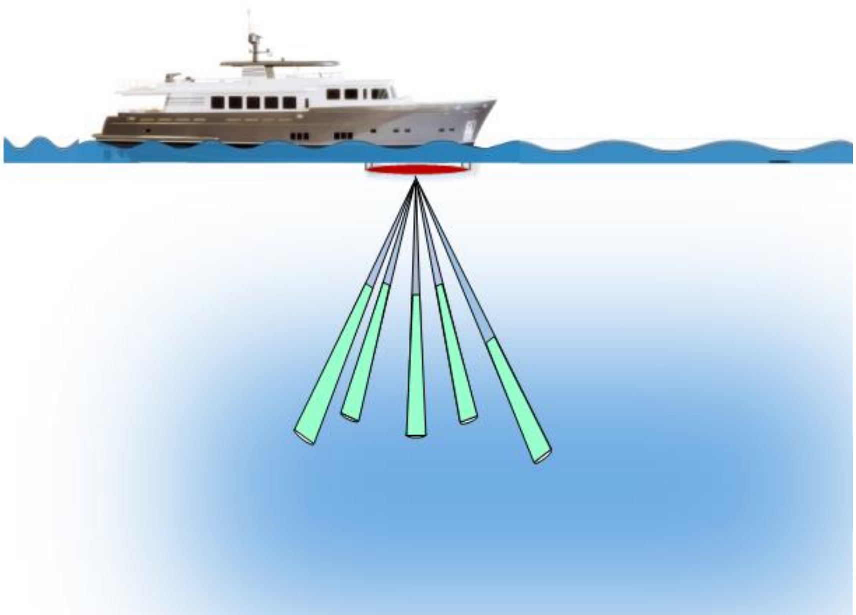
VESSEL MOUNT

DUAL FREQUENCY ACOUSTIC DOPPLER CURRENT PROFILER

OPERATION MANUAL (Limited version)



This is not the full version of the operation manual. The full version of the operation manual will be available to the customer with the instrument. Some of the contents may be missing.

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Table of Contents

1 Introduction

Thank you for purchasing a Rowe Technologies Inc. (RTI) VM ADCP–Vessel Mount Acoustic Doppler Current Profiler. This Operation Manual is intended to help RTI-VM users to get familiar with their system. This manual is specific for using the RTI-VM. The manual does not discuss all the technical issues of the RTI-VM. All documentation is being provided to you on USB storage device in a fully searchable, printable, electronic format.

RTI ONLINE

On our website at www.rowetechinc.com, you can also find technical support, user manuals, technical brochures, product datasheet about our other products etc.

1.1 How to Contact Rowe Technologies, Inc.

If you have technical problems with the instrument, please feel free to contact us at:

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Email : sales@rowetechinc.com

Web : http://rowetechinc.com/

1.2 Safety Precautions

- NEVER START pinging the SEA Surveyor with the transducer in air. This will cause the high-power transmitter to short across the transducer and damage the Dual Frequency VM transducer. When making connections between the various interfaces, do not force the connector to enter. If the connector is not properly seated or if the connector is not going in smoothly, please stop and try again so that connector enters without any problem.
- Do not place the transducer face on hard surface. The transducer surface may get damaged.
- Do not place the transducer with transducer connector facing down. The pins on the transducer connector may get damaged.

2 System Overview

2.1 Introduction

RTI is pleased to introduce the single or dual frequency Sea **SURVEYOR** for vessel-mount or fixed mount current profile measurement. RTI's Sea **SURVEYOR** ADCP and DVL employ advanced 3rd generation **ROWE ADCP** Technologies (**ADCP3**), to simultaneously measure precision Short Range and Long Range vertical profiles of:

- 3-Axis water Currents,
- Echo Intensity,
- Vertical Profiles of Plankton Size Distribution,
- 3-Axis Bottom Track and Altitude,

providing a horizontal spatial survey of the vertical profiles along the surface or subsurface vessel path.

This Sea **SURVEYOR** operates at two different frequencies namely the 38 kHz and 300 kHz. The lower frequency provides longer profiling and bottom tracking range, and the higher frequencies provide higher spatial, velocity and temporal resolution currents and echoes nearer to the vessel. The system diagram is given in Figure 1. The main features and benefits are listed below

- Single or Dual-Frequency operation in a single phased array transducer (patented) ADCP system providing:
  - High-Resolution Current Profiles in the upper and coastal ocean
  - Long-Range Current Profiles in deep ocean
- RTI's proven Doppler Signal processing and advanced Bottom detection algorithms
  - Narrowband for longer range
  - Multiple Broadband modes and bandwidths
- ± 1% Current and Bottom Velocity accuracy
- High accuracy Dual-Frequency echo intensity for plankton particle size distribution calculation over overlapping profiling range
- Host Computer control of Profiling Range/Precision Multi-Mode operation and Application Specific post signal processing

The dual frequency Sea **SURVEYOR** ADCP consists of 3 main units namely,

1. The Upper Deck Box, also known as the Deck Unit.
2. The Lower Deck Box, also known as the transceiver unit.
3. Dual frequency transducer operating at 38 kHz and 300 kHz.

The electrical specifications of the Upper Deck box and the Lower Deck Box are given below.

Table 1. Upper Deck Box (Deck Unit)

Input Voltage	90-120VAC or 220-240 VAC, 47-63 Hz
Output Voltage	90-120VAC or 220-240 VAC, 47-63 Hz
Communications	RS 422, RS 485, RS 232, Ethernet options available

Table 2. Lower Deck Box (Transceiver Unit)

Input Voltage	90-120VAC or 220-240 VAC, 47-63 Hz
ADCP Input Voltage	24-48 VDC
Output Power to Transducer	1000 W peak
Standby Power	2 W

The details of each unit are explained in the following sections.

2.2 System Block Diagram

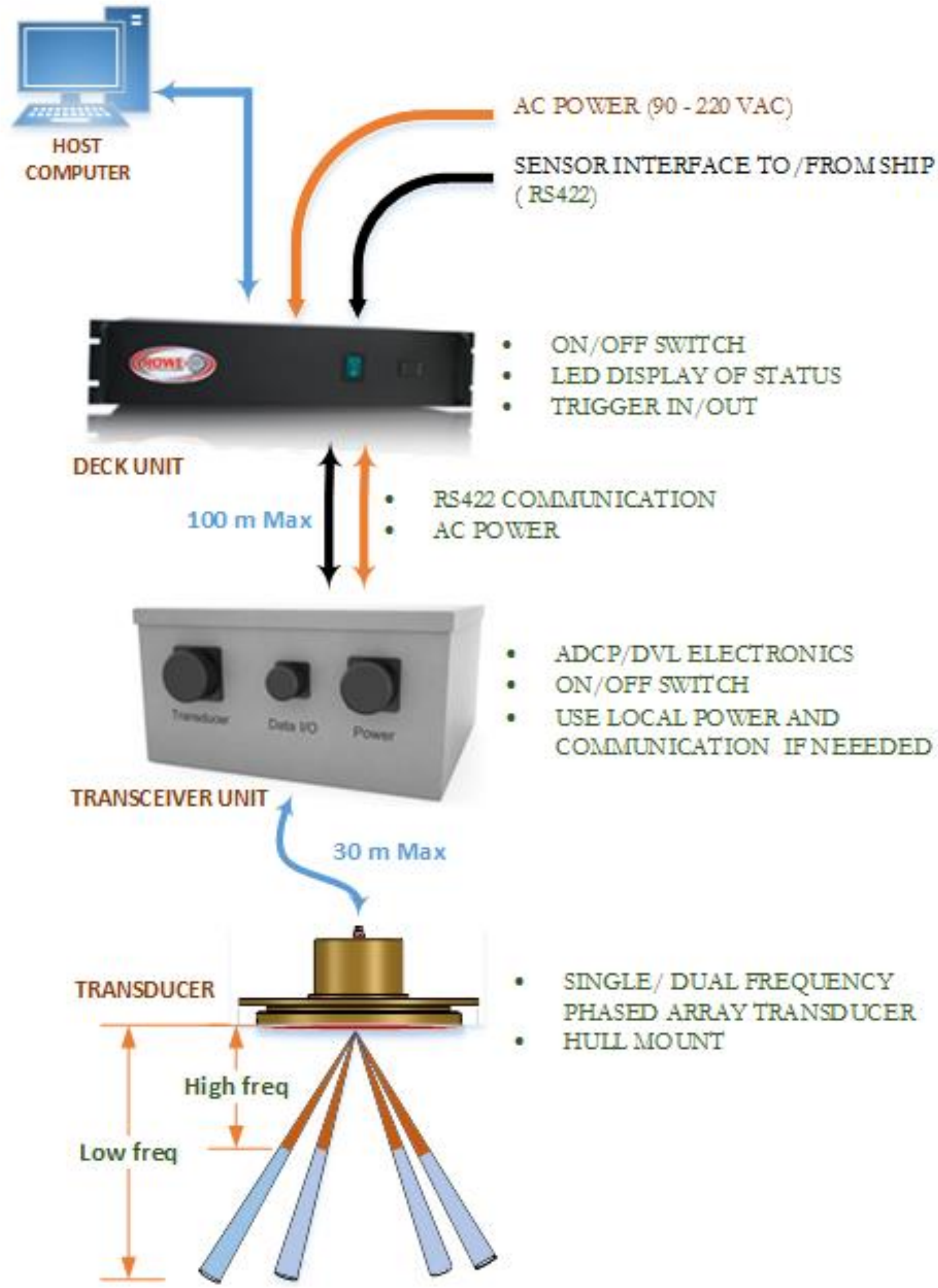


Figure 1. System block diagram of the Sea Surveyor VM 38/300 kHz. The high frequency beams (300 kHz) is denoted in orange and the low frequency beams (38 kHz) is denoted by blue from the transducer.

2.3 Upper Deck Box (Deck Unit)

The Upper Deck unit, also known as Upper Deck Unit or Deck unit, connects the host computer from the ship to the lower transceiver unit which in turn connects to the transducer. The Deck unit has an ON/OFF Switch, AC power in connector from ship, ACPower out to the Lower Deck box, Communications to the ship (RS422), Trigger In, Trigger out, and Communications to the lower deck box. The length of the cables from the upper deck unit to the lower deck unit (transceiver unit) is about 100 m. The internal block diagram of the upper deck unit showing the internal connections between the various connectors is given below in Figure 2. The front view and the back view of the deck unit is shown below in Figure 3 and Figure 4 respectively.

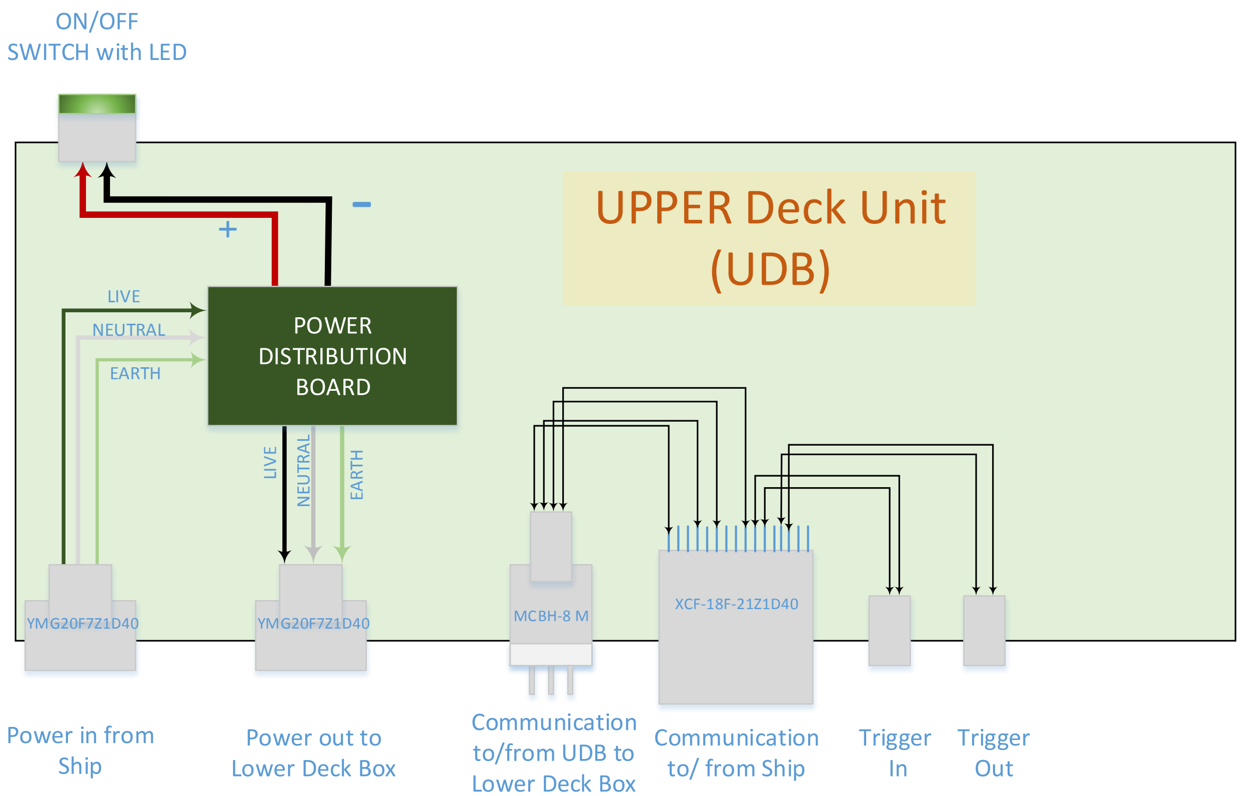


Figure 2. Internal block diagram of the upper deck unit showing the connections between the various connectors. LDB is the lower deck box and UDB is the upper deck box.

- Power Switch: The power switch has an inbuilt Green LED indicating the power on condition and proper working of the system. It has an internal fuse.
- AC power In connector: This connector is used for connecting the AC power from the ship. The input voltage range is from 90 – 240 V AC.
- AC power out Connector: This connector is used for connecting the power from upper deck unit to the lower deck unit (transceiver). The length of the cable is ~ 100m.

- Ship communication Connector: This connector is used for connecting the communication port to the host computer in the ship from the upper deck unit.
- Communication to the Lower Deck Box: This connector is used for communicating from the upper deck unit to the lower deck unit through the host computer. The length of the cable is around 100 m.
- Trigger In – Trigger in connection is a logic +5 V Logic level signal. The input resistance is 1 k Ohm. The BNC connector cable is provided to the user.
- Trigger out – Trigger out connection is a logic +5 V Logic level signal. The BNC connector cable is provided to the user.

The front and the back view of the upper deck box is given below in Figure 3 and Figure 4 respectively.

Figure 3. Front view of the Upper Deck Bos showing the Power on/Off Switch with LED.

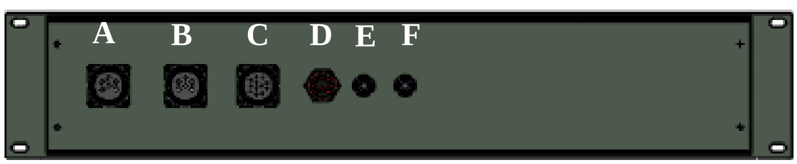


Figure 4. Back view of the Upper deck unit with labels showing the various connectors. A) AC power in from Ship, B) AC Power to Lower Deck Box (LDB), C) Communication from Ship PC, D) Communication cable to Lower Deck Box (LDB), E) Trigger in, F) Trigger out.

2.4 Lower Deck Box (Transceiver unit)

The Lower Deck Box also called as the Transceiver unit or Lower Deck unit contains the ADCP electronics, power and communications to/from the upper deck box, power and communications to/from the transducer, AC to DC converter, power on/off switch w/LED and a fuse box. The lower deck unit acts as a interface between the upper deck unit and the transducer. The length of the cable from the lower deck unit to the transducer is approximately 30 m. The internal block diagram of the lower deck unit is given below in Figure 5.

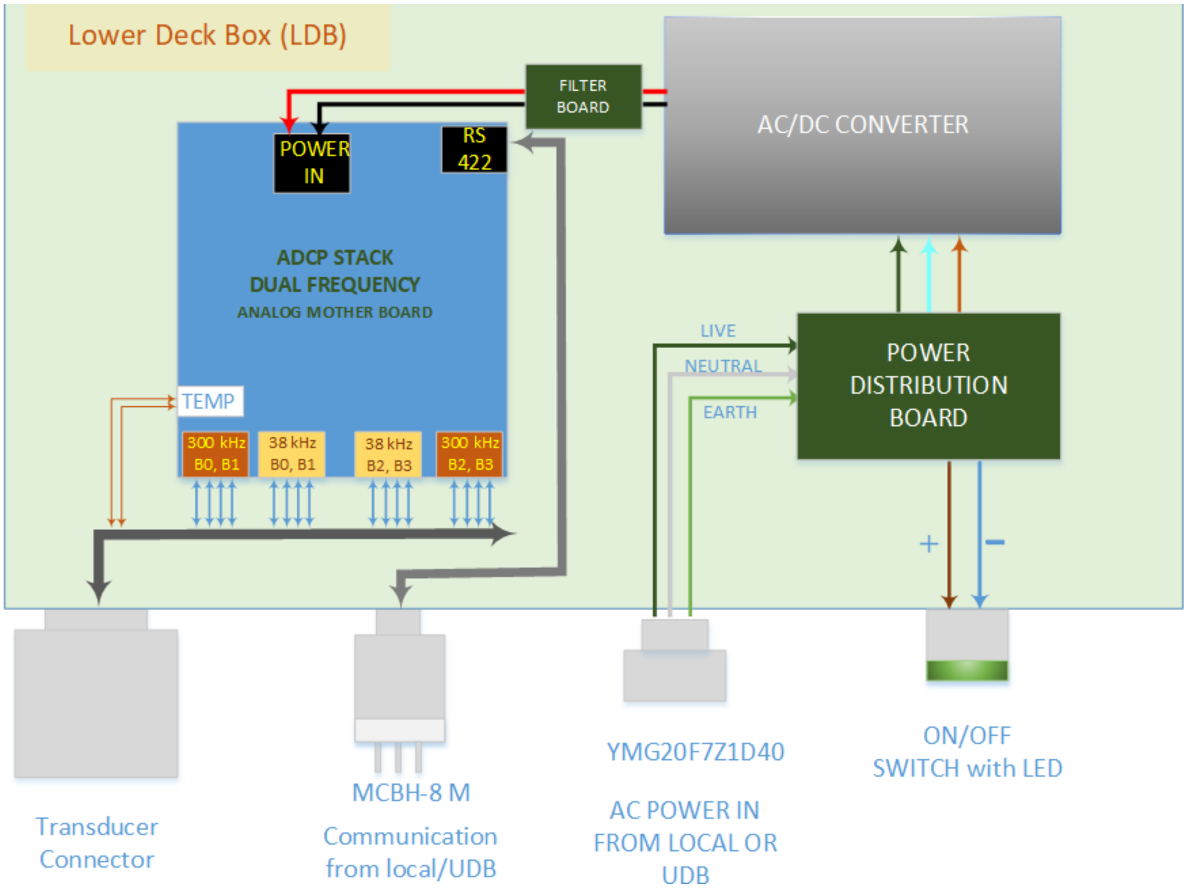


Figure 5. Internal block diagram of the Lower deck box showing the connections between the various interfaces. LDB is the lower deck box and UDB is the upper deck box.

2.4.a Lower Deck Box as Standalone unit

The Lower Deck Box can be used as a Standalone unit without the Upper Deck Box by following these steps,

1. Connect the 2 m AC Power cable from the ship to the Lower Deck unit.
2. Connect the 3 m green communication test cable (provided to the user) into the Lower Deck unit. The other end of the communication cable plugs into the Ship PC through the blue Rs-422 converter box.
3. Connect the 30 m transducer cable into the Lower Deck box.
4. Switch on the Power switch. The green light on the Power switch indicates the system is ON.

Note: The Lower deck unit can also be used as a standalone unit i.e. the power can be directly given to the lower deck unit instead of applying to the Upper deck Box and the test communication cable can be connected to the host computer through the RS 422 converter box (Blue Box) provided to the user. If needed, the upper deck unit and the long power and communication cables (~ 100 m) can be avoided. This is designed for user convenience.

The isometric view of the lower deck box is shown below in Figure 6 below.

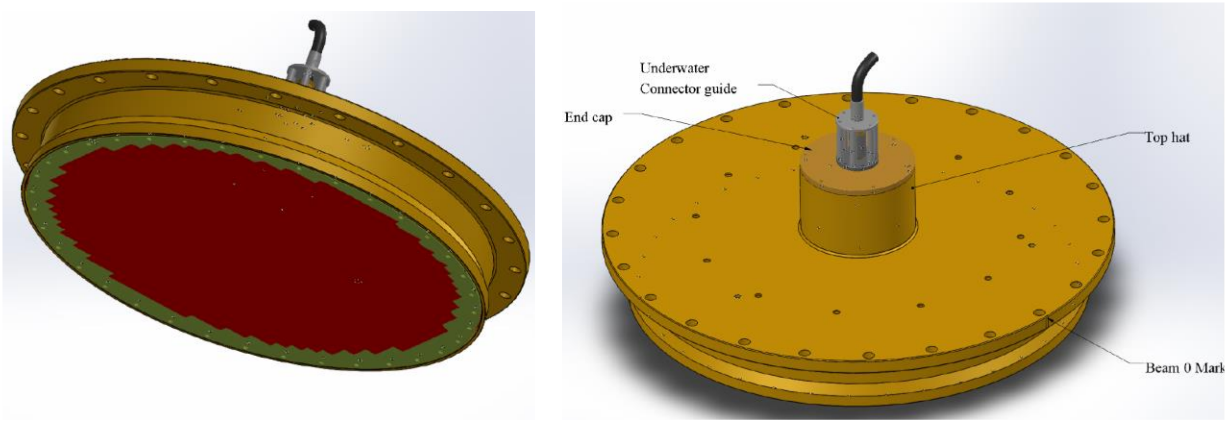
Figure 6. Isometric view of the lower deck box showing the connectors, A) Transducer connector, B) Communication to upper deck box/local computer, C) Power in From upper deck box/ local D) Power on/off switch with LED.

2.5 Transducer

The dual frequency transducer (top view, side view) are shown below in Figure 7 and Figure 8. The transducer operates in two frequencies namely the 38 kHz and 300 kHz. The transducer cable connects the transducer from the lower deck box. Please note the following,

- Beam 0 Mark: The Beam 0 mark is noted on the transducer housing with a notch as shown in Figure 7 and Figure 8 below.
- Transformer Board: The transformer board is mounted on the top hat of the transducer.
- Urethane Encapsulation: The front end of the transducer is encapsulated with red color Polyurethane. Make sure not to set the transducer on a hard surface.
- Housing: The housing material of the transducer is Navy Bronze. Care should be taken to thoroughly clean the transducer regularly every time when it is out of water.

Note: The transducer face is susceptible to be damaged. Care must be taken to avoid placing the transducer on a hard surface. The mechanical features and the hardware required to assemble the transducer is detailed separately in the installation guide section.



(a) (b)

Figure 7 . Vessel Mount Dual-Frequency transducer housing showing the (a) transducer face encapsulated with red colored poly urethane and (b) the top view showing the underwater connector guide, top hat, Beam 0 Mark.

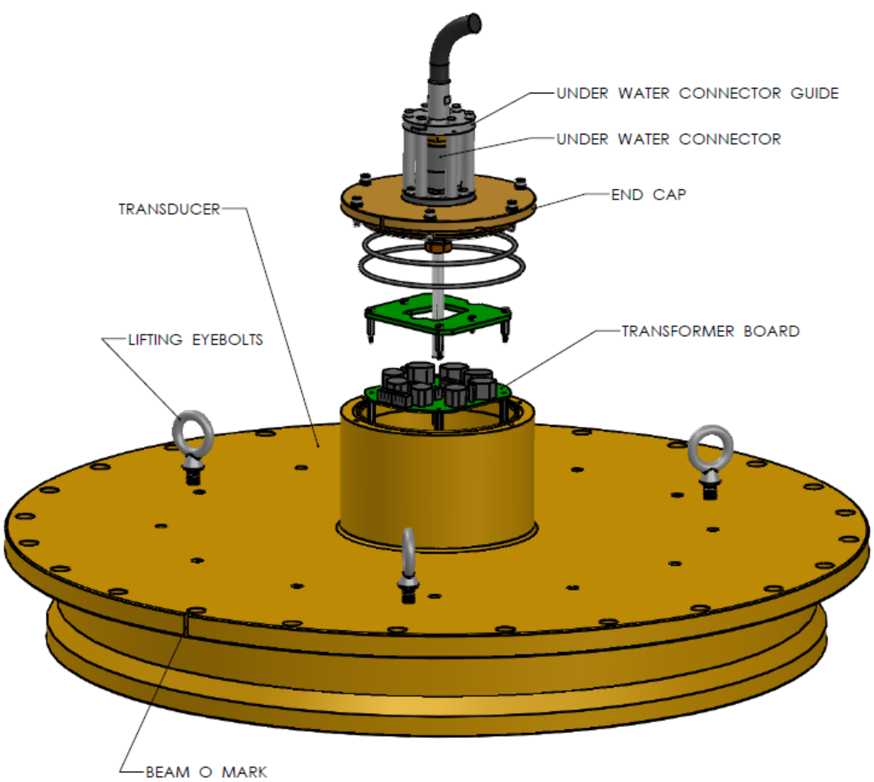


Figure 8. Side view of the Dual Frequency VM transducer in bronze housing with eyebolts used for lifting the transducer and exploded view of the transformer board in the transducer housing. The underwater connector guide (Carriage), underwater connector in the end cap is also shown.

2.6 Connections to the instrument – Upper Deck Box

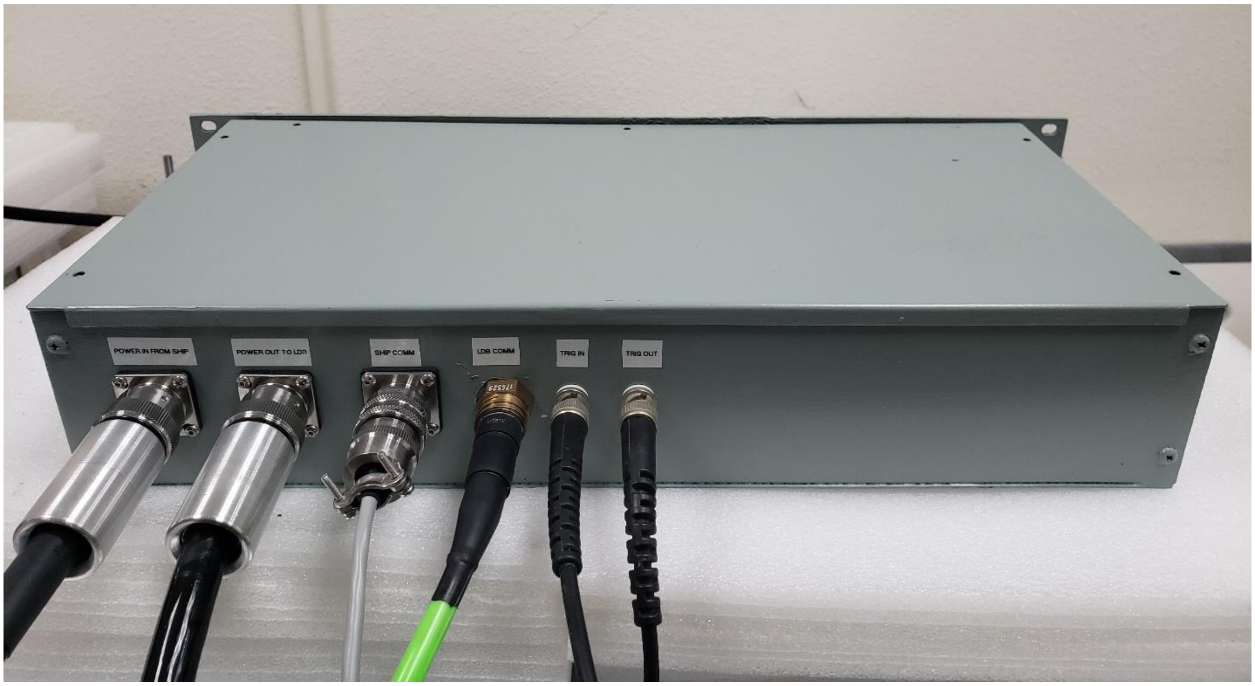


Figure 9. Shows the picture of the Upper deck box with all the connectors inserted.

Note: Do not force the connector to enter. If the connector is not properly seated or if the connector is not going in smoothly, please stop and repeat the process so that connector enters without any problem.

2.7 Connections to SHIP PC

To communicate from the SHIP PC to the VM unit, plug in the female part of the connector of the 2 m connection cable into the Upper deck box. The other side of the communication cable has a terminal block and gets plugged into the RS422 converter as shown in Figure 10. The other end of the RS422 converter blue box has a USB connector that gets plugged into the Ship PC. Please make sure the settings of the RS422 converter are not changed. The other end of the RS 422 converter is connected to the Ship PC.

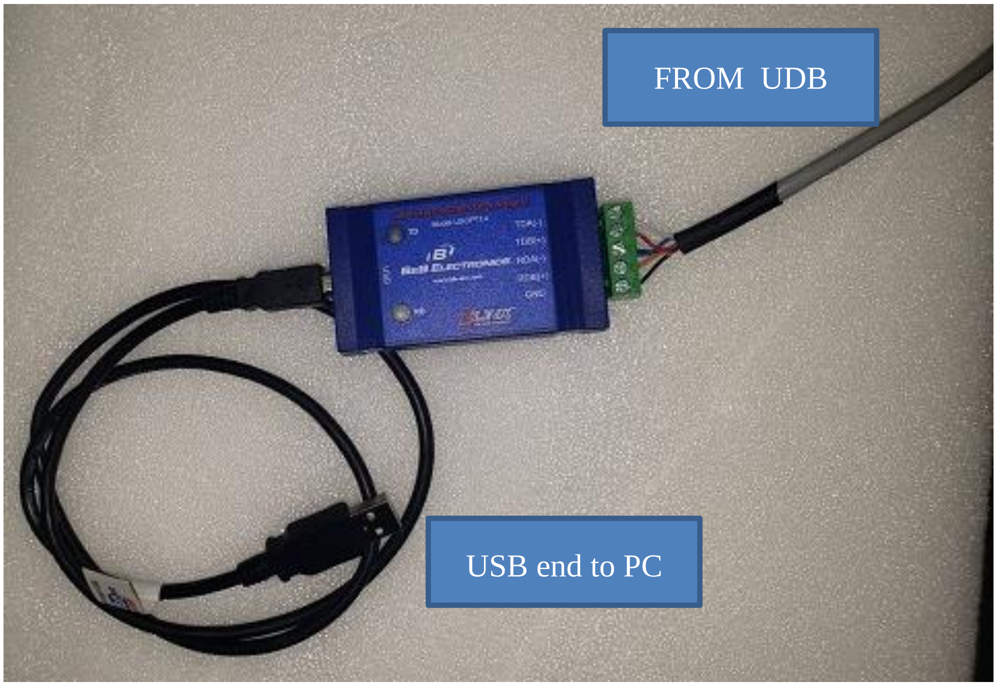


Figure 10. Showing the Blue communication terminal block that connects the Communication cable from the Upper deck box and the PC. The USB end of the terminal block gets plugged into the PC to establish the connection between the Ship PC and ADCP.

