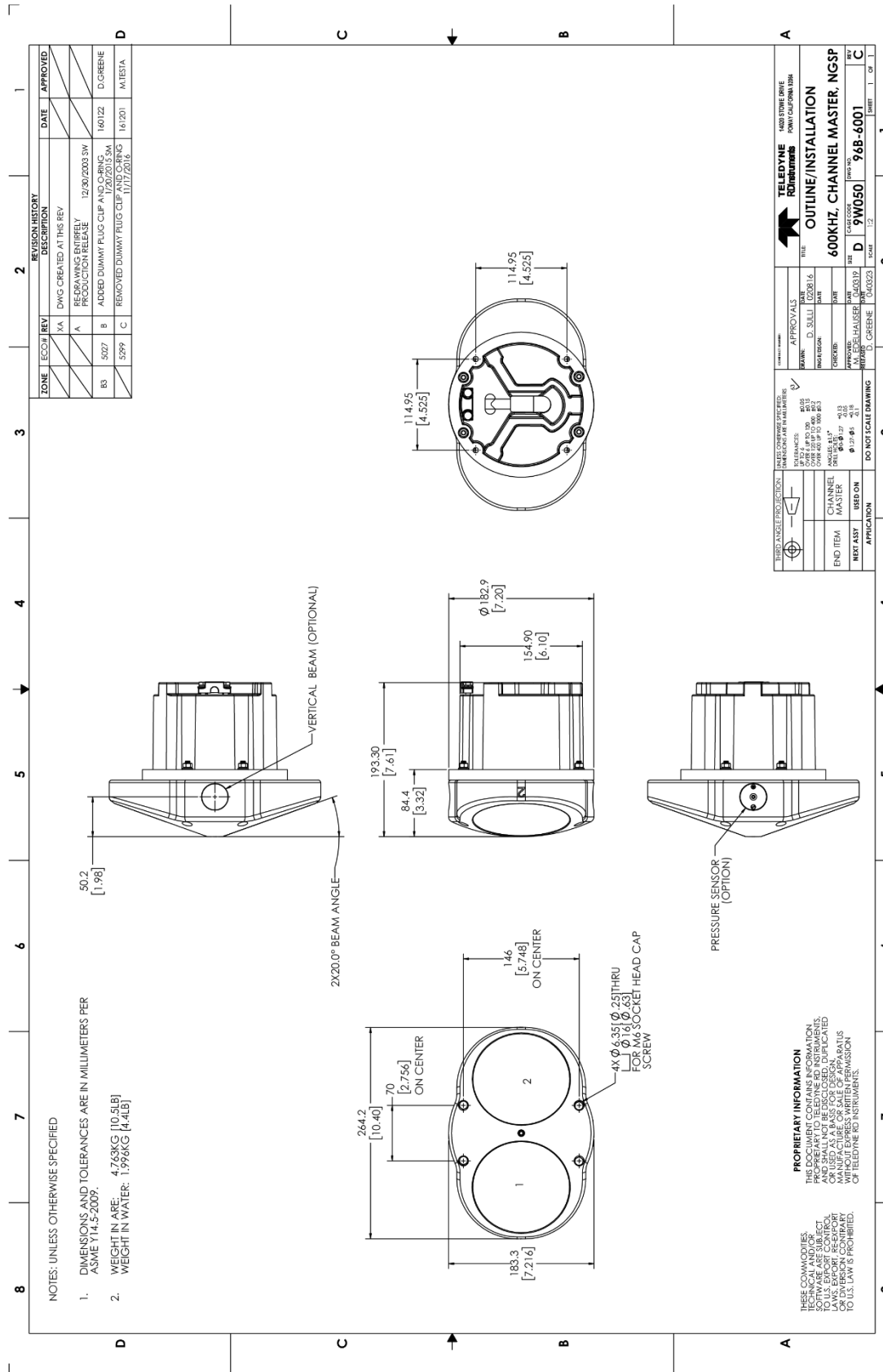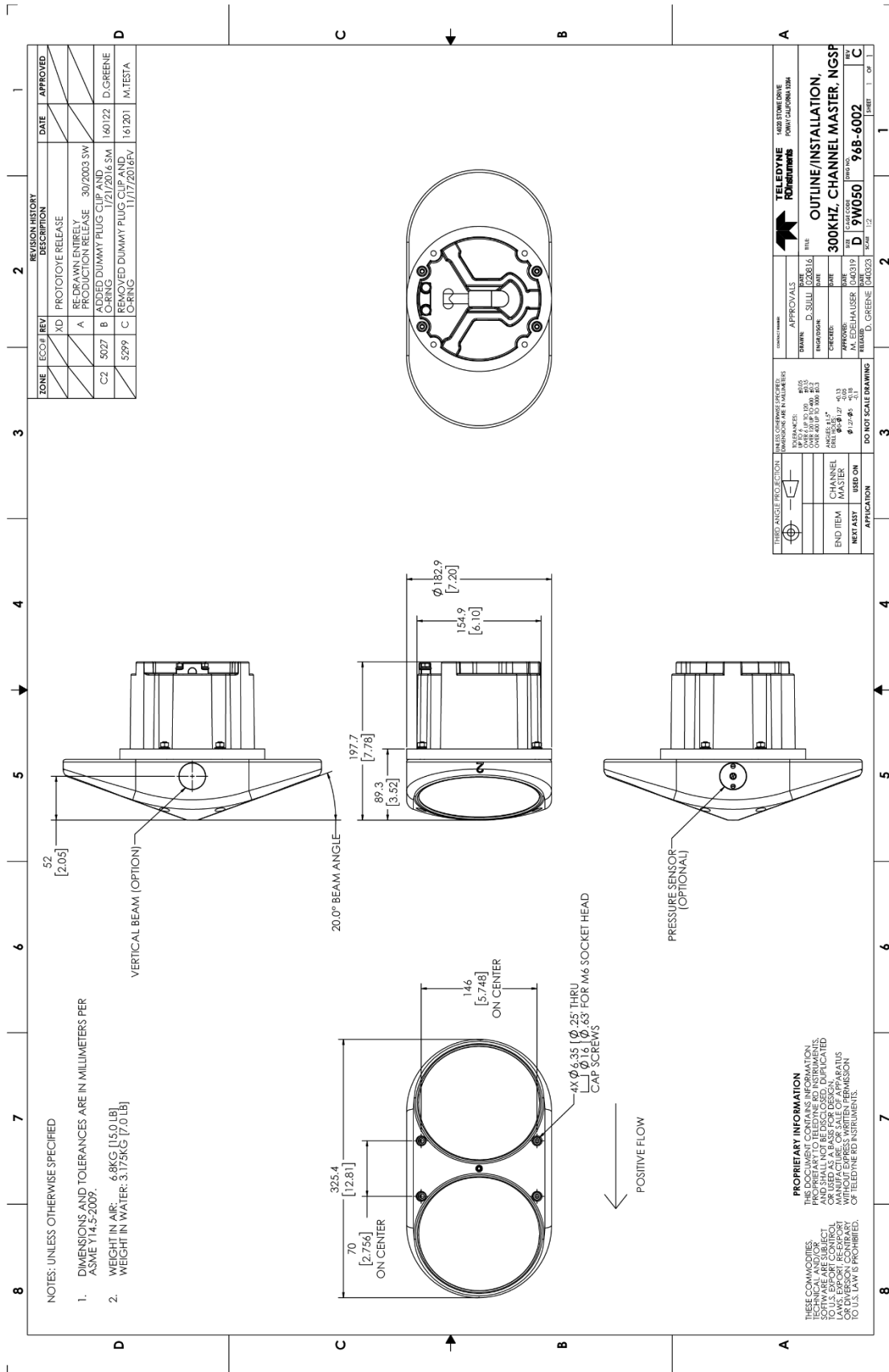