Table 3. Vessel Mount Dual Frequency External interfaces

RS 422 (Standard) **Terminal Block**	**a. 8 bit, No Parity, 115200 Baud (can go higher for short distances)** **b. Full Duplex** **c. Good noise immunity** **d. Long distances (20 m)**
Power	240 V AC
TRIG Out	Trigger output line from VM-DF Upper Deck Box
TRIG IN	Trigger input line from VM-DF Upper Deck Box

2.8 Connections on the Lower Deck Box

CONNECTIONS PART 2 - LOWER DECK BOX

Figure 11: Side View of the Lower Deck Box showing the Transducer Connector, RS-422 Communication to Upper deck box/local PC, power input from the Upper Deck Box/ Local, input power, Power Switch with LED.

Note: An optional 3 m communication cable is also available for connecting to the Lower Deck Box directly to the Ship PC for debugging and testing the Lower Deck Box and the transducer without the Upper Deck Box and the 100 m communication cable. Make sure to also connect the 2 m power cable locally into the Lower Deck Box if the user wants to operate the system with the Lower Deck Box and the transducer without the use of the Upper Deck Box.

Note: The Lower Deck Box can also be used as a standalone unit by inserting the 2 m power cable into the Lower deck box, without the Upper Deck Box and the 100 m power and communication cable. Make sure to also connect the 3 m communication test cable locally into the Lower Deck Box.

Figure 12: This picture shows the cables connected to the Lower Deck Box. The Power Switch is also shown.

Note: Do not force the connector to enter. If the connector is not properly seated or if the connector is not going in smoothly, please stop and repeat the process so that connector enters without any problem.

2.9 Connections to Vessel Mount Transducer

Figure 13: shows the transducer cable inserted into the female connector on the transducer endcap.

2.10 Installation Guidelines

2.10.a Transducer outline drawing

The transducer outline drawing is provided below.

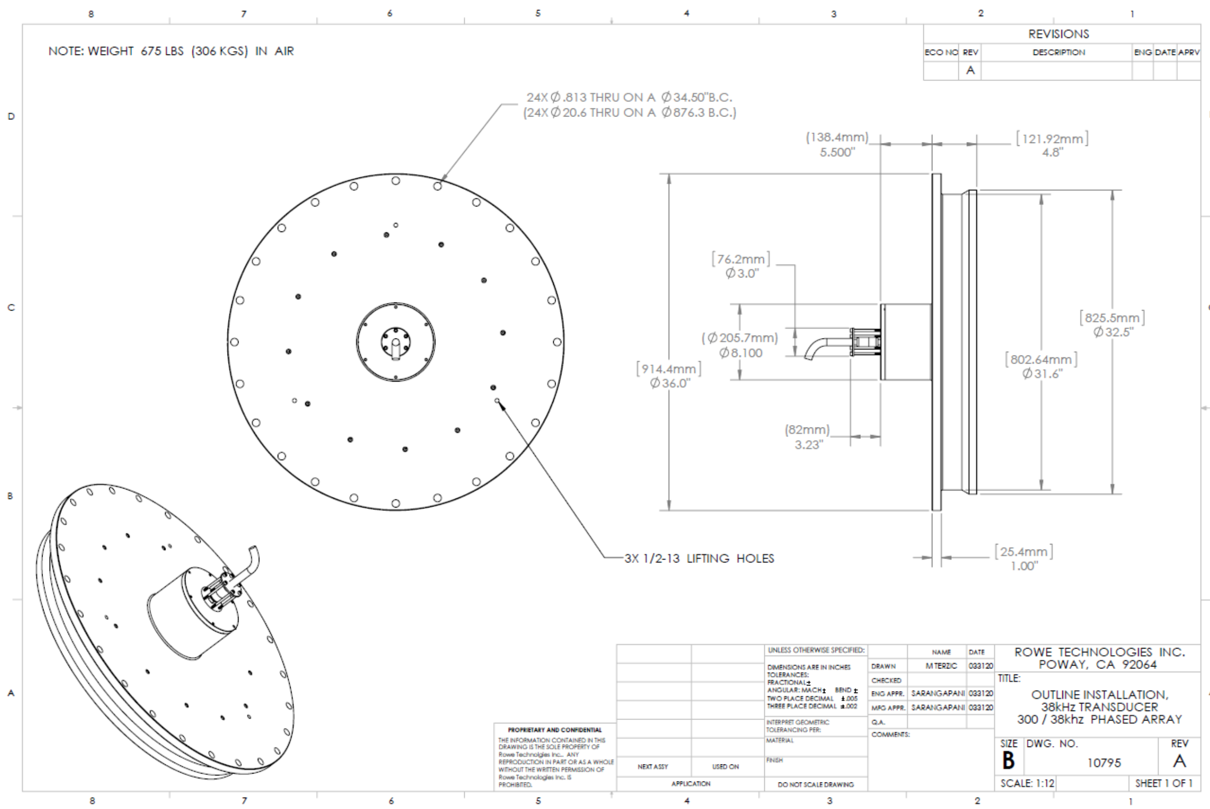


Figure 14. Transducer outline drawing

✖ Note:

NEVER START pinging the SEA Surveyor with the transducer in air. This will cause the high-power transmitter to short across the transducer and damage the Dual Frequency VM transducer.

2.10.b Using Mechanical Isolators

RTI recommends using the mechanical isolators for installing the VM unit on the ship. The isolators purpose is to reduce/prevent the mechanical vibrations to not couple to the transducer. An illustration of the use of isolators is also given in Figure 15 and Figure 16.

Note:

The isolators are not provided with the unit. Two samples of the isolators are provided as an example along with the shipping package for reference.

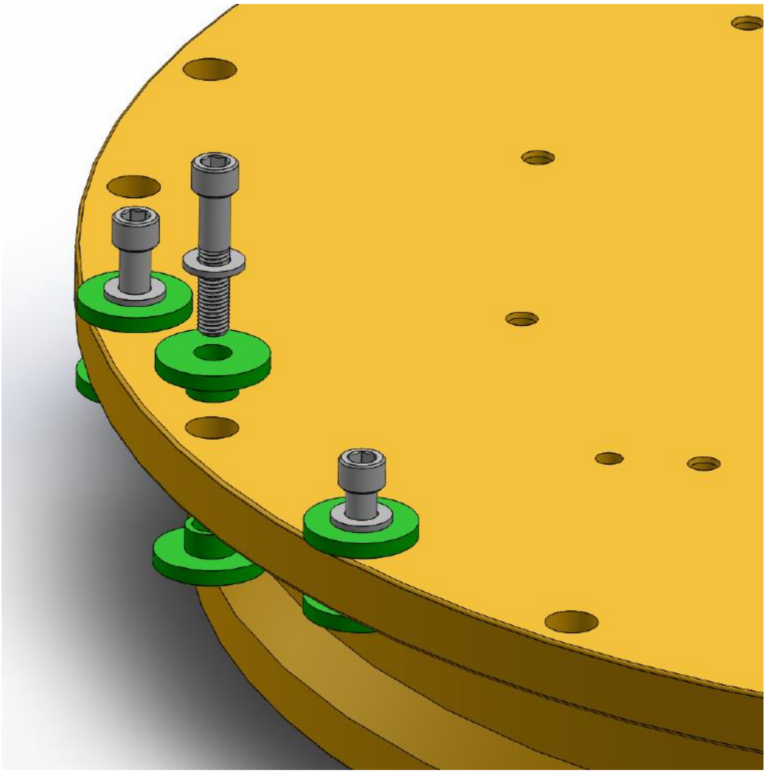


Figure 15. Illustration of the mechanical isolators (green) used in the VM unit. The purpose of the isolators is to isolate or reduce the noise coupling to the transducer.

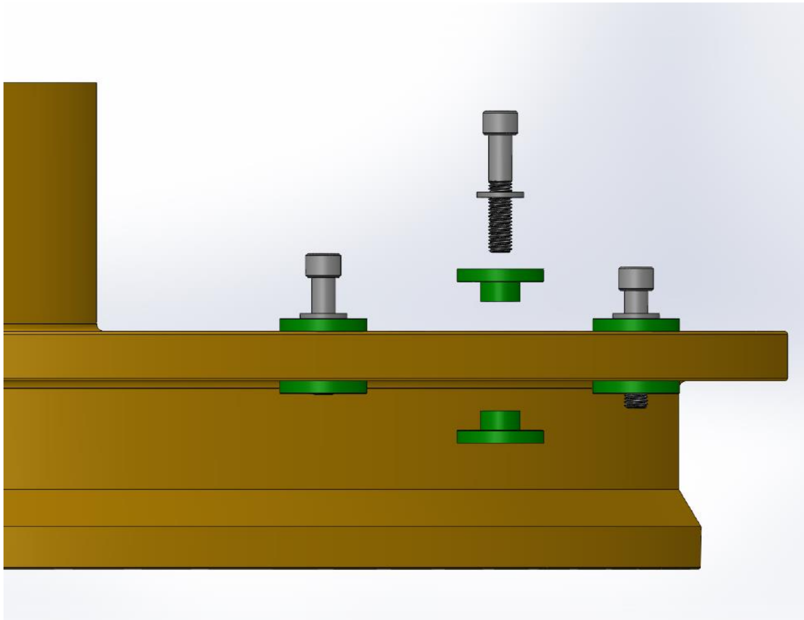


Figure 16. Side view of the illustration of the isolators used in the VM unit on top and bottom side.

2.11 Periodic maintenance

1. Make sure to clean the face of the transducer after the deployment to prevent any barnacle contamination.
2. Make sure to clean the transducer housing with fresh water – to prevent any salt deposition on its surface after each use.
3. Make sure to not damage the face of the transducer – make sure the face is protected.
4. The structural integrity of cables and connectors are also important, be sure to there are no cuts or cracks in the cable or connectors. It is important to make sure that when reassembling the system that the nuts and bolts are tightened sufficiently. In addition, it is essential that all O-rings are properly greased and seated in the groove found in the transducer head.
5. Cable Connections – Be certain that all the cables are properly connected as outlined in Section 2.14. When using a wet-mateable connection, be sure to first mate the connectors completely and then tighten the locking sleeve. This is the proper procedure for wet-mateable connections (Do not connect the wet-mateable connectors partially and then use the locking sleeve to tighten – this will not provide an adequate seal for the connector).
6. Replacing the O-rings. Care must be taken to replace the O-rings in the End cap.
7. Please also refer to Sections 7 and 8.

2.12 System Interconnection Block diagram

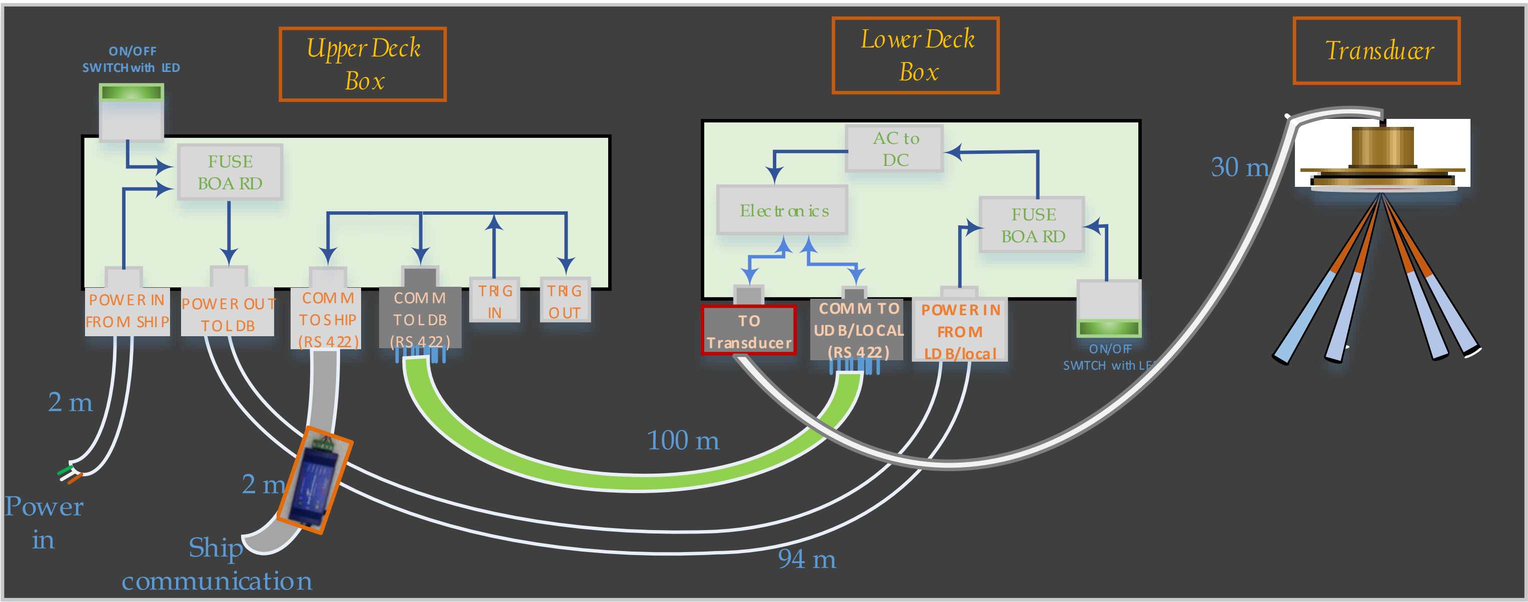


Figure 17. System Block diagram with Interconnections showing the different blocks and connections in the VM-DF ADCP system.

2.13 System Work Flow

1. Connect the 100 m Power cable from upper deck box to Lower deck box.
2. Connect the 100 m Communication cable from upper deck box to Lower deck box.
3. Connect the 30 m Transducer cable from the lower deck box to transducer. Make sure to use the transducer connector carriage to secure the transducer cable to the end-cap of the VM housing as explained in Section 2.9
4. Make sure the communication cable is connected to the Upper Deck Box from Ship PC through the blue RS422 converter block as shown in Figure 10.
5. The electronics stack for the ADCP are in the Lower Deck box.
6. Power is given to the Upper Deck box from the ship.
7. Press the Green LED button to turn on the Upper deck box. The light on the deck box indicate Switch ON.
8. Press the Green LED button to turn on the Lower deck box. The light on the deck box indicate Switch ON.
9. Use the software “CONNECT” page to connect to the instrument.
10. After following the procedure in the software section, open the “DEPLOY” page in the software to start/stop the ADCP.
11. The data can be viewed live in the “LIVE DATA” display in the software.

2.14 Cables

From the system interconnection block diagram of the VM unit in Figure 17, there are 5 cables namely,

1. 2 m Communication cable from Ship to Upper deck box. (Make sure to plug in the RS422 converter box from the Ship PC. One side of the converter box connects to the Ship PC and the other side of the converter box connects to the communication cable).
2. 2m Power cable from the ship to Upper deck box.
3. 100 m Communication cable between Upper deck box to Lower Deck box.
4. 100 m Power cable from Upper deck box to Lower Deck box.
5. 30 m Transducer cable from Lower deck box to Dual Frequency VM transducer.

Extra cables provided

1. Communication test cable (3 m) that can be directly connected to the Lower deck box for troubleshooting/debugging the instrument.
2. 10 m transducer cable.

3 Getting Started with Software

This chapter details the installing the required drivers, connecting to the instrument and installation of the software and using the software to plan, connect, view LIVE data and deploy the instrument. We strongly recommend to read all of the provided documentation.

3.1 Installing USB device software on PC

The steps for installing the USB device driver software are listed below sequentially and RTI recommends that the user follows the steps below in this order.

3.1.a Step1: Installing Driver

The first step before connecting to the RTI-VM is to make sure that the driver for the serial communications between the between the PC and the RTI-VM is installed. The driver can be found on the small CD in the box provided in the shipping case or at the following link:

http://www.bb-elec.com/getattachment/c8461811-bebf-456a-8386-6ea1281219b4/USB_Drivers_PKG_v2-08-28.zip.aspx

Follow the instructions provided on the screen to install the driver.

3.1.b Step 2: Verify COM port

To verify, insert the USB - Serial Converter into a USB port. Next go to the Control Panel and in the Device Manager menu expand the Ports menu to the COM port. The USB to serial converter should be identified as the following:

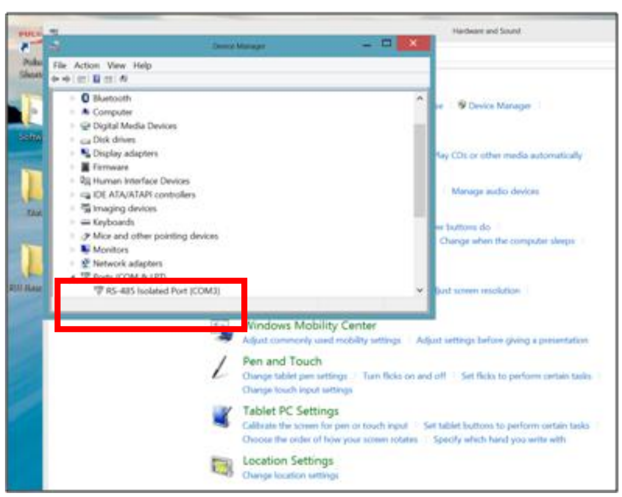


Figure 18. RS 485 Isolated COM Port setup.

This is indicated by the red box in the screen shot above. This is the COM port that the users should use to connect to the RTI-VM.

3.1.c Step 3: RTI-VM Connection to Ship PC

Connect the keyed green five-pin connector on the instrument communication cable to the USB-Serial RS 422 adaptor. The serial adapter is preset to Rs422 connections. Make sure to not change the settings on the RS422 adapter. Insert the USB connector into a USB port on the PC

3.1.d Step 4. Connecting to the Instrument via Software

Once all of the instrument interconnections are completed, open the RTI-VM Software to communicate with the ADCP.

3.2 Introduction to Software

3.2.a Introduction

RTI-VM (Vessel Mount) is a software for planning, deploying an RTI ADCP system, and for collecting and displaying the data collected by RTI's VM-ADCP. This user guide is designed to help users get familiar with the software. The home page of the software is given in Figure 19.

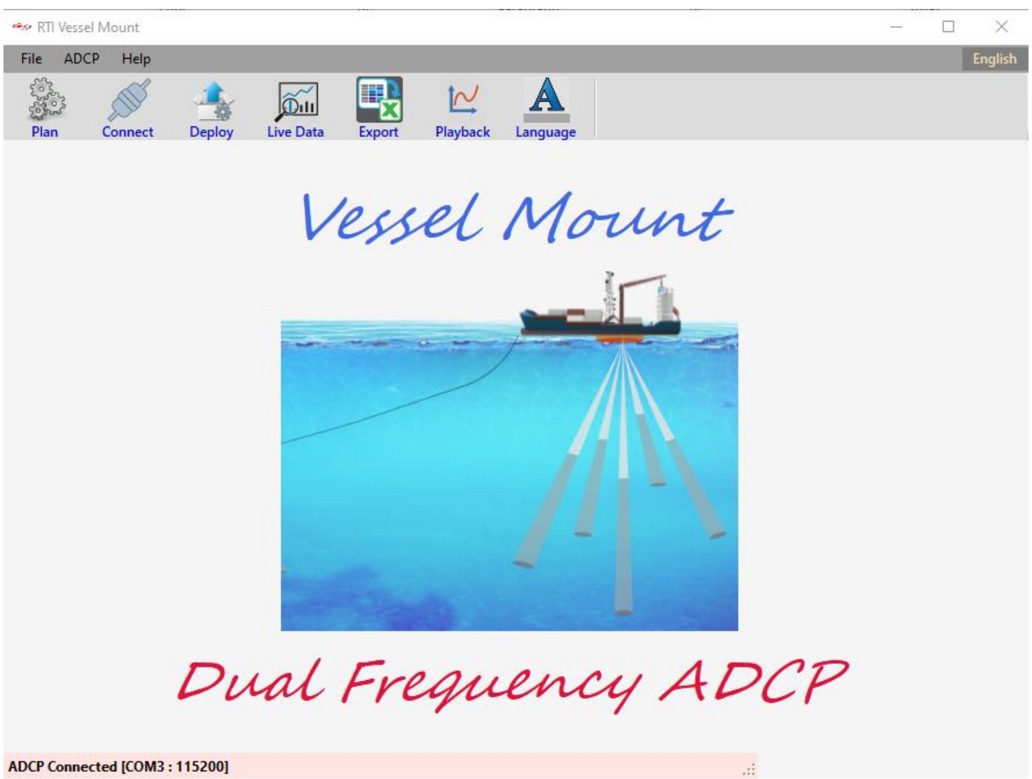


Figure 19. RTI-VM Home Page

There are six main functions of the RTI-VM software as shown in Figure 19 and are listed below.

- **Plan**: Planning a configuration to set up ADCP.
- **Connect**: Connect to ADCP and other available sensors (up to three) using serial ports
- **Deploy**: Final check, start/stop the ADCP.
- **Live Data**: Graphic display of ADCP live data
- **Export**: Export RTI Binary data to CSV format
- **Playback**: Display and post-processing of the data.

The details for each function will be elaborated later in the user guide. The functional diagram is shown in Figure 20. From the home page, the user can navigate to **Plan**, **Connect**, **Deploy**, or **Playback** and **Export** the data.

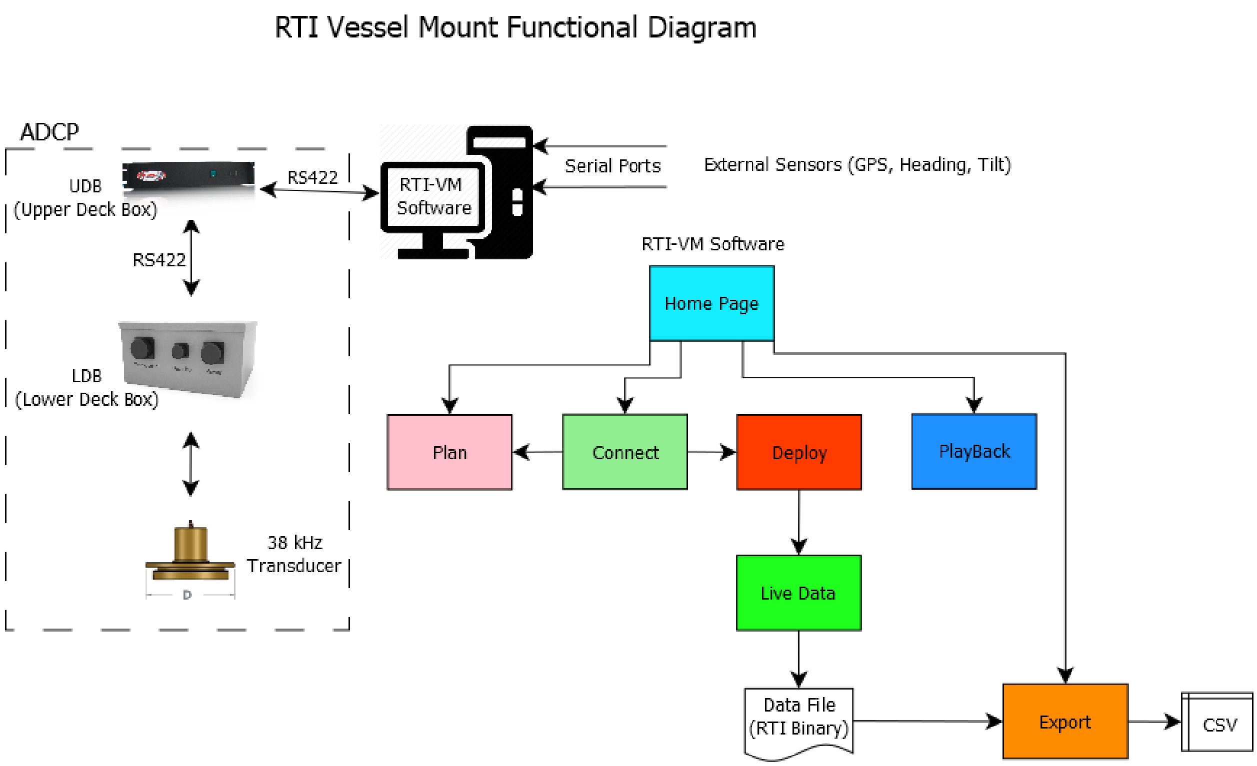


Figure 20. RTI Vessel Mount Functional Diagram

The RTI-VM software running on the PC communicates with the ADCP through serial port RS422, and receives external sensor (GPS, Heading and Tilt) data through other serial ports if available. While the RTI-VM software is running on a PC, the user can have three options: Planning a deployment, Playing back or Exporting the data, or Connect to ADCP and deploy a system. The first two options do not require an ADCP, while the third option requires the ADCP connected to the PC. When RTI-VM is started, the software will first try to setup the serial ports based on user last time configuration of the software and will try to communicate with the ADCP using this configuration. If no user setup is available, the software will just choose the first available COM port on the PC as the ADCP port. The ADCP status will show if it is connected as shown in Figure 19 bottom left. The user can change the serial ports settings in the Connect page of the software by Clicking the **Connect** button. If ADCP is connected, the **Deploy** button and the **LiveData** button will be enabled, and the user can start deploying the system by using the Deploy page and view the live data in the LiveData window. If software is not connected to the ADCP, these two buttons will be disabled.

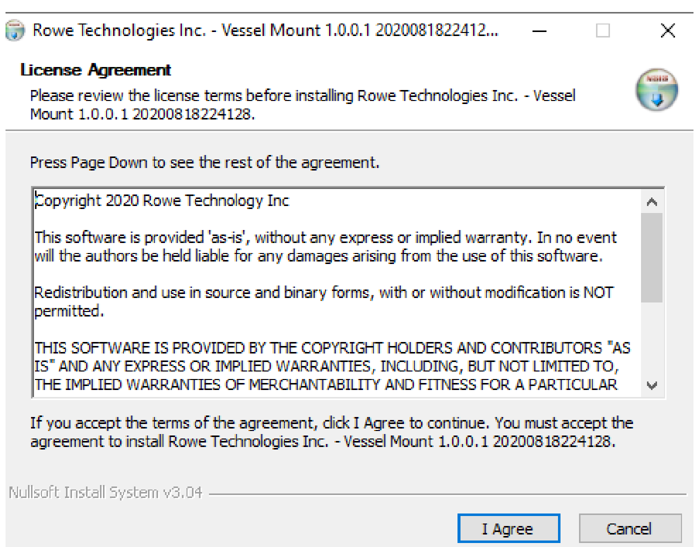
3.3 System Requirements

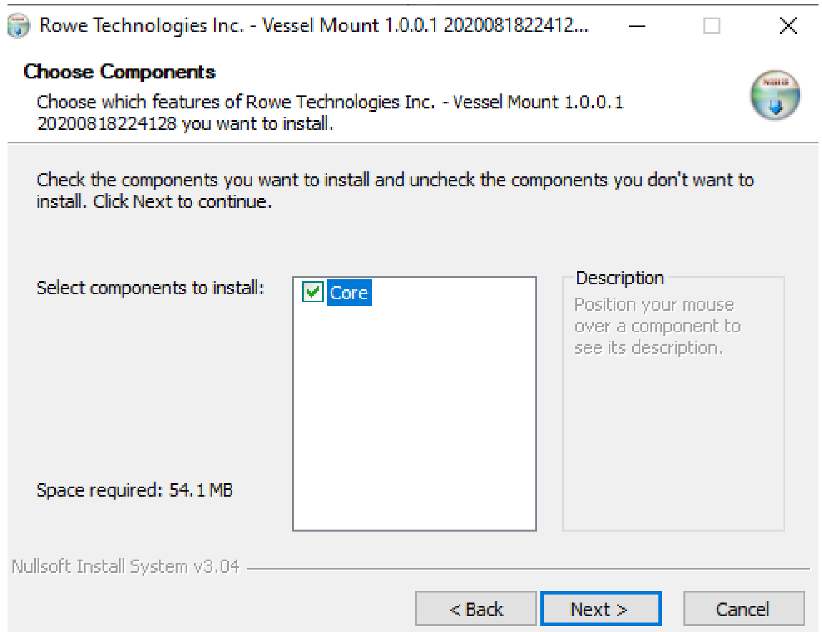
RTI-VM for PC requires the following specifications for the PC:

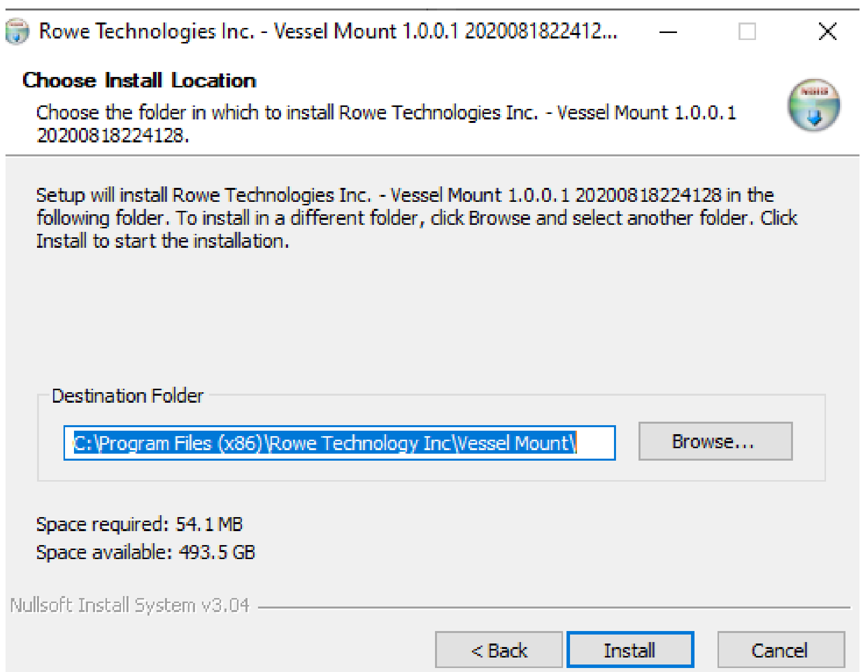
Windows Vista or newer with .NET framework 4.7
1 GHz processor or faster
1 GB RAM
1 GB hard disk space
1024 x 768 or higher screen resolution

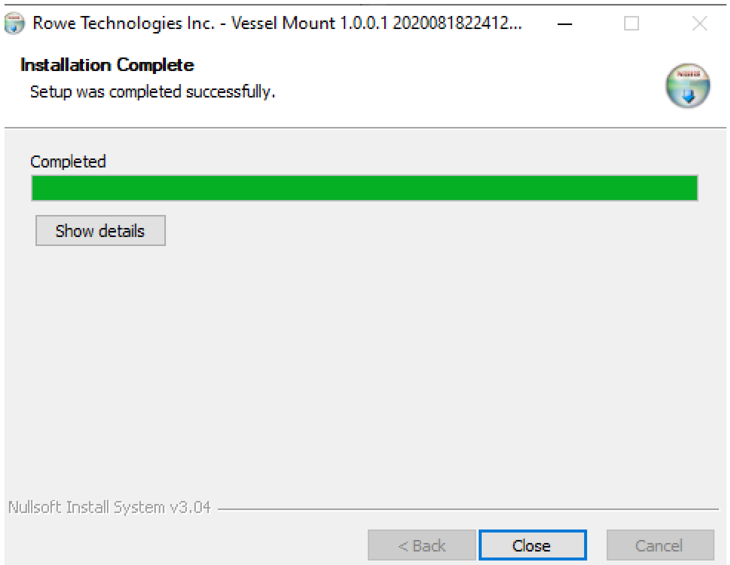
3.4 Software Installation

To install the RTI-VM software on the PC, run the installer provided to the user on a USB. (VesselMount.x.x.x.x_Installer_(xxxx).exe). Follow the installation wizard instructions and keep the default settings. This will install the software and create a working directory "\RTI\Vessel Mount" for the software under the current login user's Documents. This will be the default directory for the users to save the configuration files and data files. After installing the software, a shortcut icon of the "Vessel Mount" software icon will be on the desktop. Double click the icon to start the RTI-VM program. You are ready to go!