Mounting Plate Drawings
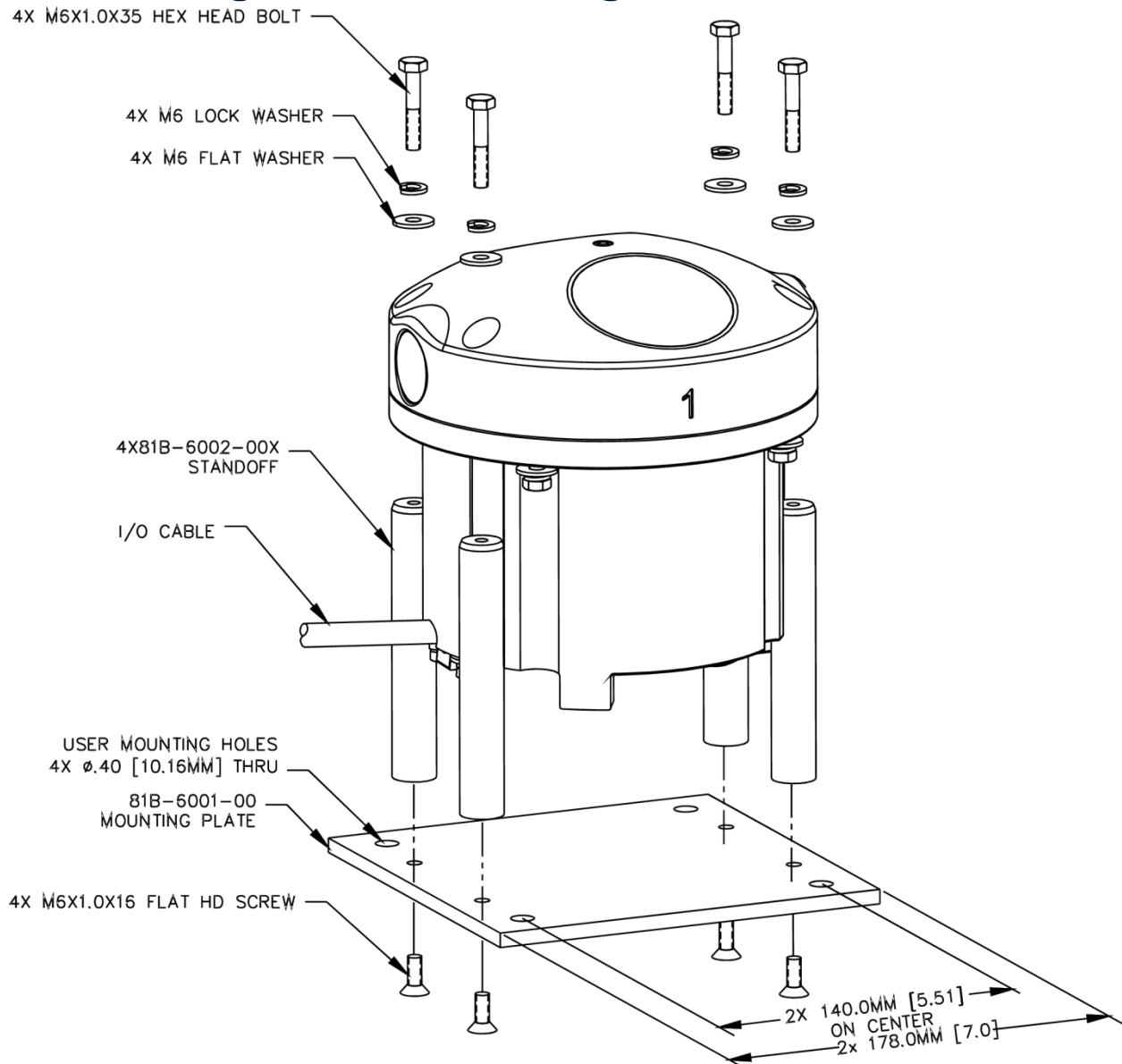
Figure 32.   ChannelMaster Mounting Plate