Rowe Technologies Inc. - Vessel Mount 1.0.0.1 2020081822412...
Choose Components
Choose which features of Rowe Technologies Inc. - Vessel Mount 1.0.0.1 20200818224128 you want to install.
Check the components you want to install and uncheck the components you don't want to install. Click Next to continue.
Select components to install:
Core
Description
Position your mouse over a component to see its description.
Space required: 54.1 MB
Nullsoft Install System v3.04
< Back
Next >
Cancel


Rowe Technologies Inc. - Vessel Mount 1.0.0.1 2020081822412...
Choose Install Location
Choose the folder in which to install Rowe Technologies Inc. - Vessel Mount 1.0.0.1 20200818224128.
Setup will install Rowe Technologies Inc. - Vessel Mount 1.0.0.1 20200818224128 in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installation.
Destination Folder
C:\Program Files (x86)\Rowe Technology Inc\Vessel Mount\
Browse...
Space required: 54.1 MB
Space available: 493.5 GB
Nullsoft Install System v3.04
< Back
Install
Cancel



3.5 Plan - Planning a deployment

There are three steps to plan the ADCP for a successful deployment namely, Select an Instrument, Set up Sensors, and Set up ADCP Parameters.

3.5.a Select an Instrument

The first step is to choose an ADCP for the deployment from the Instrument table. The instrument table shows all the RTI ADCP3 products that are designed and developed to operate from a frequency range of 38 kHz to 2.4 MHz with single and dual frequency mode of operation. The transducer type can be piston or phased array, size can be large or small. The information button icon on the right top corner of the table explains the names of the instruments (Figure 21).

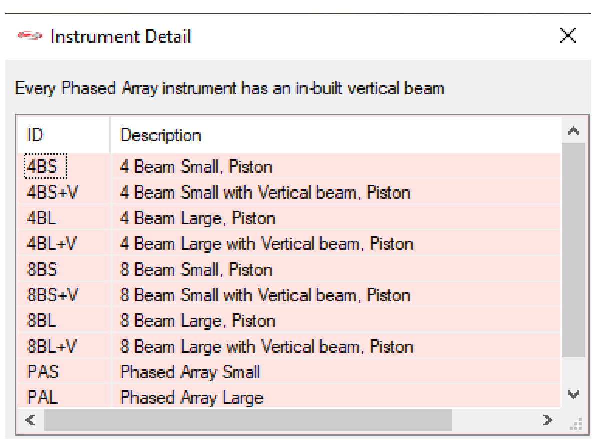


Figure 21. Instrument Description

Once the instrument is selected, the user can use the "Next" button or the steps buttons listed on left hand side to go to next page.

After selecting an ADCP from the table, the selected ADCP information such as subsystems, frequency, transducer type etc. and the default ADCP settings along with the predicted performance results will be shown in the Summary column on the right side of the window (Figure 22).

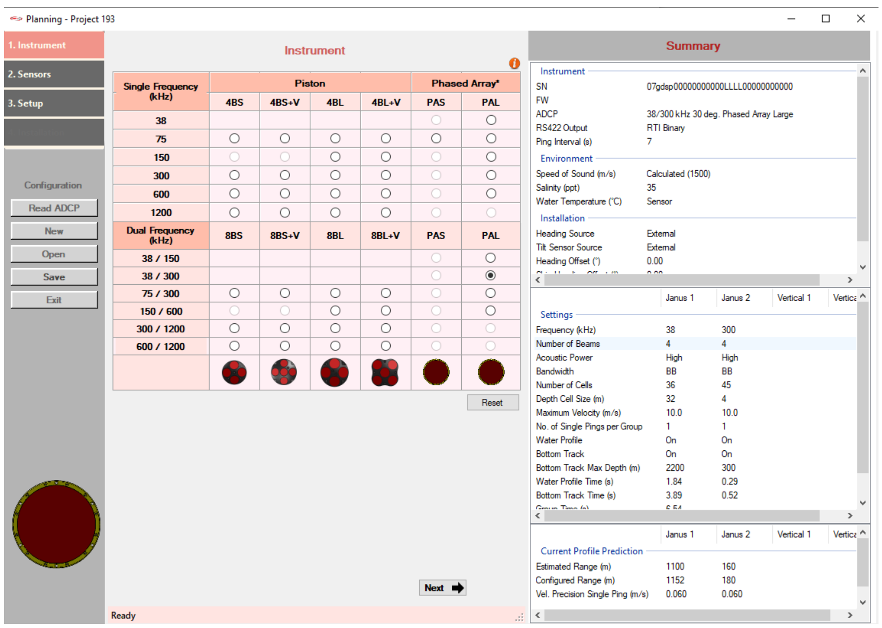


Figure 22. Planning – Select Instrument

3.5.b Set up Sensors

The Sensors page (as shown in Figure 23) is used to set up sensor source and environmental parameters for the deployment such as Speed of Sound, Salinity, Heading and Tilt Source etc.

a. **Water Temperature**: Select to read water temperature through Internal Sensor or User Input.
b. **Salinity**: Select the salinity.
   The salinity of 0 is for fresh water, 35 for ocean or saltwater, or any other user-input value between 0 and 35 ppt.

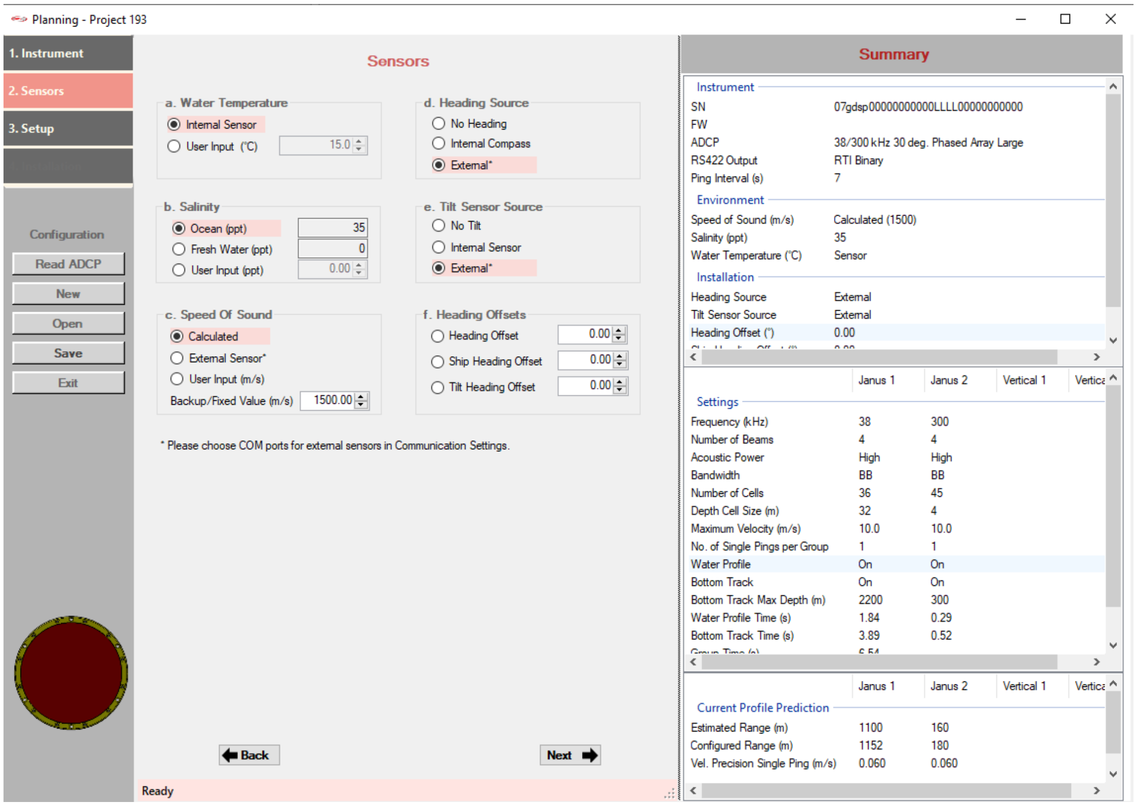


Figure 23. Planning – Sensors

c. **Speed Of Sound**: Set the speed of sound value used for ADCP data processing. The speed of sound values is used by ADCP to scale velocity data, depth cell size and range to the bottom, etc.

- Calculated: ADCP calculates speed of sound using the values of measured transducer depth, water temperature and salinity. The following equation is used to compute the speed of sound:

$$C = 1449.2 + 4.6T - 0.055T^2 + 0.00029T^3 + (1.34 - 0.01T) * (S - 35) + 0.016D$$

where:

T is the temperature in °C

S is salinity in parts per thousand

D is the depth in meters

- External Sensor: use an external device for the value of speed of sound.
- User Input: a fixed value of speed of sound (in meters per second) input by the user.

The Backup / Fixed value is necessary in situations when none of the three above options are available.

d. **Heading Source**: Select the heading source for ENU transformations.

- No Heading: means there is no heading data available.

- Internal Compass: the heading data is from an internal compass reading.
- External: ADCP will use the heading data obtained from an external GPS's $xxHDT string. If this is chosen, the user should set up the serial port and baud rate for the heading sensor in the "Connect" page. This is default value for the VM applications.

e. **Tilt Sensor Source**: Selects the tilt source for ENU transformations.
  - No Tilt.
  - Internal Sensor: uses the tilt data from an internal compass reading.
  - External: tilt data will be obtained from an external tilt sensor through a serial port. If this is chosen, the user should set up the serial port and baud rate for the tilt sensor in the "Connect" page. This is default value for the VM applications.

f. **Heading Offsets**: Sets the heading offsets.
  - Heading Offset (+/-180 deg): the offset that is used to correct the heading that ADCP has either from ADCP's PNI compass or from user's GPS heading. This offset will be added to the compass or GPS heading prior to being used within the system and then output.
  - Ship Heading Offset (+/-180 deg): system to ship heading offset. This will align the instrument axes and the ship axes.
  - Tilt Heading Offset (+/-180 deg): system to PNI compass tilt heading offset. This will align ADCP Beam 0 and the PNI compass tilt axes.

The choice for offsets to use and how to use these offsets depends on the real applications. Following are the applications that show how to set these offsets:

Application 1. Uses PNI compass for magnetic north (SC or DR).

In this application, all these offsets should be set to 0 (ZERO). The PNI heading will be the heading that will be used in system data processing and outputting.

Application 2. Same as Application 1 but need to correct declination.

In this case, use Heading Offset for correcting the declination.

Application 3. PNI compass is not aligned with ADCP Beam 0.

In this case, use Tilt Heading Offset to align PNI compass tilt axes and ADCP axes.

Application 4. Uses external heading devices either GPS or GYRO for heading.

In this case, use Heading Offset to line up ADCP instrument to North.

Application 5. ADCP is mounted on a ship but not aligned.

In this case, use Ship Heading Offset to line up ADCP instrument axes and the ship axes.

3.5.c Set up ADCP Parameters

The last step is to set up the ADCP parameters for the deployment including water profile ping parameters and bottom track ping parameters. A predicted performance of the setting is calculated based on the parameter values chosen by the user. The Setup page is shown in Figure 24.

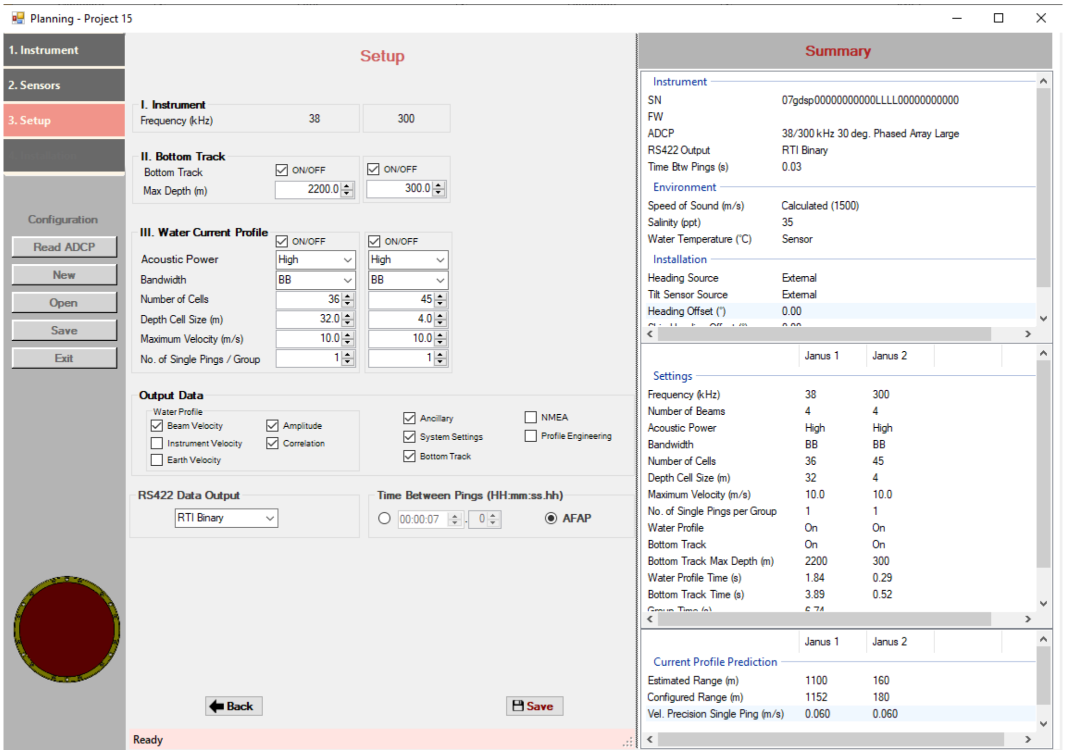


Figure 24. Planning - Setup ADCP parameters

3.5.c.i Instrument

This shows the instrument subsystem frequencies (kHz) of the selected instrument. The frequency is only for display purpose.

3.5.c.ii Bottom Track

To setup the bottom track ping parameters for each frequency.

- **Bottom Track**: to turn ON and OFF bottom track for that frequency
- **Max Depth (*m*)**: set the maximum depth in meters to search for the bottom. Setting up the appropriate depth value will reduce the amount of time in the search algorithm.

3.5.c.iii Water Current Profile (WP)

This is the place to setup ADCP parameters for water current profile pings including acoustic power, bandwidth, bin number, bin size, maximum velocity, number of single pings per group. For each subsystem, the user can choose to turn on and off the water current profile ping by checking/unchecking the ON/OFF checkbox on top of each frequency.

- Water Profile **ON/OFF**: to turn ON / OFF water current profile ping for each frequency. In the column of each frequency's setup, if the ON/OFF checkbox is checked, the water profile ping for that frequency is turned on, and all the water profile ping parameters in that frequency column will be enabled, otherwise, all the water profile ping parameters for that frequency will be disabled.

- **Acoustic Power**: set the transmit power for the WP pings. There are four levels of the power options available: High, Medium 1, Medium 2, and Low. Please note, for 38 kHz phased array, there is only one option “High” power.
- **Bandwidth**: the bandwidth of water profile ping. For Piston ADCPs, there are three bandwidth options:
    - Broadband Wide (BBW): 25 % of the operating frequency
    - Broadband Narrow (BBN): 6.25 % of the operating frequency
    - Narrowband (NB) – Typically less than 1.5 % of the operating frequency.

  For Phased Array ADCPs, there are only two options to select: Broadband (BB, 6%) and Narrowband (NB).

- **Number of Cells**: the number of depth cells.
- **Depth Cell Size (*m*)**: the vertical cell size of individual cells in the profile, in meters.
- **Maximum Velocity (*m/s*):** the maximum current velocity that can be measured in the profile. For the VM system, 10.0 m/s is set by default.
- **No. of Single Pings Per Group**: number of single pings in each subsystem. The limit for low frequency is 2 and the limit for high frequency is 4.

3.5.c.iv Output Data

This section is to choose data type that is to be included in the ensemble and will get outputted from ADCP. In the RTI binary format, data types will be stored in the specific part of the RTI data ensemble identified by its unique 7 digits ID in the format of E0000XX. Usually the default setups should work.

1) Water current profile data
    - Beam velocity (E000001)
    - Instrument velocity (E000002)
    - Earth velocity (E000003)
    - Amplitude (E000004)
    - Correlation (E000005)

Note: The default data output does not include Instrument Velocity (E000002) and Earth Velocity (E000003) data set for VM applications. They will be available in the processed data ensemble after coordinate transformation is applied. After coordinate transformation, the processed data ensemble will also have two new data sets: Ship Velocity (E000020) and Good Ship Ping (E000021). Please refer to Section 3.10 Playback – Display and process the data for detailed information about coordinate transformation.

2) Bottom track data
    - Bottom track (E000010)
3) System settings and ancillary information of ensemble
    - Ensemble (E000008)

- Ancillary (E000009)
- System setup (E000014)
- NMEA (E000011)

4) Engineering data
    - Profile engineering (E000012)

3.5.c.v RS422 Data Output

To select the data format that are outputted from ADCP to PC through RS422 port. There are seven options to choose (default RTI Binary):

- Disable
- RTI Binary
- ASCII
- PD0 Beam
- PD0 XYZ
- PD0 ENU
- PD0 SFM

3.5.c.vi Time between Pings

The time interval (in seconds) between pings. It's in the format of *HH:mm:ss.hh*. There are two options: select exact value for the time between pings, or set it ping as fast as possible (AFAP). For the first option, the values of time between pings cannot be less than group time shown in the "Settings" of Summary. For the second option, the time between pings will be set to minimum (0.03 sec).

3.5.c.vii Current Profile Prediction

The Summary section of Planning reflects the current user settings for a deployment and the predicted performance of the deployment based on the user settings. Any changes of the instrument and parameter values in the planning will result in the Summary. It is recommended that the user to check the performance results during planning, to make sure the configuration of the ADCP better serves the goal of deployment.

The following content items are for water current profile pings.

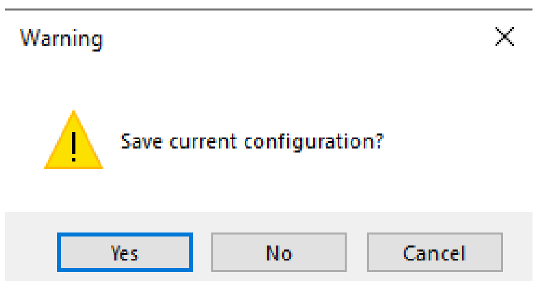
- **Estimated Range (*m*):** the default profiling range for the selected bandwidth, acoustic power and bin size for the frequency.
- **Configured Range (*m*)**: the user configured range for selected frequency, equals to bin size times number of bins.
  Note that, the configured range can be greater than the estimated range.
- **Vel. Precision Single Ping (*m/s*)**: velocity standard deviation of single ping based on the setup for current profile.

3.5.c.viii Button Functions

The buttons on the left side column are functions the user can use in planning of a deployment:

- **Read ADCP**: This button enables the user to read the configuration from the ADCP to the Planning page when the ADCP is connected. RTI-VM software will first try to connect to the ADCP by checking the serial port setup in the "Connect" page, if it couldn't find one is available, it will search all the available serial ports on the computer until it found one or there is no one that is available for ADCP connection. The status of searching will be shown in the status bar on the bottom of the page.
- **New**: Open a new Planning window to start a new planning.
- **Open**: Open an existing deployment configuration file (in .json format) that is saved on PC, display the configuration in Planning.
- **Save**: save the current settings to a .json file.
- **Exit**: Exit the Planning window.

Note: Before the user "Open" a different configuration or "Exit", the Planning window, the software will pop up a window asking if you want to save the current configuration. This will give the user a chance to save the current planning work before closing the window by accident. Similar pop-up window will happen when the user tries to Close the Planning window.



The **Next** and **Back** buttons on the bottom of each page in **Planning** will guide the user through the three different pages. The user can also use the three step buttons on the top left corner of **Planning** to switch between pages. The **Save** button on the Setup page will also save the planned settings into a file.

3.6 Connect – Connect to the system

The ADCP and external devices such as GPS, Heading and Tilt sensors are typically connected to a PC through the serial ports. The "Connect" page is to set up the serial ports and monitor the serial connection status while the program is running (as shown in Figure 25). There is a single ADCP port that is dedicated to ADCP and three NMEA ports (NMEA 1 – 3) for users to connect to the external GPS, Heading and/or Tilt sensors. If connected, these ports will show the data on screen. Appropriate COM port and baud rate must be selected to see the data displayed on screen. Click the "Scan" button to refresh the available serial ports in the "COM Port" dropdown list.

There are three main connection status based on the connection of the ADCP, namely, Connected, Connected & pinging, and Not connected.

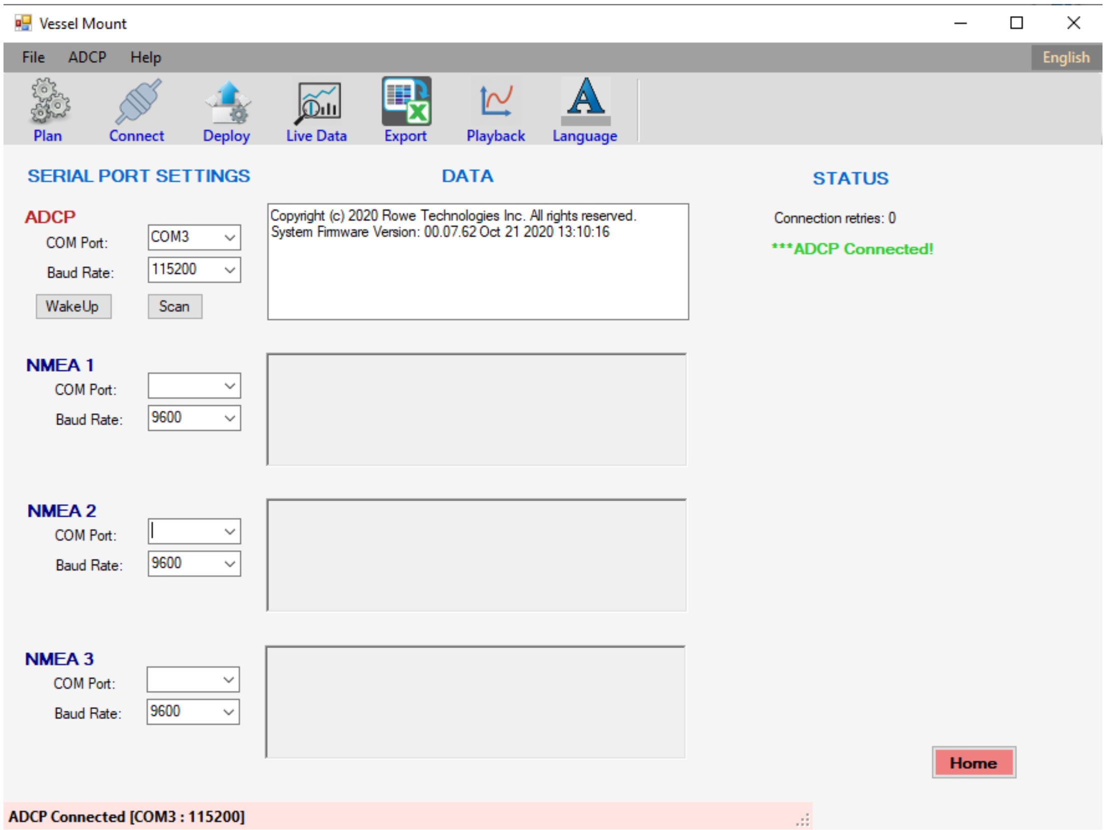


Figure 25. Connect Page

The RTI-VM program will continuously check the connection of all the serial ports and update the status accordingly. The ADCP connection status will also be shown in the status bar on the bottom of the program as shown in Figure 25.

3.6.a Connected

In this case, ADCP is connected to the PC but is not pinging. The ADCP Copyright message and the system firmware version information will be shown in the ADCP DATA box and will be continuously refreshed. The "STATUS" column will show the "ADCP Connected" message as shown in Figure 26. One or multiple NMEA ports may be connected to the external sensors to receive data (GPS, Heading, Tilt). The receiving sensor data will be shown in the NMEA boxes, and the "NMEA *n* Connected" in the "STATUS" column of each NEMA port indicates that the serial port is connected.

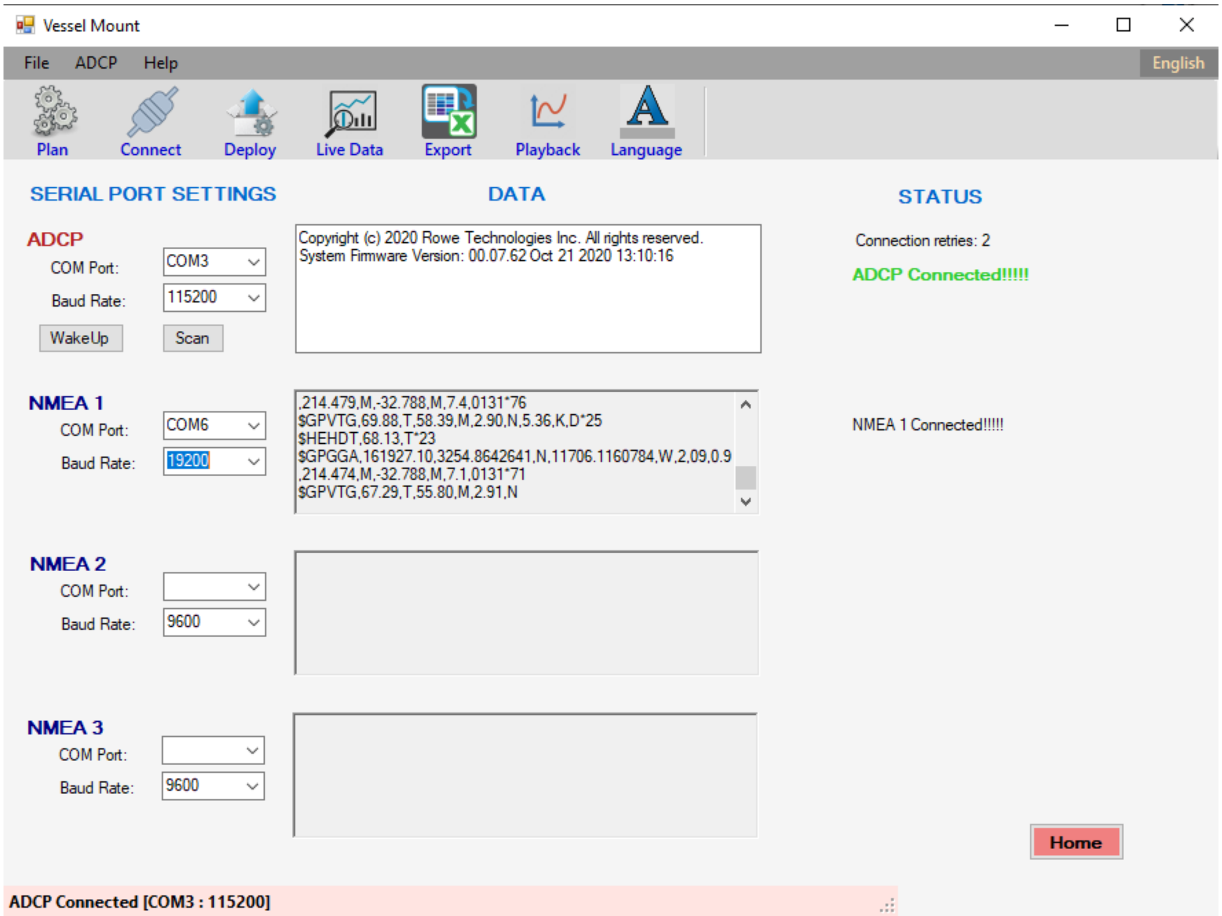


Figure 26. Connected

3.6.b Connected & Pinging

The second case is when ADCP is connected to the PC and is pinging. If the external sensor (GPS, Heading, Tilt) is connected, then the corresponding data will be received and displayed in the DATA Box in Connect page. When an ADCP ensemble is received through the serial port, the ensemble number, date and time and the data status of the ensemble will be shown in the ADCP DATA box. The received external sensor data will be shown in the NMEA DATA box (Figure 27) of that respective serial port. The data collected by ADCP will be automatically recorded into a file and will be stored on the PC. The user can click the "LiveData" button icon to open the Live Data display window to view the data (Figure 28)

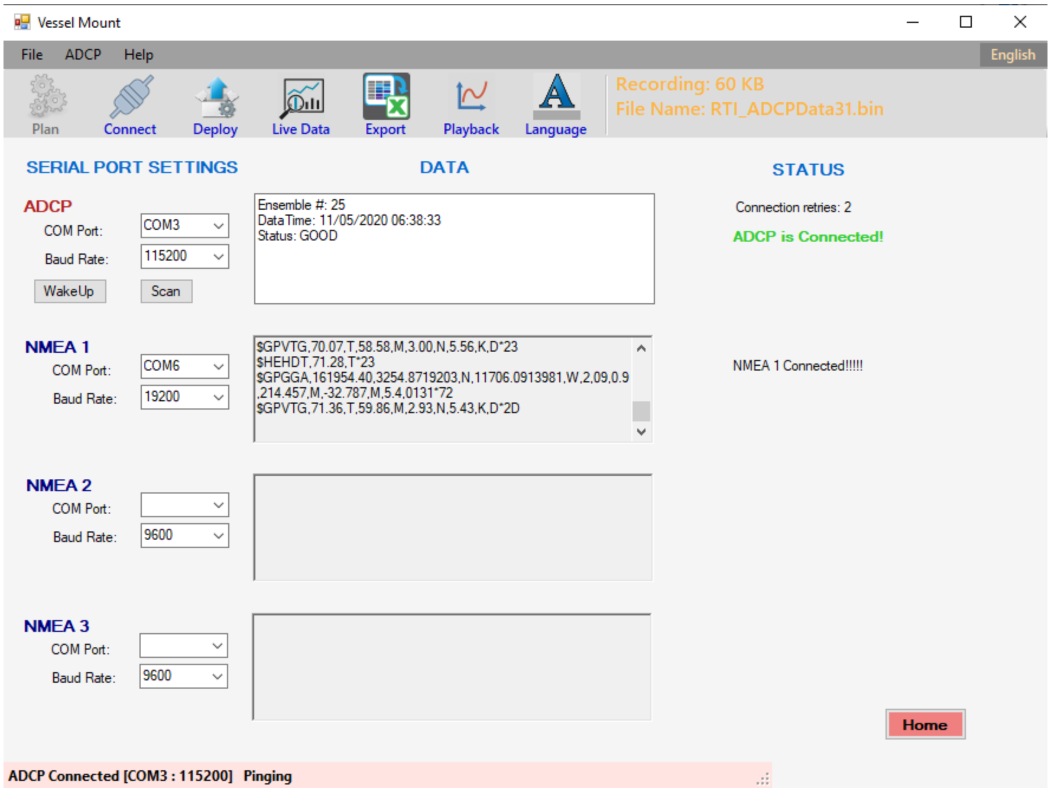


Figure 27. Connected & Pinging

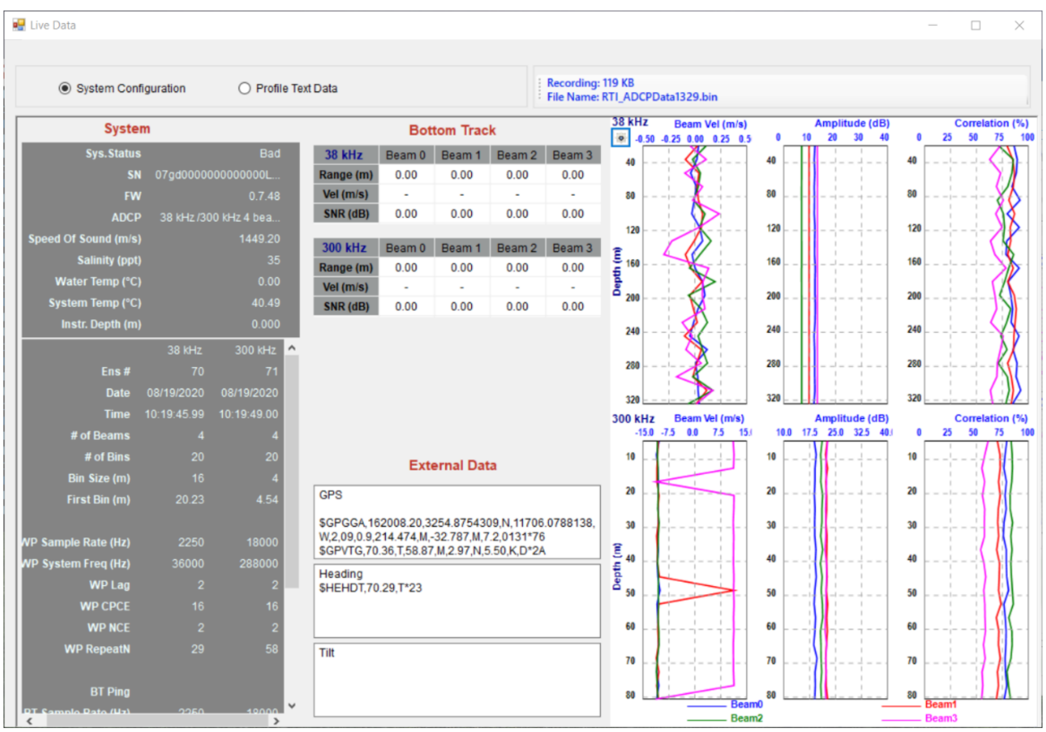


Figure 28. Live Data Display

3.6.c Not Connected

In this case, ADCP is not connected to the PC, the NMEA ports are not connected (Figure 29). The "Deploy" and "LiveData" buttons will be disabled. The user should check the ADCP and the serial ports to make sure that they are connected correctly to their COM ports and with the correct baud rates.