NOTES

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Appendix A

NOTICE OF COMPLIANCE

In this chapter, you will learn:

- Date of Manufacture
- Environmental Friendly Use Period (EFUP)
- Waste Electrical and Electronic Equipment Directive (WEEE)
- CE
- Material Disclosure

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 1 on page 2.

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 to one of the TRDI facilities below.

Teledyne RD Instruments USA
14020 Stowe Drive
Poway, California 92064

Teledyne RD Instruments Europe
2A Les Nertieres
5 Avenue Hector Pintus
06610 La Gaude, France

Teledyne RD Technologies
1206 Holiday Inn Business Building
899 Dongfang Road, Pu Dong
Shanghai 20122
China

CE

	This product complies with the Electromagnetic Compatibility Directive 89/336/EEC, 92/31/EEC. The following Standards were used to verify compliance with the directives: EN 61326(1997), A1(1998), A2(2001) – Class "A" Radiated Emissions.

Material Disclosure Table

In accordance with SJ/T 11364-2006, the following table disclosing toxic or hazardous substances contained in the product is provided.

Table 40:   Toxic or Hazardous Substances and Elements Contained in Product

零件项目(名称) Component Name	有毒有害物质或元素 Toxic or Hazardous Substances and Elements					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr^{6+})	多溴联苯 Polybrominated Biphenyls (PBB)	多溴二苯醚 Polybrominated Diphenyl Ethers (PBDE)
换能器配件 Transducer Assy.	X	O	O	O	O	O
接收机电路板 Receiver PCB	X	O	O	O	O	O
数据处理器电路板 DSP PCB	X	O	O	O	O	O
传感器电路板 Sensor PCB	X	O	O	O	O	O
输入输出口电路板 PIO PCB	X	O	O	O	O	O
机体装配 Housing Assy.	X	O	O	O	O	O
通讯接口板 Personality Module	X	O	O	O	O	O
水下专用电缆 Underwater Cable	X	O	O	O	O	O
专用装运箱和泡沫塑料垫 Shipping Case w/Foam	O	O	O	O	O	O

O: 表示该有毒或有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。

O: Indicates that the toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit required in SJ/T 11363-2006.

X: 表示该有毒或有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。

X: Indicates that the toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T 11363-2006.

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SDI-12 COMMAND RESPONSES

Appendix B

In this chapter, you will learn:

- List of SDI-12 commands and ChannelMaster responses

Use the following link to view the SDI-12 specification:
http://www.sdi-12.org/specification.php

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```
Command   Response                                                                              Result    Time Until the
Start Bit of the Response
0!        0<CR><LF>                                                                             pass      8.63 ms
0I!       013TRDI    28.39 208<CR><LF>                                                          pass      8.86 ms
0V!       00000<CR><LF>                                                                         pass      9.07 ms
0M!       00079<CR><LF>                                                                         pass      9.10 ms
0D0!      0+76.568-0.261-100.000-100.000<CR><LF>                                                pass      9.47 ms
0D1!      0-31.600+2.300-100.000+11.6+0<CR><LF>                                                 pass      9.45 ms
0M1!      00039<CR><LF>                                                                         pass      9.01 ms
0D0!      0-2.631+4.285-9.075+1.906+6.969<CR><LF>                                               pass      9.50 ms
0D1!      0+0.449-1.444-4.406+6.027<CR><LF>                                                     pass      9.38 ms
0M2!      00039<CR><LF>                                                                         pass      9.02 ms
0D0!      0+0.108-4.386-4.587-5.154+0.000<CR><LF>                                               pass      9.50 ms
0D1!      0+0.761+4.042-4.462+0.354<CR><LF>                                                     pass      9.38 ms
0M3!      00039<CR><LF>                                                                         pass      9.01 ms
0D0!      0+2.362-2.362-3.560-0.413+0.748<CR><LF>                                               pass      9.49 ms
0D1!      0+4.941-1.194+0.909-3.593<CR><LF>                                                     pass      9.38 ms
0M4!      00039<CR><LF>                                                                         pass      9.02 ms
0D0!      0+6.014+4.012-0.574-2.270-2.172<CR><LF>                                               pass      9.49 ms
0D1!      0+2.772-2.572+2.362-0.820<CR><LF>                                                     pass      9.38 ms
0M5!      00039<CR><LF>                                                                         pass      9.02 ms
0D0!      0+0.407+3.432+2.972+4.803+2.562<CR><LF>                                               pass      9.50 ms
0D1!      0+4.734-4.019-3.510+4.875<CR><LF>                                                     pass      9.38 ms
0M6!      00039<CR><LF>                                                                         pass      9.02 ms
0D0!      0-2.930-4.688+2.579+3.871-4.823<CR><LF>                                               pass      9.49 ms
0D1!      0+2.969-1.821+4.780-3.173<CR><LF>                                                     pass      9.38 ms
0M7!      00021<CR><LF>                                                                         pass      9.09 ms
0D0!      0-100.000<CR><LF>                                                                     pass      9.07 ms
0M8!      00021<CR><LF>                                                                         pass      9.10 ms
0D0!      0-100.000<CR><LF>                                                                     pass      9.07 ms
0M9!      00026<CR><LF>                                                                         pass      9.10 ms
0D0!      0-100.000-0.080+0.000-100.000+0+0.0<CR><LF>                                           pass      9.58 ms