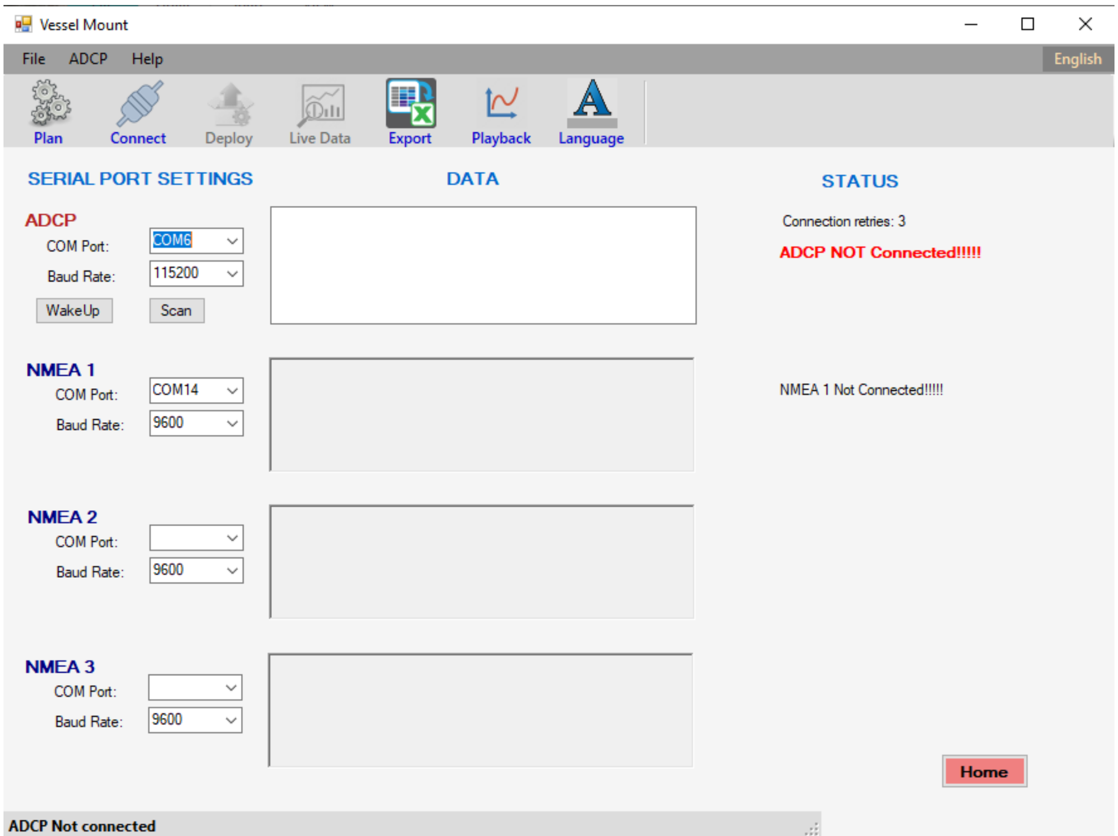


Figure 29. Not Connected

Note: This mode can be used to plan multiple configurations and store on PC for future use.

3.7 Deploy – Deploy a System

When ADCP is connected to the PC, the **Deploy** button will be enabled. The user can deploy the system using the Deploy page (Figure 30). The Deploy page has the following functions:

3.7.a Read ADCP Settings:

When Deploy page is opened, the settings on ADCP will be read from ADCP and will be shown in the right-hand side "ADCP Summary" column. The items in the "ADCP Summary" are the same as the Summary items in the Planning but the contents of the items are the readings from ADCP.

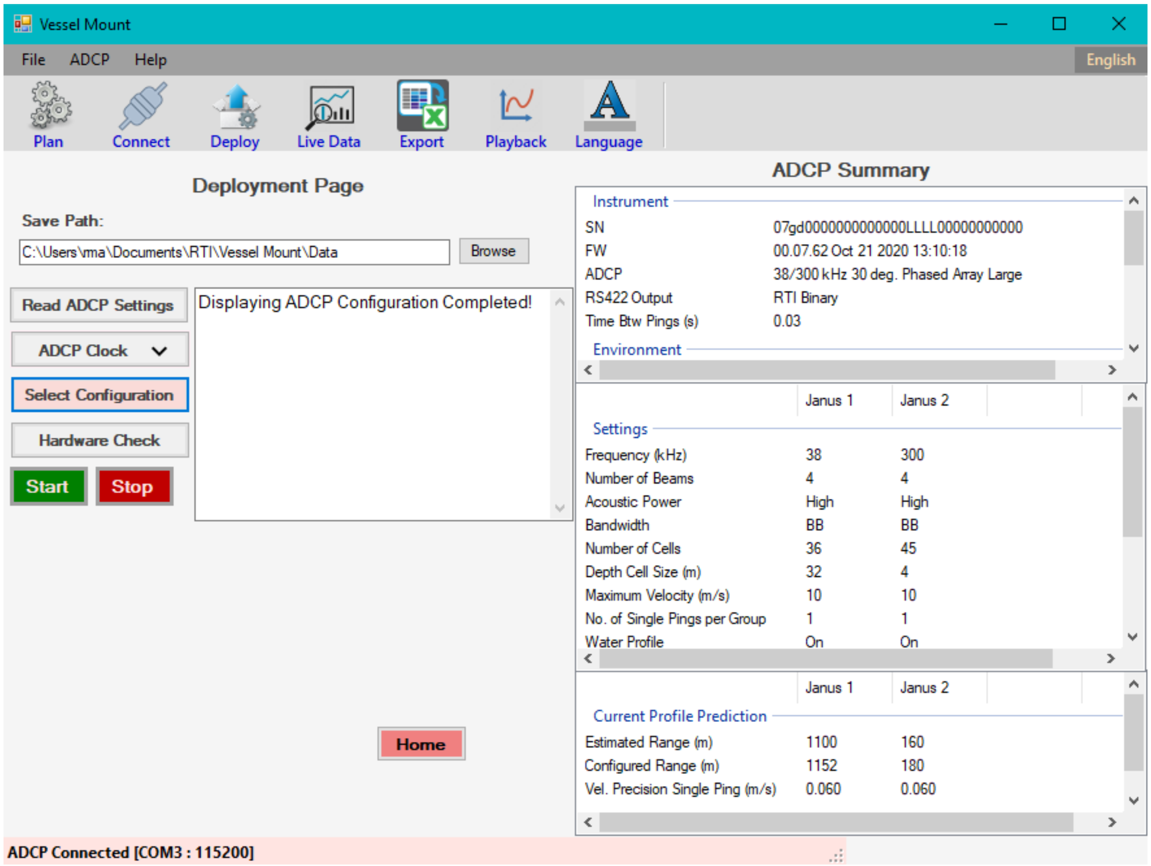


Figure 30. Deploy page

3.7.b **Save Path**:

shows the path to save the collected data in PC.

3.7.c **ADCP Clock**:

To read/set ADCP clock. The default is UTC time. The user can choose a different time zone from the list to set up ADCP time. Figure 31 shows the ADCP date and time by clicking the "Read" button.

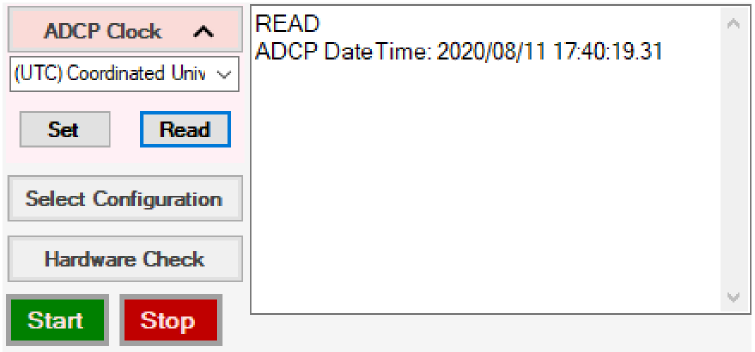


Figure 31. ADCP Clock

3.7.d **Select Configuration**:

Select an existing configuration file (.json) from PC and send it to the ADCP. The user will be able to save the current ADCP configuration on the PC before loading a new configuration from PC (Figure 32).

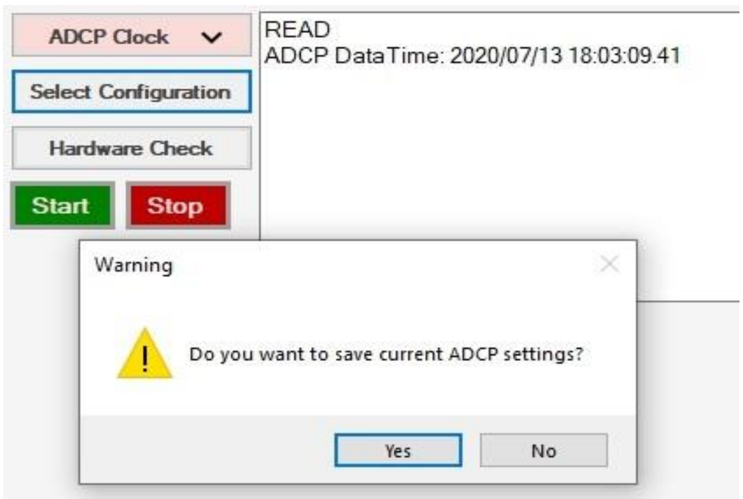


Figure 32. Option to save current ADCP configuration

Figure 33 shows a user configuration is sending to ADCP. After successfully sent the configuration to ADCP, the software will automatically read the configuration back from ADCP and show it in the Summary (Figure 34), this will let the user be able to check the deployment summary before actual deploy the system.

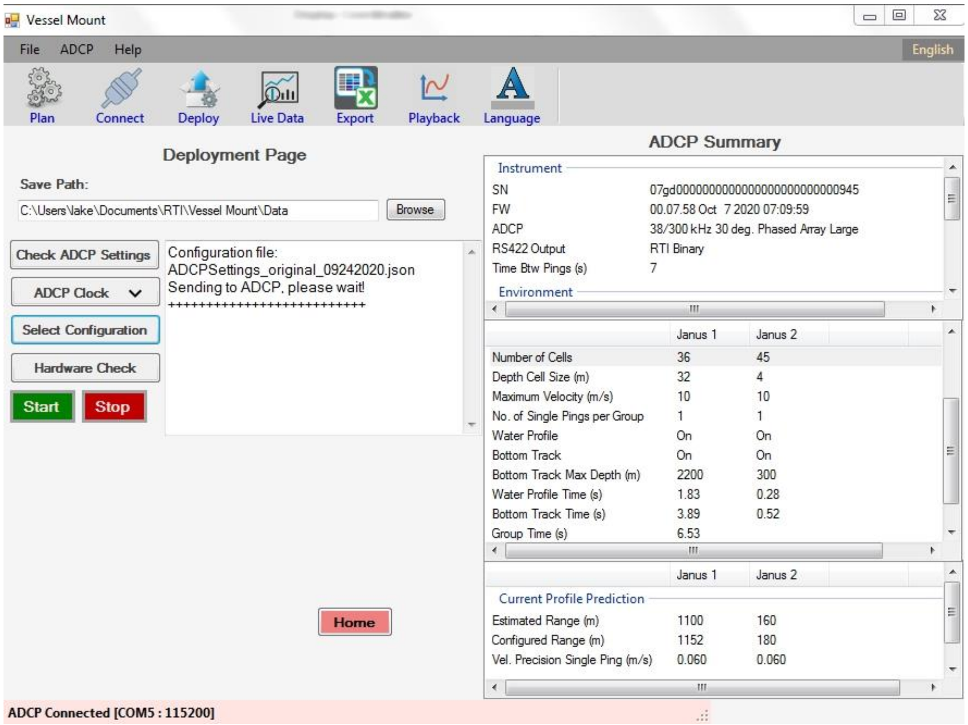


Figure 33. Sending configuration to ADCP

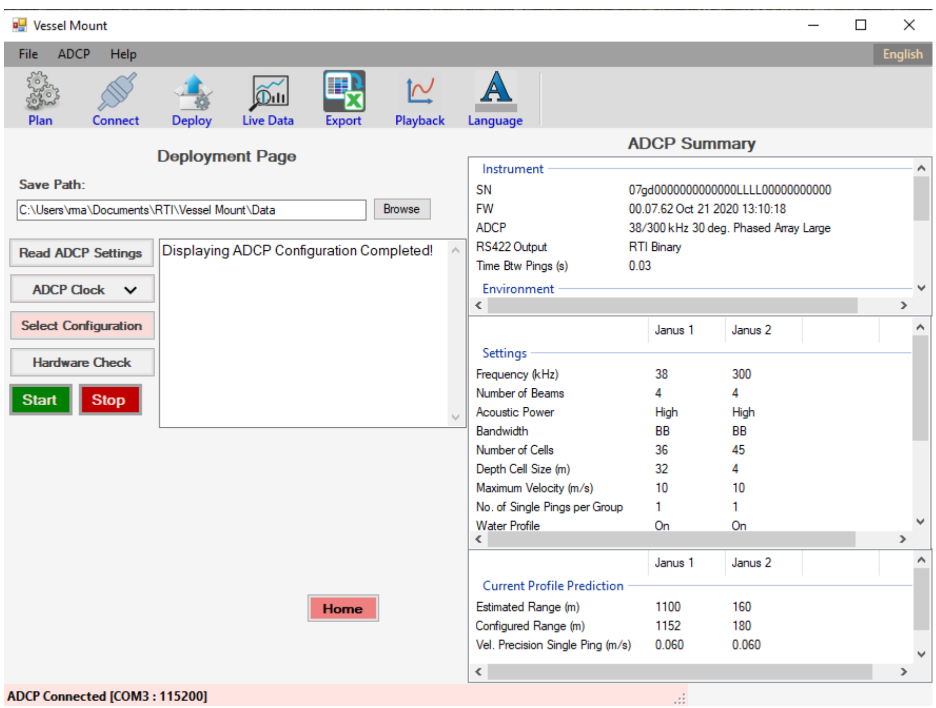


Figure 34. Read back ADCP configuration after it was sent to ADCP

Please note that the instrument type in the selected configuration file should match the target instrument type, otherwise, it will not work. Figure 35 shows a user is trying to send a configuration that dedicated to a 38/300 kHz phased array ADCP to a 75/300 kHz piston ADCP with a vertical beam of 300 kHz but failed. The warning message will be shown in the information box of the Deployment page.

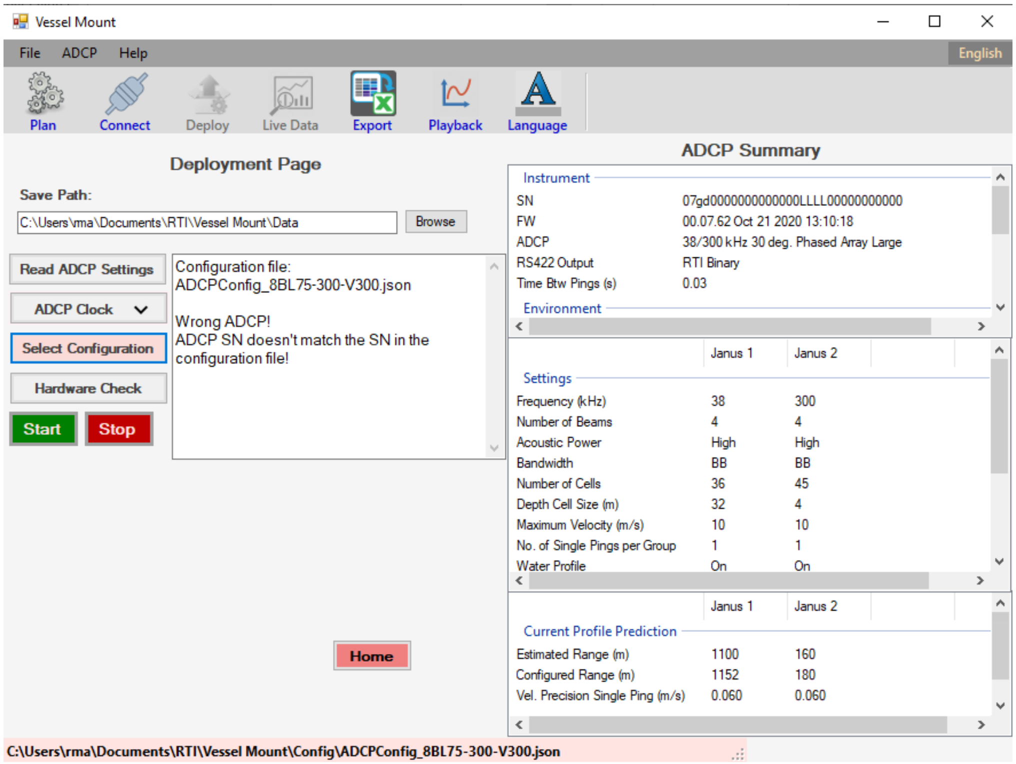


Figure 35. Sending a configuration to a wrong ADCP

3.7.e **Hardware Check**:

Check hardware before the deployment. This will check few of the hardware parameters such as temperature and voltage (as shown in Figure 36). It will show the hardware check results in the Information Box on the Deploy page. The hardware check will fail if any of the checked items fail. In the case of "Fail", the user should check the hardware to make sure it will pass the check before the deployment.

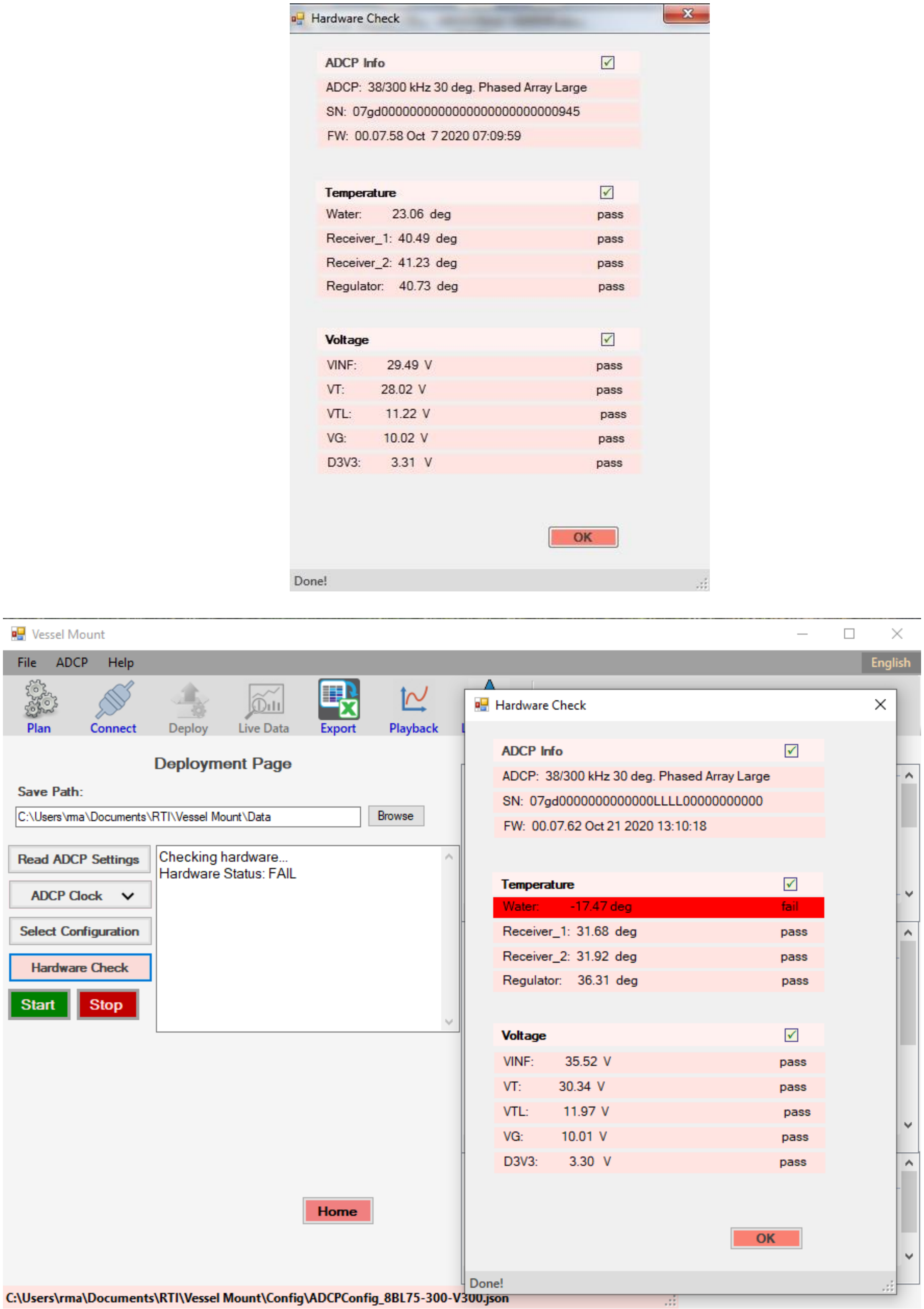


Figure 36. Hardware check

3.7.f **Start / Stop Pinging:**

The user can Start pinging by clicking the green "Start" button. The Information Box will show the ADCP status, the received ensemble information and status (Figure 37). The data collected by ADCP will be automatically saved in a file on the PC under the path where the user chose. The file name and size will be shown on the right side of the icon menu bar. The file size is limited to 300 MB, it will automatically create a new file when the current file size reached the limit. After started pinging, the user can view live data in the LiveData display window. Click the "Stop" button to stop pinging.

The user can choose to Start pinging if he/she is satisfied with the current setup or use the "Select Configuration" button to load a different configuration to ADCP.

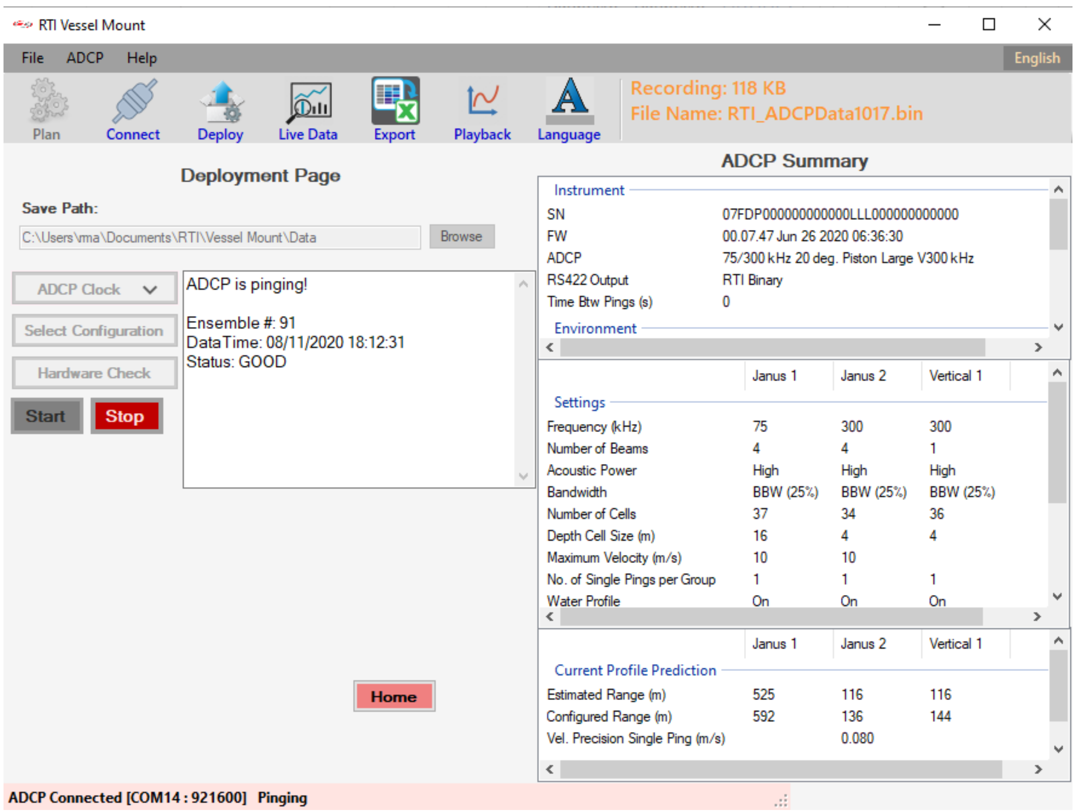


Figure 37. Start pinging

3.8 Live Data – View the live data display

When ADCP is pinging, the user can view the live data display by clicking the "LiveData" icon button. This will open the Live Data display window (Figure 38). The data recording status is shown in the top left corner of the window. There are three main columns of the Live Data display window:

- System summary column on the left: this displays the ADCP information and the current receiving ensemble information for each frequency. The ADCP information includes serial number (SN), firmware version (FW), instrument type (ADCP) and environmental parameter values such as speed of sound, salinity, water temperature, system temperature and instrument depth.
- Bottom Track data and the External Sensor data (GPS, Heading, Tilt) in the middle: the bottom track data includes bottom track range, bottom track velocity, and the signal to noise ratio (SNR) for each frequency and each beam.
- Water profile plots on the right: this includes the plots of Beam Velocity (m/s), Amplitude (*dB*) and Correlation (%) for each frequency and each beam. Top column is for 38 kHz and bottom column is for 300 kHz respectively.

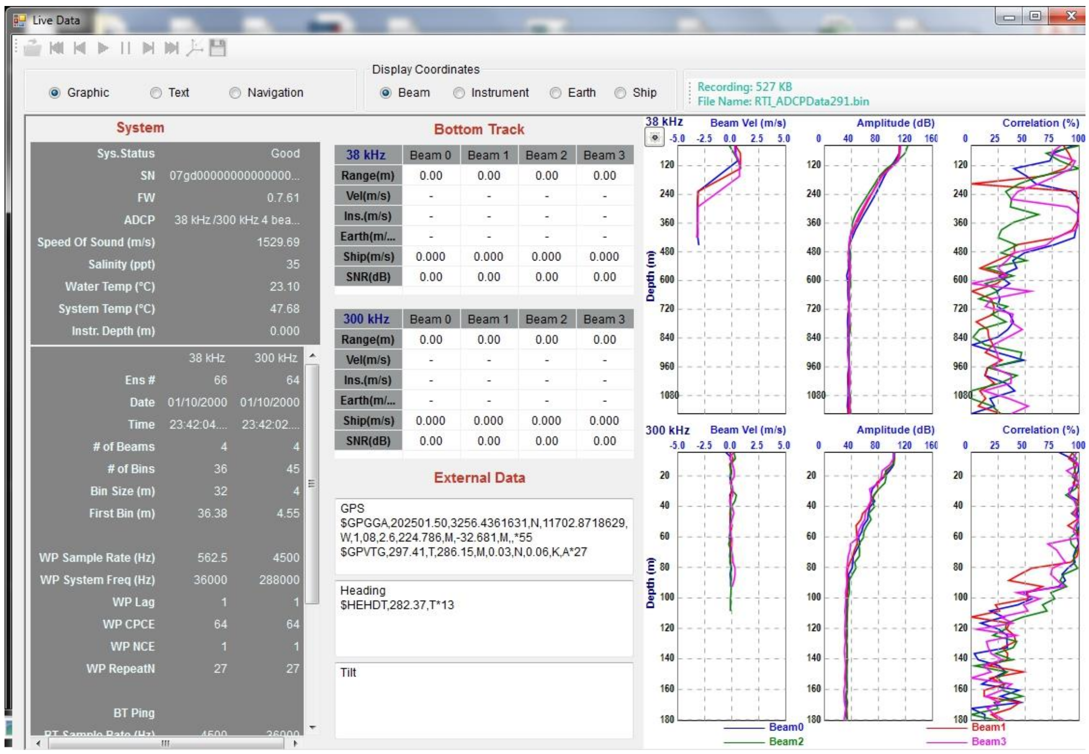


Figure 38. Live Data Display showing a 38/300 kHz dual frequency system data

The user can change the ranges of the Profile plots by clicking the  button on the top left corner of the Profile Beam Velocity plot (Figure 39).

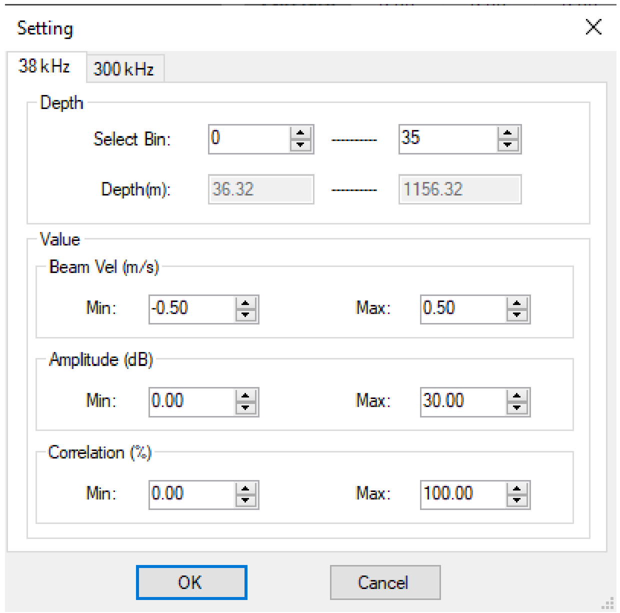
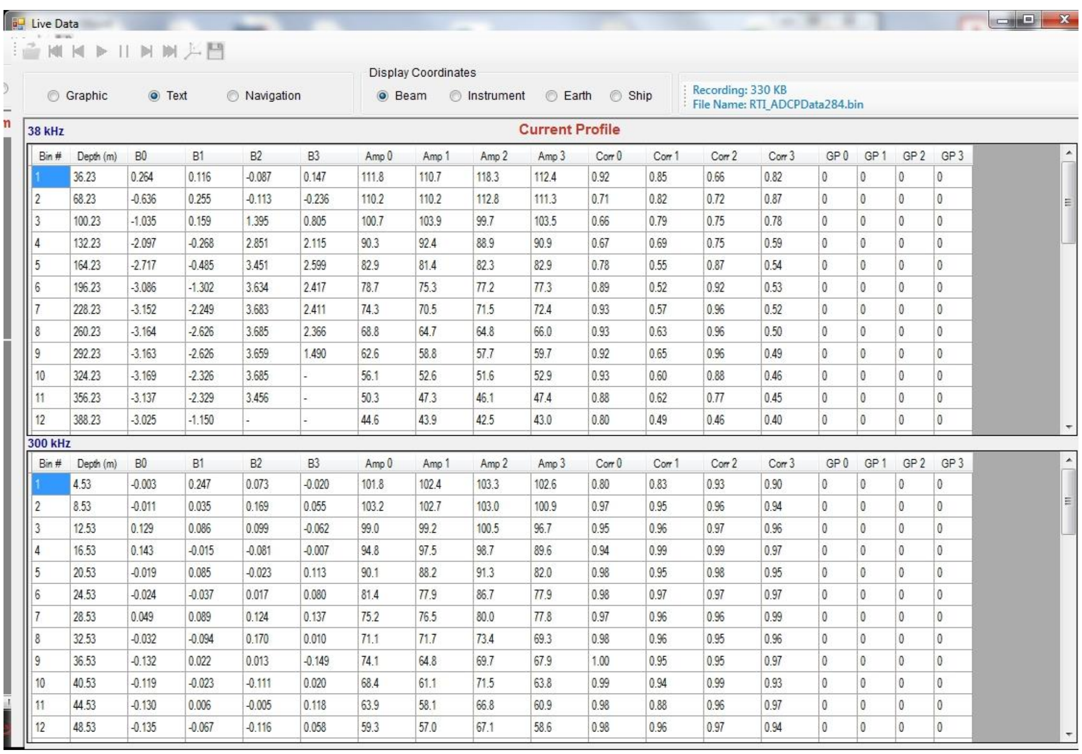


Figure 39. Set the plot ranges

The user can view the tabular view of the LIVE data by switching to the “Text” page (Figure 40).



38 kHz

Bin #	Depth (m)	B0	B1	B2	B3	Amp 0	Amp 1	Amp 2	Amp 3	Corr 0	Corr 1	Corr 2	Corr 3	GP 0	GP 1	GP 2	GP 3
1	36.23	0.264	0.116	-0.087	0.147	111.8	110.7	118.3	112.4	0.92	0.85	0.66	0.82	0	0	0	0
2	68.23	-0.636	0.255	-0.113	-0.236	110.2	110.2	112.8	111.3	0.71	0.82	0.72	0.87	0	0	0	0
3	100.23	-1.035	0.159	1.395	0.805	100.7	103.9	99.7	103.5	0.66	0.79	0.75	0.78	0	0	0	0
4	132.23	-2.097	-0.268	2.851	2.115	90.3	92.4	88.9	90.9	0.67	0.69	0.75	0.59	0	0	0	0
5	164.23	-2.717	-0.485	3.451	2.599	82.9	81.4	82.3	82.9	0.78	0.55	0.87	0.54	0	0	0	0
6	196.23	-3.086	-1.302	3.634	2.417	78.7	75.3	77.2	77.3	0.89	0.52	0.92	0.53	0	0	0	0
7	228.23	-3.152	-2.249	3.683	2.411	74.3	70.5	71.5	72.4	0.93	0.57	0.96	0.52	0	0	0	0
8	260.23	-3.164	-2.626	3.685	2.366	68.8	64.7	64.8	66.0	0.93	0.63	0.96	0.50	0	0	0	0
9	292.23	-3.163	-2.626	3.659	1.490	62.6	58.8	57.7	59.7	0.92	0.65	0.96	0.49	0	0	0	0
10	324.23	-3.169	-2.326	3.685	-	56.1	52.6	51.6	52.9	0.93	0.60	0.88	0.46	0	0	0	0
11	356.23	-3.137	-2.329	3.456	-	50.3	47.3	46.1	47.4	0.88	0.62	0.77	0.45	0	0	0	0
12	388.23	-3.025	-1.150	-	-	44.6	43.9	42.5	43.0	0.80	0.49	0.46	0.40	0	0	0	0

300 kHz

Bin #	Depth (m)	B0	B1	B2	B3	Amp 0	Amp 1	Amp 2	Amp 3	Corr 0	Corr 1	Corr 2	Corr 3	GP 0	GP 1	GP 2	GP 3
1	4.53	-0.003	0.247	0.073	-0.020	101.8	102.4	103.3	102.6	0.80	0.83	0.93	0.90	0	0	0	0
2	8.53	-0.011	0.035	0.169	0.055	103.2	102.7	103.0	100.9	0.97	0.95	0.96	0.94	0	0	0	0
3	12.53	0.129	0.086	0.099	-0.062	99.0	99.2	100.5	96.7	0.95	0.96	0.97	0.96	0	0	0	0
4	16.53	0.143	-0.015	-0.081	-0.007	94.8	97.5	98.7	89.6	0.94	0.99	0.99	0.97	0	0	0	0
5	20.53	-0.019	0.085	-0.023	0.113	90.1	88.2	91.3	82.0	0.98	0.95	0.98	0.95	0	0	0	0
6	24.53	-0.024	-0.037	0.017	0.080	81.4	77.9	86.7	77.9	0.98	0.97	0.97	0.97	0	0	0	0
7	28.53	0.049	0.089	0.124	0.137	75.2	76.5	80.0	77.8	0.97	0.96	0.96	0.99	0	0	0	0
8	32.53	-0.032	-0.094	0.170	0.010	71.1	71.7	73.4	69.3	0.98	0.96	0.95	0.96	0	0	0	0
9	36.53	-0.132	0.022	0.013	-0.149	74.1	64.8	69.7	67.9	1.00	0.95	0.95	0.97	0	0	0	0
10	40.53	-0.119	-0.023	-0.111	0.020	68.4	61.1	71.5	63.8	0.99	0.94	0.99	0.93	0	0	0	0
11	44.53	-0.130	0.006	-0.005	0.118	63.9	58.1	66.8	60.9	0.98	0.88	0.96	0.97	0	0	0	0
12	48.53	-0.135	-0.067	-0.116	0.058	59.3	57.0	67.1	58.6	0.98	0.96	0.97	0.94	0	0	0	0

Figure 40. Tabular view of the LIVE Data in Text display

The User can use the Navigation page during Play back mode. The Navigation page is used to calculate the accuracy of the bottom track data with a reference GPS. This page was used to verify the VM unit in Ocean. A picture of the Navigation page is shown in Figure 41. The user can choose to view the data display in the Navigation page but the accuracy calculation is performed in the recorded data

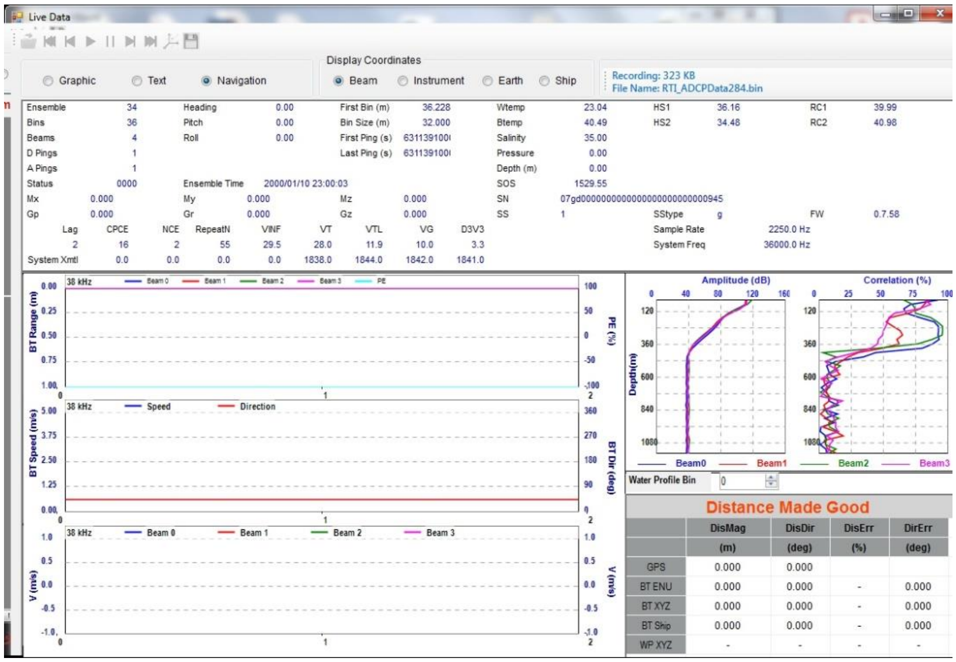


Figure 41. View of the Navigation page

3.9 Export – Export RTI Binary data to CSV format

To export the data to CSV format by using the software. Click the **Export** icon button from Home Page to open the Export page. By default, the data collected by ADCP will be sent out and saved in RTI Binary format. Click the "Extract" button in the "RTI Binary File to CSV File" to select the RTI Binary (.bin) file to extract. The binary data will be converted to CSV format by ensemble series and the resulted .csv files will be shown in the textbox as shown in Figure 42. The external sensor data will also be extracted.

The "Current Ensemble Only" will extract a single ensemble (the last ensemble for now).

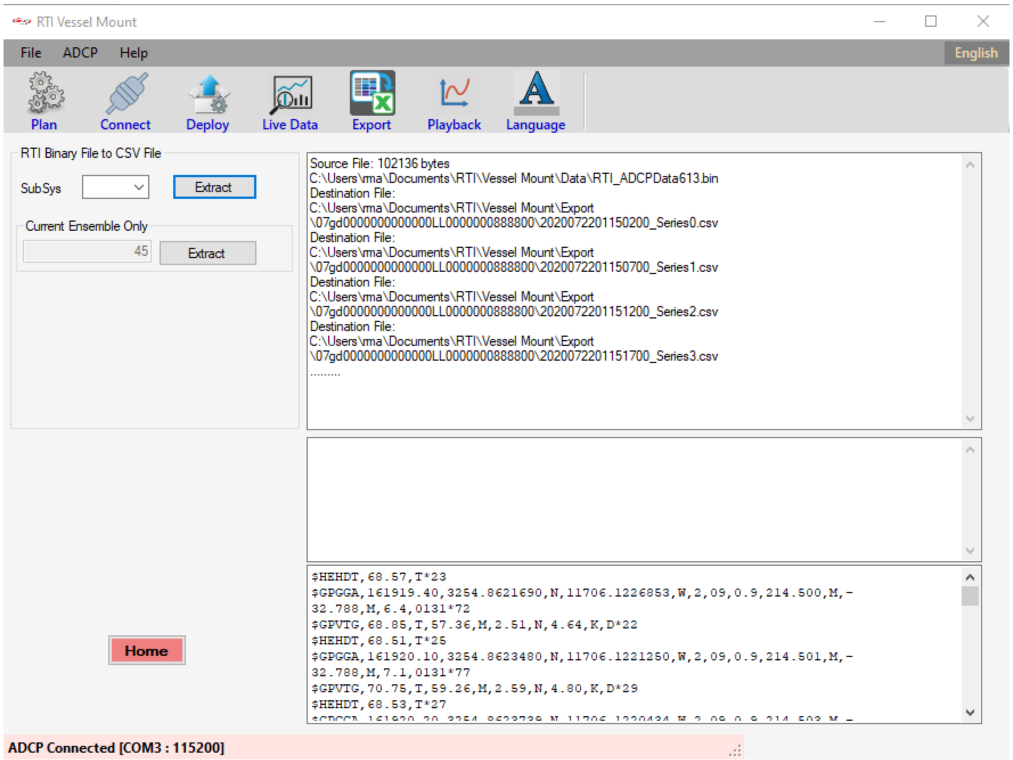


Figure 42. Export Data

3.10 Playback – Display and process the data

The Playback page is for the users to view and post-process the collected data from a file on the PC. This is the same user interface as the LiveData display except that there are display operation buttons on the left top corner (Figure. 43).

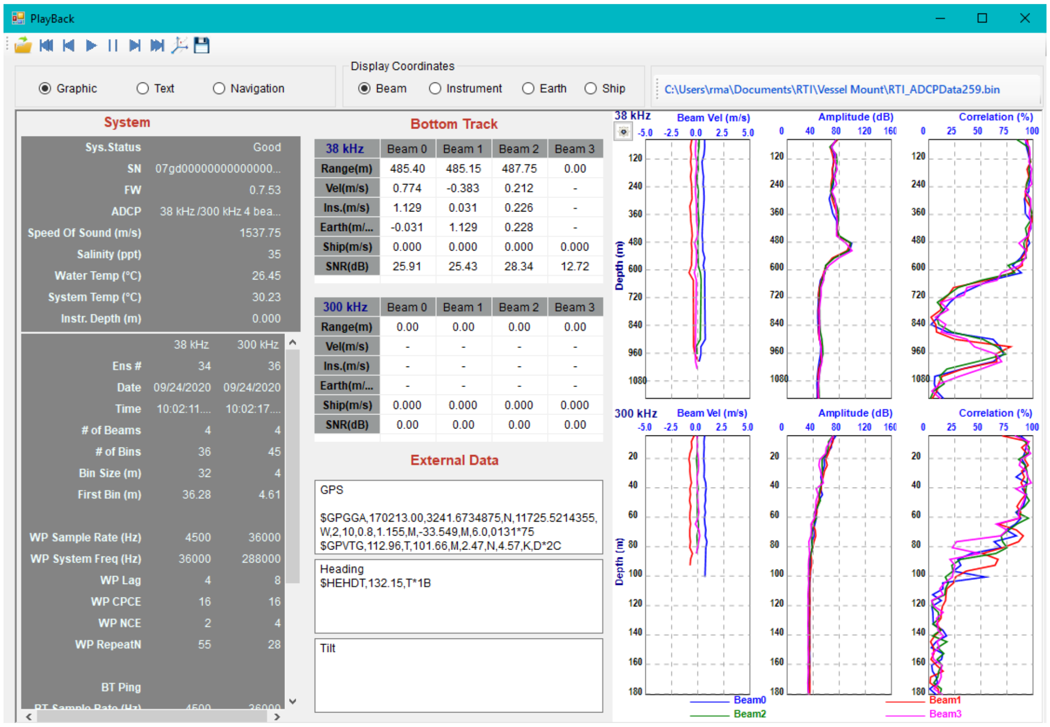


Figure. 43 Playback Home Page

There are three formats to display the data: Graphic (Figure. 43), Text (Figure 45) and Navigation (Figure 46). There are four coordinate systems options that user can choose to view the data: Beam Coordinates, Instrument Coordinates, Earth Coordinates, and Ship Coordinates. By default, the data collected from ADCP are raw data only in Beam Coordinates, the user can transform the data into other three coordinate systems by clicking the "Transform Settings" button . This will pop up a window and let the user to setup the transformation parameters such as Heading/Tilt source, Heading/Ship/Tilt heading offsets etc. as shown in Figure 44. Please note, you need to have valid Heading, Pitch and Roll values available to apply the coordinate transformation.

3.10.a Coordinate Systems

RTI uses four different coordinate systems.

1. Beam Coordinates

   The velocity vector is in the direction of each beam points.

2. Instrument Coordinates

   Beam velocity are rotated to a 3 axis velocity vector X, Y, and Z.

3. Earth Coordinates

   East, North, Vertical vectors relative to Earth.

4. Ship Coordinates

   F, S, M vectors relative to the ship.

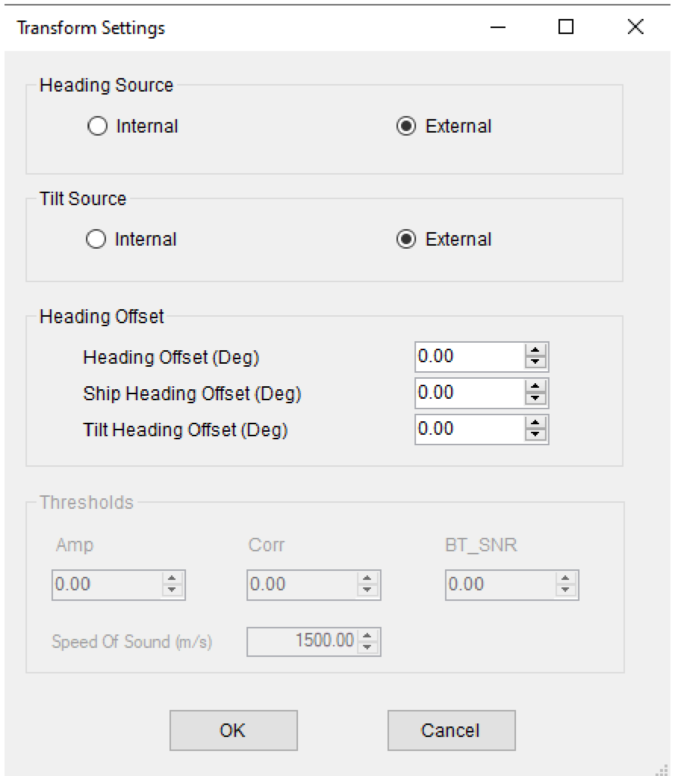
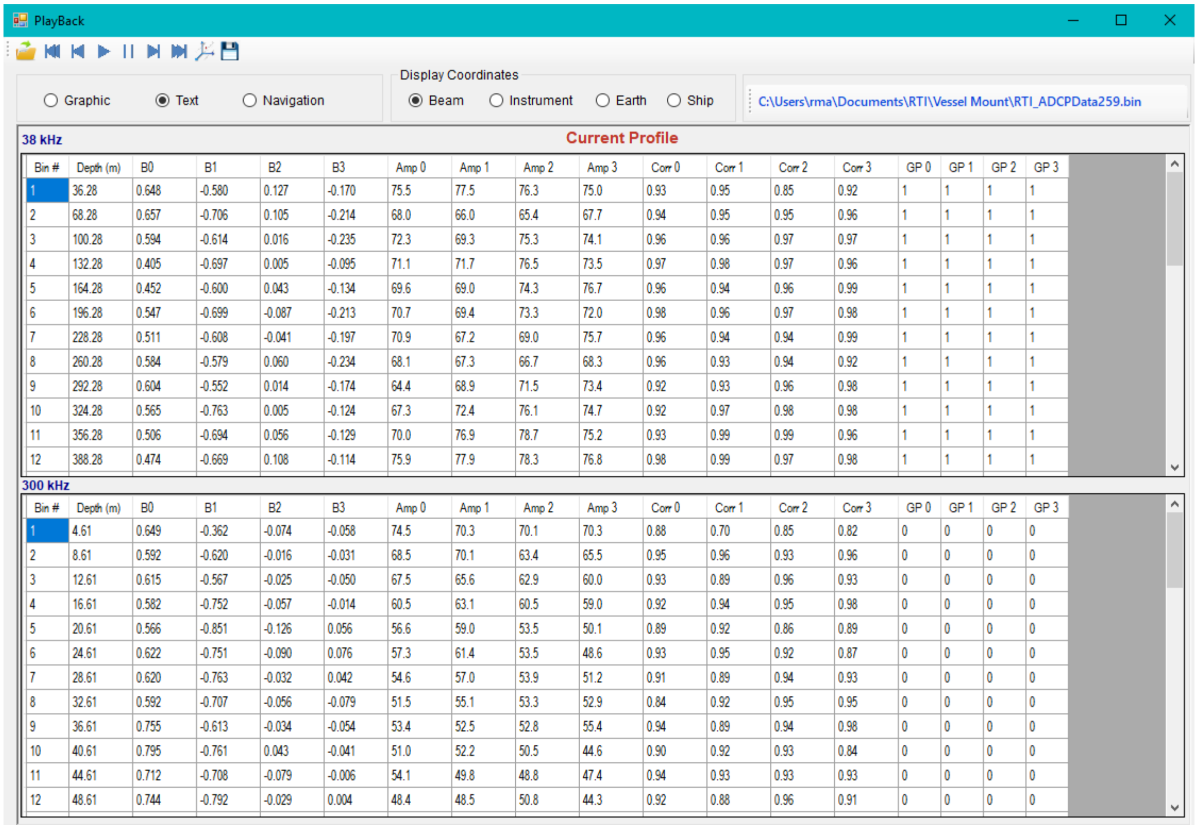


Figure 44. Transform Settings

- Heading Source
    - Internal: use the heading from ADCP.
    - External: use the heading from external sensor such as GPS.
- Tilt Source
    - Internal: use the tilt from ADCP.
    - External: use the tilt from external tilt sensor.
- Heading Offset
    - Heading Offset: the offset that is used to correct the heading.
    - Ship Heading Offset: system to ship heading offset.
    - Tilt Heading Offset: system to PNI compass tilt heading offset.

After transformation, the user can switch between these four coordinate systems in the "Display Coordinates" box to view the data in a selected coordinate system. The user can also save the processed data into a new file for future use. This new file will have all the four coordinate (Beam, Instrument, Earth, Ship) velocities. We recommended to save the processed data to a new file and keep the original raw data file untouched. The default folder for the processed file is in "ProcessedData" under the RTI\Vessel Mount\ directory.



38 kHz

Bin #	Depth (m)	B0	B1	B2	B3	Amp 0	Amp 1	Amp 2	Amp 3	Corr 0	Corr 1	Corr 2	Corr 3	GP 0	GP 1	GP 2	GP 3
1	36.28	0.648	-0.580	0.127	-0.170	75.5	77.5	76.3	75.0	0.93	0.95	0.85	0.92	1	1	1	1
2	68.28	0.657	-0.706	0.105	-0.214	68.0	66.0	65.4	67.7	0.94	0.95	0.95	0.96	1	1	1	1
3	100.28	0.594	-0.614	0.016	-0.235	72.3	69.3	75.3	74.1	0.96	0.96	0.97	0.97	1	1	1	1
4	132.28	0.405	-0.697	0.005	-0.095	71.1	71.7	76.5	73.5	0.97	0.98	0.97	0.96	1	1	1	1
5	164.28	0.452	-0.600	0.043	-0.134	69.6	69.0	74.3	76.7	0.96	0.94	0.96	0.99	1	1	1	1
6	196.28	0.547	-0.699	-0.087	-0.213	70.7	69.4	73.3	72.0	0.98	0.96	0.97	0.98	1	1	1	1
7	228.28	0.511	-0.608	-0.041	-0.197	70.9	67.2	69.0	75.7	0.96	0.94	0.94	0.99	1	1	1	1
8	260.28	0.584	-0.579	0.060	-0.234	68.1	67.3	66.7	68.3	0.96	0.93	0.94	0.92	1	1	1	1
9	292.28	0.604	-0.552	0.014	-0.174	64.4	68.9	71.5	73.4	0.92	0.93	0.96	0.98	1	1	1	1
10	324.28	0.565	-0.763	0.005	-0.124	67.3	72.4	76.1	74.7	0.92	0.97	0.98	0.98	1	1	1	1
11	356.28	0.506	-0.694	0.056	-0.129	70.0	76.9	78.7	75.2	0.93	0.99	0.99	0.96	1	1	1	1
12	388.28	0.474	-0.669	0.108	-0.114	75.9	77.9	78.3	76.8	0.98	0.99	0.97	0.98	1	1	1	1

300 kHz

Bin #	Depth (m)	B0	B1	B2	B3	Amp 0	Amp 1	Amp 2	Amp 3	Corr 0	Corr 1	Corr 2	Corr 3	GP 0	GP 1	GP 2	GP 3
1	4.61	0.649	-0.362	-0.074	-0.058	74.5	70.3	70.1	70.3	0.88	0.70	0.85	0.82	0	0	0	0
2	8.61	0.592	-0.620	-0.016	-0.031	68.5	70.1	63.4	65.5	0.95	0.96	0.93	0.96	0	0	0	0
3	12.61	0.615	-0.567	-0.025	-0.050	67.5	65.6	62.9	60.0	0.93	0.89	0.96	0.93	0	0	0	0
4	16.61	0.582	-0.752	-0.057	-0.014	60.5	63.1	60.5	59.0	0.92	0.94	0.95	0.98	0	0	0	0
5	20.61	0.566	-0.851	-0.126	0.056	56.6	59.0	53.5	50.1	0.89	0.92	0.86	0.89	0	0	0	0
6	24.61	0.622	-0.751	-0.090	0.076	57.3	61.4	53.5	48.6	0.93	0.95	0.92	0.87	0	0	0	0
7	28.61	0.620	-0.763	-0.032	0.042	54.6	57.0	53.9	51.2	0.91	0.89	0.94	0.93	0	0	0	0
8	32.61	0.592	-0.707	-0.056	-0.079	51.5	55.1	53.3	52.9	0.84	0.92	0.95	0.95	0	0	0	0
9	36.61	0.755	-0.613	-0.034	-0.054	53.4	52.5	52.8	55.4	0.94	0.89	0.94	0.98	0	0	0	0
10	40.61	0.795	-0.761	0.043	-0.041	51.0	52.2	50.5	44.6	0.90	0.92	0.93	0.84	0	0	0	0
11	44.61	0.712	-0.708	-0.079	-0.006	54.1	49.8	48.8	47.4	0.94	0.93	0.93	0.93	0	0	0	0
12	48.61	0.744	-0.792	-0.029	0.004	48.4	48.5	50.8	44.3	0.92	0.88	0.96	0.91	0	0	0	0

Figure 45. Playback Data Page

In the Navigation page, the "Start Ens: *n*" option will let the user to choose a starting ensemble *n* to view. The button will let the user to set up other parameters such as the threshold of PE in the Timeseries plotting. The user can drag the "ScrollBar" to view any data ensemble. The "Backspace" button and the "Enter" button represent the "Previous" button and the "Next" button, respectively.

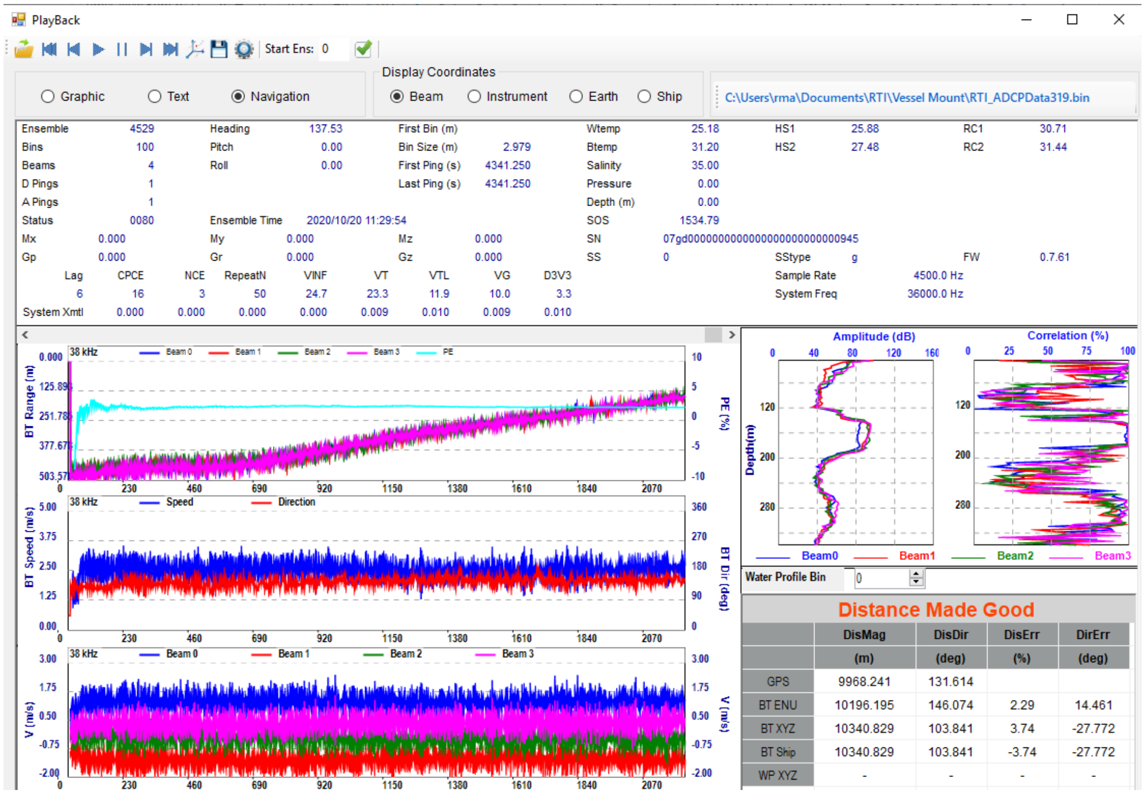


Figure 46. Playback Navigation Page

3.10.b Distance Made Good (DMG)

The purpose of the Navigation page is to check the accuracy of the ADCP measurements of both frequencies. This is done by comparing the ADCP bottom tracking results with the external GPS results. Specifically, to verify the distance traveled (Distance Made Good (DMG)) measured by the ADCP matches the distance traveled measured by GPS. This requires the ADCP to have the bottom tracking enabled and then the software has the capability to process the external GPS data.