0C!       000728<CR><LF>                                                                        pass      9.60 ms
0D0!      0+76.568-0.186-100.000-100.000-31.600+2.300-100.000+11.6+0-100.000-0.057<CR><LF>      pass     10.28 ms
0D1!      0+0.000-100.000+0+0.0-100.000+5.0+8.7+6.8+29.0+29.6+29.3+0.0+0.0+0.0-100.0<CR><LF>    pass     10.31 ms
0D2!      0-100.0-100.0<CR><LF>                                                                 pass      9.15 ms
0C1!      000364<CR><LF>                                                                        pass      9.60 ms
0D0!      0-0.279+2.031-0.243-2.497+2.802-2.766+0.659+4.948+2.264+1.896-3.802-5.423<CR><LF>    pass     10.29 ms
0D1!      0-4.180+4.738-5.738-0.305-1.759+3.632+5.673+1.070-0.896+3.671+5.673-4.426<CR><LF>    pass     10.30 ms
0D2!      0-5.344+3.130+4.813+3.911+1.683-0.538+5.033+1.624-1.220-3.045+2.470-5.128<CR><LF>    pass     10.29 ms
0D3!      0+1.368+0.610-2.215+5.791-1.736-1.122+2.484-0.568-2.277+2.657-0.427-6.217<CR><LF>    pass     10.29 ms
0D4!      0-3.819+4.767-3.097-3.720+1.355+3.862-5.994+3.219-2.408-1.191-3.802+2.247<CR><LF>    pass     10.30 ms
0D5!      0+1.043-1.161-2.470+3.566<CR><LF>                                                     pass      9.38 ms
0C2!      000364<CR><LF>                                                                        pass      9.60 ms
0D0!      0+3.169+3.786+4.249+0.751-0.663+5.105-5.997+5.489-4.892-3.081-5.745+3.258<CR><LF>    pass     10.29 ms
0D1!      0+4.111+1.706+1.339+3.770+2.260-3.212-4.370+3.163-2.995+3.481-0.804-0.551<CR><LF>    pass     10.29 ms
0D2!      0-4.423+2.434+3.629+1.086+2.854-1.020+1.325+1.890+5.351+4.970+3.734+1.093<CR><LF>    pass     10.29 ms
0D3!      0+3.156-2.208-3.566+3.058-4.442+0.171-3.891+3.524+1.112-0.082-0.541+1.473<CR><LF>    pass     10.28 ms
0D4!      0-0.571-1.496+1.821-2.743-3.051+4.236+1.132-1.788+3.990-0.919-4.150-0.115<CR><LF>    pass     10.30 ms
0D5!      0-1.158-5.568-3.625-4.616<CR><LF>                                                     pass      9.38 ms
0C3!      000364<CR><LF>                                                                        pass      9.59 ms
0D0!      0+29.0+28.9+29.1+29.3+29.2+28.8+28.7+28.9+28.8+28.1+28.6+28.9+29.0+28.7+28.8<CR><LF>  pass     10.34 ms
0D1!      0+29.0+28.8+28.5+29.0+29.4+28.9+29.0+28.9+28.9+28.9+29.3+28.7+29.3+29.0<CR><LF>       pass     10.34 ms
0D2!      0+29.2+28.3+28.7+29.0+28.8+28.7+29.4+29.1+29.0+29.4+28.9+28.8+29.4+29.0+28.8<CR><LF>  pass     10.34 ms
0D3!      0+29.3+29.1+28.6+29.0+29.2+28.7+29.2+29.0+29.1+28.7+28.5+29.2+28.8+29.1<CR><LF>       pass     10.34 ms
0D4!      0+29.2+28.6+28.7+28.8<CR><LF>                                                         pass      9.30 ms
0C4!      000364<CR><LF>                                                                        pass      9.60 ms
0D0!      0+29.5+29.7+29.6+29.4+29.7+29.6+29.7+29.9+29.8+29.6+29.7+29.6+29.9+29.2<CR><LF>       pass     10.34 ms
0D1!      0+29.3+30.0+29.5+29.8+29.6+29.0+29.4+29.7+29.8+30.0+29.8+29.3+29.9+30.4+29.2<CR><LF>  pass     10.34 ms
0D2!      0+29.5+30.1+29.4+29.4+29.9+30.0+29.9+29.6+30.0+29.6+29.5+30.8+29.3+30.2+29.9<CR><LF>  pass     10.34 ms
0D3!      0+29.6+29.6+29.8+29.8+29.8+30.3+30.1+29.5+29.7+29.4+30.0+30.4+29.7+30.2<CR><LF>       pass     10.34 ms
0D4!      0+29.4+29.7+30.1+29.5<CR><LF>                                                         pass      9.30 ms
0C5!      000000<CR><LF>                                                                        pass      9.21 ms
0C6!      000000<CR><LF>                                                                        pass      9.21 ms
0C7!      000000<CR><LF>                                                                        pass      9.20 ms
0C8!      000000<CR><LF>                                                                        pass      9.21 ms
0C9!      000000<CR><LF>                                                                        pass      9.21 ms
```