By computing the percentage of difference between the straight-line distance traveled as measured by bottom tracking of the ADCP (BT DMG) and the straight-line distance traveled as measured by the GPS (GPS DMG) we can tell the ADCP accuracy percentage. We call the value of this percentage difference the "Percent Error (PE)", and it is defined as the following

$$PE = \left(\frac{BT\ DMG}{GPS\ DMG} - 1\right) \times 100\% \quad (eq.1)$$

There are four columns in the DMG table of Navigation Page (Figure 46): Distance Magnitude (DisMag), Distance Direction (Direction), Distance Error (DisErr - PE), and Degree Error (DirErr). The plot of PE is shown in the "BT Range" timeseries plots. This accuracy page was used to check the system`s accuracy at the Ocean. All the details of the calculations are not explained here.

3.11 Language – Switch between English and Chinese

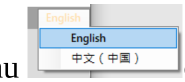
The user can use the “Language” icon  button or the dropdown menu  on the right top corner of the RTI-VM software to switch the software language between English (default) and Chinese (Figure 47).

Figure 47. Language

Note:

NEVER START pinging the SEA Surveyor with the transducer in air. This will cause the high-power transmitter to short across the transducer and damage the Dual Frequency VM transducer.

3.12 COMMAND LIST

Input Commands

Command	Description
Help, H or ?	Shows all available commands related to ADCP operation.
BREAK	Interrupts a PING or wakes up the ADCP a. Hardware BREAK A hardware break can be used on a serial port. A break occurs when the serial port data line(s) is/are held in a non-quiescent state for a period of time as long or longer than a single character. The ADCP/DVL hardware detects and wakes up with a break length as short as 10 msec. However, if the system is deployed and set to wake up at a future date/time the break needs to be 0.5 seconds or longer in duration. The long break requirement prevents an accidental break from stopping a deployment. Accidental breaks can occur when the communication cable is disconnected from a battery powered system prior to deploying it underwater. ROWETECH Pulse software plays it safe and uses a 1 second break. b. Soft BREAK **BREAK**<CR> When the ADCP/DVL decode the ASCII command "BREAK" the system stops and outputs the wakeup message

Firmware Commands

Command	Description

FMSHOW	Show Firmware Version and creation date
	`FMSHOW+`
	`Copyright (c) 2020 Rowe Technologies Inc. All rights reserved.`
	`System Firmware Version: 00.07.44 Jun 2 2020 05:43:04`

3.12.a ADCP Ensemble Commands

ADCP Ensemble Commands

Command	Description
CEPO *cccccccccccc*	Ensemble Ping Order. Sets the order in which the various subsystems will be pinged. Note: a space and at least one subsystem code must follow CEPO or the system will reject the command. *Examples:* ***CEPO 23*** will ping subsystem 2 followed by sub system 3. ***CEPO 32*** will ping subsystem 3 followed by sub system 2.

	CEPO 22 will ping subsystem 2 followed by sub system 2 using a different setup (e.g. different bin size).
CEAUTOSTART n	Auto start pinging. 0=disable, 2=RS232, 3=RS485, 4=RS422. This command allows the system automatically start pinging on power up. The ensemble data will be output on the selected serial port.
CEI HH:MM:SS.hh	Ensemble Interval. Sets the time interval that system will output the averaged profile/bottom track data. When using burst pinging and subsystems are grouped together, the time between ensembles will be CEI / (n+1). Where n is the group number contained within the CBI command. Note: all digits including the space following CEI and the separators must be part of the command or the system will reject it.
CEGI n.n	Group Interval (s).
CEGN n	Groups Per Ensemble.
CED ABCDEFGHIJKLMNOPQsssssssssssssss	Enable Data. Enable/Disable each binary data type. A one (1) enables the binary data type to be output in the RoweTech structure. A zero (0) disables it. 1. A = E000001 = beam velocity profile 2. B = E000002 = instrument profile 3. C = E000003 = earth profile 4. D = E000004 = Amplitude profile 5. E = E000005 = correlation profile 6. F = E000006 = beamN 7. G = E000007 = xfrmN 8. H = E000008 = EnsembleData 9. I = E000009 = Ancillary 10. J = E000010 = Bottom Track 11. K = E000011 = NMEA 12. L = E000012 = EngProfileData 13. M = E000013 = EngBottomData 14. N = E000014 = System Transmit Settings 15. O = E000015 = BT on WP (Range Tracking) 16. P = E000016 = Gage Height 17. Q = E000017 = ADCP2 Info 18. R = E000018 = Water Track 19. s = Spare NOTE: Setting both B and C to zero turns off the XYZ and ENU calculations which helps to decrease ping time.
CETFP YYYY/MM/DD,HH:mm:SS.hh	Ensemble Time of First Ping. Sets the time that the system will awaken and start pinging.

	Note: all digits including the space following CETFP and the separators must be part of the command or the system will reject the command.
CERECORD n,m	1. n = Ensemble Recording a. 0 = disable b. 1 = enable Rowe Binary c. 9 = enable PD0 2. m = Single Ping Recording (used when recording averaged pings n>0) a. 0 = disable b. 1 = enable 3. When ensemble recording is enabled and the ADCP is started (START<CR>) the firmware searches for the next available file number to record to on the SD card. The ensemble file name starts with the letter "A" followed by a 7 digit number and ending with the extension ".ens". For example: The first ensemble file will be named "A0000001.ens". During deployment as each ensemble is completed the data is appended to the current file. The 7 digit number following the "A" is incremented each time the system is (re)started or when the file size exceeds 16Mbytes bytes. Note: Internal ensemble data recording during burst sampling only occurs at the end of the burst. 4. When single recording is enabled and the ADCP is started (START<CR>) the firmware searches for the next available file number to record to on the SD card. The single ping file name starts with the letter "S" followed by a 7 digit number and ending with the extension ".ens". For example: The first single ping file will be named "S0000001.ens". During deployment as each ping is completed the data is appended to the current file. The 7 digit number following the "S" is incremented each time the system is (re)started or when the file size exceeds 16Mbytes bytes. Each ping, whether bottom track or profile, is considered to be a single ping. Note: No error/ threshold screening or coordinate transformation is performed on the data contained in a single ping file.
CEOUTPUT n,c	Ensemble output type. 1. n = 0 disables serial output. Saves battery energy when recording data to the SD card during a self-contained deployment by reducing extra on time of the system due to data transfer. 2. n = 1 enables the RoweTech binary output data protocol to be sent out the serial port when the system is in "profile" mode. If the system is in "DVL" mode the $PRTI01 $PRTI02 $PRTI30 $PRTI31 data strings are output. 3. n =2 enables an ASCII text serial output that is dumb terminal compatible to be sent out the serial port when the system is in "profile" mode. If the system is in "DVL" mode the $PRTI01 $PRTI02 $PRTI32 $PRTI33 data strings are output. 4. n = 3 disables all output except for a NMEA status string. Allows the user to verify that the instrument is operating normally while recording data to the internal recorder. Saves power and can improve ping timing.

5. n = 4 enable the special Ocean Server NMEA DVL data output. When CEOUTPUT 4 is selected a second parameter can be sent to select the navigation bin. CEOUTPUT 4, b<CR> where b is the profile bin that will be used in the $DVLNAV string.
6. n = 5 If the system is in "DVL" mode the $PRTI03 data string is output.
7. n = 100 selects PD0 binary output. When CEOUTPUT 100 is selected a second parameter can be sent to select the velocity coordinate system. CEOUTPUT 100, c<CR> where c = 0 is beam coordinates, c = 1 is instrument (XYZ), c = 2 is Earth (ENU), and c = 3 is Ship (SFM).
8. n = 113 selects PD13 ASCII output.
9. n = 103 selects PD3 binary output. When CEOUTPUT 103 is selected a second parameter can be sent to select the velocity coordinate system. See n = 100.
10. n = 104 selects PD4 binary output. When CEOUTPUT 104 is selected a second parameter can be sent to select the velocity coordinate system. See n = 100.
11. n = 105 selects PD5 binary output. When CEOUTPUT 105 is selected a second parameter can be sent to select the velocity coordinate system. See n = 100.
12. n = 106 selects PD6 ASCII output.
13. n = 113 selects PD13 ASCII output.

Important Note: PD output formats are industry standard formats for DVLs and are typically a string of data output that is a subset of the total data available. Below is a summary of the data available in PD specific formats:

PD0 - binary output format that includes a header, fixed and variable leader, bottom track, and water profile information. The fixed and variable leader is a recording of time, DVL setup, orientation, heading, pitch, roll, temperature, pressure and self test diagnostic results. The user can select data fields to be output. In the case with ROWETECH instruments users can select the coordinates for the data to be represented.

PD4 - is a binary output format that presents bottom track speed over bottom, speed through water and range to bottom information only.

PD5 – is a superset of PD4 and includes additional information such as, salinity, depth, pitch, roll, heading, and distance made good.

PD6 – is a text-based output format that groups separate sentences containing system attitude data, timing and scaling and speed through water relative to the instrument, vehicle, and earth coordinates. Each data sentence contains a unique starting delimiter and comma delimited fields.

PD13 - is a text output format, like PD6 with the addition of information about range to bottom and raw pressure sensor data.

C232OUT n	Ensemble Output type on the RS232 port

	1. n = 0 disables serial output. Saves battery energy when recording data to the SD card during a self-contained deployment by reducing extra on time of the system due to data transfer. 2. n = 1 enables the RoweTech binary output data protocol to be sent out the serial port. 3. n = 2 enables an ASCII text serial output that is dumb terminal compatible to be sent out the serial port. 4. n = 3 enables NMEA status string. Allows the user to verify that the instrument is operating normally while recording data to the internal recorder. Saves power and can improve ping timing. 5. n = 100 selects PD0 binary output. When CEOUTPUT 100 is selected a second parameter can be sent to select the velocity coordinate system. CEOUTPUT 100, c<CR> where c = 0 is beam coordinates, c = 1 is instrument (XYZ), c = 2 is Earth (ENU), and c = 3 is Ship (SFM). 6. n = 113 selects PD13 ASCII output. 7. n = 103 selects PD3 binary output. When CEOUTPUT 103 is selected a second parameter can be sent to select the velocity coordinate system. See n = 100. 8. n = 104 selects PD4 binary output. When CEOUTPUT 104 is selected a second parameter can be sent to select the velocity coordinate system. See n = 100. 9. n = 105 selects PD5 binary output. When CEOUTPUT 105 is selected a second parameter can be sent to select the velocity coordinate system. See n = 100. 10. n = 106 selects PD6 ASCII output. 11. n = 113 selects PD13 ASCII output.
C485OUT n	Ensemble Output type on the RS485 port. Same as C232OUT.
C422OUT n	Ensemble Output type on the RS422 port. Same as C232OUT.
CUDPOUT n	Same as C232OUT except the selected data is directed to the Ethernet UDP port. See UDPPORT command.
CMACOUT n	Same as C232OUT except the selected data is directed to the Ethernet port.

3.12.b Water Profile Commands

Note: To control subsystems other than 0 add [c] to the command string, where c is the subsystem number.

Water Profile Commands

Command	Description
CWPON 1	Water Profile Pings On. Enables or disables water profile pings.

	1. Enable / Disable a. 0 = disable water profiling. When the application requires bottom tracking only disabling profiling allows for more bottom pings per second. b. 1 = enable water profiling.
CWPBB 1, 2, 3	Water Profile Broad Band. Sets water profile coded pulse transmission and lag. 1. Transmit Pulse Type and Processing a. 0 = Narrowband. i. Provides long range profiles at the expense of variance. ii. Not recommended for use with bin size less than the default bin size. b. 1 = Broadband. i. Typically 15% less range than narrow band but has greatly reduced variance (depending on lag length). ii. Used in conjunction with CWPBP for small bins. c. 2 = Un-coded Broadband (no ambiguity resolver) i. Non-coded has slightly higher variance than the coded transmit without the annoying autocorrelation side peaks. Better for small bins 2. Lag length in vertical meters (m). a. Not used with Narrowband. b. A longer lag will have lower variance and a lower ambiguity velocity. 3. Beam Multiplex (not implemented) a. 1 = ping and process each beam one at a time. b. 2 = ping and process beam pairs. c. 4 = ping and process all four beams together.
CWPBL n.nn	Water Profile Blank (meters). n.nn = 0 to 100. Sets the vertical range from the face of the transducer to the first sample of the first bin.
CWPBS n.nn	Water Profile Bin Size (meters). n.nn sets the vertical bin size.
CWPBN n	Water Profile Bin N. n = 0 to 200 sets the number bins that will be processed and output.
CWPP n	Water Profile Pings. n = 0 to 10,000 sets the number of pings that will be averaged together during the ensemble.
CWPTBP n.nn	Water Profile Time Between Pings. n.nn = 0.00 to 86400.00 seconds (24 hours) sets the time between the last ping, regardless of ping type, and the next profile ping.
CWPMS n	Max Speed (not used).
CWPRC abcdefgh	Receiver Control a. Preamp Gain 0 = High, 1 = Low b. Rcvr Power 0 = OFF, 1 = ON c. Spare d. LPF Bandwidth 0 = wide, 1 = narrow e. Rcvr BIT not used f. Vertical Beam not used g. IF Bandwidth 0 = wide, 1 = narrow h. PA 0 = disabled, 1 = enabled
CWPRF abc	Power Supply Switching Frequency a. F2 b. F1

c. F0

CWPRT a,b,c,d	Water Profile Range Tracking (not implemented) a. 0 = disable, 1 = enable, 2 = enable use pressure sensor window b. Begin bin or % of pressure depth if a = 2 c. End bin d. SNR (dB) Threshold
CWPST 1, 2, 3	Velocity Screening Thresholds 1. Correlation Threshold (0.00 to 1.00). a. Used for screening profile beams. A beam with a correlation value less than the threshold will be flagged bad and not included in the bin average. Nominal beam correlation values are dependent on the pulse coding, the number of repeated codes, and whether not the pulse-to-pulse processing is being used. For example: i. The pulse-to-pulse nominal correlation is 1.00. A correlation value of 0.50 occurs when the signal is equal to the noise (SNR = 1 or 0dB). ii. Broad band correlation is dependent on the number of repeated code sequences in the transmission. If 5 repeats are transmitted the nominal correlation will be 4/5 or 0.80. A correlation value of 0.4, in this case, indicates a signal to noise ratio is 1. 2. Q Good Threshold (m/s) a. Used for screening transformed profile bins. A bin with a, absolute Q velocity that is higher than the Q threshold will be flagged as bad. Beam coordinate velocity data is not affected. 3. V Velocity Threshold (m/s) a. Used for screening transformed profile bins. A bin with a, absolute Vertical velocity that is higher than the V threshold will be flagged as bad. Beam coordinate velocity data is not affected.
CWPX 1, 2	Water Profile Transmit Length (meters) i. Vertical Transmit Size (0 to 100 m). a. A value of 0.00 (default) will cause the system to set transmit to the same length as the bin size. ii. Broadband Transmit Code. a. A value of 0 (zero) selects the best match from the default code table. A value of 1 selects single element per lag repeat for lowest transmit power with corresponding reduced maximum range.
CWPTC a,b,c,d	Transmit Control a. Beam Transmit Enable • 000001111 = beams 3 to 0 enabled • 100000000 = beam 8 enabled b. Broadband Transmit Bandwidth • 0=default, 1=50%, 2=25%, 3=12.5%,4=6.25%,5=3.125%,6=1.5625% c. Broadband Sample Rate • 0=default, 1=50%, 2=25%, 3=12.5%,4=6.25%,5=3.125%,6=1.5625% d. Disable Transmit Current Shutdown • 0 = enable, 1 = disable
CWPTP a	Transmit Power (binary)

	a. 1000 High Power, 0000 Low Power

3.12.c Bottom Tracking Commands

Command	Description
CBTON *n*	Bottom Track ON. Enable or disable bottom track pings. 1. n = 0 disable bottom tracking. Allows for more water profile pings per second and saves battery energy during self-contained deployments. 2. n = 1 enable bottom tracking. When enabled a bottom track ping occurs once per ensemble. Or, when profiling is enabled, a bottom track ping occurs at the beginning of the ensemble and then after every 10 profile pings in the ensemble. If there are less than 10 profile pings per ensemble the bottom track ping will only occur once at the beginning of the ensemble.
CBTBB 1, 2, 3, 4, 5	Bottom Track Narrowband/Broadband control. 1. Mode a. 0 = Narrowband long range. Maximum velocity 11 m/s 20 degree beam angle, 7 m/s for a 30 degree. b. 1 = Broadband coded transmit. Maximum velocity 13 m/s 20 degree beam angle, 9 m/s for a 30 degree. c. 2 = Broadband non-coded transmit. Maximum velocity 22 m/s 20 degree beam angle, 15 m/s for a 30 degree. d. 3 = NA. e. 4 = Broadband non-code pulse to pulse. Maximum velocity dependent on lag length. f. 5 = NA. g. 6 = NA. h. 7 = Auto Switch between Mode 0, 2, and 4. 2. Pulse-to-Pulse Lag(m) a. Lag length in vertical meters. When enabled bottom track will use pulse-to-pulse transmit and processing at depths less than ½ the lag length. Allows for near bottom ultra-low variance velocity measurements. 3. Long Range depth (m) a. The range in meters beyond which the bottom track will switch to narrowband long range processing when n = 7. 4. Beam Multiplex a. 1 = ping and process each beam one at a time. b. 2 = ping and process beam pairs. c. 4 = ping and process all four beams together. 5. Auto Lag adjust a. 0 = use lag length in parameter #2 b. 2 = set lag length to twice the range to the bottom c. 3 = set lag length to 3 times the range to the bottom

CBTRC abcdefgh	Receiver Control a. Preamp Gain 0=High,1=Low b. Rcvr Power 0=OFF, 1=ON c. Spare d. LPF Bandwidth 0=wide,1=narrow e. Rcvr BIT not used f. Vertical Beam not used g. IF Bandwidth 0=wide, 1=narrow h. PA 0=disabled, 1=enabled
CBTRF abc	Power Supply Switching Frequency a. F2 b. F1 c. F0
CBTST 1, 2, 3	Bottom Track Screening Thresholds. 1. Correlation Threshold (0.00 to 1.00) a. Used for screening beam data. A beam with a correlation value less than the threshold will be flagged bad and not included in the average. Nominal correlation for bottom tracking is 1. 2. Q Velocity Threshold (m/s) a. Used for screening transformed bottom track velocities. An absolute Q velocity that is higher than the Q threshold will be flagged as bad. Beam coordinate velocity data is not affected. 3. V Velocity Threshold (m/s) a. Used for screening transformed bottom track velocities. An absolute Vertical velocity that is higher than the V threshold will be flagged as bad. Beam coordinate velocity data is not affected.
CBTBL a,b	Bottom Track Blank (meters). a. 0 to 10 meters. Sets the vertical distance from the face of the transducer at which the bottom detection algorithm begins searching for the bottom when range to the bottom is LESS than CBTT parameter b. b. 0 to 300 meters. Sets the vertical distance from the face of the transducer at which the bottom detection algorithm begins searching for the bottom when range to the bottom is GREATER than CBTT parameter b.
CBTMX a,b	Bottom Track Max Depth (meters) a. n = 5 to 10000 meters. Sets the maximum range over which the bottom track algorithm will search for the bottom. A large value will slow acquisition time. b. b = 0 disable search and use the “a” value for the search depth, b = 1 enable automatic search up to max range.
CBTTBP n.nn	Bottom Track Time Between Pings. n.nn = 0.00 to 86400.00 seconds (24 hours) sets the time between the last ping, regardless of ping type, and the next bottom track ping.

CBTT a, b, c, d	Bottom Track Thresholds. a. SNR (dB) Shallow Detection Threshold. Lowering the SNR counts "a" and/or "c" will allow to the DVL to detect smaller bottom echo at greater range. The consequence is that DVL may false detect the bottom at the wrong range when the bottom signal is weak. b. Depth (m) at which the bottom track switches from using shallow to deep SNR. Conditions in shallow water (high backscatter) can be different than deep water so "b" allows for two different SNR settings one for shallow ("a") and one for deep ("c"). c. SNR (dB) deep detection threshold. Lowering the SNR counts "a" and/or "c" will allow to the DVL to detect smaller bottom echo at greater range. The consequence is that DVL may false detect the bottom at the wrong range when the bottom signal is weak. d. Depth (m) at which the bottom track switches from low to high gain receive. The ADCP/DVL has a high power transmitter. In shallow water the bottom echo may saturate the receiver input. While this does not harm the system saturation limits the measurable signal level of the bottom echo which can make it difficult to detect the bottom in a high water backscatter environment. The ADCP/DVL places the receiver in low gain when the depth is below the "d" parameter setting. The change in gain is about 40 dB. If you observe the ADCP/DVL having difficulty detecting the bottom near the "d" setting you may need set "d" to a deeper or shallower depth depending on the depth where the detection is poor. A good rule to follow is a strong bottom echo requires a larger value in d and a weak bottom echo a smaller value.
CBTTC a, b, c, d	Transmit Control a. beam enable 00001111 = 4 beams enabled, 100000000 beam eight enabled b. Broadband Transmit Bandwidth 0=default, 1=50%, 2=25%, 3=12.5%,...6=1.5625% c. Broadband Sample Rate 0=default, 1=50%, 2=25%, 3=12.5%,...6=1.5625% d. Disable Transmit Current Shutdown 0=enable, 1=disable
CBTTP a	Transmit Power a. 1000 High Power, 0000 Low Power

3.12.d Environment

Environmental Commands

Command	Description
CWSSC 1, 2, 3, 4	Water Speed of Sound Control. 0 = command, 1 = sensor, 2 = internal calculation. 1. Water Temperature Source 2. Transducer Depth Source 3. Salinity Source 4. Speed of Sound Source
CWS n.nn	Water Salinity (ppt). Used in the water speed of sound calculation.
CWT n.nn	Water Temperature (degrees). Used in the water speed of sound calculation if the temperature sensor is not available.
CTD n.nn	Transducer Depth (meters). Used in the water speed of sound calculation.

CWSS n.nn	Water Speed of Sound (m/s). Used when the speed of sound source is set to sensor or command i.e. CWSSCx,x,x,0<CR> or CWSSCx,x,x,1<CR> . During standby and pinging the firmware monitors the communication ports for changes in CWSS and for the NMEA strings: $AML,SVM,SS,SN,nn*cs and/or $DVLSET, SS*cs. These NMEA strings are used on the Ocean Server platform for speed of sound input. When the ADCP/DVL detects a valid speed of sound NMEA string it automatically sets the CWSSC speed of sound source to 0 (command).
CHO n.nn, m.m, o.o	Heading Offset. 1. n.nn = Heading offset (-180 to + 180) added to the compass or GPS heading prior to being used within the system and then output. 2. m.m = System to ship heading offset (-180 to +180). 3. o.o = System to PNI compass offset (-180 to +180).
CHS n	Heading Source. Select the heading source for ENU transformations. 1. n = 0 for no heading 2. n = 1 for internal (PNI) compass 3. n = 2 for GPS HDT string via serial port
CTS n	Tilt Source. Select the tilt source for ENU transformations. 1. n = 0 for no tilts 2. n = 1 for internal (PNI) compass 3. n = 2 for external ATT
CVSF n.nn,m.mm	Velocity Scale Factor. Scale factor *n.nn* is applied to all water velocity measurement data. Scale factor *m.mm* is applied to all bottom velocity measurement data. New Velocity = CVSF * Velocity
CPZ	Zero Pressure Sensor. Sets the current pressure reading to the zero point (if pressure sensor is installed).

3.12.e Communications

Data Communication Commands

Command	Description
CEMAC	Temporarily enable or disable Ethernet communication. This command is typically sent via a serial port. The Ethernet port is disabled after power down or sleep. To permanently enable the port a special factory configuration command is required. When the Ethernet port is permanently enabled the system requires an additional 2 seconds after power up to begin accepting commands. One of two responses occur on the serial port after the command is accepted by the ADCP. Ethernet Port connected and ready for communication CEMAC+ MAC 02:ff:fe:fd:fc:fb IP 192.168.1.130

	Link OK Speed 1, FullDuplex 1 OR Ethernet Port is not connector and could NOT get communication with the network CEMAC+ MAC 02:ff:fe:fd:fc:fb IP 192.168.1.130 No Link
IP n.n.n.n	Set or review the IP address of ADCP. When no IP address is given, the system will return current MAC address and IP address. The default IP address is 192.168.1.130. IP+ MAC 02:ff:fe:fd:fc:fb IP 192.168.1.130
UDPPORT n	Set or review the UDP port of ADCP. n is port number. When no UDP port number is given, system will return current UDP port number. The default UDP port is 257.
C232B 1, 2, 3, 4	RS232 Serial Port Control. 1. Baud Rate (bits per second) a. 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400,460800, 921600. 2. Number of Bits: 7 or 8 3. Parity a. 0 = None b. 1 = Odd c. 2 = Even 4. Stop Bits: 1 or 2
C485B 1, 2, 3, 4	RS485 Serial Port Control. See CS232B command.
C422B 1, 2, 3, 4	RS422 Serial Port Control. See CS232B command.
CTRIG n	External Trigger. Selects which state the external hardware trigger needs to be before pinging. There are 2 types of trigger logic available Edge and Level. Edge requires the trigger line to change state before the ping occurs. For reliable edge detection the minimum width of a pulse should be >= 50 usec. Level just needs the trigger line to be either high or low. There is a 1.4 msec delay before the ping occurs after detection of the trigger. Trigger Type n = 0: disabled (default) n = 1: High level n = 2: Low level n = 3: Low to high n = 4: High to low

3.12.f System Configuration

System Configuration Commands

Command	Description
CLOAD	Load file "SYSCONF.BIN" from SD card into system configuration.
CSAVE	Save current system configuration to the file "SYSCONF.BIN" on the SD card.
CSHOW	Shows current system configuration.
CDEFAULT	Restores the system configuration to factory defaults. Note: Actual default values will vary depending on system type. Note: Default values are set for all hardware configured subsystems. When using the CEPO command defaults for repeated subsystems are set to zero (0). You need to set all the commands when using a single subsystem for multiple setups.

3.12.g System Deployment

System Deployment Commands

Command	Description
a. System Control:	
START	Start pinging continuously. Once started the system will only respond the STOP, STIME, and CSHOW commands.
STOP	Stop pinging and return to the command input mode.
SLEEP	Power down system.
b. Geo Position:	
SPOS	Display system geo position
SPOS 1, 2, 3, 4, 5	1. Lat (deg) 2. Lon (deg) 3. Depth (m) 4. Height Above Bottom (m) 5. 0 = Left Bank, 1 = Right Bank
c. Real Time Clock:	
STIME	Display system time.
STIME YYYY/MM/DD,HH:MM:SS	Set system time. Note: all digits including the space following STIME and the separators must be part of the command or the system will reject it.

3.12.h Data Storage

Data Storage Commands

Command	Description
a. File Transfer:	
DSXRfilename.abc	Data Storage XMODEM Receive (upload). This command is used to transfer a file, via the serial communication link, from an external device to the SD card contained within the ROWETECH system. File names are limited to a maximum of 8 characters before the extension.
DSXTfilename.abc	Data Storage XMODEM Transmit (download). This command is used to transfer a file, via the serial communication link, from the SD card contained within the ROWETECH system to an external device. File names are limited to a maximum of 8 characters before the extension.
b. Secure Digital:	
DSFORMAT	Data Storage Format. Stores the system files in FLASH then completely erases the SD card after which rewrites the system files to the SD card.
DSDIR n	Data Storage Directory. Show a directory of stored files. n = 0 or 1 to select one of the two the SD cards.
DSSHOW	Data Storage Show. Shows SD card capacity and usage. n = 0 or 1 to select one of the two the SD cards.

3.12.i Diagnostic

Diagnostic Commands

Command	Description
DIAGCPT	Diagnostic Compass Pass Thru. Allows an external device to connect directly to the internal compass via a serial communication link. To disconnect, the external device must send 16 consecutive X's (XXXXXXXXXXXXXXXX) to the system. The pass thru allows external software to directly access and calibrate the compass. The compass Baud rate is 38400 and should never be changed. The ADCP default Baud rate is 115200 which can be changed if desired.
DIAGSD	Shows the SD memory card manufacturer data. DIAGSD+ SD Test: Manufacturer ID: 3 OEM/Application ID: SD Product name: SB32G Product revision: 8.0 Product serial number: 3689549882

Manufacturing date: 0x138 = August 2019

CRC7 checksum: 2E

Total Space: 31166.976 MB

help.txt 2000/01/08 19:43:29 0.010

enghelp.txt 2020/05/26 11:49:13 0.001

AFILE.TXT 2020/05/28 06:06:21 0.000

sleep.bin 2000/01/08 19:47:08 0.073

A0000000.ens 2020/05/26 11:49:22 0.029

A0000001.ens 2020/05/28 06:06:28 0.050

0:/SYSTEM~1

0747.bl 2020/06/26 06:36:19 0.812

Used Space: 0.975 MB

FAT:

type 3

drive 0

csize 64

n_fats 1

wflag 0

SD File Write Result OK

SD File Read Result OK

Data Verification PASS

Test PASS

DIAGPNI n	Shows the compass/tilt sensor data. 1. n = 0 shows the current PNI configuration DIAGPNI 0+ Type: PRME,Revision: 0109 Declination: 0.000 True North: FALSE Big Endian: TRUE Mounting Ref: Standard -180 User Cal Stable Check: TRUE User Cal Num Points: 0 User Cal Auto Sampling: FALSE Baud Rate: 38400 Polling Mode: FALSE Flush Filter: FALSE Sensor Acq Time: 0.00 Interval Rsp Time: 0.00 Filter: Taps = 4, 0.0467086577, 0.4532913423, 0.4532913423, 0.0467086577 2. n = 1 shows the current Heading/Pitch/Roll values: DIAGPNI 1+ H= 90.37, P= -0.17, R= 0.14

3. n = 2 continuously shows the current Heading/Pitch/Roll values:
   H= 90.37, P= -0.17, R= 0.14

DIAGSAMP

Diagnostic Sensor Sample.

1. n = 1 run the test once.
2. n = 2 run the test continuously.

```
Heat_Sink_1   29.74 deg
Heat_Sink_2  975.01 deg
Water        24.97 deg
Receiver_1    29.50 deg
Receiver_2    29.74 deg
Regulator     32.65 deg

VINF        19.53 V
VT          17.65 V
VTL          0.99 V
VG          10.03 V
D3V3         3.31 V

Spare        199.00 counts

Heading       0.00 deg
Pitch         0.00 deg
Roll          0.00 deg
```

DIAGRTC n

Shows the Real Time Clock registers, time, and temperature.

1. n = 1 for single output.
2. n = 2 for continuous output.

```
DIAGRTC 1+
time: 20/07/08 1 07:32:11
alm1: 00 00 00 00
alm2: 00 00 00
ctrl: 00h
stat: 00h
ofs:  00h
temperature: 30.750 C
RTCINT 1
```

DIAGRCV a,b,c

Test Receiver Noise.

a. 1 runs the test once and displays the results. 2 runs the test continuously.
b. First beam number to test.
c. Number of beams to test.

```
DIAGRCV 0,1,1<CR>
Beam 1   DP300  Amp(dB)   Freq(Hz) Correlation Result
      HGWBWB  34.733    -33.609     0.032   PASS
      LGWBWB  35.725   -674.960     0.045   PASS
      HGNBWB  31.384   -228.426     0.042   PASS
      LGNBWB  31.697    -59.701     0.063   FAIL
      HGWBNB  33.655    -47.611     0.068   FAIL
      LGWBNB  37.093    -22.873     0.130   FAIL
      HGNBNB  33.196     29.273     0.054   FAIL
      LGNBNB  33.099   -124.820     0.070   FAIL
```

3.13 ROWETECH Binary Data

1. ROWETECH Binary Data Packet consists of 3 sections
    a. 32 byte Header
        i. 16 bytes containing 0x80
        ii. 4 byte Ensemble number
        iii. 4 byte Ensemble number ones compliment
        iv. 4 byte payload size (in bytes)
        v. 4 byte payload size ones compliment
    b. MAT-File Payload
        i. Version 4 MAT-File Format (see matlab4.pdf for details)
        ii. A MAT-file may contain one or more matrices. The matrices are written sequentially to a file, with the bytes forming a continuous stream. Each matrix starts with a fixed-length 20-byte header that contains information describing certain attributes of the Matrix. The 20-byte header consists of five long (4-byte) integers.
        iii. ADCP Velocity, Amplitude, and Statistical data are contained in bins x 4 arrays (row x column).
        iv. ADCP Ancillary data such as Time, Heading, Pitch, Roll and Temperature are contained in an n x 1 array. Where n is the number of rows.
    c. CRC-16 Checksum (see appendix B for example)
        i. 4 byte checksum of all the bytes in the payload
            1. First 2 bytes are always 0
            2. The second 2 bytes contain the CRC-16 value
                a. CCITT 16 bit algorithm (X^16 + X^12 + X^5 + 1)
                b. CRC seed = 0

Note:

If you remove the ROWETECH header for each ensemble Matlab is able to directly read in the ensemble.

2. ROWETECH matrix names are contained in the payload (see Appendix B1 for details)

3. Binary Ensemble decoding (see Appendix B2 for a C# example)

4. This is a hex capture of the first few bytes in a binary file:

```
53 54 41 52 54 06 0d 0a 80 80 80 80 80 80 80 80
80 80 80 80 80 80 80 80 01 00 00 00 fe ff ff ff
88 0b 00 00 77 f4 ff ff 0a 00 00 00 14 00 00 00
04 00 00 00 00 00 00 00 08 00 00 00 45 30 30 30
30 30 31 00 5a 9a ee bd 96 7a f7 bd 5b 27 db bd
4e 8a 27 be b0 90 43 be a8 b8 5a be 8d 56 82 be
a5 d7 16 be 84 48 03 be a8 c6 b1 42 50 f9 04 be
```

```
c5 ca 8e be 43 9b c5 be a8 c6 b1 42 a8 c6 b1 42
a8 c6 b1 42 a8 c6 b1 42 a8 c6 b1 42 a8 c6 b1 42
a8 c6 b1 42 72 17 16 bf 99 88 28 bf 1c 48 f6 be
bc 9f 16 bf 2c 67 1a bf 72 28 27 bf 56 ad 3a bf
68 24 43 bf 16 6b 44 bf b4 47 2a bf 6a 40 43 bf
cf 99 2e bf 1f f4 46 bf a8 c6 b1 42 a8 c6 b1 42
```

a. Yellow is the word START followed by a CRLF. This was captured when the user started the ADCP.
b. Green is the ROWETECH 32 byte Header.
c. Cyan is the matlab version 4 matrix-header containing 5 integer values are that are set to 10, 20, 4, and 8.
    i. The 10 indicates the matrix contains 4 byte floating point numbers.
    ii. 20 is the number of rows in the matrix which is number bins in the ADCP profile.
    iii. 4 is the number of columns which is the number of ADCP profile beams.
    iv. 8 is the number of bytes in the matrix name.
d. Pink is the matrix name or "E000001".
e. Following that there is 4*20 = 80 floating point numbers in the matrix (not all shown here).
f. The next matrix "E000002" starts after the last floating point number... and so on until all of the matrices in the ensemble are read in.
g. The end of the ensemble has 4 more bytes that are used as a checksum.
h. The next ensemble starts with a 32 byte header just like the previous one and contains the same matrix names repeated but with new data.
i. If you remove the ROWETECH header for each ensemble Matlab is able to directly read in the ensemble.

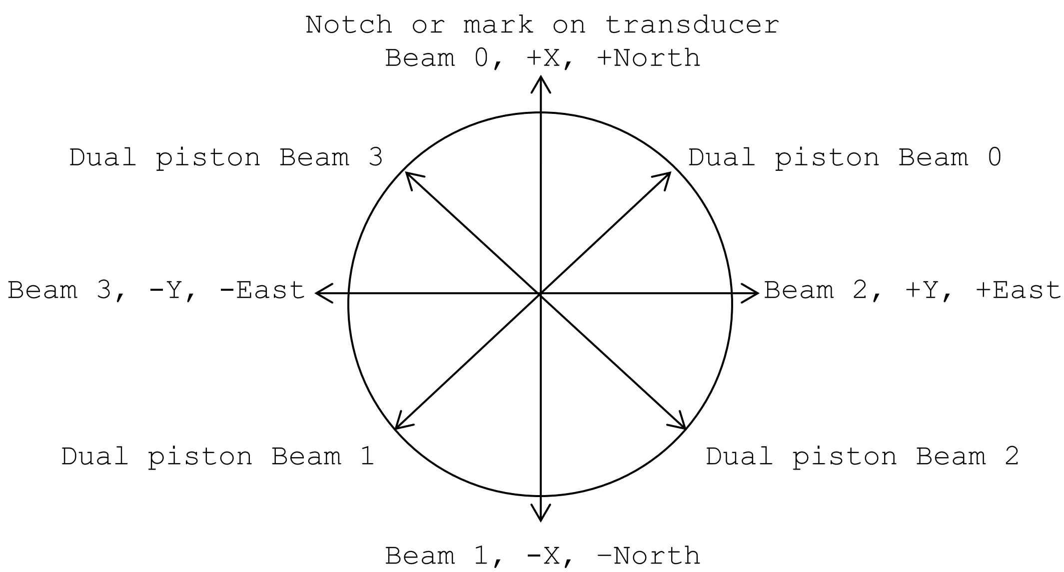
3.14 Coordinate systems

ROWETECH uses three different coordinate systems.

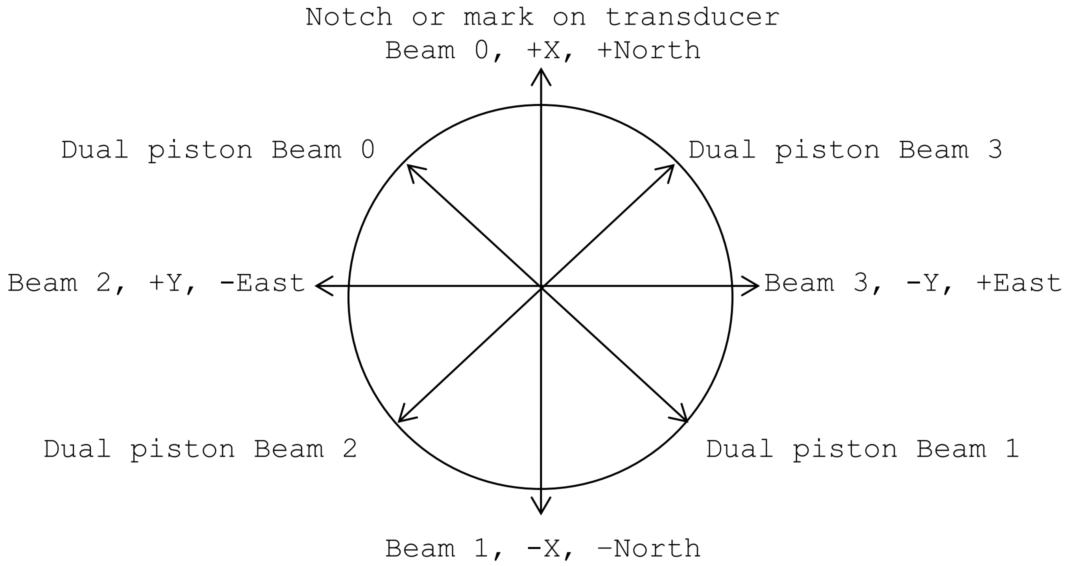
1. Beam
    a. The velocity vector is in the direction each beam points.
    b. Beams are located on azimuth angles of 0, 90, 180, and 270 degrees around transducer.
    c. Beam elevation angles can be 15, 20, or 30 degrees from vertical.
    d. A positive velocity measurement occurs when a beam and an object move closer together.
    e. Beam velocity data is useful for beam diagnostics.
    f. Beam velocity data may require further processing to be useful for navigation or scientific work.
2. Instrument
    a. Beam velocities are rotated to a 3 axis velocity vector X, Y, and Z. The X axis is along a line drawn between beams 0 and 1. The Y axis is along a line drawn between beams 3 and 2. The Z axis is orthogonal to both the X and Y axes.
    b. The instrument coordinate system follows the Right Hand Rule convention.
3. Earth
    a. With the addition of a Heading, Pitch, Roll (HPR) sensor the beam velocities are "bin mapped" to a common horizontal plane and then rotated to the Earth referenced velocity vector East, North, and Up (ENU).

Note:

Transformed bottom and water track velocity data are reported as transducer motion. Transformed water profiling bin velocities are reported as water motion. In other words, bottom track velocities have an opposite sign from profile bins if the measured velocity is only due to transducer motion.



Downward facing Transducer (face away from observer)



Upward facing Transducer (face towards observer)

Note:

The Earth frame references in the above diagram (North, East, etc.) correspond to the case where the X-axis is aligned with the North with the instrument level. That is, the compass measures heading relative to the X-axis and pitch and roll about the Y and X axes

3.15 GPS Compass

When using a GPS compass to rotate from the ADCP/DVL XYZ coordinate system to the ENU system use the following:

1. Align beam 0 with the GPS compass North. Beam 0 is located by a small notch on the side of the transducer.
2. Extract the GPS heading from the NMEA HDT string.
3. Process the ADCP XYZ velocity data using the following C# code:

```
double theta = GPS_HDT / 180.0 * Math.PI; //convert from degrees to radians
double CosT = Math.Cos(theta);
double SinT = Math.Sin(theta);
double NorthVelocity = VelocityX * CosT - VelocityY * SinT;
double EastVElocity  = VelocityX * SinT + VelocityY * CosT;
```

4. Repeat the processing for all bins and bottom velocities.

3.16 Payload Matrix Contents

1. **E000001**
    a. Single Precision Floating Point
    b. Bins x Beams
        1. Beam Velocity in m/s
            a. Contains the Beam coordinate velocity profile data as measured along each beam. The data is useful for diagnostic purposes and for when the user wants to perform their own transformation. It is arranged beam 0 to 3 for all bins.

2. **E000002***
    a. Single Precision Floating Point
    b. Bins x Beams
        1. Instrument Velocity in m/s
            a. Contains the Instrument coordinate velocity profile. It is arranged X, Y, Z, Q for all bins where:

3. **E000003***
    a. Single Precision Floating Point
    b. Bins x Beams
        i. Earth Velocity in m/s
            1. Contains the Earth coordinate velocity profile. It is arranged E, N, U, Q for all bins where:

4. **E000004**
    a. Single Precision Floating Point
    b. Bins x Beams
        i. Amplitude in dB
            1. Contains the Beam Amplitude profile. It is arranged beam 0 to 3 for all bins.

5. **E000005**
    a. Single Precision Floating Point
    b. Bins x Beams
        i. Correlation where 1.0 = 100% and 0.5 = 50% correlation.
            1. Contains the Beam Correlation profile. It is arranged beam 0 to 3 for all bins.

6. **E000006**
    a. 32 bit Integer

b. beams x bins
    1. Good Beam Pings
        a. Contains the number of good pings for each bin/beam in the beam velocity data matrix E000001. It is arranged beam 0 to 3 for all bins.

7. **E000007***
    a. 32 bit Integer
    b. Bins x Beams
        1. Good Earth Pings
            a. Contains the number of good pings for each bin/beam in the ENUQ velocity data matrix E000003. It is arranged NG3, NG3, NG3, and NG4 for each bin. Where: NG3 = the Number of Good 3 beam solutions and NG4 = the Number of Good 4 beam solutions in the bin.

Note: ROWETECH systems can use 3 or 4 beams to solve for the Earth coordinate system. If 4 beam velocities are available then all 4 are used. If only 3 beams are available, perhaps due to a beam failure or a signal fade, the 4th beam velocity is calculated from the other 3 before calling the Earth transformation function (shown above). To calculate a 3 beam solution it is assumed that the beams are configured as a 4 beam Janus transducer and that the Q velocity on average is equal to 0.0 m/s.

Since

```
Q = (BM0 + BM1 - Bm2 - BM3) = 0.0
```

The “missing” beam solution is:

```
BM0 = -BM1 + BM2 + BM3;
BM1 = -BM0 + BM2 + BM3;
BM2 =  BM0 + BM1 - BM3;
BM3 =  BM0 + BM1 - BM2;
```

8. **E000008**
    a. 32 bit Integer
    b. 25 x 1
        i. Ensemble data
            1. Ensemble Number
            2. Bins
            3. Beams
            4. Pings in Ensemble (desired)
            5. Ping Count (actual)
            6. Status (see appendix for description)
            7. Year
            8. Month
            9. Day
            10. Hour
            11. Minute

12. Seconds
13. 1/100 Seconds
14. System Serial Number A (see appendix for a description of the SN)
15. System Serial Number B
16. System Serial Number C
17. System Serial Number D
18. System Serial Number E
19. System Serial Number F
20. System Serial Number G
21. System Serial Number H
22. System Type and Firmware Version
    a. Most significant byte contains a code that describes the hardware Subsystem for this data set. (See description of this code in appendix B5).
    b. Next byte contains the Major firmware version.
    c. Next byte contains the Minor firmware version.
    d. Least significant byte contains the firmware Revision.
23. Subsystem Configuration
    a. Most significant byte contains a number that identifies which command setup is being used for the current subsystem. Use this byte along with the System Type byte to separate the ensembles for each setup/subsystem.
    b. Next byte contains the Burst ID.
24. Status 2
    a. (see appendix B6 for description)
25. Burst Index
    a. Increments at the end of each burst. Used to help group bursts together after data output.

9. **E000009**
    a. Single Precision Floating Point
    b. 29 x 1
        i. Ancillary data (Contains additional Ensemble data)
            1. Range of First Bin from the transducer in meters
            2. Bin Size in meters
            3. First Profile Ping Time in seconds
            4. Last Profile Ping Time in seconds
            5. Heading in degrees
            6. Pitch in degrees
            7. Roll degrees
            8. Water Temperature in degrees (used in SOS)
            9. System Temperature in degrees
            10. Salinity in parts per thousand (ppt) (used in SOS)
            11. Pressure in bar
            12. Depth in meters (used in SOS)
            13. Speed Of Sound in m/s
            14. Raw magnetic field strength (uT) (micro Tesla)

15. Raw magnetic field strength (uT) (micro Tesla)
16. Raw magnetic field strength in (uT) (micro Tesla)
17. Pitch axis Earth's gravity vector (G) component output.
18. Roll axis Earth's gravity vector (G) component output.
19. Vertical axis Earth's gravity vector (G) component output.
20. Heat Sink 1 Temperature in degrees
21. Heat Sink 2 Temperature in degrees
22. Receiver 1 Temperature in degrees
23. Receiver 2 Temperature in degrees
24. System Input Voltage (VDC)
25. Transmit Gate Voltage VG (VDC)
26. Transmit High Power Voltage VT (VDC)
27. Transmit Low Power Voltage VTL (VDC)
28. 3.3 VDC
29. Spare

18. **E000010**
    a. Single Precision Floating Point
    b. 95 x 1
        i. Bottom Track data
            1. First Bottom Track Ping Time in seconds
            2. Last Bottom Track Ping Time in seconds
            3. Heading in degrees
            4. Pitch in degrees
            5. Roll in degrees
            6. Water Temperature in degrees (used in SOS)
            7. System Temperature in degrees
            8. Salinity in parts per thousand (ppt) (used SOS)
            9. Pressure in bar
            10. Depth in meters (used in SOS)
            11. Speed Of Sound in m/s
            12. Status (final value is logical OR of each bit below)
                i. Good Status 0x0000
                    a. Water Track 3 Beam solution 0x0001 (DVL only)
                        i. 3 of 4 beams have a valid signal
                    b. Bottom Track 3 Beam Solution 0x0002
                        i. 3 of 4 beams located the bottom
                    c. Bottom Track Hold (not searching yet) 0x0004
                        i. Holding the search to last known depth
                    d. Bottom Track Searching 0x0008
                        i. Actively searching for the bottom
                    e. Hardware Timeout 0x8000
                        i. The hardware did not respond to the ping request
            13. Number of Beams
            14. Ping Count
            15. Range_0 (Beam 0 vertical range in meters)
            16. Range_1 (Beam 1 vertical range in meters)
            17. Range_2 (Beam 2 vertical range in meters)
            18. Range_3 (Beam 3 vertical range in meters)
            19. SNR_0 (Beam 0 Signal to Noise in dB)

20. SNR_1 (Beam 1 Signal to Noise in dB)
21. SNR_2 (Beam 2 Signal to Noise in dB)
22. SNR_3 (Beam 3 Signal to Noise in dB)
23. Amplitude_0 (Beam 0 Bottom Amplitude in dB)
24. Amplitude_1 (Beam 1 Bottom Amplitude in dB)
25. Amplitude_2 (Beam 2 Bottom Amplitude in dB)
26. Amplitude_3 (Beam 3 Bottom Amplitude in dB)
27. Correlation_0 (Beam 0 Correlation (0.5 = 50%))
28. Correlation_1 (Beam 1 Correlation (0.5 = 50%))
29. Correlation_2 (Beam 2 Correlation (0.5 = 50%))
30. Correlation_3 (Beam 3 Correlation (0.5 = 50%))
31. Velocity_0 (Beam 0 Velocity in m/s)
32. Velocity_1 (Beam 1 Velocity in m/s)
33. Velocity_2 (Beam 2 Velocity in m/s)
34. Velocity_3 (Beam 3 Velocity in m/s)
35. BeamN_0 (Beam 0 Number of pings averaged)
36. BeamN_1 (Beam 1 Number of pings averaged)
37. BeamN_2 (Beam 2 Number of pings averaged)
38. BeamN_3 (Beam 3 Number of pings averaged)
39. Instrument_0 (X velocity in m/s)
40. Instrument_1 (Y velocity in m/s)
41. Instrument_2 (Z velocity in m/s)
42. Instrument_3 (Q velocity in m/s)
43. XfrmN_0 (Number of 3 beam solutions averaged)
44. XfrmN_1 (Number of 3 beam solutions averaged)
45. XfrmN_2 (Number of 3 beam solutions averaged)
46. XfrmN_3 (Number of 4 beam solutions averaged)
47. Earth_0 (East velocity in m/s)
48. Earth_1 (North velocity in m/s)
49. Earth_2 (Up velocity in m/s)
50. Earth_3 (Q velocity in m/s)
51. EarthN_0 (Number of 3 beam solutions averaged)
52. EarthN_1 (Number of 3 beam solutions averaged)
53. EarthN_2 (Number of 3 beam solutions averaged)
54. EarthN_3 (Number of 4 beam solutions averaged)
55. SNRS_0 (Pulse Coherent, short lag, first echo Signal to noise dB)
56. SNRS_1 (Pulse Coherent, short lag, first echo S/N dB)
57. SNRS_2 (Pulse Coherent, short lag, first echo S/N dB)
58. SNRS_3 (Pulse Coherent, short lag, first echo S/N dB)
59. AmplitudeS_0 (Pulse Coherent, short lag, first echo amplitude dB)
60. AmplitudeS_1 (Pulse Coherent, short lag, first echo amplitude dB)
61. AmplitudeS_2 (Pulse Coherent, short lag, first echo amplitude dB)
62. AmplitudeS_3 (Pulse Coherent, short lag, first echo amplitude dB)
63. VelocityS_0 (Pulse Coherent, short lag, first echo velocity m/s)
64. VelocityS_1 (Pulse Coherent, short lag, first echo velocity m/s)
65. VelocityS_2 (Pulse Coherent, short lag, first echo velocity m/s)
66. VelocityS_3 (Pulse Coherent, short lag, first echo velocity m/s)
67. NoiseAmplitudeS_0 (Pulse Coherent, short lag, first echo velocity m/s)
68. NoiseAmplitudeS_1 (Pulse Coherent, short lag, first echo velocity m/s)
69. NoiseAmplitudeS_2 (Pulse Coherent, short lag, first echo velocity m/s)

70. NoiseAmplitudeS_3 (Pulse Coherent, short lag, first echo velocity m/s)
71. CorrelationS_0 (Pulse Coherent, short lag, first echo correlation %)
72. CorrelationS_1 (Pulse Coherent, short lag, first echo correlation %)
73. CorrelationS_2 (Pulse Coherent, short lag, first echo correlation %)
74. CorrelationS_3 (Pulse Coherent, short lag, first echo correlation %)
75. Heat Sink 1 Temperature in degrees
76. Heat Sink 2 Temperature in degrees
77. Receiver 1 Temperature in degrees
78. Receiver 2 Temperature in degrees
79. System Input Voltage (VDC)
80. Transmit Gate Voltage VG (VDC)
81. Transmit High Power Voltage VT (VDC)
82. Transmit Low Power Voltage VTL (VDC)
83. 3.3 VDC
84. Spare
85. Depth Sounder Range
86. Depth Sounder SNR
87. Depth Sounder Amp
88. Ship_0
89. Ship_1
90. Ship_2
91. Ship_3
92. ShipN_0
93. ShipN_1
94. ShipN_2
95. ShipN_3

19. **E000011**
    a. 8 bit Byte
    b. n x 1
        i. External NMEA ASCII collected during ping
            1. Contains captured serial NMEA data that arrived during the ensemble. One 8 bit byte per ASCII character. Maximum number of bytes = 8192.

20. **E000012**
    a. Single Precision Floating Point
    b. 23 x 1
        i. Profile Engineering data contains data that describes the Profile ping setup.
            1. Reserved
            2. Reserved
            3. Reserved
            4. Reserved
            5. Reserved
            6. Reserved
            7. Reserved
            8. Reserved
            9. Reserved
            10. Reserved
            11. Reserved

12. Reserved
13. SamplesPerSecond
14. SystemFreqHz
15. LagSamples
16. CPCE
17. NCE
18. RepeatN
19. Reserved
20. Reserved
21. Reserved
22. Reserved
23. Water Profile Gain Setting 0 = low, 1 = high

21. **E000014**
    a. Single Precision Floating Point
    b. 35 x 1
        i. System Settings
            1. Bottom Track SamplesPerSecond
            2. Bottom Track SystemFreqHz
            3. Bottom Track CyclesPerCodeElement
            4. Bottom Track NumberOfCodeElementsInCode
            5. Bottom Track NumberOfRepeatedCodes
            6. Water Profile SamplesPerSecond
            7. Water Profile SystemFreqHz
            8. Water Profile CyclesPerCodeElement
            9. Water Profile NumberOfCodeElementsInCode
            10. Water Profile NumberOfRepeatedCodes
            11. Water Profile NumberOfSamplesInLag
            12. System Input Voltage
            13. Transmitter High Power Voltage
            14. Bottom Track Mode
            15. Bottom Track Pulse to Pulse Lag (m)
            16. Bottom Track Long Range Switch Depth (m)
            17. Bottom Track Beam Multiplex
            18. Water Profile Mode
            19. Water Profile Lag (m)
            20. Water Profile Transmit Bandwidth
            21. Water Profile Receive Bandwidth
            22. Transmitter Boost Negative Voltage
            23. WP beam Mux
            24. Reserved
            25. Reserved
            26. Reserved
            27. Reserved
            28. Transmitter Current 0,0
            29. Transmitter Current 0,1
            30. Transmitter Current 0,2
            31. Transmitter Current 0,3
            32. Transmitter Current 1,0
            33. Transmitter Current 1,1
            34. Transmitter Current 1,2
            35. Transmitter Current 1,3

22. **E000020***
    a. Single Precision Floating Point
    b. Bins x Beams
        i. Ship Velocity in m/s
            1. Contains the Ship coordinate velocity profile. It is arranged F, S, M, Q for all bins where:

23. **E000021***
    a. 32 bit Integer
    b. beams x bins
        i. Good Ship Pings
            1. Contains the number of good pings for each bin/beam in the Ship velocity data matrix E000020. It is arranged beam 0 to 3 for all bins.

Note:

Please Note*, **E000002, **E000003**, **E000007**, **E000020** and **E000021** are not in the firmware output, they are available in the processed Ensembles after coordinate transformation is performed and with navigation data (heading, pitch and roll). The processed data is available in PLAYBACK mode ONLY and only if Navigation data is available.

3.17 C# Checksum Calculation

The following C# code calculates the checksum for the ROWETECH ensemble:

```
const int HDRLEN = 32;
long csum = 0;

long EnsembleSize  = DataBuff [24];
        EnsembleSize += DataBuff [25] << 8;
        EnsembleSize += DataBuff [26] << 16;
        EnsembleSize += DataBuff [27] << 24;

 //CCITT 16 bit algorithm (X^16 + X^12 + X^5 + 1)

 ushort crc = 0; //seed = 0
 for (i = HDRLEN; i < EnsembleSize + HDRLEN; i++)
 {
    crc = (ushort)((byte)(crc >> 8) | (crc << 8));
    crc ^= DataBuff[i];
    crc ^= (byte)((crc & 0xff) >> 4);
    crc ^= (ushort)((crc << 8) << 4);
    crc ^= (ushort)(((crc & 0xff) << 4) << 1);
 }
 ushort csum = crc;
```

3.18 C# Binary Data Packet

1. Ensemble Binary Data Packet consists of 3 sections
    a. 32 byte Header
        i. 16 bytes containing 0x80
        ii. 4 byte Ensemble number
        iii. 4 byte Ensemble number ones compliment
        iv. 4 byte payload size (in bytes)
        v. 4 byte payload size ones compliment
    b. MAT-File Payload
        i. Version 4 MAT-File Format (see matlab4.pdf for details)
        ii. A MAT-file may contain one or more matrices. The matrices are written sequentially to a file, with the bytes forming a continuous stream. Each matrix starts with a fixed-length 20-byte header that contains information describing certain attributes of the Matrix. The 20-byte header consists of five long (4-byte) integers.
        iii. Velocity, Amplitude, and Statistical data are contained in bins x 4 arrays (row x column).
        iv. Ancillary data such as Time, Heading, Pitch, Roll and Temperature are contained in an n x 1 array. Where n is the number of rows.
    c. CRC-16 Checksum
        i. 4 byte checksum of all the bytes in the payload
        ii. First 2 bytes are always 0
        iii. The second 2 bytes contain the CRC-16 value
        iv. CCITT 16 bit algorithm (X^16 + X^12 + X^5 + 1)
        v. CRC seed = 0

3.19 System Serial Number and Subsystem Codes

1. The system serial number is 32 bytes in length
    a. SNXX0123456789ABCDEabcdefghi123456
        i. The first 2 bytes after the SN (XX) are combined to form an integer number. This number describes the base electronics hardware architecture.
        ii. The next 15 bytes (0 - E) represent the 15 possible different sub systems.
            1. Each of the 15 digits 0 through E contains a code (0 - Z) that describes a subsystem. See list below for a description of the codes.
            2. Subsystem references are made by using the corresponding character 0 – F. For example: the command CWPP[3] 10<CR> sets the number of water track pings for subsystem 3 to 10 pings. Subsystem 3 is the 4th subsystem contained in the SN.
        iii. The next 9 bytes (a – i) are spares.
        iv. The last 6 digits (1 - 6) are the system serial number.
    b. Example 1:
        i. SN07gd0000000000000000000000000945
            1. ADCP3 PLATFORM Dual Frequency 38/300 kHz 30 degree Phased Array, serial number 945
    c. Example 2:
        i. SN01340000000000000000000000000001
            1. Dual frequency 600/300 kHz 4 beam 20 degree piston, serial number 1
    d. Example 3:
        i. SN01K00000000000000000000000000001
            1. A 150 kHz 4 beam 30 degree array, serial number 1
    e. Example 4:
        i. SN01KOc00000000000000000000000001
            1. A dual 150/600 kHz 4 beam 30 degree array
            2. A 1200 kHz 4 beam 20 degree piston opposite facing
            3. Serial number 1

ADCP 03 system SN07xx
Subsystem Codes:
code description
0 Reserved
A Spare
B 1.2 MHz 4 beam 20 degree piston
C 600 kHz 4 beam 20 degree piston
D 300 kHz 4 beam 20 degree piston
E 150 kHz 4 beam 20 degree piston
F 75 kHz 4 beam 20 degree piston
G Spare
H Spare
I 1.2 MHz 4 beam 20 degree piston, 45 degree heading offset
J 600 kHz 4 beam 20 degree piston, 45 degree heading offset
K 300 kHz 4 beam 20 degree piston, 45 degree heading offset
L Spare
M Spare
N 1.2 MHz 1 beam vertical piston
O 600 kHz 1 beam vertical piston
P 300 kHz 1 beam vertical piston
Q 150 kHz 1 beam vertical piston
R Spare
S Spare
T Spare
U Spare
V Spare
W Spare
X Spare
Y Spare
Z Spare
a Spare
b 1.2 MHz 4 beam 30 deg array
c 600 kHz 4 beam 30 deg array
d 300 kHz 4 beam 30 deg array
e 150 kHz 4 beam 30 deg array
f 75 kHz 4 beam 30 deg array
g 38 kHz 4 beam 30 deg array
h Spare
i Spare
j Spare
k Spare
l Spare
m Spare
n 1.2 MHz 1 beam vertical array
o 600 kHz 1 beam vertical array
p 300 kHz 1 beam vertical array
q 150 kHz 1 beam vertical array
r 75 kHz 1 beam vertical array
s 38 kHz 1 beam vertical array
t Spare

u Spare
v Spare
w Spare
x Spare
y Spare
z Spare

3.20 System Status Words

The System Status word is output with both the NMEA and Binary data structures. The final value is the logical OR of each bit shown below:

Status word 1:

1. 0x0000 Good Status
2. 0x0001 Bottom track long lag processing is in use
3. 0x0002 Bottom track 3 beam solution
    a. Indicates the bottom track velocity output contains a 3 beam solution.
4. 0x0004 Bottom track hold
    a. Indicates bottom track did not detect the bottom but is still using the last good detection as an estimate of the bottom location.
5. 0x0008 Bottom Track Search
    a. Indicates bottom track is actively changing the ping settings to attempt bottom detection.
6. 0x0010 Bottom Track long range narrow band processing is being used.
    a. Indicates bottom track is using the narrow band processing for long range bottom detection.
7. 0x0020 Bottom track coast.
    a. Indicates the bottom track output filter is in use but no new data is available for output.
8. 0x0040 Bottom track proof.
    a. Indicates bottom track is waiting for the next valid bottom track ping before allowing velocity data to be output.
9. 0x0080 Bottom track low gain.
    a. Indicates bottom track has reduced the receiver gain below the selected switch range.
10. 0x0100 Heading sensor Error
11. 0x0200 Pressure Sensor Error
12. 0x0400 Power Down failure
    a. System power did not shut off between ensembles.
13. 0x0800 Non Volatile data error
    a. Non volatile memory storage checksum failed.

14. 0x1000 Real Time Clock (RTC) error
    a. The RTC did not respond or the time data value contained illegal values i.e. month = 13.
15. 0x2000 Temperature sensor Error
    a. The temperature sensor ADC did not respond or the temperature value was out of range (-30 to 70 C).
16. 0x4000 Receiver data error
    a. The receiver did not output the expected amount of data.
17. 0x8000 Receiver Timeout
    a. The receiver hardware did not respond to the ping request.

Status Word 2:

1. 0x0000 Good Status
2. 0x0001 Transmitter 1 error
3. 0x0002 Transmitter 2 error
4. 0x0004 Internal Temperature error

4 Boards

4.1 Internal Parts of Lower Deck Box

Figure 48: Front view of the Lower Deck Box

Figure 49: Isometric view of the Lower Deck Box

Internal Parts of Lower Deck Box

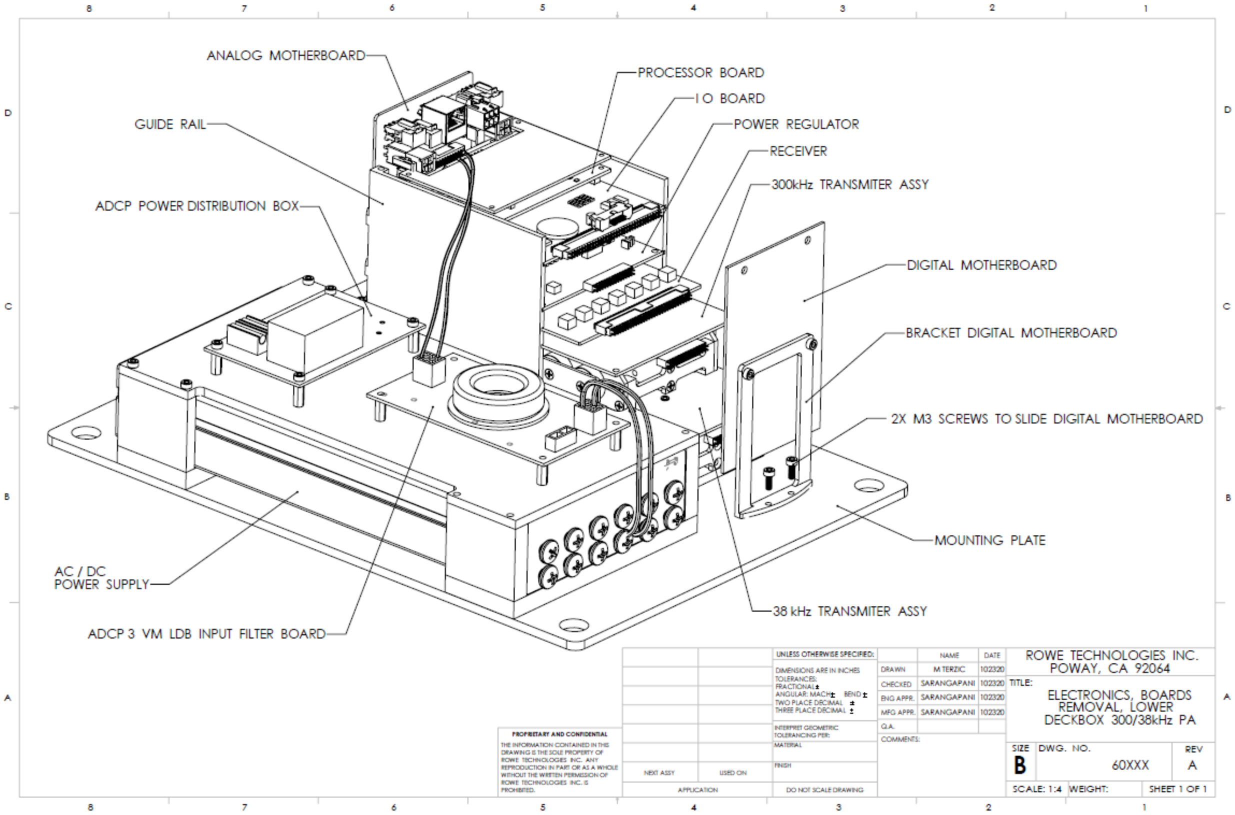
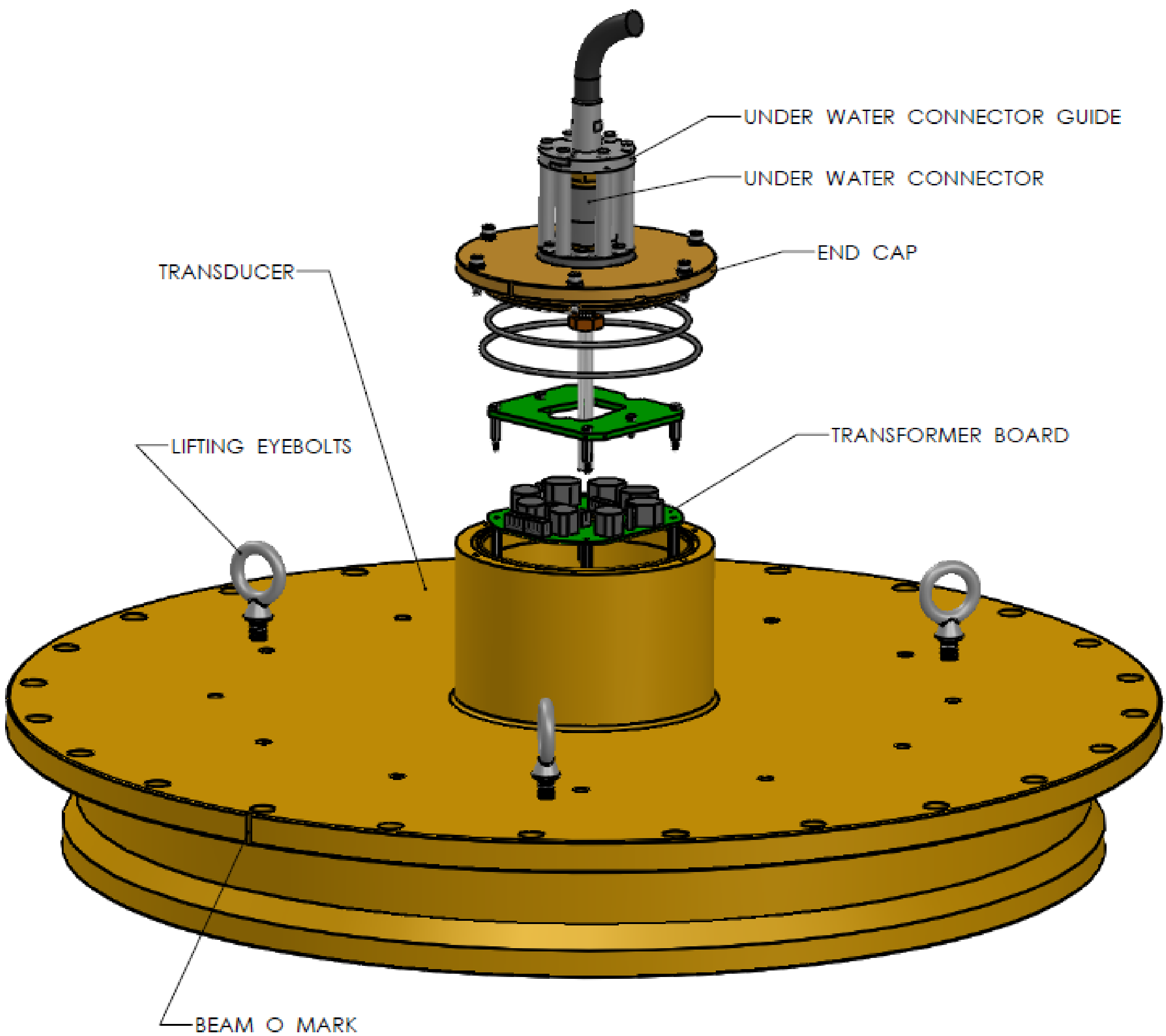


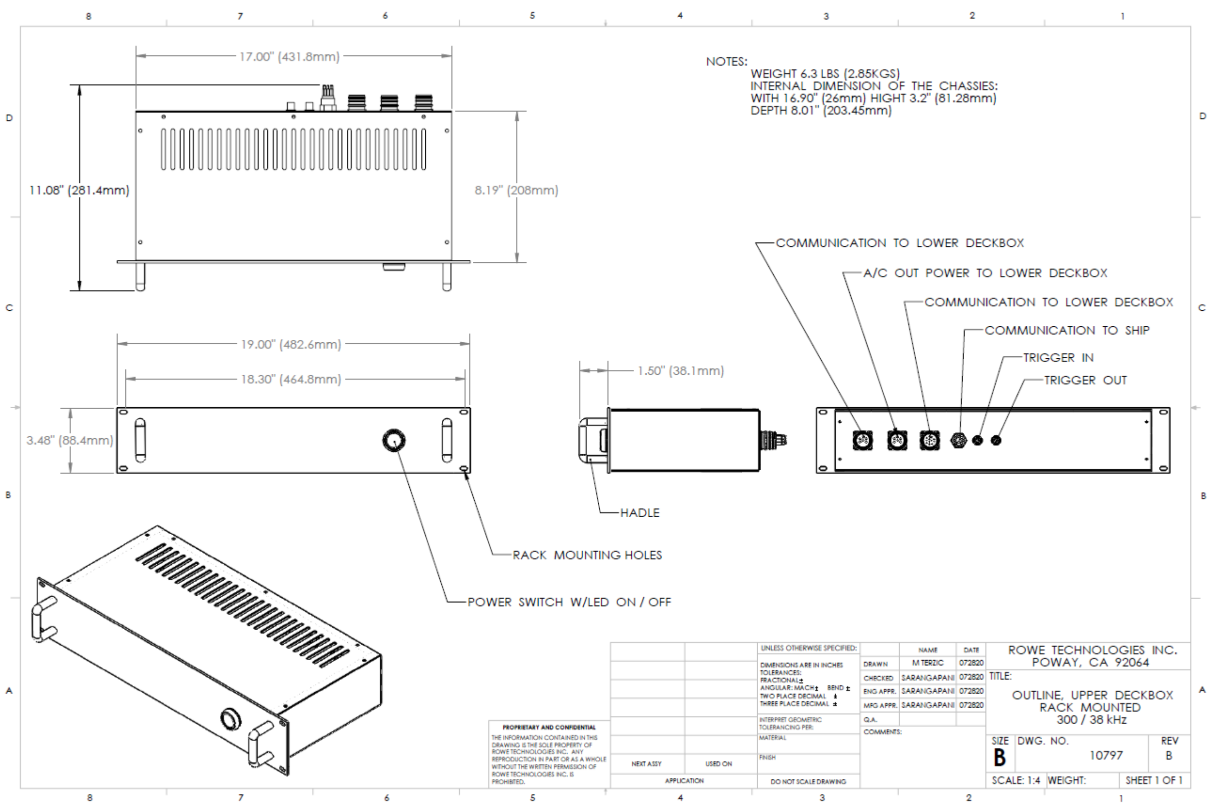
Figure 50 Mechanical drawing showing all the components of the electronics stack inside the Lower Deck Box.

4.2 Transformer Board in Transducer End-cap

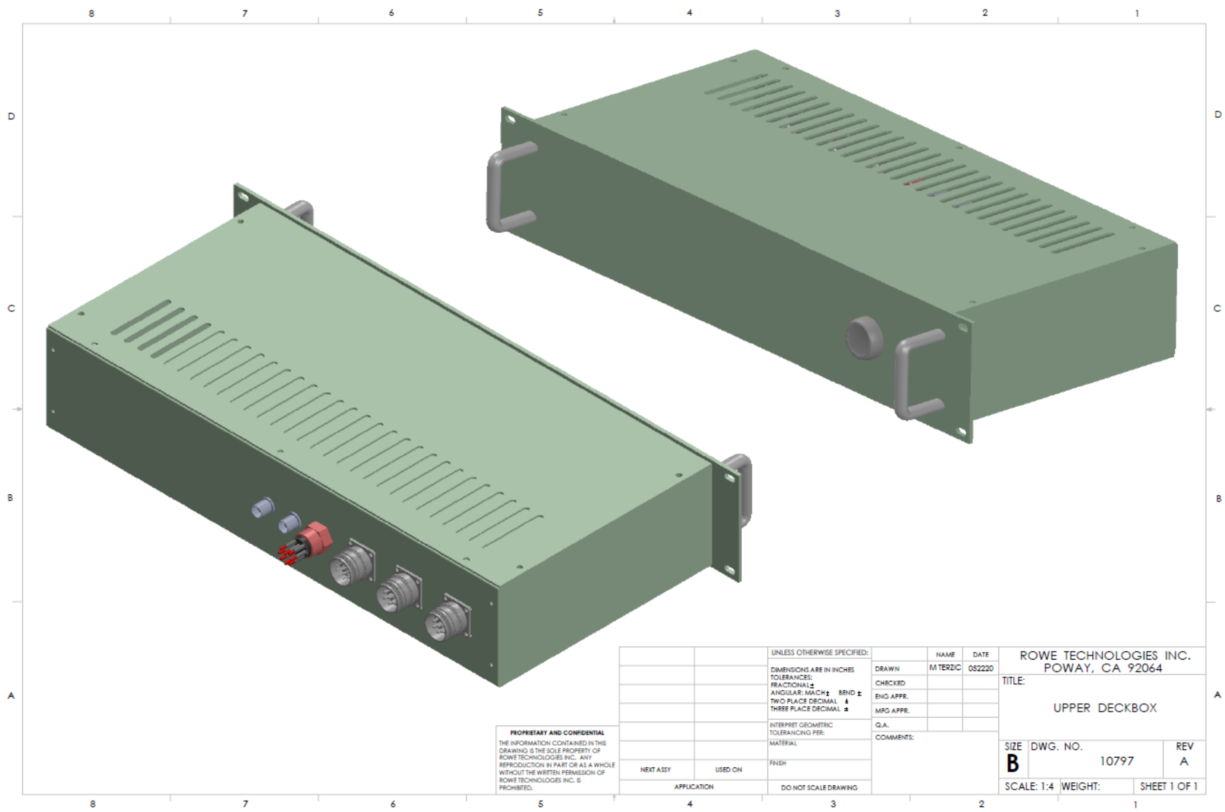


5 Outline drawings

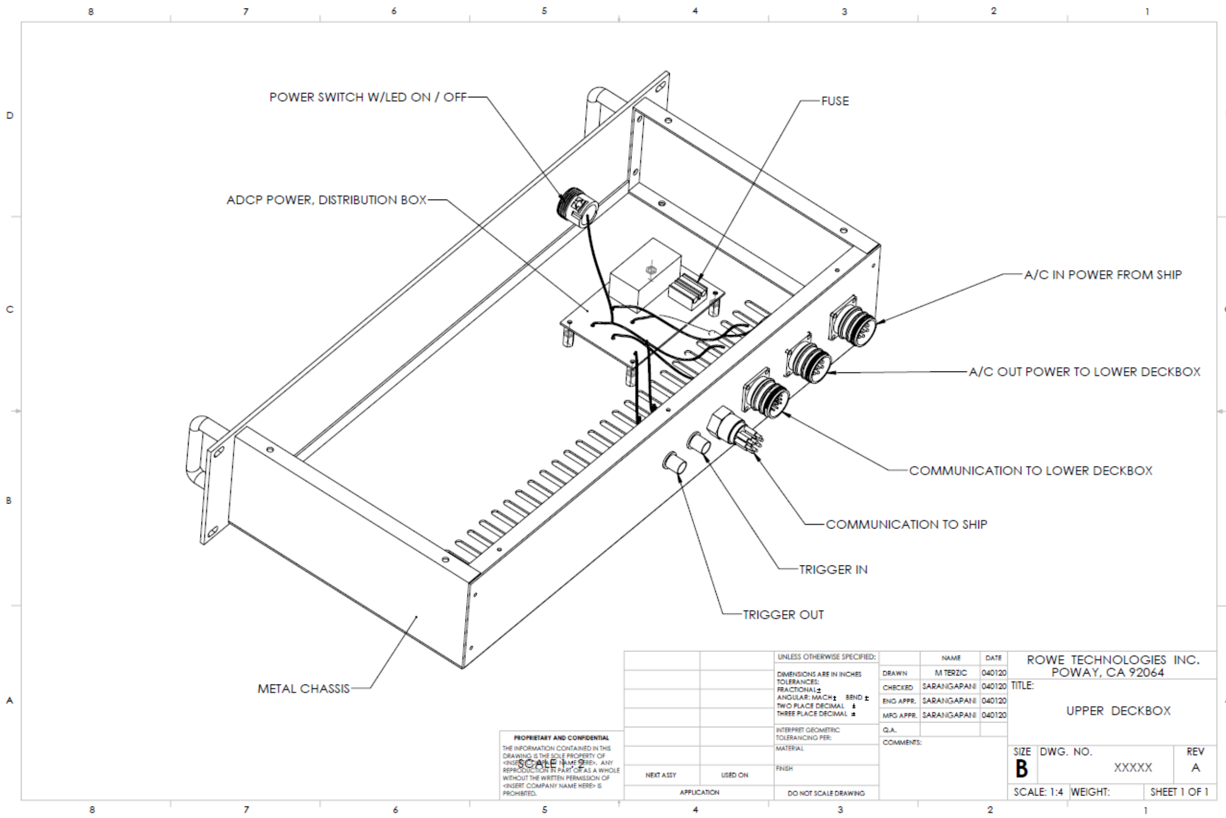
5.1 Upper Deck Box



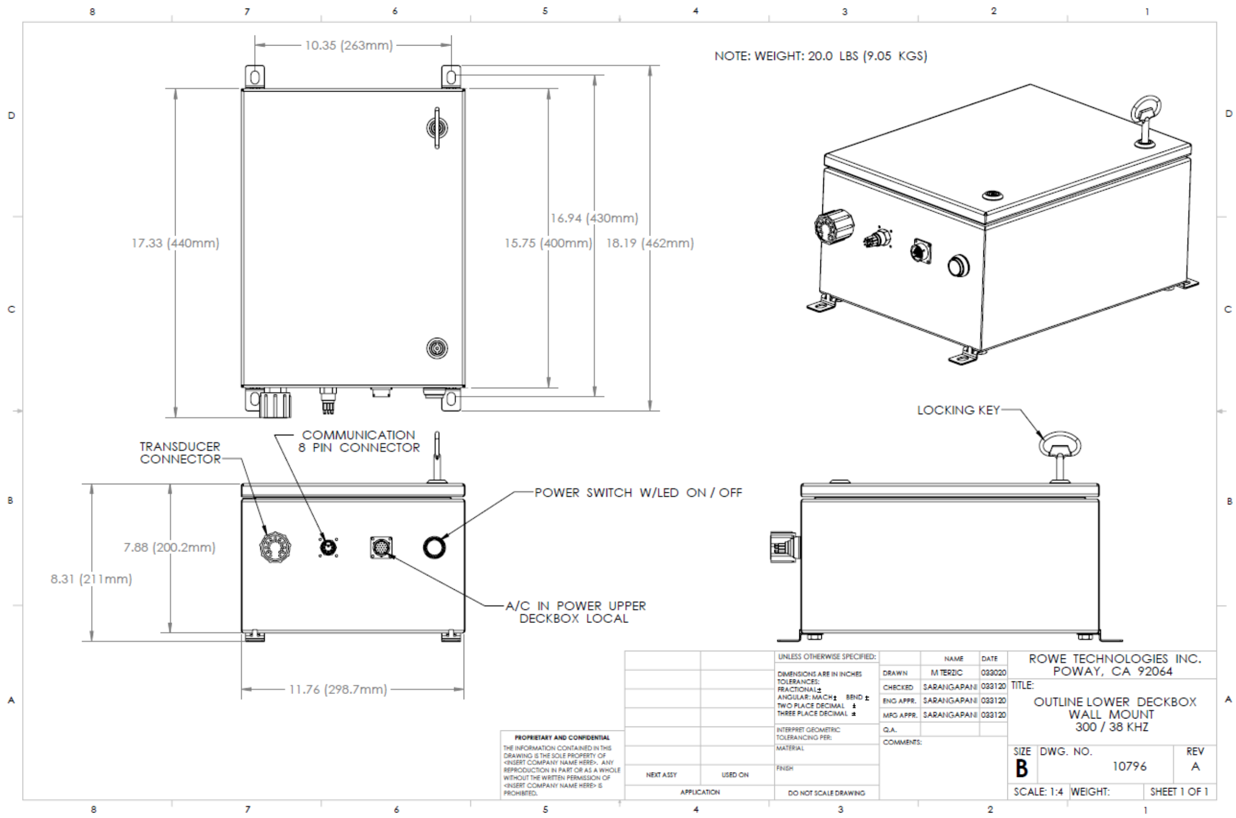
5.2 Upper Deck Box in Color



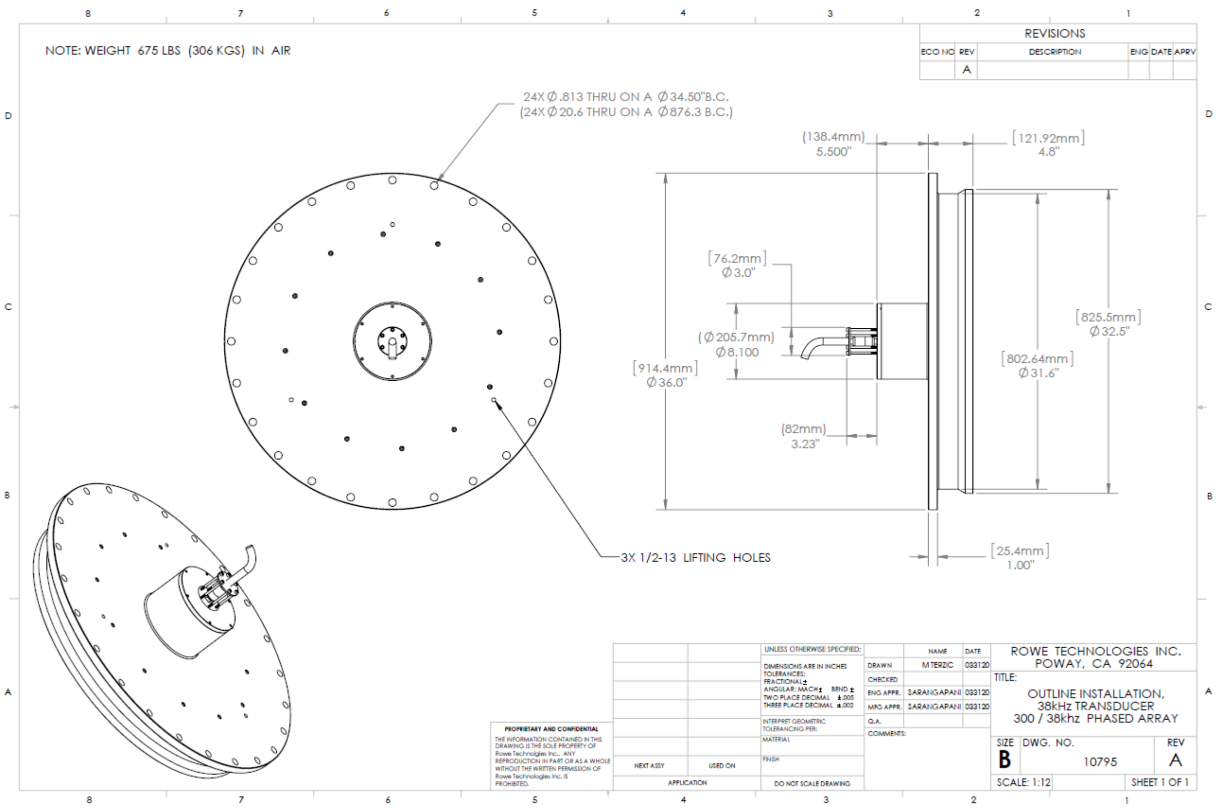
5.3 Upper Deck Box Open View with Connectors



5.4 Lower Deck Box



5.5 Transducer Outline



6 Connection Diagnostics

6.1 Troubleshooting

This procedure presumes the operator has basic knowledge of the VM unit and has experience with serial communication interfaces and test equipment and the user has read the Section 3.2 that describes the user about the software. For further assistance, contact Rowe Technologies directly. Connect VM unit communication port(s) to the Windows PC. Open the VM software. Select the Connect Page on the VM software. Select communication port and Baud rate. The default baud rate is 115200.

The Wake Up message should be on the screen:

Copyright (c) 2020 Rowe Technologies Inc. All rights reserved.
Vessel Mount
DA38 DA300
SN: 07gd00000000000000000000000945
FW: 00.07.62 Oct 21 2020 13:10:18

If there is no Wakeup message displayed on the Connect Page screen:

- Verify the Baud rate and Communication port setting.
- Verify the wiring of the communication port.
- Verify RS422 communications on the PC going into the PC. Then send a command for e.g. START to the port. You should see the command/characters echoed on the Terminal screen.
- Connect an Oscilloscope to the RS422 data lines (Then send a command for e.g. START. The command/characters on the scope display the bit rate and should match the PC Baud rate.
- Try swapping the 2 data lines on the RS422.
- Connect an oscilloscope to the ADCP/DVL output data lines on either communication port.
- Turn OFF the VM unit power. Wait 10 seconds. Turn ON the VM unit power supply.
- Restart the PC and try again.
- Measure the voltage at the input to the VM unit pin1 on the power connector. The voltage should be 24-36 VDC depending on the power supply. If the voltage is out of range find another supply.
- Make sure the Green light is ON in the Upper and Lower Deck Box when the Power switch is pressed on.
- Remove the underwater connectors and reattach it. If there is still an issue contact ROWETECH with the results of these tests.

7 Preparing for a Deployment

7.1 Checklist

RTI recommends the following checklist that may help the user towards a successful deployment.

Structural Integrity – The structural integrity of cables and connectors are also important, be sure to there are no cuts or cracks in the cable or connectors. It is important to make sure that when reassembling the system that the nuts and bolts are tightened sufficiently. In addition, it is essential that all o-rings are properly greased and seated in the groove found in the transducer head.

Cable Connections – Be certain that all the cables are properly connected as outlined in Section 2.14, 2.6, 2.7, 2.8, 2.9. When using a wet-mateable connection, be sure to first mate the connectors completely and then tighten the locking sleeve. This is the proper procedure for wet-mateable connections (Do not connect the wet-mateable connectors partially and then use the locking sleeve to tighten – this will not provide an adequate seal for the connector).

Power – Make sure that the power connections are properly connected.

Plan – RTI VM software comes with an option of planning the deployment in the office. Multiple setups can be planned and saved to the PC and later can be reloaded before deploying the unit.

8 Instrument Care

Below are some general guidelines for taking care of the Instrument.

8.1 Guidelines to Instrument Care

Please consider the following guidelines to prolong the life of your instrument, decrease the risk of damage and continue its factory tested performance:

Please do not open the instrument housing enclosure unless you have contacted service at ROWETECH. There is no regular field maintenance to perform on these units.

Handle with care- dropping the unit or severe impact could damage the transducer elements, the water tight integrity of the instrument housing and the internal electronics of the system.

Avoid leaving the instrument in direct sun light for long periods of time. If they do need to be placed in direct sun light consider a cover. Try not to store or transport these items in extreme temperatures. When the instrument and deck box are not in use please place them back in the original shipping container.

Keep the instrument clean and clear of dirt, oils and any chemicals. Dirt may contaminate the O-ring seals and the electrical connection of the underwater connector.

The transducer face (Red color) is manufactured with a special urethane. The urethane is also softer than the other exterior acetal housing material. The transducer faces must be given extra care to avoid punctures, cuts, direct sun light, any chemical contact, discoloration from oils and contaminates in the water. The transducer face is soft enough to sustain impressions from anything left on it or if it is placed against or on top of anything.

Please do not “ping” your instrument in air for any prolong amounts of time, this could cause damage to the transducer and the electronics. Please immerse the unit in a container of water for lab testing.

8.2 Tips For A Successful Deployment

Care must be taken in choosing a deployment site. Sometimes the best site for measuring waves may not be the best site for deploying an ADCP.

- **Knowledge of typical wave environment:** Having an idea of the expected sea conditions will assist in proper system set up. Attention to the details in the early stages will ensure best data measurements.
- **Bottom conditions:** The system must be mounted stable and as close to plumb as possible. Anchored gimbaled mounts are ideal.
- **Median currents:** Mount must be secure enough to resist ambient currents
- **Theft:** Any object with a surface witness is subject to theft. Diver deployable mounts are preferred.
- **Optimized location:** Care must be taken to locate the best location for deployment. Any location where there are nearby barriers or barrage materials should be avoided to prevent reflected waves from biasing the data. Areas subject to excessive silting, high ambient acoustical noise, or large EMI sources should be avoided.
- **Maintenance recovery:** Local conditions determine the maintenance period. Bio-fouling removal, battery replacement, data download are typically done during the maintenance. Intervals may be as frequent as 30 days, or as long as 180 days depending on deployment conditions.
- **Barrier to navigation:** System must be mounted so as to not interfere with vessel navigation or harbor operations.
- **Bottom mount type:** There are many different types of commercial bottom mounts available, or you can build your own simple mount. Ferrous materials must be avoided to prevent biasing of the compass. Trawl-resistant mounts should be used in areas with high fishing or recreational traffic. Simple clump weighted fixtures can be used where there is minimal trawling events. Rowe Technologies does not supply the bottom mounts, but our technical staff can assist in the proper selection.
- **Cabling for power/data transmission:** If using a near real-time system, proper sizing and armoring of the cable must be done. Cables in the surf zone should be armored and properly anchored.
- **Data processing:** Once the samples have been collected the data must be sent to a computer for processing into currents and the standard wave parameters.
- **Data archiving:** While your interest may be only in near real-time wave conditions, it is recommended that the raw data be collected and archived for future use. The data you collect today may have future significance many years from now.
- **Permits and licensing:** Operators of scientific equipment in the coastal regions may be subject to local permitting and licensing requirements. It is the responsibility of the operator to ensure that all proper permits and licenses are obtained before deployment.
- **Mechanical Isolators:** Using the mechanical isolators for attaching the transducer to the ship as shown in Section 2.10.b can prevent/reduce noise coupling to the transducer measurements.

9 Warranty Policy

9.1 Warranty Information

Equipment manufactured by Rowe Technologies Inc., (ROWETECH) is covered under a 12 month, limited warranty, which begins from the date of original shipment. This warranty extends to all parts and labor for any malfunction caused by defects in material or errors in workmanship that occurred during the manufacturing process. Any third party items incorporated into, or included with the equipment will bear the warranty of their manufacturer.

This warranty is based upon proper operation and maintenance of the equipment, as detailed in the User's Guide, and does not apply to goods that have been subject to shipping damage, improper installation, misuse/neglect, alteration, damaged during use, or the like. The warranty does not cover deficiencies with the design of the equipment or any damages that are a result of measurement errors from the equipment.

Upon notification of the nature of the defect, ROWETECH will ask you to either return the equipment to a service facility for repair, or we will ship you replacement parts. If the equipment needs to be returned, ROWETECH will provide you with a return merchandise authorization (RMA) number. The equipment should be shipped in the original packaging, with all delivery costs, including duties, taxes, etc., covered by the customer. ROWETECH reserves the right to refuse receipt of equipment returned without a valid RMA number.